



Schumpeter

Feathering its own Nestlé

The world's biggest food company gives a flavour of the future

SWITZERLAND IS KNOWN for its timepieces. But it is also home to another business that for most of its history has operated with metronomic regularity. That is Nestlé, the world's biggest food company. Established in the 1860s in Vevey, a small town on the shores of Lake Geneva that remains its home to this day, it has long been seen as an opaque behemoth with an insular culture and the occasional brush with scandal. Yet a billion of its products are consumed every day. Its sales last year surpassed \$93bn. When it talks coffee, it talks in 100bn cupfulls. Data may be the new oil in America and Asia, but in Europe hot beverages are hotter than either crude or computing. With a market value of \$320bn, Nestlé is worth more than Royal Dutch Shell, the continent's biggest energy firm, and SAP, its software giant.

Many global food firms have been models of reliability. Other venerable names, such as Campbell's, Danone, Kraft Heinz and Unilever (which sells more non-food items than food), also have roots stretching back over a century. Yet five years ago, amid a sharp slowdown in growth, the industry suddenly found itself under siege. 3G, a Brazilian private-equity group with a zeal for ruthless cost-cutting, merged H.J. Heinz and Kraft Foods. Two years later American activists targeted Nestlé, demanding the same recipe. The same year Kraft Heinz tried and failed to take over Unilever, and later saw its profits tumble, leaving 3G's reputation in tatters.

Europe's consumer-goods business is still growing at about half the pace it did a decade ago. It badly needs a caffeine shot. No one has shown better how to administer one than Mark Schneider, Nestlé's first chief executive

from outside the firm in almost a century—and the *barista-in-chief* of its three-year turnaround.

Mr Schneider, a straight-talking German with an American passport and a fondness for quips, is the perfect foil for bossy hedge funds. He is not prone to panic. But nor is he complacent. He came from outside the food industry, so sees it with fresh eyes. He carried out what Martin Deboo of Jefferies, a bank, calls “the chief-executive version of Blairism”, steering a middle course between the aggressive profit-margin targets desired by the Americans and the meagre restructuring tolerable to the Swiss. Most significant, he revived confidence in organic sales growth, a metric that had fallen at Nestlé from an annual 7.5% in 2011 to 2.4% the year he took over. During the slash-and-burn era of 3G, sales growth was for wimps. No longer—partly thanks to Mr Schneider.

The importance of sales growth is hard to overstate in food. Bernstein, a broker, calls it the “lifeblood” of the industry. In recent years it has been pummelled by changing diets, digitalisation and deflation in parts of the rich world, as well as sluggishness in emerging markets. But Mr Schneider swiftly found remedies.

The first was innovation. Thanks to e-commerce, small upstart brands were able to elbow aside the behemoths and sell directly to consumers. He responded by forcing boffins to bring Nestlé’s ideas to market more quickly, often digitally. The three years it sometimes took them was fine for a car, but not for a chocolate bar, he says. New ideas he cherishes include allergy-busting cat foods and vegan burgers. Second, he was quick to strike transformative deals. Within six months of licensing Starbucks coffee in 2018, Nestlé had already launched 24 of the chain’s products. Third, he bought and sold companies, adding to fast-growing nutritional-health businesses and selling down pedestrian ones such as ice cream in America and packaged meat in Europe.

Nestlé has sped up growth in other areas, too. It is moving relentlessly upmarket. Last year the share of sales from premium products rose to more than a quarter, including items with naked snob appeal such as “flat white over ice” Nespresso pods. It has joined the craze for plant-based foods and other healthy fare (never mind that this makes its confectionery business look increasingly out of place). And it is desperate to improve its reputation for sustainability. On December 3rd it said it would invest SFr1.2bn (\$1.3bn) over five years to help its farmers improve their soils as part of a SFr3.2bn effort to combat climate change. It has also pledged to make packaging recyclable or reusable by 2025. These are attempts to soften its image as a corporate goliath, which puts off not just young shoppers but snobby well-off ones, too.

For now, investors are impressed. As Mr Deboo notes, the share price has already awarded Nestlé ten out of ten for the turnaround, though that may be premature. Sales growth has still not recovered to the 4-6% a year that the firm once promised. Infant formula remains a laggard. So does water, with its cheapest bottled products, consumed in offices, battered by the pandemic. And Nestlé is not immune to industry-wide problems. Growth is slowing in emerging markets as people there spend less on ingestible treats and more on digital goods. Moreover, low incomes among the young will dampen their appetite for premium products.

Relatively speaking, the virus has been kind to Nestlé. Most of its products are used at home, rather than on-the-go, so extra sales for the pantry easily eclipsed what was lost at the sweet shop. Danone, a European rival that was already struggling to keep up with Nestlé at the start of last year, has slipped much further behind.

Still, Mr Schneider is no blithe optimist. In a recent Zoom meeting held amid stockmarket euphoria about the prospects for a covid-19 vaccine, he was cautious. As a former health-care executive used to handling cold

chains, he expressed doubts about the ability to distribute vaccines at the required temperatures, especially in the developing world. The longer it takes to spread the vaccine, the higher public debts will pile up, potentially casting a “long shadow” over the 2020s. On top of that, he notes, a demographic challenge is looming with rising numbers of elderly requiring medical care. “I’m quite muted in my outlook,” he admits. But Nestlé, in more than 150 years of history, has survived worse. ■



熊彼特

加固雀巢

世界上最大的食品公司让人一尝未来的味道

瑞士以钟表闻名。但它也是另一家企业的所在地，这家企业在其历史的大部分时间里都以钟摆般规律的节奏运营着。它就是雀巢，世界上最大的食品公司。它于19世纪60年代在日内瓦湖畔的小镇沃韦（Vevey）成立，至今那里仍是它的家园。长期以来它都被视为一个不透明的庞然大物，有着与世隔绝的文化，偶尔爆出些丑闻。然而，人们每天要消费10亿件雀巢的产品。去年其销售额超过930亿美元。当它谈论咖啡时，用的单位是千亿杯。在美国和亚洲，数据可能是新时代的石油，但在欧洲，热饮比原油或计算还火热。雀巢市值3200亿美元，超过欧洲最大的能源公司荷兰皇家壳牌公司和欧洲软件巨头SAP。

许多全球食品公司都是可靠性的典范。其他受尊崇的品牌如金宝汤、达能、卡夫亨氏，以及联合利华（如今销售的非食品类商品比食品更多）的历史也可追溯到一个世纪前。然而在五年前，增长急剧放缓，该行业猛然间发现自己遭遇围攻。热衷无情削减成本的巴西私募股权集团3G资本合并了亨氏和卡夫。两年后，美国的维权投资者盯上了雀巢，要求用同样的方式调整其业务结构。同年，卡夫亨氏试图收购联合利华未果，之后利润暴跌，3G的声誉也因此受损。

欧洲的消费品业务仍在以仅为十年前一半的速度增长。这个行业迫切需要来个人给它灌点儿咖啡因。没有谁比马克·施耐德（Mark Schneider）更能胜任这项任务了。他是雀巢近一个世纪以来第一位来自公司外部的首席执行官，也是雀巢三年转型期背后的“首席咖啡师”。

施耐德是个有话直说的德国人，持有美国护照，爱说俏皮话，与专横的对冲基金形成了鲜明的对照。他不容易惊慌，但也不志得意满。他来自食品行业之外，因此能贡献不同的视角。他实施了杰弗瑞银行的马丁·德博

(Martin Deboo) 所说的“首席执行官版本的布莱尔主义”，在美国人期望的激进利润率目标和瑞士人能忍受的小打小闹的重组之间走出一条中间路线。最重要的是，他重新唤起了对有机销售增长的信心，在雀巢，这一指标从2011年的年均7.5%下降到他接手那一年的2.4%。在3G资本大刀阔斧改革企业的时代，销售增长是怂包才操心的事。再也不是这样了——一定程度上是施耐德的功劳。

在食品行业，销售增长的重要性怎么强调都不为过，经纪公司盛博称之为该行业的“命脉”。近年来，销售增长受到部分富裕国家饮食变化、数字化和通缩以及新兴市场疲软的冲击。但施耐德迅速找到了解决办法。

首先是创新。电子商务崛起后，新贵小品牌也能挤开巨头公司，直接把东西卖给消费者。他的对策是迫使研究人员更快地将雀巢的创意推向市场，通常是以数字的形式。他说，一辆汽车有时需要三年时间才能推向市场，这是可以接受的，但巧克力不行。他寄予厚望的新创意包括抗过敏猫粮和素食汉堡。其次，他在达成变革性的交易时动作很快。2018年，雀巢在拿到星巴克许可的六个月内就推出了24款星巴克咖啡。第三，他买卖公司，扩大快速增长的营养保健业务，抛售乏善可陈的那些，例如在美国的冰淇淋和在欧洲的包装肉类业务。

雀巢还加快了其他领域的增长。它正不懈地向高端市场挺进。去年，高端产品的销售份额上升至超过四分之一，其中有Nespresso“冰澳白”胶囊咖啡等赤裸裸地主打“逼格”的产品。它投身植物性食品和其他健康食品的热潮（先别管这会让它的甜食业务越发显得处境尴尬）。它还迫切希望提高自己在可持续发展方面的声誉。12月3日，它表示将在五年内投资12亿瑞士法郎（13亿美元）帮助农民改良土壤，作为其投入32亿瑞士法郎应对气候变化计划的一部分。它还承诺在2025年前做到所有产品包装都可回收或重复利用。这些都是在试图软化其企业巨无霸的形象，这种形象不仅让年轻消费者却步，也让自我感觉良好的富人反感。

就目前来看，这一切打动了投资者。正如德博指出的，雀巢的转型已经在股价上得到了十足的回馈，尽管这可能还言之过早。销售增长仍未恢复到

公司之前承诺的每年4%到6%的水平。婴儿配方奶粉业务依然吊车尾。在疫情的冲击下，雀巢面向办公室的水业务连同它最便宜的瓶装产品也落到了后面。全行业都面临的问题雀巢同样未能幸免。新兴市场的增长正在放缓，那里的人们的零食支出减少，在数字商品上的支出增加。此外，低收入也将抑制年轻人对高端产品的兴趣。

相对来说，新冠病毒对雀巢还算手软。它大部分产品都是供人们在家里而不是带出门使用的，所以基本食品的销售增长可以轻松盖过甜食业务的损失。雀巢在欧洲的竞争对手达能在去年初就已经不大跟得上它，现在已经落后了许多。

尽管如此，施耐德不是盲目乐观主义者。在最近一次Zoom会议上，尽管股市因新冠疫苗的前景而一片欢腾，他还是很谨慎。作为一名惯于处理冷链的前医疗集团主管，他怀疑人们是否有能力在所需温度下分发疫苗，特别是在发展中国家。疫苗接种普及耗时越久，公共债务就会越多，可能会给接下来这十年蒙上“长长的阴影”。除此之外，他指出，人口结构的挑战正在逼近，会有越来越多的老年人需要医疗护理。“我的展望相当保守。”他承认。但在150多年的历史中，雀巢连更难的情况也都挺过去了。■



Productivity trends

Reasons to be cheerful

There are tentative signs that productivity growth might accelerate

THE PROSPECTS for a productivity resurgence may seem grim. After all, the past decade has featured plenty of technological fatalism: in 2013 Peter Thiel, a venture capitalist, mused of the technological advances of the moment that “we wanted flying cars, instead we got 140 characters”. Robert Gordon of Northwestern University has echoed this sentiment, speculating that humanity might never again invent something so transformative as the flush toilet. Throughout the decade, data largely supported the views of the pessimists.

What is more, some studies of past pandemics and analyses of the economic effects of this one suggest that covid-19 might make the productivity performance worse. According to research by the World Bank, countries struck by pandemic outbreaks in the 21st century (not including covid) experienced a marked decline in labour productivity of 9% after three years relative to unaffected countries.

And yet, stranger things have happened. The brutal years of the 1930s were followed by the most extraordinary economic boom in history. A generation ago economists had nearly abandoned hope of ever matching the post-war performance when a computer-powered productivity explosion took place. And today there are tantalising hints that the economic and social traumas of the first two decades of this century may soon give way to a new period of economic dynamism.

Productivity is the magic elixir of economic growth. Increases in the size of the labour force or the stock of capital can raise output, but the effect of

such contributions diminishes unless better ways are found to make use of those resources. Productivity growth—wringing more output from available resources—is the ultimate source of long-run increases in incomes. It's not everything, as Paul Krugman, a Nobel economics laureate, once noted, but in the long run it's almost everything.

Economists know less about how to boost productivity than they would like, however. Increases in labour productivity (that is, more output per worker per hour) seem to follow improvements in educational levels, increases in investment (which raise the level of capital per worker), and adoption of new innovations. A rise in total factor productivity—or the efficiency with which an economy uses its productive inputs—may require the discovery of new ways of producing goods and services, or the reallocation of scarce resources from low-productivity firms and places to high-productivity ones.

Globally, productivity growth decelerated sharply in the 1970s from scorchingly high rates in the post-war decades. A burst of higher productivity growth in the rich world, led by America, unfolded from the mid-1990s into the early 2000s. Emerging markets, too, enjoyed rapid productivity growth in the decade prior to the global financial crisis, powered by high levels of investment and an expansion of trade which brought more sophisticated techniques and technologies to the developing-economy participants in global supply chains. Since the crisis, however, a broad-based and stubbornly persistent slowdown in productivity growth has set in (see chart 1). About 70% of the world's economies have been affected, according to the World Bank.

Accounting for the slowdown is a fraught process. The World Bank reckons that slowing trade growth and fewer opportunities to adopt and adapt new technology from richer countries may have helped depress productivity

advances in the emerging world. Across all economies, sluggish investment in the aftermath of the global financial crisis looks a culprit: a particular problem in places with ageing and shrinking workforces. Yet while these headwinds surely matter, the bigger question is why new technologies like improved robotics, cloud computing and artificial intelligence have not prompted more investment and higher productivity growth.

Broadly speaking, three hypotheses compete to explain these doldrums. One, voiced by the techno-pessimists, insists that for all the enthusiasm about world-changing technologies, recent innovations are simply not as transformative as the optimists insist. Though it is possible that this will turn out to be correct, continued technological progress makes it look ever less plausible as an explanation for the doldrums. AI may not have transformed the world economy at the dramatically disruptive pace some expected five to ten years ago, but it has become significantly, and in some cases startlingly, more capable. GPT-3, a language-prediction model developed by OpenAI, a research firm, has demonstrated a remarkable ability to carry on conversations, draft long texts and write code in surprisingly human-like fashion.

Though the potential of the web to support an economy in which the constraints of distance do not bind has long underwhelmed, cloud computing and video-conferencing proved their economic worth over the past year, enabling vast amounts of productive activity to continue with scarcely an interruption despite the shuttering of many offices. New technologies are clearly able to do more than has generally been asked of them in recent years.

That strengthens the case for a second explanation for slow productivity growth: chronically weak demand. In this view, expressed most vociferously by Larry Summers of Harvard University, governments' inability to stoke enough spending constrains investment and growth. More

public investment is needed to unlock the economy's potential. Chronically low rates of interest and inflation, limp private investment and lacklustre wage growth since the turn of the millennium clearly indicate that demand has been inadequate for most of the past two decades. Whether this meaningfully undercuts productivity growth is difficult to say. But in the years before the pandemic, as unemployment fell and wage growth ticked up, American labour productivity growth appeared to be accelerating, from an annual increase of just 0.3% in 2016 to a rise of 1.7% in 2019: the fastest pace of growth since 2010.

But a third explanation provides the strongest case for optimism: it takes time to work out how to use new technologies effectively. AI is an example of what economists call a "general-purpose technology", like electricity, which has the potential to boost productivity across many industries. But making best use of such technologies takes time and experimentation. This accumulation of know-how is really an investment in "intangible capital".

Recent work by Erik Brynjolfsson and Daniel Rock, of MIT, and Chad Syverson, of the University of Chicago, argues that this pattern leads to a phenomenon they call the "productivity J-curve". As new technologies are first adopted, firms shift resources towards investment in intangibles: developing new business processes. This shift in resources means that firm output suffers in a way that cannot be fully explained by shifts in the measured use of labour and tangible capital, and which is thus interpreted as a decline in productivity growth. Later, as intangible investments bear fruit, measured productivity surges because output rockets upward in a manner unexplained by measured inputs of labour and tangible capital.

Back in 2010, the failure to account for intangible investment in software made little difference to the productivity numbers, the authors reckon. But productivity has increasingly been understated; by the end of 2016, productivity growth was probably about 0.9 percentage points higher than

official estimates suggested.

This pattern has occurred before. In 1987 Robert Solow, another Nobel prizewinner, remarked that computers could be seen everywhere except the productivity statistics. Nine years later American productivity growth began an acceleration which evoked the golden age of the 1950s and 1960s. These processes are not always sexy. In the late 1990s, the soaring share prices of internet startups hogged the headlines. The fillip to productivity growth had other sources, like improvements in manufacturing techniques, better inventory management and rationalisation of logistics and production processes made possible by the digitisation of firm records and the deployment of clever software.

The J-curve provides a way to reconcile tech optimism and adoption of new technologies with lousy productivity statistics. The role of intangible investments in unlocking the potential of new technologies may also mean that the pandemic, despite its economic damage, has made a productivity boom more likely to develop. Office closures have forced firms to invest in digitisation and automation, or to make better use of existing investments. Old analogue habits could no longer be tolerated. Though it will not show up in any economic statistics, in 2020 executives around the world invested in the organisational overhauls needed to make new technologies work effectively (see chart 2). Not all of these efforts will have led to productivity improvements. But as covid-19 recedes, the firms which did transform their activities will retain and build on their new ways of doing things.

Early evidence suggests that some transformations are very likely to stick, and that the pandemic quickened the pace of technology adoption. A survey of global firms conducted by the World Economic Forum this year found that more than 80% of employers intend to accelerate plans to digitise their processes and provide more opportunities for remote work, while 50% plan

to accelerate automation of production tasks. About 43% expect changes like these to generate a net reduction in their workforces: a development which could pose labour-market challenges but which almost by definition implies improvements in productivity.

Harder to assess is the possibility that the movement of so much work into the cloud could have productivity-boosting effects for national economies or at the global level. High housing and property costs in rich, productive cities have locked firms and workers out of places where they might have done more with less resources. If tech workers can more easily contribute to top firms while living in affordable cities away from America's coasts, say, then strict zoning rules in the bay area of California will become less of a bottleneck. Office space in San Francisco or London freed up by increases in remote work could be occupied by firms which really do need their workers to operate in close physical proximity. Beyond that, and politics permitting, the boost to distance education and telemedicine delivered by the pandemic could help drive a period of growth in services trade, and the achievement of economies of scale in sectors which have long proved resistant to productivity-boosting measures.

None of this can be taken for granted. Making the most of new private-sector investments in technology and know-how will require governments to engineer a rapid recovery in demand, to make complementary investments in public goods like broadband, and to focus on tackling the educational shortfalls so many students have suffered as a consequence of school closures. But the raw materials for a new productivity boom appear to be falling into place, in a way not seen for at least two decades. This year's darkness may in fact mean that dawn is just over the horizon. ■



生产率趋势

乐观的理由

有初步迹象表明生产率增长可能会提速

生产率复苏的前景看似黯淡。毕竟过去十年里技术宿命论的观点很流行。2013年，风险投资家彼得·蒂尔（Peter Thiel）在思考当时的技术进步时说，“我们想要会飞的汽车，结果却只得到最多能发140个字符的帖子”。西北大学的罗伯特·戈登（Robert Gordon）附和了这种看法，推断人类可能永远不会再发明出像抽水马桶这样具改造力的东西了。过去十年，数据大体上支持了悲观主义者的观点。

此外，对过去大流行病的一些研究以及对此次疫情的经济影响的分析表明，新冠病毒可能会令生产率表现变得更差。根据世界银行的研究，在21世纪受到流行病爆发（不包括新冠）冲击的国家在三年后劳动生产率相较未受疾病侵袭的国家显著下跌了9%。

但是，更奇怪的情形亦有发生。在上世纪30年代的残酷岁月之后出现了历史上最不寻常的经济繁荣。二三十年前，经济学家对再次出现像二战后计算机驱动的那种生产率大爆发已经几乎不抱希望了。今天，一些撩拨人心的迹象表明，在经过本世纪前20年的经济和社会创伤之后，一段新的经济活力期也许即将到来。

生产率是经济增长的灵丹妙药。扩大劳动力规模或资本存量可以增加产出，但除非能找到更好的方法来利用这些资源，否则它们的作用就会逐渐减弱。生产率增长（也就是从可用资源中尽量获得更多产出）是长期收入增加的终极源头。正如诺贝尔经济学奖获得者保罗·克鲁格曼（Paul Krugman）曾指出的那样，生产率不是一切，但从长远来看它几乎就是一切。

但是，经济学家对如何提高生产率的认识还不充分。劳动生产率的提高（即每工时产出更多）似乎是随教育水平提高、投资增加（提高了工人的

人均资本水平)以及采用创新技术而来。全要素生产率(即一经济体利用其生产要素的效率)的提高可能需要发现生产商品和提供服务的新方法,或者将稀缺资源从生产率低下的企业和地方重新分配到生产率高的企业和地方。

从全球范围看,战后几十年里生产率增长飙升,到了上世纪70年代急剧放缓。从90年代中期到21世纪的头几年,以美国为首的富裕国家生产率出现了一波提速。新兴市场在全球金融危机爆发前的十年里也经历了生产率的快速增长,这得益于高水平的投资和贸易的扩张给全球供应链中的发展中经济体带来了更先进的工艺和技术。然而,自金融危机以来,生产率增长持续放缓,范围广泛,顽固持久(见图表1)。根据世界银行的数据,全球约70%的经济体受到影响。

要解释增长何以放缓是个令人头疼的难题。世界银行认为,近年来贸易增长放缓,从较富裕国家引进并因地制宜地应用新技术的机会减少,可能在一定程度上抑制了新兴世界生产率的提高。从全体经济体来看,全球金融危机后的投资低迷似乎是造成增长放缓的罪魁祸首之一,在劳动力老龄化和萎缩的地方尤其突出。然而,尽管这些不利因素确实有很大影响,但更大的问题是,为什么改进的机器人技术、云计算和人工智能之类的新技术并没有促进投资增长和生产率提升?

大体上说,有三种不同的假说尝试解释生产率低迷的问题。一种由技术悲观主义者提出,他们坚持认为尽管人们对改变世界的技术充满热情,但近年来的创新并没有乐观主义者所坚信的那样具有变革意义。尽管这最终可能会被证明是正确的,但持续的技术进步似乎使之越来越没有说服力。AI可能并没有以人们在五到十年前期望的那种惊人的颠覆性速度改变世界经济,但它的能力已有了显著的提升,在一些领域甚至堪称惊人。研究公司OpenAI开发的一种语言预测模型GPT-3展示了出色的开展对话、起草长文和编写代码上的能力,对真人的模拟程度令人吃惊。

互联网在通过打破距离限制而支持经济发展上的潜力早已不怎么激动人

心。但云计算和视频会议在过去一年中证明了它们的经济价值：在许多办公室关闭之时，它们让大量生产活动能近乎不中断地继续下去。显然，新技术能做的要比近些年人们对它们的期待更多。

这支持了对生产率增长缓慢的第二种解释：长期需求疲软。哈佛大学的拉里·萨默斯（Larry Summers）最强烈地表达了这种观点，认为政府无力刺激足够的支出，限制了投资和增长。释放经济潜力需要更多公共投资。进入21世纪以来，利率和通胀率一直处于低位，私人投资疲软，工资增长乏力，这些都清楚地表明过去20年的大多数时间里需求都不足够。很难说这是否严重影响了生产率增长。但在疫情之前的几年里，随着失业率下降和工资增长加快，美国的劳动生产率似乎在加速增长，2016年增长率仅为0.3%，2019年为1.7%，是2010年以来最快的增速。

但第三种解释为保持乐观提供了最有力的依据，它认为要弄清楚如何有效地利用新技术需要时间。AI是经济学家所说的“通用技术”的一个例子，和电力一样，它有潜力提高许多行业的生产率。但充分利用这些技术需要时间和尝试。在这方面专业知识的积累实际上就是对“无形资本”的投资。

麻省理工学院的埃里克·布林约尔松（Erik Brynjolfsson）和丹尼尔·洛克（Daniel Rock）以及芝加哥大学的查德·西威尔森（Chad Syverson）近期的研究认为，这种模式导致了一种他们称之为“生产率J曲线”的现象。新技术被首次采用之后，企业把资源转向无形资产投资，也就是开发新的业务流程。这种资源的转移意味着企业的产出会受影响，而这无法完全用可测量的劳动力和有形资本的转移来说明，因此被解释为生产率增长放缓。之后，随着无形投资开始取得成果，测得的生产率急剧提升，因为产出的飙升同样不能以可测量的劳动力和有形资本投入来解释。

几位作者认为，回到2010年时，未能考虑软件方面的无形投资对生产率数据的影响不大。但生产率越来越被低估了。到2016年底，实际生产率增长可能比官方估计的数字高出约0.9个百分点。

这种模式以前也曾出现过。1987年，另一位诺贝尔奖得主罗伯特·索洛

(Robert Solow) 指出，计算机的影响随处可见，除了在生产率的统计数据中。九年后，美国生产率开始提速，让人想起五六十年代的黄金时代。这些过程并不总是时髦酷炫。90年代末，互联网创业公司股价飙升经常占据新闻头条。刺激生产率增长的还有其他原因，例如公司数据的数字化和智能软件的部署所带来的制造工艺改良、库存管理改进以及物流和生产流程合理化。

J曲线给出了一种方法，可以将技术乐观主义及采纳新技术与差劲的生产率数据统一起来。无形投资在释放新技术的潜力方面的作用还可能意味着，尽管此次疫情造成了经济损失，但它也增加了生产率大幅增长的可能性。关闭办公室迫使公司投资于数字化和自动化，或者更好地利用现有投资。非数字化的老旧做法将不再被容忍。2020年，全球各地的高管都在投资于组织架构的改革以求有效地运用新技术，尽管这不会体现在任何经济统计数据中（见图表2）。这些努力并非都能带来生产率提升。但随着疫情逐渐消退，那些确实完成了转型的公司将维持并扩大新的经营模式。

从初步证据看，某些转变很可能持续下去，而且疫情加快了采用新技术的步伐。世界经济论坛今年对全球企业的一项调查发现，超过80%的雇主打算加快流程数字化，并提供更多远程工作的机会；50%的雇主计划加速生产任务自动化。约43%的雇主预计这样的变化会导致员工人数出现净减少，这可能会对劳动力市场带来挑战，但人数减少几乎必定意味着生产率会提高。

将大量工作移到云端是否有可能提高国家经济或全球经济的生产率，这一点更难评估。在高产的富裕城市中，高昂的住房和物业成本让公司和员工无法在本可能用更少资源做更多事的地方运营和工作。比如说，假如科技工作者可以离开美国沿海地区，到生活成本更低的城市为顶尖公司工作，那么加州湾区严格的分区规划将不再构成发展瓶颈。在旧金山或伦敦，因远程工作增加而腾出的办公空间或许可以留给那些确实需要员工现场办公的公司去用。除此之外，在政治上也允许的情况下，受疫情推动的远程教育和远程医疗也许还可 在一段时期里推动服务贸易的增长，并在那些长期

都抗拒提高生产率的措施的行业中实现规模经济。

这些都不是轻易就能实现的。要充分利用私营部门在技术和专业知识上的新投资，就需要政府设法快速恢复需求，并对宽带等公共产品做互补性投资，还要集中精力解决学校停课导致许多学生遭受教育短缺的问题。但是，新一轮生产率快速增长所需的要素似乎正准备就绪——以至少20年未见的态势。实际上，今年的黑暗也许预示着黎明即将来临。■



Free exchange

The disintermediation dilemma

Will central-bank digital currencies break the banking system?

IMAGINE IT IS 2035 and a financial crisis is raging. Credit is drying up; banks' share prices look like ski slopes and every news report features sweaty traders in shirtsleeves tugging at their collars. You log on to your banking app and peer anxiously at your savings. You could transfer them to another bank, but none seems safe. Fuelling a traditional bank run by withdrawing physical banknotes, even if there were any branches left, would be tragically passé. Luckily, there is a new escape route. At the touch of a button, you can move your funds into a central-bank digital currency (CBDC), a government-issued virtual store of value that is completely safe.

This is one scenario worrying economists working on CBDCs (of whom there are many: a survey at the start of last year found that more than 80% of central banks were studying the subject). There are many potential advantages to publicly backed digital currencies. They might make payments easier. They might "democratise" central-bank money, the part of the central bank's balance-sheet which, unlike physical cash, only banks can access now. And they would reduce the risk that cryptocurrencies replace government tender; bitcoin has been on a tear lately, and Facebook's digital coin—which on December 1st changed its name from "Libra" to "Diem"—will reportedly launch in January. But wouldn't CBDCs also make it dangerously easy to flee the banks in times of stress?

It is not just in a crisis that CBDCs might compete with banks. They would be attractive assets to hold in normal times, too, especially if, like today's central-bank money, they were a tool of monetary policy and therefore paid interest (assuming that rates are solidly positive again by 2035). Thus,

commercial banks might be drained of the deposits with which they today fund their lending. Disintermediation of the banking system might make impossible the financial magic that allows households to pair long-dated mortgage borrowing with instantaneously redeemable deposits.

The budding architects of CBDCs are looking for ways round the problem. One option, which has been suggested by researchers at the Bank of England and the European Central Bank, is to limit the amount that can be held in a CBDC. Another idea, pointed out in a recent paper by Sarah Allen of the Initiative for Cryptocurrencies and Contracts, a research group, and 12 co-authors, is to rely on banks to manage the public's holdings of CBDCs, much as many people rely on "wallets" to hold their cryptocurrency (though if the public could not hold CBDCs directly, it would not be much of an improvement on existing central-bank digital money).

The problem of disrupting the banks may be avoidable with clever engineering. But it would be wise to consider whether it even needs avoiding in the first place. For those willing to entertain futuristic ideas, CBDCs may offer an opportunity to rethink the financial system from the ground up.

Several research papers, as summarised by Francesca Carapella and Jean Flemming of the Federal Reserve in a recent review, argue that central banks could preserve maturity transformation by reordering the chain of funding. Today, households deposit money at banks, which park funds at the central bank. If people prefer CBDCs, however, the central bank could in effect pass their funds on to banks by lending to them at its policy interest rate. "The issuance of CBDC would simply render the central bank's implicit lender-of-last-resort guarantee explicit," wrote Markus Brunnermeier of Princeton University and Dirk Niepelt of Study Centre Gerzensee in a paper in 2019. Explicit and, perhaps, in constant use.

More central-bank lending might sound like an unwarranted expansion of government. But today's market for deposits is hardly laissez-faire. It is not as if households inspect banks' loan books before entrusting them with cash; they rely on the backstop of government-provided deposit insurance. And deposits are increasingly concentrated in big banks. (In fact, a recent working paper by researchers of the Bank of Canada finds that, by increasing competition for deposits, a CBDC could increase bank lending and GDP.)

The real problem with central-bank financing of banks is the risk of default. To avoid picking winners, policymakers would probably need to fund any institution that can provide satisfactory collateral. Determining which loans and other assets qualify is uncomfortable work. But central banks already make such evaluations in times of crisis. The understanding that they will accept only high-quality assets, plus minimum equity requirements to protect creditors, is supposed to prevent moral hazard.

Another idea is to make banks fund themselves with much more equity, rather than rely on deposits. That would make them look more like today's mutual funds or other unleveraged investment vehicles. This is precisely what economists such as John Cochrane of Stanford University and Laurence Kotlikoff of Boston University have long advocated: that lenders should shed their dependence on flighty sources of financing, and that households' funds should instead be parked in completely safe assets. For Mr Cochrane, CBDCs are an opportunity to pursue such "narrow banking".

To fear disintermediation at the hands of CBDCs is to believe that narrow banking would starve the economy of something it needs, and that today's "fractional-reserve" system must be preserved. But banks are not necessary for lending and borrowing to take place—in America a high share of this activity takes place in capital markets instead. If bank credit must be kept flowing, governments could subsidise it directly—making explicit what today's architecture obscures. Better that than suppressing useful

technological innovations.

Making subsidies explicit, however, is not always comfortable for the beneficiaries—or for regulators; obvious support attracts more public opprobrium. The real risk of CBDCs to the financial system may be that they eventually precipitate a new kind of run: on the idea that banks need to exist at all. ■



自由交流

脱媒困境

央行数字货币会破坏银行系统吗？

想象现在是2035年，一场金融危机正在肆虐。信贷枯竭；银行的股价走势看起来就像滑雪场的陡坡，每则新闻报道都有脱了外套的交易员满头大汗地扯衬衫领子的照片。你登录你的银行应用，焦急地查看存款。你可以把钱转到另一家银行去，但似乎哪家都不安全。即使你还能找到实体网点，取出纸币、加剧银行挤兑这种传统方式也已经是极为过时的做法。幸好还有一条新的出路。只需点一下按钮，你就可以把资金转成央行数字货币（CBDC），这是政府发行的一种虚拟储值手段，绝对安全。

这是让研究CBDC的经济学家（为数众多，去年年初的一项调查发现超过八成央行正在研究CBDC）感到担忧的情形之一。政府背书的数字货币有许多潜在的优势。它们可能会让支付更便捷；可能会“民主化”央行资金，央行资产负债表的这一部分不同于实物现金，目前只有银行才能使用；并且将降低加密货币取代法币的可能。比特币近期表现强劲，Facebook据传将在1月推出数字货币（12月1日把名称从“Libra”改为“Diem”）。但在压力巨大的时期，CBDC难道不是极容易让资金逃离银行吗？

CBDC不仅仅可能在危机期间与银行竞争。它们在平时也会是有吸引力的资产，尤其如果它们也像今天的央行资金那样是货币政策工具而会产生利息的话（假设到2035年利率又会是稳稳地为正）。这样一来，商业银行如今用于放贷的存款可能会被抽干。银行体系的“脱媒”可能会让金融魔法无法施展，即无法再让家庭同时拥有长期抵押贷款和可即时赎回的存款。

崭露头角的CBDC设计师们正在寻找解决这个问题的方法。英国央行和欧洲央行的研究人员提出了一种方法：限制能存在一种CBDC中的金额。研究小组加密货币和合约倡议组织（Initiative for Cryptocurrencies and Contracts）的萨拉·艾伦（Sarah Allen）和12位合著者近期在一篇论文中提

出了另一个想法：依靠银行来管理公众持有的CBDC，就像许多人用“钱包”来装加密货币一样（不过如果公众不能直接持有CBDC，那么也就说不上对现有的央行数字货币有多少改进了）。

颠覆银行的问题或许可以通过巧妙的设计来避免。但明智之举是先考虑是否真的需要避免。对于那些愿意探讨一些未来主义思路的人，CBDC可能会提供一个彻底反思金融系统的机会。

有几篇研究论文认为央行可以通过对融资链重新排序来保留期限转换。美联储的弗朗西斯卡·卡拉佩拉（Francesca Carapella）和让·弗莱明（Jean Flemming）最近在一篇评述中对这些论文做了总结。如今，家庭把钱存入银行，银行把资金存入央行。但如果人们更喜欢CBDC，那么央行实际上可以按政策利率向银行放贷，以此把这些资金转给银行。“CBDC的发行只会让央行隐性的最后贷款人担保显性化。”普林斯顿大学的马库斯·布伦纳迈尔（Markus Brunnermeier）和格岑赛研究中心（Study Centre Gerzensee）的德克·尼佩尔特（Dirk Niepelt）在2019年的一篇论文中写道。不仅会显性化，而且可能会被经常使用。

央行放贷增多听起来可能像政府在无端扩张。但如今的存款市场也并非自由放任。家庭在将现金托付给银行之前并不会先检查银行的贷款登记簿，但它们有政府提供的存款保险作为后盾。而且，存款越来越集中在大型银行中。（实际上，加拿大央行的研究人员最近的一篇工作论文发现，通过增加对存款的竞争，CBDC也许能增加银行放贷和GDP。）

央行为银行融资的真正问题是违约风险。为了避免出现挑选赢家的情况，决策者可能需要资助任何能提供满意抵押品的银行。确定哪些贷款和其他资产合格是个棘手的活儿。但央行在危机时期已经在做这样的评估。明白央行只接受高质量资产，外加设定最低股本要求以保护债权人，应该可以防范道德风险。

另一种想法是让银行大幅扩充股本为自己筹集资金，而不是依靠存款。那会让它们看起来更像现在的共同基金或其他无杠杆投资工具。这正是斯坦

福大学的约翰·科克伦（John Cochrane）和波士顿大学的劳伦斯·科特利科夫（Laurence Kotlikoff）等经济学家长期以来的主张：银行应避免依赖不稳定的融资来源，而家庭存款应该放在完全安全的资产上。在科克伦看来，CBDC提供了发展这种“狭义银行业务”的机会。

担心CBDC会导致银行脱媒，就是认为狭义的银行业务会让经济无法获得它需要的东西，以及必须保留现今的“部分准备金”制度。但借贷并不一定要通过银行发生——美国很大一部分借贷活动都发生在资本市场。如果必须要保持银行信贷的流通，政府可以直接补贴银行——把当今架构中模糊不清的地方明示出来。那样总比抑制有用的技术创新来得好。

但对受益人或监管机构而言，明示补贴并不总是件轻松的事。毫不遮掩的支持会引来更多的公众指责。CBDC对金融系统的真正风险可能是它们最终会引发一种新型挤兑，因为人们将质疑银行存在的必要性。■



Children

Getting girlhood right

Girls are doing better than ever. Don't let the pandemic stymie them

FOR MUCH of human history and in many places, girls were considered property. Or, at best, subordinate people, required to obey their fathers until the day they had to start obeying their husbands. Few people thought it worthwhile to educate them. Even fewer imagined that a girl could grow up to govern Germany, run the IMF or invent a vaccine.

In most of the world that vision of girlhood now seems not merely old-fashioned but unimaginably remote. In much of the rich world parents now treat their daughters as well as they do their sons, and invest as much in their future. In field after field girls have caught up with boys. Globally, young women now outnumber young men at university. The speed of change has been blistering. Fifty years ago only 49% of primary-school-age girls in lower-middle-income countries were in school, compared with 71% of boys; today the share of both is about 90%. In 1998 only half the world's secondary-school-age girls were enrolled; today two-thirds are. Over the same period rates of illiteracy fell from one in five young women aged 15-24 to one in ten, bringing them roughly on a par with young men.

Girl babies are more wanted than ever before. Parents in some countries prefer them. Even in places, such as China, where the sex-selective abortion of girl fetuses has been rife, it is often becoming less so. Girls are also less likely to be married off in childhood. In 1995 almost six in ten girls in South Asia were hitched before reaching 18; that ratio has fallen by half. Around the world, it has fallen from one in four to one in five.

Girls are healthier, too. Compared with the mid-1990s, they become sexually

active later and are more likely to use contraception. Rates of teenage pregnancy have fallen by a quarter globally and by two-thirds in South Asia and North America. Girls are less likely to suffer female genital mutilation—and object to this horrific tradition more vocally. Whereas in 2000 just 27% of women and girls in the most-affected regions said it should be banned, today 54% do.

When societies handle girlhood well, the knock-on effects are astounding. A girl who finishes secondary school is less likely to become a child bride or a teenage mother. Education boosts earning power and widens choices, so she is less likely to be poor or to suffer domestic abuse. She will earn almost twice as much as a girl without schooling.

And she will pass on a smorgasbord of advantages to her offspring. She will have fewer children, and invest more in them. They will be less likely to die in infancy, or to grow up stunted physically or mentally. She will read to them more, and help them with their homework. All this means they will learn more, and earn more as adults. A recent study by Citigroup and Plan International estimated that, if a group of emerging economies ensured that 100% of their girls completed secondary school, it could lead to a lasting boost to their GDP of 10% by 2030.

Because the benefits of nurturing girls are so large, it is a scandal that some countries have still failed to grasp them. Less than half the girls in South Asia, the Middle East or Africa have access to the contraception that they may want. Only one girl in three south of the Sahara finishes her secondary education. And although rates of child marriage have fallen by half in South Asia, they have fallen by less than that in Africa (which now has the highest rate in the world) and have remained stagnant in Latin America and the Caribbean.

The covid-19 pandemic could hobble progress for girls in poor countries, or

even reverse it. During previous disasters, they have often suffered most. When Ebola forced west African schools to close in 2014, many girls dropped out, never went back and ended up pregnant or as child labourers. UNICEF warns that something similar could happen with covid-19—but on a larger scale. Studies suggest that in the next decade 13m child marriages that would have been averted may go ahead, and an extra 2m girls may have their genitals cut.

The risk of regression is real. So it is crucial that, even if governments of poor countries have to tighten their belts, they prioritise spending on education and girls. Donors should help, too. And policies should be joined up. Persuading girls to stay in school longer is not only a way to teach them maths; it is also a chance to vaccinate them and teach them about birth control, consent and self-assertion. It can even be an opportunity to advise parents about the downsides of child marriage.

Adolescence is a crucial juncture for girls. It is when many health problems emerge or are averted; and many social ones, too, from truancy to self-harm. Only recently has this phase been recognised as the most important for brain development after infancy. Get it right and billions of girls will have a better shot at fulfilling their potential. Get it wrong and they will live poorer, shorter lives, less able to stand up for themselves, more vulnerable to coercion, and more likely to pass these disadvantages on to the next generation. So, get girlhood right. ■



【首文】儿童

让女孩健康成长

女孩们的状况比以往任何时候都好。别让疫情阻碍她们成长

在人类历史上的大部分时间里，在许多地方女孩都被视为他人的财产。或者最好的情况也不过是处于从属地位的人，要顺从她们的父亲，直到某天要开始顺从丈夫。很少人觉得她们有受教育的价值。预期一个女孩长大后可以治理德国、管理国际货币基金组织或者发明疫苗的就更少了。

在世界大多数地方，如此看待女孩在今天已不仅仅显得陈腐了，而是久远得难以想象。大部分富裕国家的父母现在对待女儿跟对待儿子一样好，对其未来的投资也一样多。在一个又一个领域，女孩已赶上男孩。全球范围内，在读大学女生的人数超过了男生。转变的速度非常惊人。50年前，中低收入国家小学适龄女孩的入学率为49%，男孩为71%，如今两者比例均为90%左右。1998年，全球只有一半的中学适龄女孩入学，而现在为三分之二。同一时期，15至24岁年轻女性的文盲率从五分之一降至十分之一，与年轻男性的比例大致相当。

女婴比以往任何时候都更受欢迎。一些国家的父母更喜欢女婴。即使在像中国这样一直大量存在做性别筛选而堕掉女胎的地方，这种情况往往也在减少。未成年女孩被嫁掉的比例也降低了。1995年，南亚几乎每10个女孩中就有六个在18岁之前结婚，现在这一比例已下降了一半。全世界范围内，这一比例已从四分之一降至五分之一。

女孩也变得更健康了。与上世纪90年代中期相比，她们进入性活跃期的时间延迟了，而且更可能使用避孕药具。少女怀孕率在全球范围内下降了四分之一，在南亚和北美均下降了三分之二。女孩遭受生殖器切割的几率在下降，也更敢于发声反抗这种可怕的习俗。2000年，在这种习俗最严重的地区只有27%的妇女和女孩认为应该禁止它，而今天为54%。

当社会处理好女孩的成长时，会有惊人的连锁效应。一个完成了中学学业

的女孩接受童婚或者成为少女妈妈的可能性会降低。教育能提升她的收入能力并扩大选择范围，也就可以降低陷入贫穷或遭受家暴的几率。她的收入将是没受过教育的女孩的近两倍。

她还会把大量优势传给后代。她会少生优生，在子女身上投入更多。她的孩子更不可能夭折或身心发育不良。她会读更多的书给孩子们听，能辅导他们做作业。这都意味着小孩会学到更多，长大后能挣更多钱。花旗集团和国际计划组织（Plan International）近期的一项研究估计，如果一批新兴经济体能确保让全体女孩都完成中学学业，那么到2030年它们的GDP将能持续提升10%。

培养女孩的好处这么大，一些国家却依然不能把握，实在糟糕。在南亚、中东或非洲，只有不到一半的女孩能获得她们可能想要的避孕药具。在撒哈拉以南，每三个女孩里只有一个能完成中学学业。虽然南亚的童婚率降低了一半，但降幅低于非洲（非洲是目前世界上童婚率最高的地区）；拉丁美洲和加勒比地区的童婚率未见改善。

新冠疫情可能阻碍甚至逆转贫穷国家在女孩问题上的进步。在以往的灾难中她们往往受害最严重。2014年，埃博拉疫情迫使西非的学校关闭，许多女孩辍学，之后再也没有重返校园，最终怀孕或成为童工。联合国儿童基金会警告，在新冠疫情中可能发生类似的事，而范围会更大。研究表明，未来十年可能会发生1300万桩本可避免的童婚，以及200万名女孩被切割生殖器。

倒退的风险切实存在。所以至关重要的是，即使穷国政府不得不勒紧裤腰带，也要优先考虑教育和女孩方面的支出。捐助者也应伸出援手。而政策应相互配合。劝说女孩延长在校时间不仅仅是为教她们数学，也是让她们有机会接种疫苗，教她们避孕、以自主自愿的“同意”原则行事，以及表达自我主张、伸张自身权益。这甚至也是向父母忠告童婚弊端的机会。

青春期对女孩来说是个关键时刻。许多健康问题会在这段时期出现或者得以避免，从逃学到自残的许多社会问题也一样。直到最近，这一阶段才被

认为是继婴儿期之后大脑发育的最重要阶段。如果能妥善对待，几十亿女孩将有更好的机会发挥自己的潜能。做得不好，她们会更贫穷，更短寿，更难以保护自身利益，更易受到胁迫，也更可能把这些不利因素传给下一代。所以，请让女孩健康成长。 ■



Digital humanities

The book of numbers

How data analysis can enrich the liberal arts

IT ALL STARTED with a preposition. In 1941 Father Roberto Busa, a Roman Catholic priest, started noting down as many uses of the word “in” as he could find in the Latin work of Thomas Aquinas, a medieval theologian and saint. Eight years and 10,000 handwritten cards later he completed his linguistic analysis of Aquinas’s “interiority”—his introspective faith—at Rome’s Pontifical Gregorian University. By then he had a suspicion that his work could be done far more efficiently. He started hunting for “some type of machinery” to speed up his new project, recording the context of all 10m words written by Aquinas.

Father Busa’s zeal took him to the office of Thomas Watson, IBM’s chairman. Soon he had switched from handwritten cards to IBM’s punch-card machines, before adopting magnetic tape in the 1950s. In the 1960s dozens of full-time typists were involved. By 1980, when his team finally printed the “Index Thomisticus” in 56 volumes, they had spooled through 1,500km (930 miles) of tape. A CD-ROM containing 1.4GB of data came out in 1992, with a website following in 2005. The 97-year-old priest died in 2011. But not before he had initiated a new quest, to annotate the syntax of every sentence in the Index Thomisticus database.

Such is the creation story of the digital humanities, a broad academic field including all sorts of crossovers between computing and the arts. The advances since its punch-card genesis have been “enormously greater and better than I could then imagine,” remarked Father Busa in his old age. “*Digitus Dei est hic!* [The finger of God is here!]” Almost every humanistic composition imaginable has been rendered in bytes. Aquinas’s works are a

speck in the corpus of Google Books, which contains at least 25m volumes and perhaps two trillion words. Naxos, a music service, has annotated 2.4m classical pieces with authorial biographies and instrumentation. Spotify, a streaming service, has 60m tunes, each with metadata about tempo, time signatures and timbre.

What started as a niche pursuit is growing rapidly. Google Scholar now contains about 75,000 academic articles and essays that mention “digital humanities”. That total is already bigger than for “Napoleon Bonaparte” (57,000) or “Romeo and Juliet” (66,000). Nearly half of the 75,000 articles were published since 2016.

Digitisation’s clearest benefits are speed and scale. Because of decades of exponential growth in computing sophistication, projects that once lasted a lifetime—literally, for Father Busa—now require a fraction of it. Take the work of Barbara McGillivray at the Alan Turing Institute, Britain’s national centre for data science. Having done her PhD in computational linguistics on the “Index Thomisticus”, she wanted to create a similar resource for ancient Greek. After starting as the institute’s first humanist in 2017, she and a colleague needed just three months to convert 12 centuries of classics into an annotated corpus of 10m words. The final product compresses Homer, Socrates and Plato into 2.5GB of tidy Extensible Markup Language (XML), complete with the grammatical properties of each word.

Curating such enormous archives is just the starting-point. The trick is to turn the data into interesting findings. Researchers have been trying to do that from almost the time when Father Busa began punching cards. From the late 1950s Frederick Mosteller and David Wallace, two statisticians, spent several years using a desk-sized IBM 7090 to calculate the frequency of words in the Federalist papers, written by Alexander Hamilton, James Madison and John Jay. They inferred that 12 anonymous essays were probably written by Madison, based on certain tics. He rarely used “upon”,

for example, whereas Hamilton often did.

Advances in machine learning have given Ms McGillivray a far shinier array of tools. Along with four co-authors, she tested whether an algorithm could track the meaning of Greek words over time. They manually translated 1,400 instances of the noun *kosmos*, which initially tended to denote “order”, then later shifted to “world” (a celestial meaning that survives in the English “cosmos”). Encouragingly, the machine agreed. A statistical model reckoned that in 700BC *kosmos* was frequently surrounded by “man”, “call” and “marketplace”, a cluster suggesting “order”. By 100AD a second cluster emerged, suggesting “world”: “god”, “appear” and “space”.

The thrill of getting “a computer to blindly agree with us”, explains Ms McGillivray, is that she could now apply it easily to the 64,000 other distinct words in the corpus. She has already spotted that *paradeisos*, a Persian loan-word for “garden”, took on its theological context of “woman”, “god” and “eat” around 300BC, when the Old Testament was first translated into Greek. At a few keystrokes, the algorithm tapped into one of history’s great intellectual exchanges, between Judaistic theology and Greek literature.

The most compelling number-crunching of this sort has focused on English writing from 1750-1900, thanks to that era’s rapid expansion of printed texts. Such Victorian data-mining has mostly taken place in America. The Stanford Literary Lab was established in 2010. In contrast to “close reading”, by which humans spot nuances on a couple of pages, the lab’s 60-odd contributors have pioneered “distant reading”, by getting computers to detect undercurrents in oceans of text.

An early project dredged through nearly 3,000 British novels from 1785-1900, to examine which types of language had gone in and out of style. The authors, Ryan Heuser and Long Le-Khac, developed a tool called “the Correlator”, which calculates how frequently a given word appeared in each

decade, and which other words experienced similar fluctuations. Though the maths was crude, it provided some surprisingly coherent clusters: “elm”, “beech” and “branch” closely tracked “tree”, for example. In order to detect broader trends, the authors then hunted for clusters that demonstrated sustained rises or falls in popularity.

First they took the words “integrity”, “modesty”, “sensibility”, and “reason”, and built a cohort of 326 abstract words correlated with them. These sentimental and moralistic terms fell increasingly out of fashion, from providing roughly 1% of all words in 1785 to half that in 1900. To provide a contrast, they then looked for a cohort of concrete terms. They found 508 correlates of the word “hard”. These fell into distinct sub-clusters: actions (“see”, “come”, “go”), body parts (“eyes”, “hand”, “face”), physical adjectives (“round”, “low”, “clear”), numbers and colours. Across the period, this “hard” cohort rose from 2.5% of words to nearly 6%. This was a pattern that led from Elizabeth Bennet’s decorous drawing room to Sherlock Holmes’ shady alleys. Strikingly, the trend-lines suggested that the movement from abstract words to concrete ones had been steady, rather than a sudden Dickensian shift (see chart 1).

Such quantitative studies don’t have to overturn grand theories to be interesting. The Correlator’s findings could sit comfortably within many books about the rise of novelistic realism. Sometimes, the benefit (and pleasure) of crunching literary data comes simply from measuring the strength and timing of historical tides. A second study from the Stanford Literary Lab concurred that 19th-century British novelists gradually removed sentimental words. The author, Holst Katsma, found a steady decline in melodramatic speaking verbs. “Exclaimed”, “cried” and “shouted” accounted for 19% of utterances in around 1800, but only 6% by 1900. (Novelists became fonder of “said”).

Nonetheless, digital humanists enjoy going against the grain. Few have

found as many quirky statistical patterns as Ted Underwood, a lecturer in English and computer science at the University of Illinois. In 2016 Mr Underwood decided to try to see what percentage of descriptions in contemporary novels are about female characters, and how this changed over time.

Mr Underwood took nearly 100,000 novels from 1800-2009 and an algorithm that apportions nouns, adjectives and verbs to specific characters. He found that women received about 50% of descriptions in 1800, but barely 30% by 1950 (see chart 2). This mirrored a similar fall in the share of novels by female authors. As writing became more lucrative, it veered away from the world of genteel ladies to that of grubby men. It was only after 1950 that female authorship and characterisation rebounded. Sabrina Lee, one of Mr Underwood's colleagues, notes that this coincided with the rise of paperback publishing and romance imprints. Even so, women's share of writing and description remained around 40% in 2010.

Some of Mr Underwood's investigations require little modelling and a lot of counting, such as an article that examined a sweeping literary claim by Thomas Piketty, an economist. Mr Piketty reckoned that widespread inflation after 1914 made people warier of wealth, and so "money—at least in the form of specific amounts—virtually disappeared from literature".

Instinctively, Mr Piketty's claim may feel true. Victorian characters often agonised over inheritance or debt, such as reckless Fred Vincy in "*Middlemarch*", who constantly counts the pounds and shillings he has gambled away. By contrast "*The Great Gatsby*", a modernist meditation on the "young and rich and wild", mentions dollars just ten times. However, after combing through 7,700 novels from 1750-1950, Mr Underwood and his co-authors found that these were outliers. The rate at which authors referenced specific amounts of cash nearly doubled in that period (see chart

3). One explanation is that their characters tended to use pocket change more often. The median amount mentioned fell from nearly 60% of annual income to less than 5%.

Because e-books are abundant and computational linguistics dates back to the dawn of the digital age, most humanistic number-crunching so far has been literary in nature. But other subjects are starting to produce peer-reviewed quantitative studies, too. In history, *Proceedings of the National Academy of Sciences* published a paper in 2018 that found Maximilien Robespierre was the most influential rhetorician of the French revolution. The authors judged this by how often members of the National Constituent Assembly copied his innovations during 40,000 speeches. In anthropology, a team of researchers published an article in *Nature* in 2019 that examined how religions developed, using a 10,000-year dataset of 414 civilisations. They found that societies tended to adopt moralising gods after they had already created complex hierarchies and infrastructure. This challenges the idea that humans needed divine rules in order to band together.

Similarly, a study on painting from 2018 found that Piet Mondrian, a Dutch modernist, dabbled with a much wider range of colour contrasts during his career than his European contemporaries. And a paper from 2020 calculated that Sergei Rachmaninoff composed the most distinctive piano pieces relative to his peers, using a similar measure of innovation to the one in the Robespierre paper (but judging by groups of notes, rather than words).

Despite data science's exciting possibilities, plenty of academics object to it. The number-crunchers are not always specialists in the arts, they point out. Their results can be predictable, and the maths is reductive and sometimes sketchy. So too are the perspectives often white, male and Western. Many also fear that funding for computer-based projects could impoverish traditional scholarship. Three academics complained in the *Los Angeles*

Review of Books in 2016 that this “unparalleled level of material support” is part of the “corporatist restructuring of the humanities”, fostered by an obsession with measurable results.

The arts can indeed seem as if they are under threat. Australia’s education ministry is doubling fees for history and philosophy while cutting those for STEM subjects. Since 2017 America’s Republican Party has tried to close down the National Endowment for the Humanities (NEH), a federal agency, only to be thwarted in Congress. In Britain, Dominic Cummings—who until November 2020 worked as the chief adviser to Boris Johnson, the prime minister—advocates for greater numeracy while decrying the prominence of bluffing “Oxbridge humanities graduates”. (Both men studied arts subjects at Oxford.)

However, little evidence yet exists that the burgeoning field of digital humanities is bankrupting the world of ink-stained books. Since the NEH set up an office for the discipline in 2008, it has received just \$60m of its \$1.6bn kitty. Indeed, reuniting the humanities with sciences might protect their future. Dame Marina Warner, president of the Royal Society of Literature in London, points out that part of the problem is that “we’ve driven a great barrier” between the arts and STEM subjects. This separation risks portraying the humanities as a trivial pursuit, rather than a necessary complement to scientific learning.

Until comparatively recently, no such division existed. Omar Khayyam wrote verse and cubic equations, Ada Lovelace believed science was poetical and Bertrand Russell won the Nobel prize for literature. In that tradition, Dame Marina proposes that all undergraduates take at least one course in both humanities and sciences, ideally with a language and computing. Introducing such a system in Britain would be “a cause for optimism”, she thinks. Most American universities already offer that breadth, which may explain why quantitative literary criticism thrived there. The sciences could

benefit, too. Studies of junior doctors in America have found that those who engage with the arts score higher on tests of empathy.

Ms McGillivray says she has witnessed a “generational shift” since she was an undergraduate in the late 1990s. Mixing her love of mathematics and classics was not an option, so she spent seven years getting degrees in both. Now she sees lots of humanities students “who are really keen to learn about programming and statistics”. A recent paper she co-wrote suggested that British arts courses could offer basic coding lessons. One day, she reckons, “It’s going to happen.” ■



数字人文

数字之书

数据分析如何能丰富人文学科

这一切始于一个介词。1941年，罗马天主教神父罗伯托·布萨（Roberto Busa）开始记录他在中世纪神学家圣托马斯·阿奎那（Thomas Aquinas）的拉丁文著作中能找到的“in”的用法。八年后，他积累了一万张手写索引卡片，之后在罗马的宗座格列高利大学（Pontifical Gregorian University）完成了对阿奎那的“内在性”（他的内省信仰）的语言分析。那时他感觉自己的工作应该可以用高效得多的方式来完成。他开始寻找“某种机器”来加速他的新项目——记录阿奎纳著述全文上千万个单词的上下文。

布萨神父对这项事业的热情驱使他走进了IBM董事长托马斯·沃森（Thomas Watson）的办公室。很快他就不再手写索引卡，而开始使用IBM的穿孔卡片机，到50年代又用上了磁带。60年代，数十名全职打字员参与进来。1980年，他的团队最终出版了56卷的《托马斯著作索引》（Index Thomisticus），此时他们已经用了长达1500公里的磁带。1992年团队发行了包含1.4GB数据的CD光盘，接着在2005年推出了网站。这位神父于2011年去世，享年97岁。但离世前他已经启动了一项新项目——对《托马斯著作索引》数据库中的每个句子做句法标注。

这就是数字人文学的创世故事。这一学科内容广泛，包括计算与人文艺术间的各种交叉。自穿孔卡片机开启这一学科以来，所取得的进步“比我那时能想象得到的要大太多，好太多”，布萨神父在晚年时说。“Digitus Dei est hic! [上帝的手指在此显圣!]”几乎所有能想到的人文著作都已有数字版。阿奎那的作品在谷歌图书（Google Books）中只是沧海一粟，该书库至少有2500万册藏书，总字数可能达两万亿。拿索斯唱片公司（Naxos）已为240万首古典作品标注了作者传记和器乐谱。流媒体服务Spotify有6000万首曲目，每首都有关于节奏、拍号和音品的元数据。

数字人文一开始只是一个小众研究领域，但正在迅速发展。谷歌学术

(Google Scholar) 现在约有7.5万篇提到“数字人文”的文章和论文。这已经超过了提到“拿破仑·波拿巴”或“罗密欧与朱丽叶”的文章数（分别为5.7万和6.6万篇）。这7.5万篇文章中近一半发表于2016年之后。

数字化最明显的好处是速度和规模。几十年来计算技术呈指数级增长，曾经要倾尽一生才能完成的研究（对布萨神父来说毫不夸张）现在只需要不太长的时日。以英国数据科学研究中心艾伦·图灵研究所（Alan Turing Institute）的芭芭拉·麦克吉利弗雷（Barbara McGillivray）的研究为例。她在以《托马斯著作索引》的计算语言学研究为课题获得博士学位后，想为古希腊语创建类似的索引。自2017年成为艾伦·图灵研究所的第一位人文学者后，她和一位同事仅用了三个月就将跨12个世纪的古希腊语经典作品转换成了含1000万个单词的带标注语料库。最终成果将荷马、苏格拉底和柏拉图的作品以整齐的可扩展标记语言（XML）格式压缩到仅2.5GB大小，并包含每个单词的语法特性。

整理如此庞大的数字档案只是个开端。难点是将数据变成有趣的研究发现。从布萨神父开始使用穿孔卡片机起，研究人员差不多就在尝试做这件事了。自上世纪50年代后期开始，弗雷德里克·莫斯特勒（Frederick Mosteller）和大卫·华莱士（David Wallace）这两位统计学家花了几年时间，用一台桌子大小的IBM 7090计算亚历山大·汉密尔顿（Alexander Hamilton）、詹姆斯·麦迪逊（James Madison）和约翰·杰伊（John Jay）撰写的联邦党人文集中单词出现的频率。基于一些下意识的用词喜好，他们推断在这些匿名发表的文章中有12篇很可能出自麦迪逊之手。例如，他很少用“基于”（upon）这个词，而汉密尔顿经常用。

机器学习的进步让麦克吉利弗雷有了一系列更高级的工具可用。她与四位合著者测试一种算法能否追踪希腊语词汇长期以来的含义演变。他们人工翻译了1400个含有名词kosmos的例子，这个词最初多用来表示“秩序”，后来演变成“世界”之意（英语的“cosmos”一词延续了这个指称宇宙的意思）。令人鼓舞的是，机器同意他们的释义。一个统计模型推断，在公元前700年，“kosmos”经常和“人”（man），“呼喊”（call）及“市

场”（marketplace）一起出现，这些词簇表明它本身有“秩序”的意思。到了公元100年，“kosmos”开始出现在包含“神”（god）、“出现”（appear）和“空间”（space）等词的第二组词簇中，表明它有“世界”之意。

“一台计算机独立计算的结果与我们的认识不谋而合”之所以令人激动，麦克吉利弗雷解释说，是因为她现在可以轻松地将机器学习应用于语料库中其他6.4万个不同语义的单词。她已经发现，在公元前300年左右《旧约》最早被译成希腊语时，希腊语中借自波斯语的“花园”（paradeisos）一词开始带有神学意义，常与“女人”（women）、“神”（god）和“吃”（eat）这些词一起出现。只消敲几下键盘，算法就挖掘出犹太教神学和希腊文学之间历史上一次重要的思想交流。

最引人入胜的数字分析主要集中在1750年至1900年的英语作品上，这得益于那个时代印刷文本的迅速发展。对维多利亚时代作品的数据挖掘主要在美国开展。斯坦福文学实验室（Stanford Literary Lab）于2010年成立。实验室的60多位撰稿人开创了“远读”（distant reading）的先河，也就是让计算机在文本的海洋中探查暗流，这是与人类在有限的篇章中发现细微之处的“近读”或“精读”（close reading）相对的概念。

一个早期项目潜入1785年至1900年间的近3000部英国小说，查找不同类型的语言的流行趋势。作者赖安·霍伊泽尔（Ryan Heuser）和朗·勒-凯克（Long Le-Khac）开发了一种叫“相关器”的工具，来计算特定单词在每个年代出现的频率，以及其他哪些单词出现了类似的波动。尽管所用的数学计算还很初级，但它还是找出了一些关联度之高令人惊讶的词簇，例如，“榆树”（elm）、“山毛榉”（beech）和“枝权”（branch）紧随“树”（tree）而出现。为了发现更广泛的趋势，两位作者随后开始寻找在流行程度上呈现持续上升或下降的词簇。

首先，他们选取了“正直”（integrity）、“谦逊”（modesty），“情感”（sensibility）和“理性”（reason）这些词，并建立了一个由326个与它们相关的抽象词组成的词群。这些与情感和道德有关的词语日益不流行：1785年它们在所有单词中的占比约为1%，到1900年下降了一半。为了做

对比，他们随后找了一组具象词。他们找到了508个和单词“硬”(hard)相关的词。这些词可以划入不同的子词簇：动作（“看见”see，“来”come, “走”go）、身体部位（“眼睛”eyes, “手”hand, “脸”face）、描述实物的形容词（“圆”round, “低”low, “清晰”clear）、数字和颜色。1785至1900年间，这个“硬”词簇在总词汇中的占比从2.5%增至6%。从伊丽莎白·班内特家优雅的客厅到福尔摩斯穿行的阴暗小巷，描写用词的变化都体现了这种转变模式。引人注目的是，趋势线表明，从抽象词到具象词的转变是稳步递进的，而不是狄更斯式的突然转变（见图表1）。

这样的量化研究并不是非得推翻宏大的理论才有意思。关联器的探索成果可以被放入许多有关小说现实主义兴起的书中而并无矛盾。有时，处理文学数据的好处（和乐趣）单纯来自衡量历史潮流的强度和时间点。斯坦福文学实验室的第二项研究同样发现，19世纪的英国小说家逐渐减少了使用感性的词语。研究作者霍尔斯特·卡特斯玛(Holst Katsma)发现，表示“说话”的夸张的动词稳步减少。在1800年左右，“惊呼”(exclaimed)、“大叫”(cried)和“高喊”(shouted)占“说话”类词语总数的19%，但到1900年仅为6%。（小说家变得更喜欢用“说”said。）

不过，数字人文学者还是会喜欢做一些与众不同的事。说到统计发现的古怪模式，谁也没有伊利诺伊大学的英语和计算机科学讲师泰德·安德伍德(Ted Underwood)的收获多。2016年，安德伍德决定尝试看看当代小说中对女性角色的描述占比，及它如何随时间而变化。

安德伍德选取了创作于1800年至2009年间的近十万部小说，并采用了一个算法来计算与特定角色相关的名词、形容词和动词使用量。他发现，在1800年，对女性角色的描述占约50%，但到1950年仅占30%（见图表2）。相应地，同一时期女性作家创作的小说占比也出现了类似的下降。随着写作变得越来越有利可图，小说的主题从大家闺秀的世界转向了粗鄙男人的世界。直到1950年之后，女性作家和角色的数量才开始反弹。安德伍德的同事塞布丽娜·李(Sabrina Lee)指出，这与平装书和浪漫小说出版的兴起是同时发生的。即便如此，女性作家和角色的占比在2010年仍然保持在40%左右。

安德伍德的一些研究几乎不需要建模，但需要大量统计，比如一篇论文检视了经济学家托马斯·皮凯蒂的一个笼统的文学观点。皮凯蒂认为，1914年以后广泛的通货膨胀让人们对财富更为谨慎，因此，“钱这个词——至少是具体金额——几乎从文学中消失了”。

从直觉上看，皮凯蒂的说法可能是对的。维多利亚时代的小说人物经常为财产继承或债务而苦恼，例如《米德尔马契》（*Middlemarch*）中鲁莽的弗雷德·文西（Fred Vincy）总在数自己赌输了多少钱。相比之下，在思索“年轻、富有和狂野”的现代派小说《了不起的盖茨比》（*The Great Gatsby*）中只提到了十次钱。然而，在梳理了1750年至1950年间的7700部小说之后，安德伍德和他的合著者发现这些只是异常情况。在这段时期里，小说作者们提到具体金钱数额的频率几乎翻了一番（见图表3）。一种解释是书中角色在更多地使用口袋里的零钱。所提到的金额的中位数从占年收入的近60%降至不到5%。

由于电子书数量众多，而计算语言学又开始于数字时代的开端，因此迄今为止大多数人文学科的数字分析实际都集中在文学作品上。但其他领域也开始出现经同行评审的定量研究。在历史方面，《美国国家科学院院刊》（*Proceedings of the National Academy of Sciences*）在2018年发表的一篇论文发现马克西米利安·罗伯斯庇尔（Maximilian Robespierre）是法国大革命中最具影响力的修辞学家。论文作者根据国民制宪会议成员在四万次发言中照搬罗伯斯庇尔创新用词的频率做出了这一判断。在人类学领域，一组研究人员于2019年在《自然》杂志上发表了一篇文章，利用414个文明跨越一万年的数据集探究宗教的发展。他们发现，社会往往是先建立了复杂的等级制度和基础设施之后，才开始搬出规范道德的神灵。这挑战了人类需要神的管治才能结合在一起的观点。

类似地，2018年一项对绘画的研究发现，荷兰现代主义画家皮特·蒙德里安（Piet Mondrian）在其创作生涯中尝试的色彩对比范围要比欧洲同时代画家都广得多。2020年的一篇论文计算得出，谢尔盖·拉赫玛尼诺夫

(Sergei Rachmaninoff) 谱写的钢琴曲与其同侪相比最有特色，这篇论文对创新的衡量方法与研究罗伯斯庇尔的那篇论文类似（不过是基于音符组合而不是用词来得出结论）。

尽管数据科学有各种令人兴奋的可能性，许多学者反对这门学科。他们指出，捣鼓数字的人并不都是人文学科专家。他们得出的结果是可预测的，而数学计算也倾向于简化问题，有时会很粗略。他们的观点也经常是基于白人、男性和西方的视角。许多人还担心，资助基于计算机的项目可能会削弱传统的学术研究。2016年，三名学者在《洛杉矶书评》(Los Angeles Review of Books) 上抱怨说，在痴迷可衡量结果的助推下，这种“前所未有的物质支持”是“对人文学科的社团主义式重构”的一部分。

有时候看起来人文学科真的有危险。澳大利亚教育部正在把历史和哲学系的学费翻倍，同时降低STEM学科的学费。自2017年以来，美国的共和党试图关闭国家人文基金会（以下简称NEH）这一联邦机构，但在国会遇阻。在英国，在2020年11月前一直担任首相约翰逊首席顾问的多米尼克·卡明斯(Dominic Cummings)主张提高数学能力，同时批评虚张声势的“牛津剑桥人文学科毕业生”不配享有那么高的声誉。（他和约翰逊在牛津大学都是文科生。）

但是，尚无证据表明新兴的数字人文科学正在摧毁传统的印刷书籍的世界。NEH的数字人文办公室自2008年设立以来，只从该基金会16亿美元的资金中得到了6000万美元的拨款。实际上，将人文与科学重新结合可能会保护它们的未来。伦敦皇家文学学会(Royal Society of Literature in London)主席玛丽娜·沃纳(Dame Marina Warner)指出，问题之一是人文学科与STEM学科之间“已经形成了巨大的隔阂”。这种分隔可能会让人文研究看起来无关紧要，而不是对科学的研究的必要补充。

这种分隔是在较近的年代才出现的。奥马尔·海亚姆(Omar Khayyam)写诗，也解三次方程式。艾达·洛夫莱斯(Ada Lovelace)认为科学富有诗意。伯特兰·罗素(Bertrand Russell)获得过诺贝尔文学奖。按照这种传统，沃纳建议所有本科生至少修一门人文课和一门科学课，最好分别是语

言和计算相关的。她认为，在英国引入这样的做法将让人们“有理由保持乐观”。大多数美国大学已经可以这样文理兼修，这可以解释为什么量化文学批评在美国会蓬勃发展。科学学科也可能从中受益。对美国年轻医师的研究发现，有过人文学习的人在同理心测试中得分更高。

麦克吉利弗雷说，自90年代末上大学以来，她亲历了“世代转变”。当时她无法选择同时学习她热爱的数学和古典文学，所以花七年的时间拿了两个学位。现在，她看到许多文科生“非常热衷学习编程和统计学”。她在最近与人合作的一篇论文中建议英国的文科课程可以提供基础编程课。她估计有一天“这会实现的”。 ■



Information technology

Hitting the reset button

Can Christian Klein overhaul SAP's ageing business model?

"COUNT ON US, hold us accountable and together we will reinvent the way businesses run." Thus ends a recent letter of support from 337 senior managers at SAP, a maker of business software, to Christian Klein, their chief executive. In April Mr Klein, then a stripling 39 years old, took over as sole boss of Europe's biggest technology firm, after running it for a few months in tandem with Jennifer Morgan, an American who used to helm SAP's business across the Atlantic. He needs all the love he can get, for SAP faces a challenge.

Mr Klein became CEO at the peak of covid-19's first wave. It had hurt SAP more than other tech firms: many of its biggest clients, such as carmakers and energy companies, were temporarily hit by the pandemic. And it struck as more rivals were vying for swathes of the business-software market that the German giant used to rule.

Then, in October, Mr Klein was humbled when he presented changes to SAP's business model that would depress margins in the short run and delay earlier revenue and profit targets by two years. Combined with lacklustre results for the third quarter, the news shaved 22% off the firm's share price, wiping out €35bn (\$41bn) in market value, the sharpest drop in 21 years and almost unheard of for a firm of SAP's size (see top chart). The purchase of almost €250m in SAP shares the following day by Hasso Plattner, chairman of the supervisory board, who co-founded the company 48 years ago, did not reassure investors.

To regain their confidence Mr Klein must improve SAP's offering in the

cloud, and persuade more of its clients to move there. And he needs to do this while fending off competition from firms such as Oracle, Salesforce and Workday in America, SAP's biggest market.

The pandemic has softened demand for “enterprise resource planning” (ERP) software, which firms use to manage their everyday operations—and which has long been SAP's forte. It has also prompted SAP's existing clients, typically large or medium-sized manufacturers, to rethink their ERP processes. “I never had so many calls from CEOs who wanted to talk about supply chains,” says Mr Klein. Retailers and manufacturers asked SAP for tools to get more visibility of their suppliers. Critically, many of them demanded that ERP, which has traditionally resided on firms' own servers, be moved to the cloud instead.

SAP is very late to the cloud, where companies have been progressively moving for the past 20 years, says Liz Herbert of Forrester Research, a consulting firm. Oracle, which also embarked on the transition belatedly, has done so swiftly. So has Microsoft, the world's biggest software-maker, with ambitions to expand its enterprise offerings. By contrast, SAP remains more of a hybrid. It has moved a chunk of its business to the cloud but many big customers still use its software on their premises.

Why the dithering? Shifting complex, customised end-to-end ERP processes to the cloud is much harder than uploading human resources, sales or customer-relationship management, Mr Klein explains. And ERP remains SAP's bread and butter: it controls 21% of the market, according to Gartner, a research firm, compared with 11% for Oracle, its closest competitor (see bottom chart). A whopping 92% of Fortune 500 companies—from carmakers, like BMW, to defence firms, such as Lockheed Martin—use SAP software. It therefore cannot get the transition wrong. SAP listened to its customers and took a methodical approach, says an executive at a rival

software firm, whereas the market wants it to move fast and break things.

Even so, says Mr Klein, “covid was clearly an inflection point.” Bosses of big firms who may have waited another five years before switching to the cloud now want to speed up. They are also demanding a closer integration of SAP affiliates acquired by Mr Klein’s predecessor, Bill McDermott. These include Concur, a travel-expenses firm; Ariba, a procurement platform; and SuccessFactors, which makes HR software. This will require additional investments by SAP. So will Mr Klein’s plan to increase spending on research and development.

SAP must now persuade its 35,000-odd ERP clients of the benefits of the cloud. It must convince investors of the same thing. Licences for on-site software bring a big chunk of revenue upfront, whereas customers initially pay much less for rolling cloud subscriptions. But recurring revenues are increasingly coveted by all manner of technology firms, from Amazon and Apple to Netflix, because they are more predictable and build a closer relationship with customers. The shift to the subscription model will eventually mean a big revenue lift for SAP, predicts Mark Moerdler at Bernstein, a broker.

As for the transition to the cloud, it need not be onerous technically. That is a bit of red herring, thinks Paul Sanderson of Gartner. The bigger challenge is changing the culture of SAP, which has become too removed from its clients.

Rivals will try to exploit the transition period to win over some of those customers. Larry Ellison, the colourful co-founder and now chief technology officer of Oracle, declared last year that “SAP’s customer base is up for grabs.” His subsequent claim that a huge client of SAP was about to defect to Oracle proved unfounded. Another such boast might not be. ■



信息技术

按下重启键

柯睿安能否彻底改变SAP日渐老化的商业模式？

“信赖我们，向我们问责，齐心协力，我们将重塑公司的运营方式。”这是商业软件公司SAP的337名高级主管最近写给CEO柯睿安（Christian Klein）的一封支持信的结尾。今年4月，不过39岁的柯睿安成为这家欧洲最大的科技公司唯一的老板。之前几个月，他与曾掌管公司美洲区业务的美国人詹妮弗·摩根（Jennifer Morgan）联合执掌SAP。在SAP面临挑战之际，任何支持对他来说都弥足珍贵。

柯睿安成为CEO之时正值第一波新冠疫情的高峰期。疫情对SAP的打击超过了其他科技公司，因为它的许多大客户，比如汽车制造商和能源公司，一时之间都受到了疫情的重创。而且，疫情来袭之时，更多竞争对手正对这家德国巨头曾经统领的商业软件市场的大片领域展开争夺。

之后，柯睿安在10月遇挫，当时他提出改变SAP的商业模式，这在短期内会降低利润，并使原定的收入和利润目标推迟两年实现。消息一出，加上第三季度表现平平的业绩，公司股价随即下跌22%，市值蒸发350亿欧元（410亿美元），创21年来的最大跌幅，这在SAP这种规模的公司中几乎闻所未闻（见图表上半部）。次日，SAP监事会主席、在48年前与他人联合创办了SAP的哈索·普拉特纳（Hasso Plattner）购买了近2.5亿欧元的公司股票，但还是没能让投资者放下心来。

为了重新赢得投资者的信心，柯睿安必须提升SAP的云服务，并说服更多客户迁移到云端。在做这些事情的同时，他还要在美国这个SAP最大的市场上抵御来自甲骨文、Salesforce和Workday等公司的竞争。

企业用来管理日常运营的“企业资源规划”（ERP）软件一直是SAP的强项。但疫情减少了企业对ERP的需求。疫情还促使SAP的现有客户（通常是大

中型制造商）重新审视自己的ERP流程。“我从未接到过这么多CEO打来电话，想谈谈供应链的问题。”柯睿安表示。零售商和制造商请求SAP提供工具以加强对供应商的了解。最重要的是，很多客户要求把一般都安装在自己服务器上的ERP迁移到云端。

过去20年里企业一直在逐步向云端转型，而SAP在这方面起步很晚，咨询公司Forrester Research的利兹·赫伯特（Liz Herbert）表示。同样起步迟缓的甲骨文迅速实现了转型；全球最大的软件公司微软也一样，并且雄心勃勃地想要扩展自己的企业云服务。相比之下，SAP仍然更像一个混合体。它已经将自己的一大块业务迁移到云端，但仍有许多大客户依旧在它们自己的服务器上使用它的软件。

SAP为什么如此踌躇？柯睿安解释说，将复杂的、按客户需求定制的端对端ERP流程转移到云端，比上传人力资源、销售或客户关系管理等数据要困难得多。而ERP仍是SAP的主要收入来源：根据研究公司高德纳

（Gartner）的数据，它控制了该市场21%的份额，而最接近的竞争对手甲骨文的份额为11%（见图表下半部）。从宝马之类的汽车制造商到洛克希德·马丁之类的国防公司，财富500强中多达92%的公司使用SAP软件。因此它的转型不容闪失。一位对手软件公司的高管说，SAP听取了客户的意见，采用有条不紊的方法，但市场却希望它迅速行动，打破陈规。

不过，“新冠肺炎显然是个拐点”，柯睿安表示。那些本来可能要再等五年才会转入云端的大公司老板现在希望加快速度。他们现在还要求SAP对柯睿安的前任孟鼎铭（Bill McDermott）收购的旗下业务做更紧密的整合。这些业务包括差旅费管理系统Concur、采购服务平台Ariba，以及人力资源管理软件制造商SuccessFactors等。这需要SAP额外投资。柯睿安增加研发支出的计划也一样。

SAP现在必须说服它的3.5万多个ERP客户相信转到云端的好处。它还必须让投资者也相信这一点。本地使用软件的授权费会给公司带来一大笔前期收入，而客户为循环式云订阅支付的费用在一开始要少得多。但是，循环收益越来越受到从亚马逊、苹果，到奈飞（Netflix）等各种各样科技公司

的青睐，因为它们的可预见性更强，还能与客户建立更紧密的关系。券商盛博的马克·莫德勒（Mark Moerdler）预测，向订阅模式的转变最终将给SAP带来巨大的收入增长。

至于向云服务的转型，从技术层面讲未必很麻烦。高德纳的保罗·桑德斯（Paul Sanderson）认为，柯睿安的解释多少是为了转移注意力。更大的挑战是改变SAP的企业文化，它已经与其客户严重脱节。

竞争对手会试图利用SAP的转型期抢走它的一部分客户。个性复杂有趣的甲骨文联合创始人、现任首席技术官拉里·埃里森（Larry Ellison）去年曾扬言，“SAP的客户就等着被抢吧。”他随后又声称SAP的一个超级大客户即将投奔甲骨文。尽管后来证明这种说法是无中生有，但很难说类似的夸口不会成真。 ■



Music rights

Tuning in

The market for song royalties is a hit for investors

BEN STENNIS is a country-music songwriter from Nashville who has written hits for performers such as Tim McGraw and Jason Aldean. Earlier this year, as the music industry was stopped in its tracks by the coronavirus, a company called Royalty Exchange offered him the chance to raise some cash. Since 2016 it has run an online marketplace that brings together musicians who want to sell their work and punters wanting to invest in royalties. Anthony Martini, a partner in Royalty Exchange, says it has 25,000 potential investors on its books, from pension funds to “dentists from Ohio”. The rate of investors signing up has doubled this year, compared with 2019.

Music royalties are a complicated business. When a song is recorded, copyrights are created both for the composition of the song and the recording itself. Each of those rights is then split into mechanical rights (generated when a song is sold in a physical format or streamed), performance rights (when it is played on the radio or live at a concert) and synchronisation rights (when it appears in a film, television programme or a video game).

The idea of investing in royalties is not new. In 1985 Michael Jackson forked out \$47.5m for the rights to the recordings of around 250 songs by The Beatles; Taylor Swift is trying to buy the rights to some of her master tapes after her previous record label was sold. But firms like Royalty Exchange are making rights affordable to a wider pool of investors; some auctions start with prices in the four figures. (Mr Stennis sold his rights, and paid off his mortgage with the proceeds.)

There are several reasons why music royalties seem attractive at the moment. Mr Martini believes investors are drawn in by a rate of return that is insulated from macroeconomic trends. Music rights offer a predictable stream of income—people tend to tune in no matter what the economy is doing. Owning a song is more fun than buying a slice of a company. And once they have been bought, songs need not require much attention.

Not everyone agrees that buying royalties should be a passive business, though. In 2018 a former manager of Iron Maiden and Guns N' Roses, Merck Mercuriadis, founded an investment company called Hipgnosis. More than 90% of the firm's shares are held by institutional investors, including AXA, an insurer, and the Church of England. The aim is to improve the lot of songwriters, who do not have the same opportunities as performers to make money through tours and merchandise.

Hipgnosis has spent more than £650m (\$870m) buying the rights to over 13,000 songs. It now owns a share of eight of the 25 most-played songs of all time on Spotify, a streaming platform, including tunes co-written with Ed Sheeran ("Shape of You") and Justin Bieber ("Love Yourself"). In addition to the hits, Mr Mercuriadis also wants to boost returns from songs that have "been left to languish" by big labels.

Hipgnosis seeks to promote its catalogue by trying to place them in films, TV programmes and streaming playlists. Since it went public in July 2018, the cumulative return on its net asset value is just shy of 40%. Music to investors' ears. ■



音乐版权

收听

歌曲版税市场是投资者的热门金曲

本·斯坦尼斯（Ben Stennis）是一名来自纳什维尔的乡村音乐创作人，他为蒂姆·麦格罗（Tim McGraw）和杰森·阿尔丁（Jason Aldean）等表演者创作了多首热门歌曲。今年早些时候音乐产业因疫情而受阻时，一家名为“版权交易所”（Royalty Exchange）的公司向他提供了筹措现金的机会。这家公司从2016年开始经营一个线上市场，把想要出售作品的音乐人和有意投资版税的投注者聚集在一起。“版权交易所”的合伙人安东尼·马丁尼（Anthony Martini）表示，公司有2.5万名潜在投资人在册，从养老基金到“俄亥俄州的牙医”都有。同2019年相比，今年投资人的签约率翻了一番。

音乐版权是门复杂的生意。在录制一首歌曲时，歌曲的创作及录音本身的版权同时生成。其中的每项权利又分为机械权（歌曲以实物格式出售或流媒体形式播放时产生）、表演权（在电台播放或音乐会现场表演时产生）和同步许可权（出现在电影、电视节目或电子游戏中时产生）。

投资版税并不是新鲜事。1985年，迈克尔·杰克逊花了4750万美元购买了披头士乐队约250首歌曲的录音权；泰勒·斯威夫特（Taylor Swift）在她之前的唱片公司被卖掉后，正试图买下她一部分母带的版权。但像“版权交易所”这样的公司正在让更多各种各样的投资者能够负担得起版权，一些拍卖的起始价为四位数。（斯坦尼斯在卖出版权后，用收益还清了自己的按揭贷款。）

有几点原因让音乐版税在眼下看起来颇具吸引力。马丁尼认为不被宏观经济趋势影响的回报率吸引了投资者。音乐版权提供了可预见的收入流——无论经济形势如何人们通常都还是会听歌。拥有一首歌比买进一家公司的股份更有趣。而一旦买下，你也不需要怎么关心歌曲。

不过，并非所有人都认同购买版权应是一门被动的生意。2018年，铁娘子乐队（Iron Maiden）和枪炮与玫瑰乐队（Guns N' Roses）的前经理人默克·梅库里亚迪斯（Merck Mercuriadis）创立了一家名为Hipgnosis的投资公司。该公司超过90%的股份由机构投资者持有，包括保险公司安盛（AXA）和英格兰教会。其目的是改善词曲作者这个群体的处境，他们不像艺人那样有机会通过巡演和周边商品赚钱。

Hipgnosis已经花费超过6.5亿英镑（8.7亿美元）购买了超过1.3万首歌曲的版权。现在它拥有流媒体平台Spotify上播放量最高的25首歌曲中的8首，包括艾德·希兰（Ed Sheeran）和贾斯汀·比伯（Justin Bieber）分别与人共同创作的“Shape of You”和“Love Yourself”。除这些大热歌曲之外，梅库里亚迪斯还想提高那些被大唱片公司“晾在一边”的歌曲的收益。

Hipgnosis设法把自己的曲目放进电影、电视节目和流媒体播放列表中来推广它们。自2018年7月上市以来，其净资产价值的累计回报率已逼近40%。对于投资者，这真是动人的音乐。 ■



Aerial combat

Virtual mavericks

Fighter aircraft will soon get AI pilots. But they will be wingmen, not squadron leaders

CLASSIC DOGFIGHTS, in which two pilots match wits and machines to shoot down their opponent with well-aimed gunfire, are a thing of the past. Guided missiles have seen to that, and the last recorded instance of such duelling was 32 years ago, near the end of the Iran-Iraq war, when an Iranian F-4 Phantom took out an Iraqi Su-22 with its 20mm cannon.

But memory lingers, and dogfighting, even of the simulated sort in which the laws of physics are substituted by equations running inside a computer, is reckoned a good test of the aptitude of a pilot in training. And that is also true when the pilot in question is, itself, a computer program. So, when America's Defence Advanced Research Projects Agency (DARPA), an adventurous arm of the Pentagon, considered the future of air-to-air combat and the role of artificial intelligence (AI) within that future, it began with basics that Manfred von Richthofen himself might have approved of.

In August eight teams, representing firms ranging from large defence contractors to tiny startups, gathered virtually under the auspices of the Johns Hopkins Applied Physics Laboratory (APL) in Laurel, Maryland, for the three-day final of DARPA's AlphaDogfight trials. Each had developed algorithms to control a virtual F-16 in simulated dogfights. First, these were to be pitted against each other. Then the winner took on a human being.

"When I got started", says Colonel Dan Javorsek, who leads DARPA's work in this area, "there was quite a bit of scepticism of whether the AI algorithms would be up to the task." In fact, they were. The winner, created by Heron Systems, a small firm in the confusingly named town of California,

Maryland, first swept aside its seven digital rivals and then scored a thumping victory against the human, a pilot from America's air force, in five games out of five.

Though dogfighting practice, like parade-ground drill and military bands, is a leftover from an earlier form of warfare that still serves a residual purpose, the next phase of DARPA's ACE (air combat evolution) project belongs firmly in the future, for it will require the piloting programs to control two planes simultaneously. Also, these virtual aircraft will be armed with short-range missiles rather than guns. That increases the risk of accidental fratricide, for a missile dispatched towards the wrong target will pursue it relentlessly. Tests after that will get more realistic still, with longer-range missiles, the use of chaff and flares, and a requirement to deal with corrupt data and time lags of a sort typical of real radar information.

The point of all this, putative Top Guns should be reassured, is not so much to dispense with pilots as to help them by "a redistribution of cognitive workload within the cockpit", as Colonel Javorsek puts it. In theory, taking the pilot out of the plane lets it manoeuvre without regard for the impact of high g-forces on squishy humans. An uncrewed plane is also easier to treat as cannon-fodder. Still, most designs for new fighter jets have not done away with cockpits. For example, both of the rival European programmes—the British-led Tempest and the Franco-German-Spanish Future Combat Air System (FCAS)—are currently "optionally manned". There are several reasons for this, explains Nick Colosimo, a lead engineer at BAE Systems, Tempest's chief contractor.

One is that eliminating the pilot does not provide much of a saving. The cockpit plus the assorted systems needed to keep a human being alive and happy at high altitude—cabin pressure, for example—contribute only 1-2% of a plane's weight. A second is that even AI systems of great virtuosity have shortcomings. They tend not to be able to convey how they came to a

decision, which makes it harder to understand why they made a mistake. They are also narrowly trained for specific applications and thus fail badly when outside the limits of that training or in response to “spoofing” by adversaries.

An example of this inflexibility is that, at one point in the AlphaDogfight trials, the organisers threw in a cruise missile to see what would happen. Cruise missiles follow preordained flight paths, so behave more simply than piloted jets. The AI pilots struggled with this because, paradoxically, they had beaten the missile in an earlier round and were now trained for more demanding threats. “A human pilot would have had no problem,” observes Chris DeMay, who runs the API’s part of ACE. “AI is only as smart as the training you give it.”

This matters not only in the context of immediate military success. Many people worry about handing too much autonomy to weapons of war—particularly when civilian casualties are possible. International humanitarian law requires that any civilian harm caused by an attack be no more than proportionate to the military advantage hoped for. An AI, which would be hard to imbue with relevant strategic and political knowledge, might not be able to judge for itself whether an attack was permitted.

Of course, a human being could pilot an uncrewed plane remotely, says Mr Colosimo. But he doubts that communications links will ever be sufficiently dependable, given the “contested and congested electromagnetic environment”. In some cases, losing communications is no big deal; a plane can fly home. In others, it is an unacceptable risk. For instance, FCAS aircraft intended for France’s air force will carry that country’s air-to-surface nuclear missiles.

The priority for now, therefore, is what armed forces call “manned-

unmanned teaming". In this, a pilot hands off some tasks to a computer while managing others. Today's pilots no longer need to point their radars in the right direction manually, for instance. But they are still forced to accelerate or turn to alter the chances of the success of a shot, says Colonel Javorsek. Those, he says, "are tasks that are very well suited to hand over".

One example of such a handover comes from Lockheed Martin, an American aerospace giant. It is developing a missile-avoidance system that can tell which aircraft in a formation of several planes is the target of a particular missile attack, and what evasive actions are needed. This is something that currently requires the interpretation by a human being of several different displays of data.

Another example is ground-collision avoidance. In 2018 a team led by the American air force, and including Lockheed Martin, won the Collier Trophy, an award for the greatest achievement in aeronautics in America, for its Automatic Ground Collision Avoidance System, which takes control of a plane if it is about to plough into the terrain. Such accidents, which can happen if a pilot experiencing severe g-forces passes out, account for three-quarters of the deaths of F-16 pilots. So far, the system has saved the lives of ten such pilots.

Eventually, DARPA plans to pit teams of two planes against each other, each team being controlled jointly by a human and an AI. Many air forces hope that, one day, a single human pilot might even orchestrate, though not micromanage, a whole fleet of accompanying unmanned planes.

For this to work, the interaction between human and machine will need to be seamless. Here, as Suzy Broadbent, a human-factors psychologist at BAE, observes, the video-game and digital-health industries both have contributions to make. Under her direction, Tempest's engineers are working on "adaptive autonomy", in which sensors measure a pilot's sweat,

heart-rate, brain activity and eye movement in order to judge whether he or she is getting overwhelmed and needs help. This approach has been tested in light aircraft, and further tests will be conducted next year in Typhoons, fighter jets made by a European consortium that includes BAE.

Ms Broadbent's team is also experimenting with novel ways to deliver information to a pilot, from a Twitter-like feed to an anthropomorphic avatar. "People think the avatar option might be a bit ridiculous," says Ms Broadbent, who raises the spectre of Clippy, a famously irritating talking paper clip that harangued users of Microsoft Office in the 1990s and 2000s. "Actually, think about the information we get from each other's faces. Could a calming voice or smiling face help?"

Getting humans to trust machines is not a formality. Mr Colosimo points to the example of an automated weather-information service introduced on aircraft 25 years ago. "There was some resistance from the test pilots in terms of whether they could actually trust that information, as opposed to radioing through to air traffic control and speaking to a human." Surrendering greater control requires breaking down such psychological barriers.

One of the aims of AlphaDogfight, says Mr DeMay, was to do just that by bringing pilots together with AI researchers, and letting them interact. Unsurprisingly, more grizzled stick-jockeys tend to be set in their ways. "The older pilots who grew up controlling the radar angle...see this sort of technology as a threat," says Colonel Javorsek. "The younger generation, the digital natives that are coming up through the pipeline...trust these autonomous systems." That is good news for DARPA; perhaps less so for Colonel Javorsek. "These things that I'm doing can be rather hazardous to one's personal career", the 43-year-old officer observes, "given that the people who make decisions on what happens to me are not the 25-year-old ones. They tend to be the 50-year-old ones." ■



空战

虚拟独行侠

战斗机很快将配备AI飞行员。但它们只会充当僚机驾驶员，而不是中队长

在传统的空中“狗斗”中，两名飞行员比拼头脑和机器，用机炮瞄准并击落对手。这已成为历史，导弹接过了任务。最近一次记录在案的狗斗发生在32年前：两伊战争接近尾声之际，伊朗的一架F-4幻影战斗机用它的20毫米机炮击落了伊拉克的一架苏-22。

但记忆挥之不去，而狗斗被认为是对受训飞行员的天赋的一种有效测验。即使是模拟狗斗也一样——在这里物理法则被代之以一台计算机内部的方程式运算。而当飞行员本身是一个计算机程序时同样如此。因此，当五角大楼下属的风险创新部门美国国防部高级研究计划局（DARPA）考虑空对空作战的未来以及人工智能（AI）在其中的角色时，它从最基本的入手——如果一战德军王牌飞行员曼弗雷德·冯·里希特霍芬（Manfred von Richthofen）在世，他可能也会赞同的。

今年8月，在位于马里兰州劳雷尔市的约翰斯·霍普金斯应用物理实验室（APL）的主持下，从大型国防承包商到小型创业公司的八支代表队齐聚线上，展开为期三天的DARPA阿尔法狗斗选拔赛决赛。每支队伍都开发了算法，在模拟狗斗中控制一架虚拟的F-16战斗机。它们先是相互比试，获胜者再与一名人类飞行员较量。

“我刚开始做这个项目时，不少人都怀疑AI算法能不能胜任。”DARPA负责这项工作的丹·贾沃塞克（Dan Javorsek）上校说。但事实上，AI做到了。最终胜出的算法来自苍鹭系统公司（Heron Systems）这家位于马里兰州加利福尼亚镇（名字很容易与同名的州混淆）的小公司。它先是横扫其他七个数字对手，然后以5比0大胜来自美国空军的一名人类飞行员。

尽管狗斗和阅兵式、军乐团等一样都是旧式战争的遗留物，仍有一些残余功能，但DARPA的“王牌”项目（ACE，“空战进化”的首字母缩写）的下一

阶段完完全全面向未来，因为它将要求驾驶程序同时控制两架战机。此外，这些虚拟战机将装载短程导弹而非机炮。这加大了意外自相残杀的风险，因为弄错了目标的导弹会对其穷追不舍。再往后的测试还将变得更加真实，会配备远程导弹，使用干扰箔和红外诱饵弹，还需要处理在真实雷达信息中常见的那类数据损坏和时滞。

应该能让公认的王牌飞行员们放心的是，这一切不是为了省掉飞行员。用贾沃赛克的说法，这是要通过“重新分配驾驶舱内的认知负荷”来帮助飞行员。理论上讲，把飞行员移出飞机可以让飞机自由移动旋转，而不用考虑高G力对脆弱人体的影响。同时也能更安心地让飞机当炮灰。不过，大多数新型战机在设计时并没有省掉驾驶舱。比如，两个互相竞争的欧洲项目——英国主导的“暴风雨”（Tempest）以及法国、德国和西班牙合作的FCAS（未来作战空中系统）——目前都是“可选人员驾驶”。这有几个原因，暴风雨战机的总承包商BAE系统公司（BAE Systems）的首席工程师尼克·科洛西莫（Nick Colosimo）解释道。

其一，省掉飞行员并不能省下多少钱。驾驶舱以及让人在高空保持存活和感觉舒适所需的各种系统——比如座舱压力——只占飞机重量的1%至2%。其二，即使是非常高超精巧的AI系统也有缺陷。它们往往无法表达自己是如何做出决定的，这样人们也就更难了解它们为何犯错。同时，它们接受的是针对特定应用的有限训练，因而一旦情况超出它们的训练范围或者要应对敌人的“欺骗攻击”时，就会严重失灵。

举一个这种缺乏灵活度的例子。在阿尔法狗斗选拔赛中，组织者额外加入了一枚巡航导弹，看看会发生什么。巡航导弹按既定路线飞行，因此其行为比有人驾驶的飞机更简单。而AI自动驾驶仪却应付不了它，这是因为在前一轮比赛中已经成功避开了这枚导弹，而在眼下正针对更高级别的威胁受训。这真是荒谬。“人类飞行员应该就不会有问题，”APL实验室负责王牌项目的克里斯·德迈（Chris DeMay）表示，“AI能有多聪明，全看你怎么训练它。”

这不仅对夺取眼前的军事胜利很重要。很多人对赋予战争武器太多的自主

权感到担忧，尤其是在有可能造成平民伤亡的情况下。国际人道法规定，军事攻击对平民造成的任何伤害应该保持在与期望获得的军事利益相称的程度以内。而AI很难具备相关战略和政治知识，因此可能无法自主判断是否应该发动攻击。

当然，人类可以远程控制无人驾驶飞机，科洛西莫表示。但是，鉴于“对抗和拥挤的电磁环境”，他怀疑通信链路是否总是足够可靠。有时候，通信中断无关紧要，飞机还是可以返航。有些情况下却会构成不可接受的风险。比如，为法国空军设计的FCAS战机将携带该国的空对面核导弹。

因此，目前的首要任务是建立军队所说的“有人-无人协同”。其中，飞行员将部分任务交给计算机，同时自己掌管其他任务。比如，今天的飞行员不再需要手动操纵雷达瞄准目标。但他们仍必须通过加速或调整方向来改变射击的命中率，贾沃赛克表示。这些“都是非常适合移交给计算机的任务”，他说。

美国航空航天巨头洛克希德·马丁就有这样移交任务的例子。该公司正在研发一种导弹规避系统，它能判断在多架飞机组成的编队中哪一架是某颗导弹的攻击目标，以及需要采取何种规避行动。目前，这种判断还需要人类解读多个不同显示器上的数据才能做出。

另一个例子是避免撞击地面。2018年，美国空军领导的一个团队（洛克希德·马丁也参与其中）凭借其自动对地防撞系统赢得了科利尔奖（Collier Trophy）这一表彰美国航空航天领域最伟大成就的奖项。该系统可以在飞机即将撞上地面时控制飞机。如果飞行员在严重的G力影响下昏迷就可能发生这类事故，F-16飞行员中四分之三的死亡都是因此而导致的。截至目前，该系统已经从这类事故中挽救了10名飞行员的生命。

DARPA的终极计划是让每组两架飞机的队伍相互对抗，每支队伍由一名人类飞行员和一个AI自动驾驶仪共同控制。许多空军人士希望，有朝一日人类飞行员甚至可以一人指挥（尽管不是“微管理”）整支无人驾驶的僚机编队。

要做到这一点，需要建立无缝衔接的人机交互。在这个方面，正如BAE公司的人为因素心理学家苏西·布罗德本特（Suzy Broadbent）所说，电子游戏和数字医疗这两个行业都可以有所作为。在她的指导下，暴风雨战机的工程师们正在研究“调适性自主”，即用传感器测量飞行员的出汗量、心率、大脑活动和眼运动等指标，以判断他或她是否处于不知所措的状态而需要帮助。这种方法已经在轻型战机上做过测试，明年将在由BAE等公司组成的一家欧洲联营企业制造的“台风”（Typhoon）战机上进一步测试。

布罗德本特的团队也在测试用推特式消息流、拟人化形象等各种新鲜方式向飞行员发送信息。“人们可能认为选用人物化身有点可笑。”布罗德本特说，她提到上世纪90年代和本世纪头10年间微软Office中的大眼夹（Clippy）留给人们的阴影。这枚喋喋不休的回形针出了名地招人烦。“说实在的，想想我们从彼此脸上获得的信息。平静的声音或者微笑的脸庞能帮到我们吗？”

让人类信任机器并不是走形式。科洛西莫以25年前飞机上开始采用自动气象信息服务为例。“当时参与测试的飞行员有一些抵触，不知道自己是不是真的可以信任这些并不是通过无线电与空管人员通话获得的信息。”交出更多控制权需要破除这种心理障碍。

德迈表示，阿尔法狗斗的目标之一正是要通过让飞行员和AI研究人员合作交流来移除这种障碍。不出所料，用惯了操纵杆的年长飞行员往往墨守成规。“那些一辈子都在控制雷达角度的老飞行员……觉得这类技术是个威胁，”贾沃赛克说，“年轻的一代，伴随着这类技术成长起来的数字原住民……信任这些自主系统。”这对DARPA而言是一个好消息；但对贾沃赛克来说或许没那么好了。“我现在做的这些事情对于个人职业生涯可能是相当危险的，”这位43岁的上校表示，“因为那些决定我命运的人不是25岁。他们往往是50岁的人。”■



Health care and technology

The dawn of digital medicine

The pandemic is ushering in the next trillion-dollar industry

IN JANUARY 2019, Stephen Klasko, chief executive of Jefferson Health, which runs hospitals in Philadelphia, chatted to a bank boss. The financier told him that 20 years ago health care and banking were the only industries yet to embrace the consumer and digital revolutions. “Now”, Mr Klasko recalls him adding, “you are alone.”

The banker had a point. The McKinsey Global Institute, the in-house think-tank of the eponymous consultancy, reckons that when it comes to digitisation, health care has indeed lagged behind not just banking but travel, retail, carmaking and even packaged goods. Some 70% of American hospitals still fax and post patient records. The CEO of a big hospital in Madrid reports virtually no electronic record-sharing across Spain’s regions when the first wave of covid-19 washed over the country this spring.

By exposing such digital deficiencies, the pandemic is at last spurring change. Confronted with shutdowns and chaos, doctors have embraced digital communication and analytics that have been common in other industries for years. Patients are growing more comfortable with remote and computer-assisted diagnosis and treatment. And enterprising firms, from health-app startups and hospitals to insurers, pharmacies and tech giants such as Amazon, Apple and Google, are scrambling to provide such services.

McKinsey estimates that global digital-health revenues—from telemedicine, online pharmacies, wearable devices and so on—will rise from \$350bn last year to \$600bn in 2024 (see chart 1). Swathes of America’s

\$3.6trn health-care market are in for a digital makeover. The same is happening in China, Europe and most other places where doctors ply their trade.

The groundwork for what looks poised to be the next trillion-dollar business has been accelerated by the pandemic. Money is pouring in. According to CB Insights, a research firm, a record \$8.4bn of equity funding flowed into privately held digital-health darlings in the third quarter of 2020, more than double the amount a year ago (see chart 2). The industry's unlisted "unicorns", worth \$1bn or more apiece, have a combined value of over \$110bn, according to HolonIQ, a research firm. In September AmWell, a telemedic in which Google has invested \$100m, raised \$742m in an initial public offering (IPO); its market capitalisation is \$6bn. On December 2nd JD Health, a digital pharmacy affiliated with JD.com, a Chinese online emporium, raked in \$3.5bn in Hong Kong's second-biggest IPO this year.

No wonder investors are giddy. Demand for digital medicine is surging. Doctolib, a French firm, says its video consultations in Europe have shot up this year from 1,000 to 100,000 a day. Ping An Good Doctor, a Chinese online health portal viewed by some as the choicest part of its insurer parent, is expanding to South-East Asia in a joint venture with Grab, a Singaporean ride-hailing giant.

As with many technology fads, some of this will turn out to be hype. Sober analysts at Gartner, a research firm, pour cold water on exaggerated claims made by proponents of individualised "precision medicine" and medical artificial intelligence (AI). But even they admit there are reasons to think that not all the excitement is overblown.

Technologies such as sensors, cloud-computing and data analytics are becoming medical-grade just as the risk of contracting covid-19 in hospitals

and clinics makes their adoption look more enticing than ever. Specialist firms like Livongo and Onduo make devices to monitor diabetes and other ailments continuously. A study by Stanford University found that nearly half of American doctors surveyed used such devices. Of that group, 71% regarded the data as medically useful. In June the Mayo Clinic, a prestigious non-profit hospital group, teamed up with a startup called Medically Home to provide “hospital-level care”, from infusions and imaging to rehabilitation, in patients’ bedrooms. Even the Apple Watch has been shown to predict a medical problem known as atrial fibrillation in a clinical trial.

Patients are keen. A study of some 16m American ones just reported in *JAMA Internal Medicine*, a journal, found that their use of telemedicine surged 30-fold between January and June. American consumers surveyed in May by Gartner were increasingly using internet and mobile apps for a variety of medical needs (see chart 3).

Critically, regulators around the world are pressing health-care providers to open up their siloed systems—a precondition for digital health to flourish. The EU is promoting an electronic standard for medical records. In August the Indian government unveiled a plan for a digital health identity with interoperability at its core. Kuantai Yeh of Qiming, a VC firm, says that China’s government, too, is trying to overcome resistance to electronic records from hospitals fearful of losing patients to rivals. Yidu Cloud, a big-data platform for hospitals, may already be the world’s largest health data set, thinks Lee Kai-fu of Sinovation Ventures, another VC firm.

Apple, with its reputation for protecting users’ privacy, is also championing a common standard. A combination of such efforts and regulatory pressure heralds “a new era” for digital medicine, thinks Aneesh Chopra, a former White House technology chief. Judy Faulkner, boss of Epic, a leading maker

of software to manage electronic health records that Mr Chopra has long urged to be more open, declares she is all for it; 40% of the data managed by her firm are already shared with non-customers, she says. Kris Joshi, who runs Change, which handles over \$1.5trn in American medical-insurance claims a year, sees more interoperability, at least between businesses.

All this is helping medicine evolve from “a clinical science supported by data to a data science supported by clinicians”, argues Pamela Spence of EY, a consultancy. Does this make health care big tech’s for the taking? Amazon wants Alexa, its digital assistant, to be able (with your permission) to analyse your cough and tell you if it is croupy or covidy. In November the online giant, which already sells just about everything else, launched a digital pharmacy to take on America’s drug-distribution coterie of pharma firms, middlemen and retailers. AliHealth, a division of Alibaba, China’s e-commerce champion, is disrupting its home pharmacy market. Its revenues leapt by 74% in the six months to September, year on year, to \$1.1bn. Apple has its watch and nearly 50,000 iPhone health apps. Google’s parent company, Alphabet, has Verily, a life-sciences division.

Tech giants’ earlier forays into health care flopped, argues Shubham Singhal of McKinsey, because they had gone it alone. Medicine is a regulatory minefield with powerful incumbents where big tech’s business models, particularly the ad-supported sort, are not a natural fit. But the pandemic has also highlighted that existing providers’ snazzy hardware and pricey services too seldom genuinely improve health outcomes. If the new generation of digital technologies is to thrive it must “improve health, not increase costs”, thinks Vivian Lee of Verily. Her firm is moving away from fee-for-service to risk-based contracts that pay out when outcomes improve (eg, if diabetics get blood sugar under control or more people get eye exams).

That points to a hybrid future where Silicon Valley works more closely with traditional health-care firms. Epic is using voice-recognition software from

Nuance, a startup, to enable doctors to send notes to outside specialists; it has also teamed up with Lyft, a ride-hailing firm, to ferry patients to hospitals. Siemens Healthineers, a big German health-tech firm, is working with Geisinger, an American hospital chain, to expand remote patient monitoring. Patients of India's Apollo Hospitals can use an app to get drug refills, tele-consultations and remote diagnoses—and even secure a medical loan through Apollo's partnership with HDFC Bank.

Dr Klasko, keen to prove the banker wrong, is embracing the hybrid approach with gusto. "You must have partnerships with providers, not just hundreds of unconnected apps." He has brought bright sparks from General Catalyst, a VC firm that made early bets on many digital-health startups including Livongo, to work alongside his innovation team in Philadelphia. "Moving fast and breaking things does not work well in health care," observes Hemant Taneja of General Catalyst. But nor does standing still. ■



医疗和科技

数字医疗的黎明

疫情正在催生下一个万亿美元产业

二〇一九年一月，在费城运营医院的杰斐逊医疗系统（Jefferson Health）的首席执行官斯蒂芬·克拉斯科（Stephen Klasko）和一位银行老板有过一次聊天。这位金融家对他说，20年前医疗和银行是仅剩的两个尚未拥抱消费革命和数字革命的行业。“现在，”克拉斯科记得他又加了一句，“就剩你们了。”

这位银行家所言非虚。麦肯锡咨询公司的内部智库麦肯锡全球研究院认为，在数字化方面，医疗业确实不只落后于银行业，还落后于旅游、零售、汽车制造，甚至包装消费品。约七成美国医院仍使用传真和邮寄方式发送病历。马德里一家大型医院的首席执行官表示，今年春季第一波新冠疫情席卷西班牙时，全国不同地区之间几乎没能共享任何电子病历。

疫情暴露出这样的数字化不足，最终推动了变革。面对停摆和混乱的挑战，医生们积极采用了在其他行业已经普及多年的数字化沟通和分析。患者也越来越适应远程和电脑辅助的诊断与治疗。富有进取精神的企业——从健康应用创业公司、医院、保险公司、药房到亚马逊、苹果和谷歌等科技巨头——正在争相提供此类服务。

麦肯锡估计，到2024年，来自远程医疗、网上药房、可穿戴设备等的全球数字医疗收入将从去年的3500亿美元增至6000亿美元（见图表1）。美国价值3.6万亿美元的医疗保健市场当中，很大一部分将经历数字化转型。中国、欧洲以及大部分有医生行医的地区也在发生同样的变化。

对于这个看起来势将成为下一笔万亿美元大生意的产业，疫情加速了其地基打造。资金正在源源不断地涌入。据研究公司CB Insights的数据，2020年第三季度，受青睐的非上市数字医疗企业已获得84亿美元的股权融资，

创下历史新高，同比增加一倍以上（见图表2）。研究公司HolonIQ指出，该行业未上市的独角兽企业（估值10亿美元或以上）的总估值已经超过1100亿美元。9月，获谷歌1亿美元投资的远程医疗公司AmWell通过IPO融资7.42亿美元，市值达到60亿美元。12月2日，中国在线商城京东旗下的数字药房京东健康在香港招股融资35亿美元，是香港今年第二大IPO。

投资者如此热情高涨不足为奇。对数字医疗的需求正在激增。法国公司Doctolib表示，该公司今年在欧洲的视频会诊量已从每天1000人次激增至每天10万。一些人认为中国在线健康门户平安好医生是其母公司平安保险旗下最优质的资产，它正通过与新加坡网约车巨头Grab组建的合资企业向东南亚扩张。

与许多科技风潮一样，这其中的一些最终只会是一场炒作而已。研究公司高德纳（Gartner）的分析师们很冷静，给个性化“精准医疗”和医学人工智能（AI）倡导者的夸夸其谈大泼冷水。但即便他们也承认，有理由认为人们的兴奋之情并非全然过了头。

鉴于在医院和门诊感染新冠肺炎的风险，传感器、云计算和数据分析等技术的应用显得比以往更有吸引力，而这些技术也正发展为医疗级别。Livongo和Onduo这类专门化公司生产针对糖尿病和其他疾病的持续监护设备。斯坦福大学的一项调查研究发现，接近半数的受访医生曾经使用过此类设备，其中71%认为这些数据具有医学价值。6月，著名非营利医院集团妙佑医疗国际（Mayo Clinic）与创业公司Medically Home合作，在患者家中提供从输液、造影到康复等“医院级护理”。一项临床试验表明甚至Apple Watch也可以预测房颤这种病症。

患者对此相当热衷。《美国医学会内科杂志》（JAMA Internal Medicine）上刚刚发表了一项对约1600万美国患者的研究，发现在1月到6月间对远程医疗的利用激增了30倍。高德纳5月对美国消费者的调查显示，他们正越来越多地使用互联网和手机应用来满足各种各样的医疗需求（见图表3）。

至关重要的一点是，世界各地的监管机构也在向医疗服务供应商施压，要求它们开放彼此孤立的系统——这是数字医疗蓬勃发展的先决条件。欧盟正在推动一项病历电子化标准。8月，印度政府公布了一项数字医疗身份识别计划，其核心就是互通性。风投公司启明创投的叶冠泰表示，中国政府也在努力克服在医院推行电子病历受到的阻力——医院担心这会导致病人轻易转换医院。另一家风投公司创新工场的李开复认为，医院大数据平台医渡云可能已成为全球最大的健康数据集。

以保护用户隐私著称的苹果公司也在倡导一个通用标准。前白宫技术官员安尼什·乔普拉（Aneesh Chopra）认为，业界的努力加上监管的压力正引领数字医学进入“新时代”。乔普拉长期敦促电子病历进一步开放，而领先的电子病历管理软件开发商Epic的老板朱迪·福克纳（Judy Faulkner）称她对此完全赞成。她表示，其公司管理的数据中已有40%与非客户共享。Change公司每年处理超过1.5万亿美元的美国医疗保险理赔，公司掌门人克里斯·乔希（Kris Joshi）也观察到互通性有所增加，至少在企业间是如此。

咨询公司安永的帕梅拉·斯宾塞（Pamela Spence）认为，所有这些都在助推医学从“由数据支持的临床科学变为由临床医生支持的数据科学”。这是否意味着医疗这块蛋糕将成为科技巨头的囊中之物？亚马逊希望其数字助理Alexa能够（在你的许可下）分析你的咳嗽声，看它是哮吼性咳嗽还是疑似新冠肺炎。11月，这家几乎无所不卖的网络巨头还推出了数字药房，向美国的制药公司、中间商和零售商结成的药品分销小圈子发起挑战。中国电子商务领军企业阿里巴巴旗下的阿里健康也正在颠覆国内药房市场。截至9月的六个月里，其收入同比激增74%，达到11亿美元。苹果拥有苹果手表和近五万个iPhone健康应用。谷歌的母公司Alphabet旗下有生命科学子公司Verily。

麦肯锡的舒布哈姆·辛格尔（Shubham Singhal）认为，科技巨头进军医疗保健领域的早期尝试之所以失败，是因为它们选择了单打独斗。医药行业监管严格，处处雷区，其中的传统企业实力雄厚，而大型科技公司的商业模式，尤其是那些依靠广告收入的模式，并不天然契合这个市场。但是，

这场疫情也凸显了现有医疗服务的弊端，各种医疗提供者的新潮硬件和昂贵服务也很少能真正改善健康。Verily的维维安·李（Vivian Lee）认为，新一代数字技术要想蓬勃发展，就必须能够“改善健康，而非增加成本”。她的公司正在从按服务付费模式转向基于风险的协议，也就是当用户健康有所改善时（例如糖尿病患者的血糖得到控制，或更多人接受眼科检查）向他们付费作为奖励。

这预示着未来将是一种混合模式，硅谷与传统的医疗公司将更加紧密地合作。Epic正在使用创业公司Nuance的语音识别软件，让医生可以将记录发送给外部的专科医生；它还与网约车公司Lyft合作来将病人送到医院。德国大型医疗技术公司西门子医疗系统（Siemens Healthineers）正与美国医院连锁集团盖辛格（Geisinger）合作，扩大远程监护病人的范围。印度阿波罗医院（Apollo Hospitals）的患者可以使用一款应用续配处方药、远程咨询和获得诊断，甚至可以通过阿波罗与HDFC银行的合作获得医疗贷款。

克拉斯科很想要证明那位银行家说错了，他正在满腔热情地拥抱这种混合模式。“你必须与供应商建立合作关系，而不是有几百上千个互不相干的应用就行了。”他把风投公司General Catalyst朝气蓬勃的人才带到费城，与他的创新团队一起工作。General Catalyst曾为包括Livongo在内的许多数字医疗创业公司提供早期投资。该公司的赫曼特·塔内加（Hemant Taneja）表示：“在医疗领域，快速行动、打破常规不大行得通。”但是一动不动也不行。 ■



Economic research

Starving for knowledge

Economists look at more than gdp when choosing countries to study

ECONOMIC RESEARCH can reverberate beyond the ivory tower. In 2003 a study of Kenyan schools found that treating intestinal worms improved attendance. After similar work confirmed the policy's benefits, one author, Michael Kremer, founded an NGO that treats 280m children a year.

Mr Kremer's work was unusually impactful, but reflects a pattern of research improving policy. One study found that telling Brazilian mayors about the gains from sending reminder letters to taxpayers sharply increased their chances of doing so. Yet many similar countries attract far fewer studies. This can leave policymakers fumbling in the dark (see Free exchange).

To measure this problem, we turned to EconLit, a database curated by the American Economic Association with 910,000 journal articles from 1990-2019. It only tracks papers with abstracts in English, the field's lingua franca, causing it to under-represent studies intended for non-Anglophone audiences. However, EconLit does include 110,000 papers in other languages with abstracts translated into English.

By far, the best predictor of the amount of research conducted on a country was its GDP. However, economic size leaves many cases unexplained. Kenya gets three times more articles than its GDP suggests; Algeria has one-quarter as many as expected.

Such outliers often cluster in research "oases" or "deserts". Obie Porteous of Middlebury College notes that studies of Africa are disproportionately concentrated in the continent's south and east. Expanding this analysis worldwide, we find that the Middle East and parts of Latin America get

relatively few papers with English abstracts. China and Russia also seem under-studied.

In contrast, South Asia and some regions in eastern Europe were oases. Like much of southern and eastern Africa, India and Pakistan were colonised by Britain. Today, many authors of articles about them work in Britain or America. Meanwhile, European research gluts seem locally driven. Lots of studies on Slovenia, which has one of EconLit's highest papers-to-GDP ratios, stem from universities in Maribor and Ljubljana that churn out articles in English.

To adjust for such factors, we built a statistical model to predict a country's share of studies in each year. GDP remained the most important variable, though it mattered less in oil-rich states. The next-best predictors of popularity in the Anglophone database were listing English as an official language and sending lots of students to American universities (boosting places like China). Variables that capture data availability, such as the number of World Development Indicators a country publishes, also had meaningful effects.

These factors improved the model a lot. They explained most of the difference between Kenya and Algeria, for example. After incorporating them, we found that a country's spending on universities, form of government and involvement in armed conflicts did not yield additional accuracy.

For policymakers in research deserts who want academic support, that is good news. In the short term, they can do little to boost national GDP significantly. But being more forthcoming with data and fostering links with Western scholars should help. ■



经济研究

渴求知识

经济学家在选择要研究的国家时，考虑的不仅仅是GDP

经济研究可以在象牙塔之外产生反响。2003年，一项针对肯尼亚学校的研究发现治疗肠道蠕虫可以提高学生出勤率。在类似的研究证实了这项政策的好处后，该研究的作者之一迈克尔·克雷默（Michael Kremer）成立了一个非政府组织，每年为2.8亿名儿童提供治疗。

克雷默的工作影响之深远异乎寻常，却也反映出一种以研究促进政策的模式。有研究发现，如果告知巴西的市长们给纳税人发提醒信带来了什么好处，会大大增加市长们这样做的几率。不过，对许多类似国家的研究却少得多。这可能使得政策制定者只能在黑暗中摸索。

为了评估这个问题，我们求助于EconLit，这是美国经济协会（American Economic Association）管理的一个数据库，收录了1990年至2019年的91万篇期刊文章。它只追踪摘要为英语（该研究领域的通用语言）的论文，因此不能充分体现面向非英语国家受众的研究。不过它也收录了11万篇以其他语言写就但摘要已翻译成英文的论文。

要预测对某国所做研究的数量，GDP是遥遥领先的最佳指标。但是，只考虑经济规模仍留下了许多无法解释的情况。关于肯尼亚的研究文章是按其GDP预测的三倍，而阿尔及利亚只是按其GDP预测的四分之一。

这些异常值常常聚集在研究的“绿洲”或“沙漠”。明德学院（Middlebury College）的奥比·波蒂厄斯（Obie Porteous）指出，对非洲的研究过多地集中在非洲大陆的南部和东部。扩展至全球看，我们发现研究中东以及拉丁美洲部分地区且有英文摘要的论文相对较少。中国和俄罗斯似乎也研究不足。

相比之下，南亚以及东欧部分地区则是绿洲。像非洲南部和东部的大部分

地区一样，印度和巴基斯坦也曾是英国的殖民地。今天，许多关于这些地方的文章的作者都在英国或美国工作。而欧洲的研究“过剩”则似乎是本地驱动的。斯洛文尼亚是EconLit中“论文-GDP”之比最高的国家之一，关于该国的许多研究都来自马里博尔（Maribor）和卢布尔雅那（Ljubljana）大量发表英文文章的大学。

为了调整这些因素，我们建立了一个统计模型来预测每年针对某国的研究文章占比。GDP仍是最重要的变量，但在石油大国则没那么重要。预测一国在EconLit的研究热门程度的第二有效的指标是将英语列为官方语言，并将大量学生送往美国大学（这提升了中国等地的研究热门程度）。体现数据可得性的变量，例如一个国家公布的世界发展指标（WDI）的数量，也有显著影响。

这些因素大大改进了模型。比如，它们解释了肯尼亚和阿尔及利亚之间的大部分差异。在纳入这些因素之后，我们发现，一个国家在大学上的支出、政治体制和卷入武装冲突的情况并不能提高准确度。

对于那些身处研究荒漠、想要学术支持的政策制定者来说，这是个好消息。短期内他们对显著提振GDP能做的不多。但更积极地提供数据，并与西方学者建立联系，应该会有所帮助。 ■



High-tech finance

Quantum for quants

Wall Street's latest shiny new thing: quantum computing

THE FINANCE industry has had a long and profitable relationship with computing. It was an early adopter of everything from mainframe computers to artificial intelligence (see timeline). For most of the past decade more trades have been done at high frequency by complex algorithms than by humans. Now big banks have their eyes on quantum computing, another cutting-edge technology.

This is the idea, developed by physicists in the 1980s, that the counter-intuitive properties of quantum mechanics might allow for the construction of computers that could perform mathematical feats that no non-quantum machine would ever be capable of. The promise is now starting to be realised. Computing giants like Google and IBM, as well as a flock of smaller competitors, are building and refining quantum hardware.

Quantum computers will not beat their classical counterparts at everything. But much of the maths at which they will excel is of interest to bankers. At a conference on December 10th William Zeng, head of quantum research at Goldman Sachs told the audience that quantum computing could have a “revolutionary” impact on the bank, and on finance more broadly.

Many financial calculations boil down to optimisation problems, a known strength of quantum computers, says Marco Pistoia, the head of a research unit at JPMorgan Chase, who spent many years at IBM before that. Quantum quants hope their machines will boost profits by speeding up asset pricing, digging up better-performing portfolios and making machine-learning algorithms more accurate. A study by BBVA, a Spanish bank, concluded

in July that quantum computers could boost credit-scoring, spot arbitrage opportunities and accelerate so-called “Monte Carlo” simulations, which are commonly used in finance to try to model the likely behaviour of markets.

Finance is not the only industry looking for a way to profit from even the small, unstable quantum computers that mark the current state of the art; sectors from aerospace to pharmaceuticals are also hunting for a “quantum advantage”. But there are reasons to think finance may be among the first to find it. Mike Biercuk of Q-CTRL, a startup that makes control software for quantum computers, points out that a new financial algorithm can be deployed faster than a new industrial process. The size of financial markets means that even a small advance would be worth a lot of money.

Banks are also buying in expertise. Firms including BBVA, Citigroup, JPMorgan and Standard Chartered have set up research teams and signed deals with computing firms. The Boston Consulting Group reckons that, as of June, banks and insurers in America and Europe had hired more than 115 experts—a big number for what remains, even in academia, a small specialism. “We have more physics and maths PhDs than some big universities,” jokes Alexei Kondratyev, head of data analytics at Standard Chartered.

Startups are exploring possibilities too. Enrique Lizaso of Multiverse Computing reckons his firm’s quantum-enhanced algorithms can spot fraud more effectively, and around a hundred times faster, than existing ones. The firm has also experimented with portfolio optimisation, in which analysts seek well-performing investment strategies. Multiverse re-ran decisions made by real traders at a bank. The job was to choose, over the course of a year, the most profitable mix from a group of 50 assets, subject to restrictions, such as how often trades could be made.

The result was a problem with around 10^{1300} possible solutions, a number that far outstrips the number of atoms in the visible universe. In reality, the bank's traders, assisted by models running on classical computers, managed an annual return of 19%. Depending on the amount of volatility investors were prepared to put up with, Multiverse's algorithm generated returns of 20-80%—though it stops short of claiming a definitive quantum advantage.

Not all potential uses are so glamorous. Monte Carlo simulations are often used in regulatory stress tests. Christopher Savoie of Zapata, a quantum-computing firm based in Boston, recalls one bank executive telling him: “Don’t bring me trading algorithms, bring me a solution to CCAR [an American stress-test regulation]. That stuff eats up half my computing budget.”

All this is promising. But quantum financiers acknowledge that, for now, hardware is a limitation. “We’re not yet able to perform these calculations at a scale where a quantum machine offers a real-world advantage over a classical one,” says Mr Biercuk. One rough way to measure a quantum computer’s capability is its number of “qubits”, the analogue of classical computing’s 1-or-0 bits. For many problems a quantum computer with thousands of stable qubits is provably far faster than any non-quantum machine that could ever be built—it just does not exist yet.

For now, the field must make do with small, unstable devices, which can perform calculations for only tiny fractions of a second before their delicate quantum states break down. John Preskill of the California Institute of Technology has dubbed these “NISQs”—“Noisy, Intermediate-Scale Quantum computers”.

Bankers are working on ways to conduct computations on such machines. Mr Zeng of Goldman pointed out that the computational resources needed to run quantum algorithms have fallen as programmers have tweaked their

methods. Mr Pistoia points to papers his team has written exploring ways to scale useful financial calculations into even small machines.

And at some point those programmers will meet hardware-makers coming the other way. In 2019 Google was the first to demonstrate “quantum supremacy”, using a 53-qubit NISQ machine to perform in minutes a calculation that would have taken the world’s fastest supercomputer more than 10,000 years. IBM, which has invested heavily in quantum computing, reckons it can build a 1,000-qubit machine by 2023. Both it and Google have talked of a million qubits by the end of the decade.

When might the financial revolution come? Mr Savoie thinks simple algorithms could be in use within 18 months, with credit-scoring a plausible early application. Mr Kondratyev says three to five years is more realistic. But the crucial point, says one observer, is that no one wants to be late to the party. One common worry is that whoever makes a breakthrough first may choose to reap the rewards in obscurity, rather than broadcast the fact to the world. After all, says Mr Biercuk, “that is how high-frequency trading got started”. ■



高科技金融

量化交易量子化

华尔街新宠：量子计算

金融业长期保持着与计算技术有利可图的关系。在采用从大型主机到人工智能的各种技术时，这个行业都走在前头（参见时间表）。在过去十年的大部分时间里，由复杂算法驱动的高频交易的交易量已经超过了人工交易。现在，大银行又盯上了另一项尖端技术——量子计算。

物理学家在上世纪80年代提出，借助量子力学种种与直觉相悖的特性，或许可以发明出量子计算机，实现非量子计算机永远无法企及的运算壮举。这个远景现在已开始逐渐成为现实。谷歌和IBM等计算巨头以及一大批较小的竞争对手都在打造和完善量子硬件。

虽然量子计算机并不会在所有领域都击败经典计算机，但它们擅长解决的许多数学问题却让银行家甚感兴趣。在12月10日的一次会议上，高盛的量子研究负责人威廉·曾（William Zeng）对听众表示，量子计算可能给这家银行以及更广泛的金融产业带来“革命性”影响。

摩根大通研究部门负责人、曾在IBM工作多年的马可·皮斯托亚（Marco Pistoia）说，许多金融运算归根结底都属于最优化问题，而这正是量子计算机众所周知的强项。有量子计算加持的量化投资机构希望通过加速资产定价、挖掘表现更好的投资组合、提高机器学习算法的准确性来提升利润。西班牙对外银行（BBVA）在7月完成的研究称，量子计算机可以增强信用评分、发现套利机会，并加速“蒙特卡罗”模拟——金融业广泛使用这种模拟预测市场动向。

当前最先进的量子计算机仍然规模小且不稳定，但即便如此，也不是只有金融业在试图利用它获利——从航空航天到制药等众多行业都在追寻“量子优势”。但有理由认为金融业可能是捷足先登的行业之一。Q-CTRL是一

家为量子计算机开发控制软件的创业公司，公司创始人迈克·比埃库克（Mike Biercuk）指出，部署一种新的金融算法可能比部署新的工业流程要快。金融市场的规模如此庞大，就算小小进步也会价值连城。

银行也在为专业知识掏腰包。包括西班牙对外银行、花旗集团、摩根大通和渣打银行在内的许多公司已经成立了研究团队，并与计算公司签署协议。波士顿咨询集团估计，截至6月，欧美的银行和保险公司已经聘请了超过115名专家。鉴于量子研究即使在学术界也仍属小众，这个数字可谓相当惊人了。渣打银行的数据分析负责人阿列克谢·康德拉特耶夫（Alexei Kondratyev）打趣说：“我们这里的物理和数学博士比一些大型大学还多。”

创业公司也在探索其中的种种可能。平行宇宙计算公司（Multiverse Computing）的恩里克·利萨索（Enrique Lizaso）认为，他的公司经量子增强的算法可以更有效地甄别欺诈，大概比现有算法快约100倍。该公司也测试投资组合优化，帮助分析师找到表现优异的投资策略。它重演一家银行的真人交易员所做的决策。这项工作要求在一年时间内，在交易频率等限制条件下，从50项资产中选择盈利能力最强的组合。

这样就产生了一个约有 10^{1300} 个可能解的问题，这个数字远远超过可见宇宙中的原子总数。在现实中，该银行交易员在经典计算机上运行的模型的辅助下实现了19%的年回报率。而根据投资者愿意承受的不同波动幅度，平行宇宙公司的算法产生了20%到80%不等的回报——尽管还没有达成绝对的量子优势。

并非所有的潜在应用都如此引人入胜。蒙特卡罗模拟常用于监管压力测试。总部位于波士顿的量子计算公司Zapata的克里斯多夫·萨瓦（Christopher Savoie）记得一位银行高管曾对他说：“不用给我交易算法，能想办法让我通过CCAR（美国一项压力测试法规）就行。这玩意吃掉了我一半的计算预算。”

所有这些前景无限。但采用量子技术的金融家也承认，目前硬件仍是软

肋。“现在量子计算机运算的规模还是太小，不足以在真实世界里实现对经典计算机的优势。”比埃库克说。对量子计算机性能的一种粗略的衡量方法是看它的“量子比特”数量，量子比特类似于经典计算机中的1或0。对于许多计算问题来说，一台拥有数千个稳定量子比特的量子计算机理论上要比任何能造出来的非量子机器都快得多——只是它尚未出现。

目前，量子计算只能将就着使用不稳定的小型设备，它们的运算维持时间远远不到一秒，然后其精细的量子态就会坍塌。加州理工学院的约翰·裴士基（John Preskill）给这些设备取名“NISQ”，即“带噪声的中等规模量子计算机”。

银行家们正想方设法在这样的机器上完成运算。高盛的威廉·曾指出，随着程序员调整了方法，运行量子算法所需的计算资源已经缩减。皮斯托亚称他的团队撰写了一些论文，探讨如何缩小实用金融计算的规模，使之可以在小型机器上运行。

程序员和硬件制造商相向而行，总有一天双方可以汇合。2019年，谷歌率先展示了“量子霸权”，用53个量子比特的NISQ机器在几分钟内完成了世界上最快的超级计算机需要一万多年才能完成的计算。斥巨资研究量子计算的IBM估计自己到2023年可制造出有1000个量子比特的计算机。两家公司都谈到在十年内可以达到一百万量子比特。

这一金融革命究竟何时到来？萨瓦认为18个月内就可以部署简单的算法，早期的应用很可能是信用评分。康德拉特耶夫则认为，在三到五年内实现可能更加现实。但一位观察人士说，关键在于没人希望落在后面。大家普遍担忧的是，无论谁首先取得突破，都可能不会公之于众而是选择闷声发大财。毕竟，比埃库克说，“高频交易就是这么来的”。■



Market mania

Froth or fundamentals?

There may be more sense to recent market movements than you think

EVEN IN NORMAL times, there is an element of drama to the markets. The oil price may spike or slump in reaction to a geopolitical wobble; bond yields may leap on strong jobs figures; and shareholders may pump up a stock that posted juicy profits. But 2020 has taken the drama to an extreme (see chart 1). The equity sell-off in March was unmatched in its swiftness: stocks lost 30% of their value in a month. The yield on ten-year American Treasuries, the most important asset worldwide, fell by half between January and the middle of March and then by half again in a matter of days, before seizing up and yo-yoing. The contract for imminently delivered barrels of American oil briefly went negative. Over the course of 2020 timber prices have fallen by half, doubled, doubled again, fallen by half once more and then doubled again (overall, they have doubled in 2020).

If the plunge in asset prices as countries locked down terrified asset managers, then recovery—led by a fierce bull run in tech stocks over the summer—has made them uneasy. It was only in 2018 that a public company, Apple, first became valued at more than \$1trn. In net terms, Apple has gained around \$750bn this year. Tesla has increased in value six-fold this year, to a market capitalisation of more than \$600bn, roughly the value of the other seven most valuable carmakers combined. Even stocks that were unloved earlier in the year, like banks and energy firms, have rebounded of late, on a spate of good news—of an effective vaccine, and of a clear victory for Joe Biden in America’s presidential elections. When Airbnb, a platform for booking overnight stays, made its public debut on December 10th—after a year in which no-one travelled anywhere—its share price leapt by 115%. On

December 5th the value of global stocks crossed \$100trn for the first time.

Financial markets reflect investors' expectations about the future, so it is hardly surprising that they have been chaotic in 2020. But the rebound in risky assets amid fragile economic conditions prompts the question of whether bubbles have formed in certain assets, or whether the ups and downs can be explained by rapidly shifting fundamental factors.

Consider first the evidence for froth. Even as profits slumped, investors in the S&P 500 benchmark index earned 14.3% (excluding dividends) in 2020, about double the typical return over the past 20 years. The gains have pumped up measures of stockmarket valuations. One such gauge is the cyclically adjusted price-to-earnings, or "CAPE", ratio, devised by Robert Shiller, a Nobel-prizewinning economist. This looks at inflation-adjusted share prices relative to the ten-year average of real earnings per share. When the ratio is high, stocks are dear relative to their earnings; such periods have tended to be followed by low long-term returns over the next decade. In America the ratio in November 2020 was 33, above its level earlier in the year (see chart 2). Only twice before has the ratio exceeded 30 in America—the late 1920s and the early 2000s.

The big tech firms, many of which were expected to benefit from online shopping and home working, have played a disproportionate role in the broader rally. They account for two-thirds of the total returns from holding the S&P 500. At the start of 2020 Alphabet, Amazon, Apple, Facebook and Microsoft were worth around \$5trn and made up 17.5% of the value of the index. The five are now worth more than \$7trn, and their share has risen to 22% (see chart 3).

Further evidence of froth is the frenzy around initial public offerings of firms such as Airbnb, and the revival in retail trading. Retail investors

accounted for 20% of the volume of stock trading, up from 15% in 2019. In the summer small buyers of call options—bets on share prices rising—were responsible for more derivatives trading than large ones.

The circumstantial evidence, then, looks bubbly. But a cross-examination of fundamental factors suggests that these can explain more than a fair chunk of what is going on. Cyclical assets, like stocks in restaurants and retailers, or commodities, like oil and copper, tend to rally as business booms. These fell quickly in value in February and March, followed by slow recoveries as the world reopened. But since November 9th, when news of an effective vaccine broke, they have surged. Container-freight rates have risen to all-time highs. Brent crude oil rose above \$50 a barrel for the first time since March on December 10th.

Moreover, the move in interest rates appears to more than explain the behaviour of equity prices. In isolation, the CAPE ratio ignores the impact of discount rates on valuations. The value of a firm, to its shareholders, is the present value of a firm's future profits—meaning share prices tend to be sensitive to changing expectations of future profits, but also to the discount rate used to calculate what those are worth today. There have been enormous changes in this discount rate for stocks. At the start of 2020 the yield on ten-year Treasuries was 1.8%; by the middle of March it was just 0.6%. Since the vaccine news yields have risen once more, to around 0.9%.

To account for this, on November 30th Mr Shiller published “excess CAPE yield” numbers, which are calculated by inverting the CAPE ratio, to give an indication of the expected yield on equities, and then subtracting the expected real returns on holding bonds (which, thanks to low rates and modest inflation expectations over the next decade, are negative). The excess yield is actually higher than in January (see chart 4). In other words, equities have become more attractive than bonds—at first probably because bond yields fell so quickly, boosting the relative appeal of stocks, but lately

thanks to the vaccine heralding the return of growth and profits, which a modest increase in yields has not offset.

The rise in share prices alone, then, is probably not enough to indicate a mania, given the shift in discount rates. This may not dispel investors' disquiet, in part because they are surrounded by evidence of exuberance. But the case for a bubble, at the very least, is not open and shut. ■



市场狂热

是泡沫还是基本面？

最近的市场走势可能比你认为的要合理

即使在正常时期，市场也存在些许戏剧性。油价可能会因地缘政治动荡而飙升或骤降；强劲的就业数据可能会让债券收益率激增；股东们可能会推高盈利丰厚的股票。但在2020年，这种戏剧性达到了极致（见图表1）。3月时股票抛售速度之快前所未见：股市在一个月内跌去了30%。全世界最重要的资产——十年期美国国债——从1月到3月中旬收益率下跌了一半，之后短短几天内又跌去一半，接着止住跌势，开始上下波动。即将交割的美国原油合约一度跌至负值。在这一年里，木材价格先是下跌一半，然后翻一番，再翻一番，再跌一半，继而又翻一番（总体上它们在2020年翻了一番）。

如果说各国封锁引发的资产价格暴跌已把资产经理们吓得不轻，那么今年夏天由科技股强劲的牛市行情引领的股市复苏又让他们感到不安。直到2018年才有一家上市公司（苹果）的市值首次超过1万亿美元。按净值计算，苹果今年上涨了约7500亿美元。特斯拉的市值今年增长了五倍，突破6000亿美元，大致相当于另外七家市值最高的汽车制造商的总和。即使是像银行和能源公司这样在今年早些时候不受待见的股票近来也在一连串好消息（包括一种有效疫苗问世、拜登在美国总统选举中完胜等）的刺激下反弹。在经历了几乎无人出门旅行的一年后，短租预订平台爱彼迎在12月10日上市，当日股价便飙升115%。12月5日，全球股票总市值首次突破100万亿美元。

金融市场反映的是投资者对未来的预期，因此2020年市场如此混乱也就不足为奇了。但在脆弱的经济环境下风险资产的价格却反弹了，这就引发了一个问题：某些资产是否已经出现了泡沫，还是说这些波动可以用快速变化的基本面因素来解释？

先来看关于泡沫的证据。一边是利润大幅下滑，一边却是标普500基准指数的投资者在2020年获得了14.3%的回报率（不包括股息），约为过去20年一般回报率的两倍。这样的收益推高了股市的估值标准。其一是获得诺贝尔奖的经济学家罗伯特·席勒（Robert Shiller）提出的周期调整市盈率，即CAPE。它考察的是经通胀调整的股价与每股10年平均实际收益的比率。当CAPE高企时，股价相对于收益来说过高；这种情况出现后，接下来往往会有10年的长期回报率走低。2020年11月美国股市的CAPE为33，高于今年早些时候的水平（见图表2）。美国历史上CAPE超过30的情况只有两次，分别发生在上世纪20年代末和本世纪初。

大型科技公司——其中很多被认为会从网购和居家办公中受益——在更广泛的止跌回升中发挥了异乎寻常的作用。它们贡献了标普500指数总回报的三分之二。2020年初，Alphabet、亚马逊、苹果、Facebook以及微软的总市值约为5万亿美元，占标普500指数总市值的17.5%。目前，这五大公司的市值超过7万亿美元，占比已升至22%（见图表3）。

存在泡沫的更多证据是对爱彼迎等公司上市的狂热，以及散户交易的复苏。散户投资者的股票交易量占比从2019年的15%上升到20%。今年夏天，押注股价上涨的看涨期权的小买家进行的金融衍生品交易超过了大买家。

由此，从间接证据看存在泡沫。但对基本面要素的交叉验证表明，它们可以解释眼下的大部分情况。周期性资产，比如餐饮和零售股票或石油和铜等大宗商品，往往随商业繁荣而价格上涨。它们在二三月间迅速下跌，之后随着世界重新开放而缓慢回升。但自11月9日传出一种有效疫苗即将推出的消息后，它们开始飞涨。集装箱运价已升至历史新高。12月10日，布伦特原油自3月以来首次突破每桶50美元。

此外，利率的变动似乎与股价走势高度相关。孤立地看，CAPE没有考虑折现率对股价的影响。对股东来说，公司的价值就是它未来收益的现值——这意味着股价往往不仅对未来收益的预期变化很敏感，还对用来计算

未来收益现值的折现率很敏感。股票的折现率发生了巨大变化。2020年初，十年期美国国债收益率为1.8%，到3月中旬仅为0.6%。自从疫苗的消息传出后，它又上涨到0.9%左右。

为了解释这一点，席勒在11月30日提出了“超额CAPE收益率”，这个指标是用CAPE的倒数（体现股票的预期收益率）减去持有债券的预计实际收益率（由于低利率和对未来10年较低的通胀预期，这一收益率为负数）。目前超额CAPE收益率实际上高于今年1月的水平（见图表4）。换句话说，股票已经变得比债券更有吸引力。究其原因，一开始可能是因为债券收益率下跌得太快，加大了股票的相对吸引力；但最近是因为疫苗的推出预示着经济增长和利润的恢复，债券收益率的小幅上涨并不能抵消这一影响。

因此，考虑到折现率的变化，单单股价的上涨可能不足以表明这是一股狂热。这也许无法消除投资者的忧虑，一定程度上是因为他们周围不乏证据显示出现了过度繁荣。但要说存在泡沫，支撑这一看法的理据最起码不是一目了然的。 ■



Bartleby

Straight talking

What if executive memos were clear and honest?

FOLLOWING THE tragic yachting accident that killed my predecessor, Buck Passer, the board decided on a change of direction at Multinational United Subsidiary Holdings (MUSH). As the new chief executive, I would like to live up to my nickname, “Honest Harry” Hunter and tell it to you straight.

We had a dreadful 2020. To be fair, nobody could have reasonably expected the executive team to predict a global pandemic which resulted in widespread economic shutdowns. But by the same token, if managers aren’t at least partly responsible during the bad times, they shouldn’t take full credit for the good times. Most executives are riding on the backs of central bankers who have slashed the cost of capital and on technology pioneers who have made it easier to transact and communicate.

So, given that my fellow executives took bonuses in the boom years, we are slashing their salaries by half. That will give us more money to save jobs in the rest of the group. This may upset people in the C-suite and prompt some of them to leave. We will miss them—and wish them well finding a new job in the current labour market. We also know that many of you had to keep coming into our factories and warehouses during the pandemic while most of the office staff have been able to work from home. So as budgets are tight, we are making sure that the salaries of those essential workers keep pace with inflation this year. For everyone else, there will be a pay freeze.

Another cost-saving measure will be the elimination of my predecessor’s use of management consultants. I have nothing against the profession, which is full of bright people. But if my executive team needs advice on how

to do their jobs, that raises the question of why they were hired in the first place.

What about 2021? There is no point in making economic predictions; the best approach is to clear up the mistakes made in the past. First of all, my predecessor bought too many companies without considering whether they would fit well with the rest of the group. Chief executives like acquisitions: to expand their empires and give them news to announce when they are talking to investors. Time the purchase right and you can boost both earnings and the share price.

But all too often these are vanity purchases, like the middle-aged man who buys a Porsche to reclaim his lost youth. When combining companies, it is possible to make savings in areas like procurement but these are often more than offset by the loss of morale that occurs when managers try to mesh organisations with completely different cultures. So we are not going to make any acquisitions in 2021. Instead, we are going to see if some of our subsidiaries can be spun off as stand-alone organisations. They can probably manage their businesses far better than we can.

Speaking of management changes, too much staff time is taken up by meetings. From now on, team leaders will have a 15-minute catch-up every morning; if there is important news, they can message employees directly. Most of the staff should not be expected to attend an internal meeting more than once a month. That should give them more time to meet the important people, our suppliers and customers, or just to get on with their jobs.

Other changes are required to end the gobbledegook that plagued the previous regime. We will no longer have a “human resources” department: our employees are people, not resources. That section has been renamed personnel. Similarly, the whole concept of a “thought leadership” division is both pretentious and Orwellian; clients are not impressed by this waffle

and in order to save money I will shut our unit down.

Finally, there is a lot of talk about corporate purpose, and a lot of grandiose language tends to be used by other executives. So let me tell you the purpose of this business under my leadership. It is to create a company that provides products and services that customers are eager to buy. In turn, that depends on ensuring that our employees are both well-rewarded and committed to their tasks. If we can achieve those goals, then the returns to shareholders will look after themselves.

So enjoy your holiday break—you have earned it. I can't promise you that things will be better in 2021. But if they aren't, it won't be for lack of effort from me or the rest of the management team. Thanks for all you have done this year.

Best wishes, Harry Hunter ■



巴托比

实话实说

高管的备忘录写得清晰又坦诚是什么样？

我的前任巴克·“没担当”·帕瑟在悲剧性的游艇事故中不幸身亡，之后董事会决定改变跨国联合附属控股公司（MUSH）的发展方向。作为新任首席执行官，我愿不负我“诚实哈里”的绰号，对各位实话实说。

我们经历了糟糕透顶的2020年。说句公道话，没有人会期望高管团队能够提前预测到这次导致大范围经济停摆的全球疫情。但按照相同的逻辑，如果管理层在经济萧条时不用承担至少一部分责任，那么在顺风顺水时也不该把功劳全都揽到自己身上。多数企业高管现在不过是在搭顺风车，靠的是央行官员大幅降低资金成本，以及科技先锋把交易和沟通变得更便利。

因此，考虑到我的高管同事们在繁荣期已经拿过奖金，公司正把他们的薪水减半。这样我们就会有更多钱来保住其他员工的饭碗。这可能会让最高管理层感到不快，其中一些人可能会选择走人。我们会想念他们——并祝愿他们在眼下的就业市场找到新工作。我们也知道，疫情期间我们的大多数文职人员可以在家工作，但你们当中许多人还得继续回到工厂和仓库。所以，在预算吃紧之时，我们会确保这些关键岗位的员工今年的工资能跟上通胀。而其他所有人将被冻薪。

另一个节省成本的措施将是解聘我前任雇用的管理顾问们。我对这个职业并不反感，他们之中确实也有很多能人。但如果我的高管团队需要别人的建议才知道如何开展工作，那就要问问，公司当初请他们来做什么？

那么2021年会如何？预测经济前景没什么意义，最好的办法还是清理过去犯下的错误。首先，我的前任收购了太多公司，却没有考虑它们是否契合集团内的其他业务。首席执行官都喜欢收购，这可以扩大他们的商业帝国版图，在面对投资者时又有新消息可宣布。把握好收购时机可以让盈利和股价都升高。

但这些收购太多时候只是为了满足虚荣心，和一个中年男人买辆保时捷来重拾逝去的青春没什么两样。公司合并可能会在采购等方面节省开支，但当管理层试图融合文化截然不同的组织时往往会导致士气低落，最后得不偿失。因此我们不打算在2021年收购任何公司。相反，我们还会看看是否能剥离一些子公司，让它们独立运作。它们管理自己业务的能力恐怕要比我们强得多。

说到管理上的改变，员工在会议上耗费了太多时间。从今天开始，团队主管每天早上可以花15分钟时间开个沟通晨会；如果有任何重要消息，可以直接通知员工。大多数员工每月参加的内部会议不应超过一次。这会让他们有更多时间去见重要的人——我们的供应商和客户，或者单纯去完成他们的工作。

之前的管理架构中充斥着各种官样文章，必须通过改革清除。“人力资源”部门将不复存在：我们的员工是人，不是资源。该部门现已更名为人事部。同样，“思想领导力”部门这整个概念装腔作势又专横无理。客户对这种花俏的废话并不感冒，出于节省经费的考虑，我会把这个部门砍掉。

最后，现在很多人热衷于谈论企业使命，许多高管的言语也甚为浮夸。那么我来告诉你，在我的领导下这家公司的使命是什么。我们要打造一家公司来提供客户渴望购买的产品和服务。反过来，这取决于我们的员工能否获得良好的回报，并全心投入自己的工作。如果我们能实现这些目标，那么股东的回报自然也水到渠成。

所以，请好好享受这个假期吧——这是你们应得的。我不能保证2021年情况会好转。但如果事情不尽人意，我和管理团队也已经竭尽所能了。感谢大家这一年来的所有付出。

致以最美好的祝愿，哈里·亨特 ■



Cinema and streaming

Big bets on the small screen

Hollywood is pivoting to home entertainment

IF ANY INDUSTRY could use help from Wonder Woman, it is cinemas. Lockdowns and a dearth of new releases have reduced worldwide box-office takings by about 70% in 2020. Thankfully for theatre owners, the corseted crusader charged to the rescue on Christmas Day, giving audiences a reason to go back to the movies.

Yet in a plot twist, AT&T, the telecoms giant that owns the film's producer, Warner Bros, has announced that "Wonder Woman 1984" and the 17 feature films on Warner's release slate for 2021 will be made available on its HBO Max streaming service on the day they are released in cinemas, which historically have had an exclusive run of a few months. Purists are aghast. "The future of cinema will be on the big screen, no matter what any Wall Street dilettante says," declared Denis Villeneuve, whose sci-fi epic, "Dune", is among the affected films.

Warner is not the only studio shifting its focus to the small screen. In July Universal Pictures, part of Comcast, a cable company, did a deal with AMC, the world's largest cinema chain, to give theatres just 17 days before its films are made available online (AMC will get a cut of streaming revenues). Paramount Pictures, owned by ViacomCBS, has sold several films to Netflix this year rather than release them to empty auditoriums. And on December 10th Disney, Hollywood's biggest studio, signalled that it, too, sees its future in streaming.

In a presentation to investors the studio announced a blitz of new content for its Disney+ streaming service: ten "Star Wars" series, ten more based

on Marvel comic books, 15 other new original series and 15 feature films. By 2024 Disney+ will be spending \$8bn-9bn annually on content, up from \$2bn in 2020. Add ESPN+, which shows sports, and Hulu, another Disney streaming channel, and the company will splurge \$14bn-16bn a year, nearly as much as the \$17bn that Netflix, which pioneered streaming, earmarked to spend in 2020.

Disney's "content tsunami" is "frightening to any sub-scale company thinking about competing in the scripted entertainment space", wrote Michael Nathanson of MoffattNathanson, a media-research firm. The Wall Street dilettantes swooned: Disney's share price leapt by almost 14% the day after its presentation, reaching an all-time high and adding \$38bn to its stockmarket value (see chart).

Disney now expects 230m-260m Disney+ subscribers by 2024—more than treble its previous target. The extra viewers, and a planned price rise, put the service on track to break even in 2024, despite more content spending. Across all its streaming channels Disney expects more than 300m subscribers by 2024—maybe enough to overtake Netflix, currently on 195m. Disney will take Netflix on more directly via a new service, Star, with a wider range of programming, including a new show starring the indefatigable Kardashian clan.

Two months ago Disney began a corporate restructuring to increase its focus on streaming. Since then it has trimmed jobs at ABC News and announced the winding up of its radio business. The plans for Disney+ imply that by 2024 streaming will be the company's single largest business by revenues, notes Benjamin Swinburne of Morgan Stanley, a bank. Whatever some directors may think, "made for TV" is no longer a slur in Hollywood. ■



电影院与流媒体

小屏幕上的大赌注

好莱坞正在转向家庭娱乐

如果说有哪个行业需要神奇女侠的帮助，那就是电影院了。由于封城和缺乏新片上映，2020年全球票房收入减少了约70%。让影院业主们庆幸的是，这位穿着紧身胸衣的战士在圣诞节冲锋陷阵展开营救，给观众一个回到影院的理由。

不过情节突转，该片的制作方华纳兄弟的母公司电信巨头AT&T宣布，《神奇女侠1984》和2021年华纳预备发行的17部剧情片将在它旗下的HBO Max流媒体平台上与院线同步上映。在这以前，院线一般都有头几个月的独播权。正统派对此感到震惊。“不管华尔街那帮半吊子怎么说，电影的未来还是在大屏幕。”丹尼斯·维伦纽夫（Denis Villeneuve）说，他的科幻大片《沙丘》（Dune）是受影响的影片之一。

华纳并不是唯一一家将重心转向小屏幕的电影公司。7月，有线电视公司康卡斯特（Comcast）旗下的环球影业与全球最大的连锁影院AMC达成一项协议，只给影院17天时间独播环球影业发行的电影，之后影片就能在线上点播（AMC将从流媒体收入中拿到分成）。维亚康姆哥伦比亚广播公司（ViacomCBS）旗下的派拉蒙影业今年把几部电影卖给了奈飞（Netflix），而不是在空荡荡的影院上映。12月10日，好莱坞最大的电影公司迪士尼也传达了认为自己的未来在流媒体的信号。

在一场面向投资者的发布会上，迪士尼宣布将在其流媒体服务Disney+上发起新一波内容轰炸：10部《星球大战》剧集、10部根据漫威漫画改编的剧集、15部新的原创剧集和15部剧情片。到2024年，Disney+每年在内容上的支出将从2020年的20亿美元增至80亿到90亿美元。加上播放体育节目的ESPN+和迪士尼的另一个流媒体频道Hulu，迪士尼每年要烧掉140亿至160亿美元，与流媒体先驱奈飞在2020年为内容拨出的170亿美元相差不

多。

迪士尼的“内容海啸”可是“吓到了任何想在剧作类节目领域拼一把的小规模公司”，媒体研究公司MoffattNathanson的迈克尔·内森森（Michael Nathanson）写道。华尔街的半吊子们都乐晕了：迪士尼的股价在计划公布后的第二天跃升近14%，达到了历史新高，市值增加了380亿美元（见图表）。

迪士尼现在预计，到2024年Disney+的订户将达到2.3亿至2.6亿，是之前目标的三倍多。观众数量的增长加上计划中的提价令这项服务有望在2024年实现盈亏平衡，即便内容支出会增加。迪士尼预计，到2024年，旗下所有流媒体频道的订户将超过3亿——或许足以超过目前拥有1.95亿用户的奈飞。迪士尼将通过一项新服务Star与奈飞展开更直接的竞争，Star将提供更广泛多样的节目，包括一档以永不疲倦的卡戴珊家族为主角的新节目。

两个月前迪士尼开始重组，把重心进一步转向流媒体。自那以后，它在美国广播公司新闻台（ABC News）裁员，并宣布关闭其广播业务。摩根士丹利的本杰明·斯温伯恩（Benjamin Swinburne）指出，Disney+的计划意味着到2024年，按收入计算，流媒体将成为迪士尼最大的单一业务。无论一些导演怎么想，“电视电影”在好莱坞已不再是上不了台面的事物了。■



Economies past

Factories and families

Working from home had its advantages, even in the 18th and 19th centuries

SALLY BROWN, who was born in Vermont in the early 1800s, had a typically varied schedule for a working woman of the time. As her diary shows, one day she is finishing stockings; another she is milking a cow; another she is refining wool. All of her jobs were done from home.

The shift from offices to kitchen tables among white-collar workers in 2020 seems unprecedented, and only possible with Slack and Zoom. But it is nothing new. Indeed, the history of home-working suggests some surprising parallels with today.

The emergence of capitalism in Britain and elsewhere from the 1600s to the mid-19th century did not take place primarily in factories, but in people's houses. Workers made everything from dresses to shoes to matchboxes in their kitchens or bedrooms. When Adam Smith wrote "The Wealth of Nations" in 1776, it was perfectly common to work from home. Smith famously described the operation of the division of labour in pin-making, but not in a dark, satanic mill. He was describing a "small manufactory" of perhaps ten people—which could well have been in or attached to somebody's house.

It is not easy to put exact numbers on how many people have worked from home during different historical periods. Even in Britain, where economic data reach farther back than in any other country, little reliable labour-force data exist until the mid-1800s. Other sources left clues, however. One relates to the meaning of the word "house". Today it connotes domesticity. But up until the 19th century it had a much broader definition, with the

suffix “-house” encompassing economic production, too. In “A Christmas Carol”, Scrooge works in a “counting-house”. Architecture offers other hints. In Britain, many 18th-century houses still have unusually large upstairs windows; cloth-weavers, who worked there, needed as much light as they could get.

Around 1900 French administrators took the lead in asking people about their place of work, not only what they did. They found that one-third of France’s manufacturing workforce worked from home. Danish surveys around the same time found that a tenth of the total workforce did so full-time at home. These research efforts took place at the high point of the factory-based system of production; in previous decades the share of home-working would have been far higher. According to one estimate for America, using official data, in the early 1800s more than 40% of the total workforce laboured from home. Only by 1914 did the majority of the labour force work in an office or factory.

The emergence of an at-home industrial workforce had two main causes. The growth of global trade and the rise in per-person income from the 1600s onwards raised demand for manufactured goods such as woollens and watches. But the emerging new technology was more suited to small-scale working than large-scale factories (the spinning jenny, the machine which kickstarted the industrial revolution, was not invented until the 1760s). Homes were the obvious place to be.

What emerged was called the “putting-out system”. Workers would collect raw materials, and sometimes equipment, from a central depot. They would return home and make the goods for a few days, before giving back the finished articles and getting paid. Workers were independent contractors: they were paid by the piece, not by the hour, and they had little if any guarantee of work week to week.

Accounts of what it was actually like to work from home in the 18th and 19th centuries are few and far between. Many putting-out workers were women, who were less likely to write autobiographies (women's dominance in the putting-out system also explains why generations of historians have not paid it much attention). Some characteristics nonetheless emerge from the archives. Average working hours were longer (see chart). Unlike today, where most people have one job, people flitted from one task to another, depending on where money could be made, like Sally Brown.

Some economic historians suggest that workers were mercilessly exploited under the putting-out system. Those who owned the machines and raw materials enjoyed enormous power over those they employed. With workers dispersed across a county, it was difficult for them to team up against exploitative bosses to demand better pay, let alone form trade unions. Bosses "could easily gang up against the rural spinner who faced a take-it-or-leave-it offer of work," argue Jane Humphries and Ben Schneider of Oxford University, in a paper from 2019. Some workers truly struggled. Thomas Hood's poem "The Song of the Shirt" evokes a home-working woman labouring in poverty.

As a result, some historians welcome the development of the factory system from the late 18th century onwards. Workers moved from a place where domestic life intermingled freely with economic production to a place solely dedicated to the pursuit of efficiency. It is hardly surprising that labour productivity was higher in the factory, nor that the factory system gradually outperformed the putting-out system and came to replace it. Crammed together in a factory, workers could more easily club together to ask for higher wages; trade unions started to grow from the 1850s onwards. According to English data, factory workers were paid 10-20% more than home-workers.

But is that the whole story? Some home-workers resisted the shift to the

factory system—most notably by joining the Luddites, a society of English textile workers in the 19th century who smashed up machines which they perceived were putting them out of a job. Another explanation is that factory owners, at least in the short term, had little option but to offer higher wages in order to entice workers from their homes. That suggests that home-working had its advantages.

One such advantage was economic. Home-workers may have been poorly paid relative to factory folk, but they could earn income by other means. Wool-industry home-workers would receive a given quantity of material and were then supposed to return the same weight of material fashioned into stockings. But by exposing the wool to steam, it would weigh more, allowing the workers to keep some of the raw materials.

That was not the only advantage. Home-workers in rural or semi-rural areas could forage for fuel and food, and so boost their meagre incomes. One observer in 1813 noted sniffily that women in Surrey, a county close to London, were making three shillings a week from cutting down heath to make brooms—“miserable productions and trifling employments”, in his view. But three shillings a week was not far off average female earnings at the time.

Home-workers also had more control over their time. So long as the work was done to the required standard and on time, they were not told exactly when or how to do it. That was in sharp contrast to the factory, where every aspect of life was planned in advance and workers were closely monitored. And home-workers could decide on the exact mix between work and leisure—in contrast to factory workers, who either worked the 12- or 14-hour days stipulated by the factory owner or none at all. Average working hours in the 18th century were shorter than they became in the 19th. After drinking heavily on Sunday evening, home-workers often took the day off before they went “reluctantly back to work Tuesday, warmed to the task Wednesday,

and laboured furiously Thursday and Friday”, as David Landes, an economic historian at Harvard University, put it. People also got more sleep.

This greater autonomy was especially important for mothers. In a world where men did little by way of family work, women could combine child care with contributing to the family income. It was far from easy. Sometimes women would give their infants “Godfrey’s Cordial”, a mixture of sugar syrup and laudanum, to knock them out for a while. But home-working allowed for the combination of paid work and family work in a way that the factory system did not. As factories spread, female labour-force participation fell.

In 1920 Max Weber, a German sociologist, argued that the separation of the worker’s place of work from their home had “extraordinarily far-reaching” consequences. The factory was more efficient than the home-based system which had preceded it—but it was also a space in which workers had less control over their lives, and where they had much less fun. Depending on how permanent it proves to be, today’s pandemic-induced shift back to the home could have similarly far-reaching effects. ■



经济的往昔

厂与家

就算在18和19世纪，在家工作也有其优势

莎莉·布朗（Sally Brown）于19世纪初出生在佛蒙特州。她的日程安排总是变来变去，带有那个时代职业女性的鲜明特点。她的日记显示，今天她在对长筒袜做最后的加工，明天在挤牛奶，隔天又在梳理羊毛。她所有的活都是在家完成的。

白领们在2020年这一年从办公室转移到了餐桌，这似乎前所未有，而且好像没了Slack和Zoom不行。但这并不是什么新鲜事。事实上，居家工作的历史跟今天有一些惊人的相似之处。

从17世纪头十年到19世纪中叶资本主义于英国和其他地方兴起时，它并不主要发生在工厂，而是在人们的家里。工人在厨房或卧室里制作从衣服、鞋子到火柴盒的各种东西。亚当·斯密在1776年写下《国富论》时，在家工作司空见惯。斯密对扣针生产过程的劳动分工有过著名的描述，但它并不发生在黑暗、邪恶的工厂中，而是一个十个人左右的“小制造厂”——它很可能就在某人的房子里，或者紧挨着某人的房子。

不同的历史时期都有多少人在家工作？对此很难给出确切的数字。即使是在经济数据统计比其他任何国家都要久远的英国，也是直到1805年前后才开始有可靠的劳动力数据。不过，其他地方留下了线索。其中之一与“房子”（house）一词的意思有关。今天这个词会让人想起家庭生活，但在19世纪前它的意思要宽泛得多，“-house”这个后缀的意思也涵盖经济生产。

《圣诞颂歌》（A Christmas Carol）中的斯克鲁奇（Scrooge）就在一个“账房”（counting-house）里工作。建筑也留下了其他证据。在英国，许多18世纪建造的房子楼上仍有着异常大的窗户：当时在里面工作的织布工需要尽可能多的光线。

大约在1900年，法国行政人员率先调查人们的工作地点，而不仅仅了解他

们的工作内容。他们发现法国有三分之一的制造业劳动力在家工作。丹麦大约在同一时间开展调查，发现所有劳动力中有十分之一全职在家工作。这些研究发生时正值基于工厂的生产制度发展的最高点，在此前的几十年里，在家工作的人的比例还要高得多。运用官方数据对美国的一项估计显示，在19世纪头几年，总劳动力中超过40%的人在家工作。一直要到1914年，大部分劳动人口才在办公室或工厂里工作。

在家工作的工业劳动力的出现有两个主要原因。进入17世纪后，全球贸易和人均收入的增长提高了对毛织品和手表等制成品的需求。但是比起大型工厂，新兴的技术更适合小规模的劳动（启动了工业革命的珍妮纺纱机直到18世纪60年代才被发明出来）。家成了顺理成章的选择。

由此出现了所谓的“散工制”。工人们从中央仓库领取原材料，有时也会领设备。他们会回家做几天活，然后上交成品，拿到报酬。工人是独立的承包商：他们按件而不是按小时计酬，而且基本上也不能保证周周都有活干。

关于18和19世纪居家工作的真实情况的记述少之又少。许多散工是女性，她们写自传的可能性更小（散工制中女工数量之多也解释了为什么历代历史学家都没怎么太关注这个制度）。然而还是能从档案中捕捉到一些特征。当时的平均工作时间更长（见图表）。今天大多数人都只做一份工作，而那时的人会从一份活计跳到另一个，全看哪里有钱可赚，就像莎莉·布朗那样。

一些经济史学家认为，工人在散工制之下受到了无情的剥削。对于自己雇来的人，拥有机器和原材料的人享有巨大的权力。由于工人分散在郡内各处，他们很难联合起来向剥削人的老板要求加工资，更不用说成立工会了。牛津大学的简·汉弗莱斯（Jane Humphries）和本·施耐德（Ben Schneider）在2019年的一篇论文中指出，老板们“很容易联合起来，打压那些没什么选择，‘要么干，要么走人’的农村纺织工人”。一些工人确实挣扎过活。读托马斯·胡德（Thomas Hood）的诗《衬衫之歌》（The Song

of the Shirt），脑海中就会浮现在家工作的贫苦妇女辛苦劳作的画面。

因此，一些历史学家很认可自18世纪末开始的工厂制度的发展。工人们从一个家庭生活与经济生产无阻碍交融的地方搬到了一个专门追求效率的地方。工厂的劳动生产率更高不足为奇，工厂制度的效益逐渐优于散工制并最终取代了散工制也不让人意外。在人挤人的工厂，工人可以更方便地聚结在一起，要求更高的工资；从19世纪50年代起，工会开始发展。根据英国的数据，工厂工人的工资比在家工作的工人高10%到20%。

然而这就是事情的全貌了吗？一些在家工作的人抵制向工厂制度的转变——最明显的表现就是加入路德派，这个由19世纪英国纺织工人组成的团体捣毁了他们认为会让他们失业的机器。另一种解释是，工厂主别无选择，只能通过提高工资来吸引工人走出家门，至少短期内是如此。这表明在家工作有其优势。

其中一个优势是财务上的。相比工厂工人，在家工作的人可能收入较低，但他们可以通过其他方式赚取收入。毛纺业的居家工作者会收到一定数量的原料，然后要按要求交还与所耗费原料重量相等的长袜。但是，将羊毛在蒸汽中蒸烫后可以增加重量，这样工人就能留下一些原料。

这还不是唯一的优势。农村或半农村地区的居家工作者可以在外面寻觅燃料和食物，从而增加他们微薄的收入。1813年，一位观察者不屑地指出，在离伦敦不远的萨里郡，妇女砍伐灌木来做扫帚，每周能赚三先令——在他看来，她们的“产品可怜兮兮，工作也微不足道”。但是，每周三先令快赶上当时女性的平均收入了。

在家工作的人也对自己的时间有更多支配权。他们无需遵循具体的工作时间和工作方式，只要能依照标准按时完成工作就行。这与工厂形成了鲜明的对比，在工厂里，生活的方方面面都是预先计划好的，工人们也会受到密切监视。在家工作的人可以自主分配工作和休闲的时间，而工厂工人要么得按照厂主的规定每天工作12或14小时，要么一整天一点活也不干。18世纪的平均工作时长比19世纪要短。正如哈佛大学的经济史学家大卫·兰

德斯（David Landes）所说，周日晚上喝个烂醉后，在家工作的人周一通常会休息一天，“周二不情不愿地回到工作岗位，周三找找工作状态，周四和周五再拼命苦干”。当时人们的睡眠时间也更多。

这种更大的自主权对母亲来说尤其重要。在一个男人几乎不做家务的世界里，这可以让女人兼顾照看孩子和增加家庭收入。这绝非易事。有时候，女人会给她们的婴儿喂一种叫“戈弗雷香酒”的糖浆和鸦片酊的混合物，让他们昏睡一段时间。但是，在家工作使得有偿工作和家务相结合成为可能，这是工厂制度不能给予的。随着工厂的扩张，女性劳动力参与率下降了。

德国社会学家马克斯·韦伯在1920年指出，工人的工作场所与家的分隔产生了“极其深远”的后果。工厂的效率要比之前基于家庭的制度高，但在工厂这个空间里，工人对自己生活的支配力更小，乐趣也少得多。今天，由疫情引发的向家庭的回归可能会产生同样深远的影响，待看它会持续多久了。 ■



The highest fidelity

An auricular spectacular

Tricking the brain about where a recorded sound is coming from can enrich the listener's experience

HUMAN BEINGS are good at locating the sources of sounds. Even when blindfolded, most people can point to within ten degrees of the true direction of a sound's origin. This is a useful knack for evading danger. It is also an extraordinary cerebral feat. Partly, it is a matter of detecting minute differences of volume in each ear. Partly, it comes from tiny disparities in the time it takes a sound to reach two ears that are not equidistant from its source. The heavy lifting of sound-location, however, involves something else entirely.

Audio buffs call it the head-related transfer function. A sound is modulated by the body parts it encounters before it reaches the eardrums. In particular, the various tissues of the head attenuate higher frequencies, weakening the top notes of sound waves that have passed to an eardrum through the skull compared with those from the same source that have arrived directly through the air. The cartilaginous ridges, troughs and protuberances of the outer ear also alter sound before it is transduced into nerve signals. Sounds arriving from different angles are therefore modified in consistent ways that the brain learns to recognise.

For all of their acoustic spatial awareness, however, brains can still be fooled by appropriate technology into believing a sound is coming from somewhere that it is not. That sounds like the basis of a big business. And it is.

One way to simulate the "immersive" sound of reality through a pair of earbuds is by using a pair of recordings made with microphones embedded

in the ear canals of a special dummy head. These heads are made to have the same shape and density as those of their flesh-and-blood counterparts. That means they modulate sound waves passing through them in a realistic manner. Recordings made using them therefore log what would arrive at the ear canals of someone listening to the sound in question for real. When they are played back, what a user hears recapitulates that experience, including the apparent directions from which the sounds are coming.

Dummy-based binaural recordings of this sort have been around for a while. But making them is clunky. It is also expensive. A good dummy head can cost \$10,000, and time in a professional recording studio is hardly cheap. These days, though, the process can be emulated inside a computer. And that is leading to a creative explosion.

The trick that the emulator must master is a process called phase modulation. This involves retarding a sound's high, medium and low frequencies by the slight but varying fractions of a second by which those frequencies would be delayed by different parts of the ears and head in reality. So writing the appropriate software starts by collecting a lot of data on how sound waves interact with a human head, and that means going back to the studio to conduct special binaural recordings, often using people instead of dummies. The resulting signals can then be decomposed into their component frequencies, which yields an understanding of how to modulate a given frequency to make it seem as if it is arriving from a particular location.

Demand for software to mix sound in this way has shot up, says Lars Isaksson of Dirac Research, a firm in Uppsala, Sweden. Dirac developed its own version of such software, known as Dirac 3D Audio, by using a year's worth of recordings it made that encompassed each degree of rotation, both side to side and up and down, around a listener's head. This panaudicon provided, Mr Isaksson says, notable smoothness in the simulated

movement of sound sources. Makers of video games are a big market for such stuff.

Dirac is not alone. Half a dozen other firms, including Dolby Laboratories of America and Sennheiser of Germany, also now make immersive software. To use it, a sound engineer employs a graphic interface that includes a representation of a sphere surrounding an icon representing the listener. The engineer uses a mouse to move sound channels—vocals, percussion and so on, if the product is music—to the points in the sphere from which their outputs are intended to originate. Software of this sort provides a way to take any recording and “project it in 3D”, says Véronique Larcher, co-director of Sennheiser’s division for immersive audio.

Sennheiser’s product is called AMBEO. Dolby’s is called Atmos. This has generated the soundtracks of more than 20 video games and 2,500 films and television shows, as well as many pieces of music. Immersive sound may even come to videoconferencing. Dirac is promoting software that makes the voices of participants seem to emerge from the spots on the screen where their images appear. The software uses a laptop’s camera to track listeners’ heads. To those who look, say, left, it will sound as though their interlocutors are off to the right. Dirac is in talks with videoconferencing firms including BlueJeans, Lifesize and Zoom.

Facebook, a social-media company, is also designing “spatialised audio” for video calls that use its Oculus virtual-reality headsets. Ravish Mehra, head of audio research at Facebook Reality Labs, is coy about how long it will take his team to perfect the aural illusion that this is intended to create. But he says software the firm has in development can modify the frequencies and volumes of sounds so that they match the virtual surroundings chosen for a call, as well as the speaker’s perceived position. The acoustics of a beach, he notes, are unlike those of a room.

Such stuff is for the professionals. But amateurs can play too. For the man or woman in the street who wants to jazz up a record collection, many simpler programs now permit people to give a more immersive feeling to their existing recordings by running them through software that modulates the sounds of those recordings to achieve that end.

Programs of this sort cannot handle different parts of a recording differently in the way that studio-based systems manage, but they do create an illusion of sonic space around the listener. Isak Olsson of Stockholm, who has put together two such packages, 8D Audio and Audioalter, describes them as seeming to increase the size of the room. This helps to overcome a phenomenon known as the “in-the-head experience”. And, as Michael Kelly, head of engineering at Xperi, an immersive-software firm based in California, observes, sounds that appear to come from outside the head are more comfortable.

At the other end of the technological scale from such do-it-yourself kits, a number of firms, Dirac, Dolby, Facebook, Sony and Xperi among them, are working on a bespoke approach to sonic immersion. They are tailoring it, in other words, to an individual listener’s anatomy.

One method, that being used by Sony, is to ask potential customers to upload photographs of their ears. Another, which may be adopted by Xperi, is to repurpose data from the face-recognition systems that now unlock many people’s smartphones. If this way of thinking works, it will bring with it the ultimate in high fidelity. This is a recognition that, in the real world, even if what they are hearing is the same set of sound waves, every listener’s experience is different—and that this needs to be replicated in the world of recorded sound, too. With that realisation, acknowledgment of the head-related transfer function’s importance has reached its logical conclusion. And the term “headbanging” may take on a new and positive meaning. ■



最高保真

听觉盛宴

迷惑大脑，为它营造出虚幻的声音方位，可以丰富听者的体验

人类擅长定位声音的来源。即使被蒙上眼睛，大多数人也能准确判断声音的方位——误差不超过十度。这是一项实用的避险本领，也是大脑的一个非凡技艺。它部分是基于察觉音量在两耳中的细微差异，部分是因为两耳与声源的距离不等，导致声音在到达两耳时有细小的时间差。但声源定位中最难的部分完全缘于另一个因素。

音频行家称之为“头相关传输函数”。声音在到达鼓膜前会先被它经过的人体部位调制。尤其是头部的各种组织会削弱较高频的声音。因此，相比来自同一声源但通过空气直接传输到达鼓膜的声波，那些经过颅骨到达的声波的最高音部分会被减弱。在声音被转换成神经信号前，外耳的软骨嵴、耳窝和隆起也会改变声音。因此，来自不同角度的声音以始终如一的方式被调节，而大脑学会了识别这些差异。

然而，尽管大脑具备感知听觉空间的能力，但恰当的技术仍能欺骗大脑，让它错误判断声音的源头。这听上去像是能发展出一门大生意。事实也的确如此。

若要用一副耳机来模拟“沉浸式”实境音效，方法之一是在一个专用的仿真人头的耳道里植入一对麦克风，用这对麦克风录制一组录音。这些仿真人头的形状和密度都制作得和有血有肉的真人头部一样，这样它们就会像真人头部那样调制通过其中的声波。由此得到的录音记录了在现实环境中声音传到听者耳道时的状况。当这些录音通过耳机回放时，那种听觉体验就会在听者耳中重现，包括这些声音听起来是从哪些方向传来的。

这种基于人体模型的双声道录音已经面市一段时间了。但制作这种录音既繁重又昂贵。一个像样的仿真人头的造价可能要一万美元，而且租用专业录音棚也不便宜。不过，现在可以用计算机模拟这个过程。这带来了创新

的激增。

用计算机模拟必须掌握一种叫作相位调制的方法。它需要把声音的高、中、低频部分以不同的幅度各做几分之一秒的短暂延迟，和现实中耳朵和头的不同部位对不同频率声音的延迟一样。因此，要编写出合适的软件首先要收集大量声波与人类头部相互作用情况的数据，这意味着还是要回到专业录音棚完成专门的双声道录音，这往往使用的是真人而不是仿真人。生成的信号而后被分解成不同的频率，从而得知应该如何调制某个频率，使它听上去似乎来源于一个特定的位置。

位于瑞典乌普萨拉（Uppsala）的Dirac Research公司的拉尔斯·伊萨克松（Lars Isaksson）表示，对这样的混音软件的需求已经激增。Dirac公司自己也开发了一款名为Dirac 3D Audio的混音软件，利用了它制作的长达一年的录音，其中的音源围绕听者头部上下左右各个旋转角度变换方位。伊萨克松表示，这种全景式声音在模拟声源运动时的流畅性非常出众。电子游戏开发商是这类软件的大客户。

Dirac并不是独此一家。包括美国杜比实验室（Dolby Laboratories）和德国森海塞尔（Sennheiser）在内的其他五六家公司也在设计沉浸式软件。在使用这类软件时，录音师打开一个图形界面，其中包括一个球体，包裹着一个代表听众的图标。录音师用鼠标把声道（如果制作的是音乐，那么这些声道就是人声、打击乐等）移动到球体中不同的点上，这样这些声道上的声音输出就会从这些位置发出。森海塞尔沉浸式音频部门的联合负责人维罗妮卡·拉尔谢（Véronique Larcher）说，使用这类软件可以处理任何录音，让它“以3D形式呈现”。

森海塞尔的产品叫AMBEO。杜比的叫Atmos。除了许多音乐作品，还有超过20款电子游戏、2500部电影和电视节目使用了这种软件来生成配音。沉浸式声音甚至可能用于视频会议。Dirac正在推广一款软件，可以让与会者的声音听起来好像是从他们在屏幕上的图像位置发出来的。该软件使用笔记本电脑的摄像头跟踪听者的头部。比如，在那些往左边看的人听来，他们的谈话对象好像在向右边移动。目前Dirac正在与BlueJeans、

Lifesize和Zoom等视频会议公司洽谈。

社交媒体公司Facebook也在为自己的Oculus VR头显的视频通话设计“空间音频”。Facebook现实实验室（Facebook Reality Labs）的音频研究负责人拉维什·梅赫拉（Ravish Mehra）不愿透露他的团队需要多长时间才能完善“空间音频”想要营造的听觉幻象。但他表示，Facebook正在开发的软件可以调整声音的频率和音量，使之与通话者选择的虚拟环境以及通话者所显示的位置相匹配。他指出，在海滩和在室内的声学设计是不一样的。

这些软件是为专业人士设计的，但业余爱好者也可以玩。对于那些想为自己收藏的唱片增添趣味的普通人来说，现在有很多更简单些的程序可以做到这一点，它们能给唱片调音，带来更多身临其境的感觉。

尽管这类程序无法像录音棚级别的系统那样对唱片的不同部分采取不同的处理方式，但它们确实在听者周围营造了一种声音的空间幻象。斯德哥尔摩的伊萨克·奥尔森（Isak Olsson）把两个这样的软件包——8D音频和Audioalter——整合在一起用，他说这似乎让房间变大了。这有助于克服一种叫作“头中效应”的现象。并且，正如加州的沉浸式软件公司Xperi的工程主管迈克尔·凯利（Michael Kelly）所说，感觉上来自头脑之外的声音听起来更舒服。

不同于这样的DIY设备，在技术“音阶”的另一端，包括Dirac、杜比、Facebook、索尼以及Xperi等在内的许多公司正在研发沉浸式定制音效。换言之，它们正在根据听者各自不同的身体构造为他们量身定做沉浸式音效。

索尼正在采用的方法是请潜在客户上传他们耳朵的照片。Xperi可能会采用另一种方法，把现在很多人用来解锁手机的人脸识别系统的数据改用于设计音效。如果这类思路奏效，它将带来最高的保真度。这也就等于承认在现实世界中，即使听到的是同一组声波，不同听者的体验也各不相同——而这一点也需要在录音的世界里加以复制。实现了这一点后，对“头相关传递函数”重要性的认知才达到了它唯一合理的结论。而“重金属乐迷

的疯狂甩头”这个词可能会有新的正面含义。 ■



The Economist film

Disrupting Corruption 2 - Ukraine

While clean leadership is vital to tackling corruption, so is having the ability to spot it. In Ukraine, another country with a deep history of corruption, the struggle for greater financial transparency has been hard fought.



经济学人视频

颠覆者系列 | 大数据反腐：乌克兰

清廉勤政是打击腐败的重要一环，但对腐败行为的识别能力也很重要。乌克兰曾经腐败成风，争取财政透明化的进程更是得来不易。



Covid-19

Variations on a theme

SARS-CoV-2 is following the evolutionary rule book to perfection

NATURAL SELECTION is a powerful force. In circumstances that are still disputed, it took a bat coronavirus and adapted it to people instead. The result has spread around the globe. Now, in two independent but coincidental events, it has modified that virus still further, creating new variants which are displacing the original versions. It looks possible that one or other of these novel viruses will itself soon become a dominant form of SARS-CoV-2.

Knowledge of both became widespread in mid-December. In Britain, a set of researchers called the Covid-19 Genomics UK Consortium (COG-UK) published the genetic sequence of variant B.1.1.7, and NERVTAG, a group that studies emerging viral threats, advised the government that this version of the virus was 67-75% more transmissible than those already circulating in the country. In South Africa, meanwhile, Salim Abdool Karim, a leading epidemiologist, briefed the country on all three television channels about a variant called 501.v2 which, by then, was accounting for almost 90% of new covid-19 infections in the province of Western Cape.

Britain responded on December 19th, by tightening restrictions already in place. South Africa's response came on December 28th, in the wake of its millionth recorded case of the illness, with measures that extended a night-time curfew by two hours and reimposed a ban on the sale of alcohol. Other countries have reacted by discouraging even more forcefully than before any travel between themselves and Britain and South Africa. At least in the case of B.1.1.7, though, this has merely shut the stable door after the horse has bolted. That variant has now been detected in a score of countries

besides Britain—and from these new sites, or from Britain, it will spread still further. Isolated cases of 501.V2 outside South Africa have been reported, too, from Australia, Britain, Japan and Switzerland.

So far, the evidence suggests that despite their extra transmissibility, neither new variant is more dangerous on a case-by-case basis than existing versions of the virus. In this, both are travelling the path predicted by evolutionary biologists to lead to long-term success for a new pathogen—which is to become more contagious (which increases the chance of onward transmission) rather than more deadly (which reduces it). And the speed with which they have spread is impressive.

The first sample of B.1.1.7 was collected on September 20th, to the south-east of London. The second was found the following day in London itself. A few weeks later, at the beginning of November, B.1.1.7 accounted for 28% of new infections in London. By the first week of December that had risen to 62%. It is probably now above 90%.

Variant 501.V2 has a similar history. It began in the Eastern Cape, the first samples dating from mid-October, and has since spread to other coastal provinces.

The rapid rise of B.1.1.7 and 501.V2 raises several questions. One is why these particular variants have been so successful. A second is what circumstances they arose in. A third is whether they will resist any of the new vaccines in which such store is now being placed.

The answers to the first of these questions lie in the variants' genomes. COG-UK's investigation of B.1.1.7 shows that it differs meaningfully from the original version of SARS-COV-2 in 17 places. That is a lot. Moreover, several of these differences are in the gene for spike, the protein by which coronaviruses attach themselves to their cellular prey. Three of the spike

mutations particularly caught the researchers' eyes.

One, N501Y, affects the 501st link in spike's amino-acid chain. This link is part of a structure called the receptor-binding domain, which stretches from links 319 to 541. It is one of six key contact points that help lock spike onto its target, a protein called ACE2 which occurs on the surface membranes of certain cells lining the airways of the lungs. The letters in the mutation's name refer to the replacement of an amino acid called asparagine ("N", in biological shorthand) by one called tyrosine ("Y"). That matters because previous laboratory work has shown that the change in chemical properties which this substitution causes binds the two proteins together more tightly than normal. Perhaps tellingly, this particular mutation (though no other) is shared with 501.V2.

B.1.1.7's other two intriguing spike mutations are 69-7odel, which knocks two amino acids out of the chain altogether, and P681H, which substitutes yet another amino acid, histidine, for one called proline at chain-link 681. The double-deletion attracted the researchers' attention for several reasons, not the least being that it was also found in a viral variant which afflicted some farmed mink in Denmark in November, causing worries about an animal reservoir of the disease developing. The substitution is reckoned significant because it is at one end of a part of the protein called the S1/S2 furin-cleavage site (links 681-688), which helps activate spike in preparation for its encounter with the target cell. This site is absent from the spike proteins of related coronaviruses, such as the original SARS, and may be one reason why SARS-CoV-2 is so infective.

The South African variant, 501.v2, has only three meaningful mutations, and all are in spike's receptor-binding domain. Besides N501Y, they are K417N and E484K (K and E are amino acids called lysine and glutamic acid). These two other links are now the subject of intense scrutiny.

Even three meaningful mutations is quite a lot for a variant to have. Just one would be more usual. The 17 found in B.1.1.7 therefore constitute a huge anomaly. How this plethora of changes came together in a single virus is thus the second question which needs an answer.

The authors of the COG-UK paper have a suggestion. This is that, rather than being a chance accumulation of changes, B.1.1.7 might itself be the consequence of an evolutionary process—but one that happened in a single human being rather than a population. They observe that some people develop chronic covid-19 infections because their immune systems do not work properly and so cannot clear the infection. These unfortunates, they hypothesise, may act as incubators for novel viral variants.

The theory goes like this. At first, such a patient's lack of natural immunity relaxes pressure on the virus, permitting the multiplication of mutations which would otherwise be culled by the immune system. However, treatment for chronic covid-19 often involves what is known as convalescent plasma. This is serum gathered from recovered covid patients, which is therefore rich in antibodies against SARS-CoV-2. As a therapy, that approach frequently works. But administering such a cocktail of antibodies applies a strong selection pressure to what is now a diverse viral population in the patient's body. This, the COG-UK researchers reckon, may result in the success of mutational combinations which would not otherwise have seen the light of day. It is possible that B.1.1.7 is one of these.

The answer to the third question—whether either new variant will resist the vaccines now being rolled out—is “probably not”. It would be a long-odds coincidence if mutations which spread in the absence of a vaccine nevertheless protected the virus carrying them from the immune response raised by that vaccine.

This is no guarantee for the future, though. The swift emergence of these

two variants shows evolution's power. If there is a combination of mutations that can get around the immune response which a vaccine induces, then there is a fair chance that nature will find it. ■



新冠肺炎

主题变奏曲

新冠病毒正按进化规则趋于完美

自然选择是一股强大的力量。在具体过程仍存争议的情形中，它让一种蝙蝠体内的冠状病毒进入人体并逐渐适应。其演变结果已在全球传播。现在，在两个独立但同时发生的事件中，它进一步修改该病毒，形成了新的变种，正在取代原始毒株。其中两个新变种之一看来可能会很快成为新冠病毒的主要毒株。

人们从12月中旬开始普遍了解了这两个新变种。英国新冠肺炎基因组学联盟（Covid-19 Genomics UK Consortium，以下简称COG-UK）的研究人员公布了变种毒株B.1.1.7的基因序列，而追踪新发病毒的英国新发呼吸道病毒威胁顾问小组（NERVTAG）提醒英国政府，这种毒株的传染性比之前在英国国内流传的毒株高67%至75%。与此同时，在南非，著名流行病学家萨利姆·阿布德勒·卡里姆（Salim Abdoor Karim）通过全部三个电视频道向全国通报了一种名为501.v2的变种病毒，当时南非西开普省（Western Cape）的新冠肺炎新病例中近90%是感染了这种毒株。

英国在12月19日做出反应，收紧了现行的限制措施。南非则在12月28日确诊病例达到100万后行动起来，采取把宵禁延长两小时和重新实施禁酒令等措施。其他国家的应对方式是比之前更加严苛地限制本国与英国和南非之间的旅行。但这些不过是亡羊补牢，至少就B.1.1.7而言是这样的。英国以外的几十个国家已经检测到了这一变种，而且还会进一步从这些新地点或英国向外传播。另外，在南非以外，澳大利亚、英国、日本和瑞士也发现了感染501.v2的散发病例。

迄今为止的证据表明，这两个新变种尽管传染性更强，但就具体感染病例来看，都不比原来的毒株更危险。在这一点上，它们的变化符合进化生物学家对新病原体会寻求长期生存的预测，即变得传染性更强（增加继续传

播的机会），而不是更致命（降低传播机会）。两者已呈现的传播速度颇为惊人。

B.1.1.7毒株最早是在9月20日在伦敦以东南地区采集的样本中发现的。第二个样本于次日在伦敦发现。几周后，即11月初，B.1.1.7已占到伦敦新感染病例的28%。到了12月的第一周，这一比例已升至62%。现在可能已经超过90%。

501.V2变种也有类似的发展轨迹。它始于东开普省（Eastern Cape），第一批样本可追溯到10月中旬，此后蔓延至其他沿海省份。

B.1.1.7和501.V2变种的迅速流行带来了几个问题。首先，为什么这两者能如此大行其道？其次，它们是在什么情况下产生的？第三，它们会否让现在各地正在大量订购的新疫苗失效？

第一个问题的答案在于变体病毒的基因组。COG-UK对B.1.1.7的研究显示，它与原始新冠病毒有17处显著突变。这是很高的变异程度。而且其中多处突变出现在突刺蛋白这一新冠病毒用来与受体细胞结合的蛋白的基因上。研究人员尤其注意到其中三处突变。

首先是N501Y，它影响的是突刺氨基酸链的第501个位点。它是“受体结合域”（第319至541位点）中的六个关键接触点之一，有助突刺蛋白与目标——肺部气道上皮细胞表面的ACE2受体蛋白——结合。这个突变的名称中的字母表示名为酪氨酸（生物学符号为“Y”）的氨基酸替换了原本的天冬酰胺（“N”）。这一点很重要，因为之前的实验室研究表明，这种替换所导致的化学特性变化会使两种蛋白比一般情况下结合得更紧密。501.V2也有这种突变（虽然其他突变并不相同），也许很说明问题。

B.1.1.7的另两个耐人寻味的突刺突变是69-70del（第69和70位点的氨基酸缺失）和P681H（第681位点的氨基酸由脯氨酸变为组氨酸）。双位点氨基酸缺失引起研究人员关注的原因是多方面的，尤其是去年11月在丹麦养殖水貂中发现的新冠病毒变种中也存在这种变异，令人担忧水貂成为新冠病毒传播的动物宿主。而P681H被视为重要突变是因为它出现在突刺蛋白的

S1/S2弗林蛋白酶切割位点（第681至688位点）的一个端点，这个位点可以激活突刺准备与受体细胞结合。这个位点在关联性的冠状病毒（如最初的SARS病毒）的突刺蛋白中是不存在的，这可能是新冠病毒传染性如此之强的原因之一。

南非的501.v2变种只有三个显著突变，全部发生在突刺的受体结合域。除了N501Y之外，另两个突变是K417N和E484K（K和E分别代表赖氨酸和谷氨酸），研究员正密切研究这两个位点的突变。

即使只有三处显著突变，对于一个病毒变种来说也已经不少了。通常的情况是只有一处突变。因此，B.1.1.7中发现的17处突变是极为反常的现象。单个病毒是如何发生这么多变异的？这是第二个需要解答的问题。

COG-UK研究报告的作者提出了一种见解：B.1.1.7并非偶然性的变化累积结果，而可能是一个进化过程的结果——但该进化过程发生在一个人身上而非在一个人群中。他们观察到，有些人之所以会出现新冠肺炎慢性症状，是因为他们的免疫系统不能正常运作，因而无法清除病毒。研究员猜测，这些不幸的患者可能成为了病毒新变种的孵化器。

他们的理论是这样的。起初，这样的病人由于缺乏先天免疫力，给病毒造成压力较轻，令本该被免疫系统遏止的病毒变异大量出现。然而，慢性新冠肺炎的治疗往往涉及“恢复期血浆”，这是从康复的新冠患者身上采集的血清，因而富含对抗病毒的抗体。作为一种疗法，这往往是有效的。但施以多种抗体对患者体内已有的多样病毒造成了强大的选择压力。COG-UK的研究人员估计，这可能导致某些突变组合成功进化，而如果没有“恢复期血浆疗法”，这些变种可能本不会出现。B.1.1.7可能就是这么来的。

第三个问题——新冠病毒的这两个新变种是否能抵御现在推出的疫苗？答案是“多半不会”。在没有疫苗时就已出现的突变若能保护它们所在的病毒不被疫苗引起的免疫反应排斥，那会是极为偶然的巧合。

但将来就说不准了。这两个变种的迅速崛起显示了进化的力量。只要存在一种突变组合能绕过疫苗所引起的免疫反应，自然选择的力量就很有可能

找到它。 ■



Free exchange

A bug problem

China is intent on shrinking Ant. A lighter touch on fintech would be wiser

THERE ARE both petty and respectable explanations for China's assault on Ant Group. The fintech giant was less than 48 hours away from the world's biggest initial public offering when regulators halted it in November—the first in a series of moves aimed at taming the fast-growing firm. The petty is that Jack Ma, Ant's outspoken founder, had offended Chinese leaders with a blunt speech. The respectable is that the government needed to act because Ant threatened financial stability. As a state newspaper recently put it, Ant had become “too big to fail”, presenting itself as a tech firm but pumping out loans. The petty explanation, to the extent that it is right, can be dismissed as a China-specific problem, a reflection of the Communist Party's tightening grip on tycoons. But the respectable explanation deserves a hearing, not least because of its global resonance. As Apple, Facebook and Google get into payments and more, the question of how to regulate Big Tech on its forays into finance will become all the more prominent.

The main charge against Ant is that it offers what can be described as consumer subprime with tech characteristics. Its model is to identify small borrowers—both individuals and businesses—and supply them with credit from banks. Ant's customers only ever interact with its sleek app, yet it is an intermediary. It provides funding for just 2% of the value of the loans it distributes, with the rest coming from banks and other firms. Ant, in effect, serves as their agent, feeding them a constant stream of clients. The concern therefore is that, like subprime-mortgage originators in America in the early 2000s, Ant does not have enough skin in the game. What would stop it from lending carelessly? China's response includes a draft rule that would require Ant to fund 30% of its loans, which would force it to hold more capital and

slow it down. On December 27th the central bank also told Ant to return to its roots as a payments firm, a low-margin, low-risk business.

At first glance such measures may seem prudent. But there is a strong case to be made that lighter regulation would be the better approach. For a start, the parallel with subprime mortgages is not very good. Most of Ant's loans are small (as little as 20 yuan, or \$3, for consumers), with a tenor of just a few months or so, and spread across many sectors. It thus relies on a constant churning of credit. If bad loans surge, banks can scale back almost instantly. That is a far cry from subprime mortgages, much larger loans that ran for many years and were, by definition, all tied to the property market.

Given how new fintech still is, detailed studies of its impact have emerged only recently. They highlight another problem with excessive regulation: fintech is good for the economy, and smothering it could limit its potential. Three points stand out. First, fintech firms reach borrowers under-served by banks. As banks normally vet loans on a case-by-case basis, they prefer large, established clients. Fintech firms go for just the opposite. Harold Hau of the University of Geneva and other researchers examined Ant's loan offers to 2.9m vendors on an e-commerce site. They found that 39% of vendors with low credit scores in cities with low amounts of bank lending accepted Ant's offers, as against only 17% of those with high credit scores in cities with more bank lending.

A similar pattern exists elsewhere. Researchers at the Bank for International Settlements (BIS) looked at 79 countries during 2013-19. Where banking sectors were less competitive and banks had less incentive to pursue smaller clients, fintech lenders grew larger. They also seem less likely to discriminate by race. A study of America's mortgage market found that minority customers had similar rejection rates to white ones when using fintech firms, but 6% more rejections than white people via face-to-face lenders.

As valuable as inclusion is, it would not prove sustainable if a large share of fintech credit went bad. Hence the importance of the second point: the bedrock of data and algorithms on which it is built. Ant, for one, includes hundreds of variables in its credit model, from users' friend networks to their consumption patterns. Before the pandemic, the delinquency rate on its loans to small businesses was about 2%, compared with 6% for banks. In a paper from 2019, Jon Frost, then of the Financial Stability Board, and other economists turned to a hard case—Argentina—to test the hypothesis that fintech firms have an information advantage over banks. Sure enough, they did. The loss rate for Mercado Libre, an e-commerce firm, on loans to high-risk clients was 2.8%, about the same as banks' loss rate on their best small-business clients.

Lastly, far from endangering the economy, fintech lending may actually bolster its resilience. Leonardo Gambacorta of the BIS and others have examined more than 2m Chinese firms that borrowed from both Ant and conventional banks. Bank credit was closely tied to local house prices; loan officers trust it both as collateral and as a shorthand for gauging economic health. Fintech credit was uncorrelated with house prices and instead linked to measures of business health such as transaction volumes. The upshot is that in a housing downturn, banks tighten credit to small firms, worsening economic pressure. By contrast, without property as collateral, fintech lending may be more stable, limiting contagion.

None of this is to deny that fintech could give rise to new problems. In making credit easily available, consumers can end up with too much debt. Firms may misuse the data they hoover up. Regulators must be vigilant against fraud, which plagued China's peer-to-peer lending industry a few years ago. And for well-run firms, monopoly is a serious risk. Once big enough, Ant could use its market power to block competitors and extract more profits.

Perspective is needed, though. Fintech is still in its infancy. Ant is by far the biggest of the upstarts globally, but the outstanding value of all the loans it has arranged amounts to less than 1% of the total assets held by China's commercial banks. At this stage prudent regulators would not rein it in, but give it room to run. ■



自由交流

蚂蚁大小的问题

中国决意要让蚂蚁收缩。对金融科技少一些干预也许才更明智

中国为何突然重拳出击蚂蚁集团？对此事的解读有鸡毛蒜皮和像样本面的两种。去年11月，距这家金融科技巨头完成全球最大的IPO不到48小时之际，监管部门对其按下暂停键，开始了意在驯服这家迅速扩张的公司的一系列动作。对此鸡毛蒜皮的解读是直言不讳的蚂蚁创始人马云一次尖锐的发言冒犯了中国领导人。更上得了台面的解释是蚂蚁威胁到了金融稳定，需要政府出手干预。近期一份官方报纸写道，蚂蚁以科技公司自居却大量放贷，已经变得“大到不能倒”。前一种解读如果真的切中要害，则反映出共产党加强对商业大亨的掌控这种中国特色问题，可以被暂搁一边。后一种解释却值得关注，尤其考虑到它涉及一个全球共有的议题。随着苹果、Facebook和谷歌参与到支付等领域中，如何监管科技巨头进军金融业将成为日益突出的问题。

蚂蚁的主要罪状是它提供的产品实际上是带有科技特色的消费次级贷款。其商业模式是找到包括个人和企业的小额借款方，把来自银行的贷款提供给他们。在这一过程中其客户仅仅与它时髦流畅的应用发生互动，但它仍是其中的中介方。它发放的全部贷款中只有2%的资金来自蚂蚁，其余由银行和其他机构提供。蚂蚁实际上是这些机构的代理人，为它们提供源源不断的客户。因此，令人担忧的是蚂蚁在这整个链条中没有共担足够的风险，就像本世纪初美国次级抵押贷款的发起人那样。如何保证它不会轻率地放贷呢？为此中国起草了一项暂行办法，要求蚂蚁为其贷款出资不低于30%，这将迫使该公司持有更多资本，并放缓其扩张速度。12月27日，央行还要求蚂蚁回归其作为一家支付公司的本源——一种低利润、低风险的业务。

乍一看，这些措施是审慎的。但是，有充分的理由相信更宽松的监管会更好。首先，与次级房贷相提并论并不十分恰当。蚂蚁大部分的贷款都是小

额贷（消费贷低至20元），期限只有几个月左右，而且分散在众多行业。因此它依靠信贷的不断滚动。如果不不良贷款激增，银行几乎可以立即缩减规模。这与次级房贷的情形相去甚远，后者的规模要大得多，期限持续很多年，且顾名思义完全与房地产市场挂钩。

由于金融科技这一块仍然是新事物，有关其影响的详尽研究直到最近才开始出现。这些研究强调了过度监管的另一个问题：金融科技有益于经济，抑制它可能会限制它的潜力。这里有三大要点。首先，金融科技公司覆盖了银行服务不足的借款人。由于银行通常逐笔审查贷款申请，它们更青睐大型的成熟客户。而金融科技公司恰恰相反。日内瓦大学的哈罗德·豪（Harold Hau）和其他研究人员分析了蚂蚁集团向一个电商网站上的290万个商户提供的贷款。他们发现，在银行贷款总额偏低的城市里，39%的低信用评分商户接受了蚂蚁的贷款，而在银行贷款较多的城市里，高信用评分商户使用蚂蚁贷款的比例只有17%。

在世界其他地方也能观察到类似的情形。国际清算银行（BIS）的研究人员分析了79个国家在2013到2019年间的情况。在银行业竞争较少、银行追逐小型客户的动力更小的地区，金融科技贷款机构的发展规模都更大。这些机构的种族歧视倾向似乎也更低。一项对美国抵押贷款市场的研究发现，在使用金融科技公司的服务时，少数族裔客户被拒贷的比率与白人客户近似，但在传统机构内面对面申请贷款时，他们的被拒率要比白人高6%。

尽管普惠性非常重要，但如果金融科技信贷出现大面积坏账也会无法持续。因此第二点就非常重要了：金融科技立足于数据和算法。例如，蚂蚁的信用模型包含了数百个变量，涵盖了从用户的朋友网络到其消费模式等方方面面。疫情爆发前，它的小企业贷款的逾期率约为2%，而银行的该比率为6%。在2019年的一篇论文中，当时在金融稳定委员会（Financial Stability Board）任职的乔恩·弗罗斯特（Jon Frost）和其他经济学家用阿根廷这个棘手的案例来检验一个假设：金融科技公司相比银行拥有信息优势。果不其然，这个假设是成立的。电商平台美客多（Mercado Libre）对高风险客户的贷款损失率为2.8%，与银行在其最优质小企业客户上的损失

率相当。

最后，金融科技放贷非但不会危及经济，反而可能增强经济的韧性。国际清算银行的莱昂纳多·甘巴科尔塔（Leonardo Gambacorta）等人研究了从蚂蚁和传统银行借款的200多万家中国公司。银行信贷与当地房价密切相关：信贷员认为房产既是可靠的抵押品，又能大致衡量经济健康状况。金融科技公司的信贷与房价并不关联，而是与交易量等商业健康指标挂钩。其结果是，当房地产市场陷入低迷时，银行会收紧对小企业的信贷，从而加剧经济压力。相比之下，金融科技公司不以房地产为抵押品，其贷款可能更加稳定，有助于控制危机蔓延。

所有这些都不能否认金融科技可能会引发新问题。随着信贷变得更触手可及，消费者最终可能会负债累累。企业可能会滥用它们收集到的海量数据。监管机构必须警惕欺诈，几年前中国的P2P借贷行业就饱受欺诈困扰。而对于经营良好的公司，垄断是一个切实的风险。一旦体量足够大，蚂蚁可以利用其市场地位来阻遏竞争对手，榨取更多利润。

不过，这里需要以更全面的视角来准确、公正地评估现状。金融科技仍处于起步阶段。在该领域的新兴企业中，蚂蚁的规模遥遥领先，但它的未偿贷款总额还不到中国商业银行总资产的1%。在目前这个阶段，真正审慎的监管者不会勒紧缰绳，而是给予它奔跑的空间。 ■



The future of e-commerce

The great mall of China

The next big thing in retail comes with Chinese characteristics

ALMOST EVERYONE in China knows “Austin” Li Jiaqi. The 28-year-old “Lipstick Brother”, started out flogging make-up products in Nanchang, a provincial city, and now sells them to millions by live-streaming on Taobao, part of Alibaba, China’s biggest internet retailer—once shifting 15,000 sticks of lipstick in five minutes. Some will recognise Chen Yi, nicknamed “Little Monster”, a 24-year-old girl-next-door from the coastal city of Qingdao who sells sunscreen, snacks and lots more besides to her 20,000 followers on WeChat, a ubiquitous messaging app: a nice supplement to her day job as a bartender. More obscure but no less enterprising, farmers and fishermen show off juicy apples or prize lobsters in short videos, digital showmanship accompanied by new delivery networks that allow city dwellers to procure the produce.

Such are the faces—lipsticked, sunscreened, weather-worn or besnorkeled—that have helped propel an explosion of e-commerce in China. In rapid-fire videos or days-long jamborees, they flicker across hundreds of millions of smartphone screens in a cyber-bazaar that in 2019 was almost twice the size of those of America, Britain, Germany, Japan and South Korea combined—and growing faster (see chart 1).

As online shopping has soared, even before covid-19 added extra fuel, Chinese internet firms have dreamed up new ways to engage consumers. In contrast to Taobao, the new ventures do not yet make money. But they are growing apace. Chinese tech firms are pouring fortunes into them. Some of this capital flows straight back out as subsidies to entice buyers and sellers to the platforms, which clearly cannot go on for ever. But the effervescence

is here to stay—and Westerners are only starting to notice. “If you want to see the future, look at China,” Mark Schneider, boss of Nestlé, the world’s biggest food company, instructs his executives. Lubomira Rochet, head of digital marketing at L’Oréal, a French beauty behemoth, contrasts the bottom-up, “consumer-centric” vibrancy of Chinese e-commerce with the West’s “tech-driven”, top-down approach.

Some Western tech executives dismiss the Chinese experience as a function not of creativity and enterprise but of structural forces. They cite China’s higher mobile share of e-commerce—90% versus 43% in America (see chart 2). Others put it down to a concentrated market, where the top three firms, Alibaba, JD.com and Pinduoduo, account for more than 90% of all digital merchandise sales, a state of affairs that is beginning to trouble Chinese trustbusters, who on December 24th announced an investigation into Alibaba. In America the online titan, Amazon, and its two challengers, Shopify and eBay, accounted for less than 50%.

Yet a survey of Chinese e-commerce reveals genuine dynamism. It is not just Alibaba making the running. In a few years Pinduoduo has captured 14% of the market, helping to trim Alibaba’s share from 67% to 61%—and forcing the giant to moderate the “take rate” it charges those selling via its platforms. Digital firms from outside retail are muscling in, including Meituan, which started out in food delivery, and ByteDance, which owns TikTok and its Chinese short-video cousin, Douyin. The newcomers bring the sort of verve to online shopping in China that characterised America’s consumer boom of the 1950s and 1960s.

Indeed, to understand the evolution of Chinese e-commerce, look back to the birth of 20th-century consumerism in America. It was built around overlapping technologies. The car carried people to the suburbs, giving rise to the shopping mall, a place not just to shop but to mingle and have fun.

Although radio and television played a role, through advertising and product placement, Western retail's bedrock was—and continues to be—bricks and mortar. According to Bain, a consultancy, America has 3.3 times as much physical shop floor per person as China does. Bernstein, a broker, reckons that America's 330m people have 30 times as many malls as 1.4bn Chinese do.

The West's finest shops are as dazzling as ordering on Amazon is drab. They also represent legacy investments that retailers are loth to undermine. As a result, neither retailers nor their customers have had much of an incentive to shun them—at least before covid-19.

Not so in China. Like everyone else in the world, Chinese still buy most things in physical shops. Especially outside big cities, though, many of these are shabby. Some sell fake goods. So China's nascent middle class, armed with smartphones and broadband internet, finds online shopping both more rewarding and comfier than in the West, says Marc-André Kamel of Bain. A high population density makes delivery cheaper for consumers.

The result is a mix of shops, entertainment venues, food courts, games arcades and gathering places that replicates the 20th-century American mall in digital form, and hybrid links of the virtual with the physical. Videos show something being crafted by hand. Influencers draw attention to how the item is used. Friends recommend it (or not) on social media. Shoppers band together with other netizens to buy it in bulk at a discount. Live broadcasts turn the whole process into entertainment. And a network of real-world businesses delivers the purchases.

The anchor cyber-tenant is commonly a super-app like WeChat, which has 1.2bn users. It is owned by Tencent, China's biggest internet company—and directs traffic to JD.com and Pinduoduo, in which Tencent holds stakes. The line in people's minds between social networks and shopping websites

does not exist in China, notes Frédéric Clément of Lengow, a consultancy. Shoppers love it. Bernstein expects e-commerce to account for more than a quarter of all retail sales in China by 2021, roughly twice the share in America, even after the pandemic-induced stampede online.

The first pillar of this new retail architecture is “social commerce”. This relies on three related technologies: live-streaming, short-form video and social-networking. The biggest live-streamer is Alibaba’s Taobao Live. In just 30 minutes of presales for Singles Day, China’s answer to Black Friday, it notched up \$7.5bn-worth of sales, about as much as Amazon is thought to have sold in its “Prime Day” in October (which actually lasted 48 hours). In June Douyin set up its own shopping platform, having earlier hosted live-streams where the likes of Taobao teamed up with celebrity influencers to sell products. The video-app’s 600m daily users confer a valuable resource—their attention. In the autumn it made its proprietary debut on Singles Day.

Fitch, a ratings agency, thinks the market for live-stream retail neared 1trn yuan (\$153bn) in 2020, double the prior year’s amount (see chart 3). Kuaishou, Douyin’s short-video rival, expects the gross value of goods sold on live-streams to rise from 4.2% of online sales in 2019 to almost a quarter by 2025.

Live-streaming has boomed as covid-19 confined Chinese to their living rooms while many captivating alternatives, like Netflix, remained banned in the country. For people on relatively low salaries, the discounts on some of the merchandise are worth time spent glued to a live-stream. According to Elijah Whaley, marketing chief of PARKLU, one of a booming cottage industry of influencer agencies, Western brands shipped unsold products to China, where live-streams offered a way to flog them. Ms Rochet says L’Oréal’s boss in China was flooded with emojis, likes and questions when

he live-streamed a recent sales event. It included “lucky charms” that gave a few fortunate shoppers big discounts.

Many bargains are available for bulk purchases. This is where the social networks come in. Pinduoduo, founded in 2015 and now worth \$175bn, enables groups, often formed via WeChat, to haggle with merchants, especially on groceries. It still makes a loss and burns cash. But its revenues are soaring, by almost 90% year on year in the third quarter. Seven-year-old Xiaohongshu, or Little Red Book, is already one of China’s most popular apps for cross-border commerce, with an estimated 85m users, according to Tenba Group, a consultancy. Its customers, most of whom are young women, exchange shopping experiences via text, images and video. Tenba calls it a Chinese mix of Instagram and Pinterest, two American photo-sharing apps.

The second pillar of China’s great digital mall is familiar to Western retailers as “omnichannel”. Like social commerce, it too has boomed amid pandemic lockdowns and shop closures. In China the biggest e-emporiums have their own supermarket businesses, such as Alibaba’s Freshippo and JD.com’s 7Fresh grocery chain. JD.com also has what it calls a “new-markets” business, which works with some of China’s 6.8m local grocery stores. It ships them branded goods, delivers what is already on their shelves to local buyers, and feeds them data to optimise their operations.

Some physical retailers, for their part, offer digital coupons to encourage customers to pay a visit, as well as using live-streaming to generate buzz and, hopefully, foot traffic. Others offer “grab-and-go” shopping, including staffless stores and smart vending machines where payments are made by scanning QR codes.

Alibaba says that its hybrid sales more than doubled in the 12 months to March 2020, year on year, to 86bn yuan. They rose from 11% of its main

retail revenues to 17%. Sales from JD.com's supermarket business grew by 48% year on year in the third quarter. Meituan has broadened its speedy deliveries from takeaway meals to groceries. Mini-warehouses built by startups such as Missfresh, which promises 30-minutes grocery deliveries, are mushrooming in Chinese cities.

Before 2020 both social commerce and hybrid shopping provoked mostly bemusement in the West. Covid-19 has led to a swift reappraisal. As George Lee, Facebook's head of product, puts it, the pandemic was a "call to action". The social network caters to the 160m businesses, mostly small and medium-sized, that use its apps and had to shift online as authorities ordered many physical shops to shut.

In May it introduced Facebook Shops, enabling businesses to set up a single online store on its core social network and its sister app, Instagram. In November Instagram redesigned its home screen for the first time in years, introducing tabs called Reels and Shop, which promote short videos, as well as online retail. Facebook's messenger apps, including WhatsApp, can be used to communicate with businesses on its platforms and may eventually be used for sales. Facebook Live also does streaming. In December Walmart, America's largest supermarket chain, held what it called a "Holiday Shop-Along Spectacular" on TikTok, with which it has formed a partnership. It allowed viewers to buy some of its fashion items exhibited by celebrities directly via the video app, apeing what Douyin has been doing in China.

Vishal Shah of Instagram makes a distinction between "buying" and "shopping" to describe Facebook's aim—in other words, turning a utilitarian process into a more personal experience. Other social-media firms are moving in the same direction. Since 2020 Snapchat users can try on make-up and shoes virtually, bolstering what the app calls "shopability". Shopify has enlisted TikTok to enable its 1m-plus merchants to market their wares by video.

In omnichannel sales, as in most things e-commercial, Amazon is ahead of the pack. It owns almost 500 Whole Foods Market stores and has opened some Amazon Fresh grocers in America that offer free same-day delivery to some members of its Prime subscription service. But big-box retailers like Walmart and Target, whose in-store pickups on online purchases have been a hit with covid-wary shoppers fearful of crowded aisles, have made huge strides.

Not everyone thinks that America will follow the trail blazed by China. Bain says that recent inroads notwithstanding, social commerce accounts for a much smaller share of total retail sales in America than in China. Russell Grandinetti, Amazon's head of international retail, says consumers want different things at different times. Sometimes they just want to buy stuff quickly and cheaply, not be wowed by celebrities. He says Amazon pioneered certain browsing techniques, such as online book reviews and tips that "people who bought this also bought that". He notes that Prime Video and Twitch, Amazon's gaming platform, have attracted "millions of customers" primarily interested in entertainment to its free shipment of goods. As for live-streaming, "It just hasn't taken off in the West the same way it has in China."

It will do eventually, Mr Grandinetti thinks. Other observers point out that the sheer size of America's physical retail presence makes the logistics of weaving offline and online cheaper—which may encourage more hybrid shopping models. In other ways America will chart its own path. Pricier labour than in China may lead to faster automation of online fulfilment. Greater concern over privacy relative to convenience may dampen shoppers' appetite for sharing their spending habits with friends on social media.

And China's retail razzmatazz could yet lose its vim. An ageing population will eventually reduce supply of cheap warehouse workers and delivery drivers. That may mean higher delivery fees, longer waiting times, perhaps

even unions demanding better working conditions, further raising costs. Trust in influencers, particularly those paid big money to promote brands, is waning. Those making less may lose patience and stick to their day jobs. “The top 1% make a killing. The rest are starving artists,” says PARKLU’s Mr Whaley.

Perhaps the main reason Western firms have been slow to emulate Chinese e-commerce is not its inherent flaws but their overspecialisation. From Amazon’s home in Seattle and Facebook’s in Silicon Valley to Walmart’s in Bentonville, American companies have tended to focus on their core business—be it e-commerce, social media or supermarkets. Only recently have they begun to invade each other’s turf. In time that may lead to more blurring of business boundaries. As Eric Feng, Facebook’s head of commerce incubations, summed it up at a recent virtual panel, tongue only slightly in cheek: “China, you are the light that will show us the way.” ■



电子商务的未来

中国大卖场

零售业的下一个大事物具有中国特色

在中国，“奥斯汀”李佳琦几乎家喻户晓。这个28岁的“口红一哥”原先在南昌卖化妆品，现在在阿里巴巴旗下中国最大的互联网零售平台淘宝上向千百万消费者直播卖货，曾在五分钟内卖出1.5万支口红。有些人可能认得昵称“小怪兽”的陈怡（音译），这个来自沿海城市青岛的24岁邻家女孩在微信这款人人都在使用的即时通讯应用上向她的两万名粉丝销售防晒霜、零食和其他很多东西，很好地贴补了她在酒吧的正职收入。还有很多知名度不高但同样劲头十足的农民和渔民在短视频中展示他们多汁的苹果或高品质的大龙虾，这种在数字平台上的表现力加上新的配送网络让城市居民能够直接购买农产品。

就是这一张张涂着口红、擦着防晒霜、顶着风吹日晒或戴着潜水呼吸管的面孔推动了中国电子商务的爆炸式增长。在语速飞快的视频直播或持续数天的购物狂欢节中，它们在几亿台智能手机的屏幕上晃动。中国的网上集市在2019年的销售额几乎是美国、英国、德国、日本和韩国总和的两倍，并且增长还在提速（见图表1）。

在没有疫情推波助澜之前，线上购物就已经迅速发展，期间中国的互联网公司构想出了吸引消费者的新方法。和淘宝不同，这些新公司尚未盈利，但发展迅猛。中国的科技公司正向它们大量注资。部分资金被用作补贴来吸引买家和卖家加入平台，相当于一投进去就直接流出，这种模式显然不可持续。但火热的局面将继续下去，而西方人才刚刚开始注意到这些。“想预见未来，就看看中国。”全球最大的食品公司雀巢的老板马克·施耐德（Mark Schneider）告诉他的高管们。法国美妆巨头欧莱雅的数字营销主管卢博米拉·罗谢特（Lubomira Rochet）认为，中国生机勃勃的电子商务是自下而上、“以消费者为中心”驱动的，而西方的是“技术驱动”、自上而

下的。

一些西方科技主管不以为然，认为中国电子商务的发展靠的不是创造力和创业精神，而是结构性力量。他们指出中国移动电子商务占比达到90%，远高于美国的43%（见图表2）。其他一些人则将其归因于高度集中的市场：排名前三的公司（阿里巴巴、京东和拼多多）占到了电商销售总额的90%以上，这种局面开始引起中国反垄断机构的担心，已于12月24日宣布对阿里巴巴展开调查。在美国，在线巨头亚马逊以及它的两个挑战者Shopify和eBay所占比例加起来不到50%。

然而，对中国电子商务的一项调查表明它的活力“货真价实”。并非只有阿里巴巴一家在推动这个热潮。拼多多在短短几年间已经占领了14%的市场，部分导致了阿里巴巴的市场份额从67%减少到61%，并迫使这家巨头降低了对其平台上的卖家收取的“佣金率”。零售业以外的数字公司纷纷强势挤入，其中包括以食品外卖起家的美团和拥有抖音及其海外版TikTok的字节跳动。这些后来者为中国线上购物带来的活力与美国上世纪五六十年代的消费热潮很相似。

实际上，要理解中国电子商务的演进，可以回顾一下20世纪美国消费主义的诞生。后者出现的基础是多种技术同时发挥作用。当时汽车将人们带到郊区，催生了大型购物中心，人们在这些商城里不光购物，也展开社交和娱乐。尽管广播和电视通过广告和产品植入发挥了一定作用，但西方零售业的基石过去是实体店，目前仍是。根据咨询公司贝恩的说法，美国人均实体店铺面积是中国的3.3倍。经纪公司盛博估计，3.3亿美国人拥有的购物中心数量是14亿中国人的30倍。

逛西方最高档的实体店铺令人眼花缭乱，与在亚马逊上点击下单的平淡乏味对比鲜明。这些店铺也是零售商很不想要去破坏的传统投资。其结果就是零售商和顾客都不大有意愿去绕开实体店——至少在疫情之前是这样。

在中国不是这样。和世界上其他地方的人一样，中国人仍然在实体店里购买大多数产品。但许多实体店的购物环境简陋，尤其是在大城市以外的地

方。有些还卖假货。因此，比起西方国家，拥有智能手机和宽带互联网的中国新兴中产阶级觉得线上购物更有成效也更自在，贝恩的马克·安德烈·卡梅尔（Marc-André Kamel）说。人口密度高也降低了消费者要承担的递送成本。

结果就形成了一个商店、娱乐场馆、美食广场、游戏厅和聚会地的综合体——以数字形式复制了20世纪的美国购物中心——以及连接虚拟与实体空间的混合链路。视频展示手工制品，网红示范其使用方式，朋友在社交媒体上推荐（或不推荐）购买。消费者与其他网民一起以折扣价“团购”。直播将整个过程变成了一种娱乐。最后由实体企业网络送货上门。

这个网上购物中心的主要驻场租户通常是一个超级应用，比如拥有12亿用户的微信。微信为中国最大的互联网公司腾讯所有，并将流量引向腾讯持股的京东和拼多多。在中国，人们脑中并不存在社交网络和购物网站之间的界限，咨询公司乐售（Lengow）的弗雷德里克·克莱门特（Frédéric Clément）说。消费者很喜欢这种形式。盛博预计，即使在疫情引发的线上购物潮过去之后，到2021年电子商务仍将占中国零售总额的四分之一以上，约为美国该比例的两倍。

这种新零售架构的第一个支柱是“社交商务”。它依赖三种相关联的技术：直播、短视频和社交网络。最大的直播平台是阿里巴巴的淘宝直播。双十一（中国版黑色星期五）预售刚开启30分钟，销售额就达到75亿美元，差不多等同于亚马逊在10月的“Prime Day”（实际上持续了48小时）估计达到的销售额。淘宝之类的商家也与名人网红合作，在抖音上直播带货，这推动抖音于去年6月开设了自己的购物平台。抖音的六亿日活用户贡献了一个宝贵的资源——他们的注意力。到了秋天，抖音也推出了自家的第一个“双十一”购物节。

评级机构惠誉（Fitch）认为，2020年直播零售的市场规模接近一万亿元，是2019年的两倍（见图表3）。抖音的短视频竞争对手快手预计，到2025年，直播销售的商品总价值在线上销售中的占比将从2019年的4.2%增长到近四分之一。

中国人因疫情困在家中，而奈飞（Netflix）等许多“吸睛”的替代选择在中国仍然被禁，直播得以蓬勃发展。对于薪水相对较低的人来说，为了获得某些商品的折扣，花时间追直播是值得的。居家式网红中介行业蓬勃发展。其中一家网红中介公司PARKLU的营销主管伊利亚·惠利（Elijah Whaley）说，西方品牌把卖不出去的产品运到中国，通过直播渠道清货。罗谢特说，欧莱雅中国区的老板在最近一次直播销售活动中受到扑面而来的各种表情、点赞和提问冲击，疲于应对。这场直播还送上了“幸运大礼包”，为几名幸运顾客提供了超值折扣。

批量购买有各种砍价的空间。这就轮到社交网络出场了。成立于2015年的拼多多现在市值1750亿美元，让消费者可以组团——通常是通过微信来拼团——与商户讨价还价，尤其是对日用品。拼多多仍在亏损，继续烧钱。但其营收正在迅速增长，去年第三季度同比增长了近90%。咨询公司天马的数据显示，推出七年的小红书已经是中国最受欢迎的跨境电商应用之一，估计有8500万用户。其顾客以年轻女性为主，她们通过文字、图片和视频交流购物经验。天马称小红书是Instagram和Pinterest这两个美国照片共享应用的中国结合版。

中国宏伟的数字商城的第二大支柱是西方零售商熟知的“全渠道”或称“全通路”。和“社交商务”一样，全渠道模式也在疫情封锁和商店关闭期间蓬勃发展。在中国，最大的几家电子商场拥有自己的实体超市业务，例如阿里巴巴有盒马鲜生，京东有7Fresh生鲜连锁。京东还有它所谓的“新通路”业务，与全中国680万家日杂店中的一部分展开合作。京东向它们运送品牌商品，把店里货架上已有的商品配送给本地买家，并向它们提供数据以优化它们的运营。

某些实体零售商则会提供数字优惠券以鼓励顾客到店消费，也通过网上直播来吸引关注，希望能增加到店客流。还有些实体店提供“无结账”购物，包括扫码支付的无人商店和智能自动售货机。

阿里巴巴表示，在截至2020年3月的12个月里，其混合渠道销售额同比增

长一倍以上，达到860亿元，在它的主要零售收入中的占比从11%上升到17%。京东超市业务的销售额在第三季度同比增长48%。美团已将其配送业务范围从外卖扩展到了生鲜杂货。由承诺30分钟送日杂到家的每日优鲜等创业公司建立的迷你仓库正在中国的城市里遍地开花。

在2020年之前，社交商务和线上线下混合购物在西方触发的反应大多是茫然。疫情让人们迅速重新审视这两种模式。正如Facebook的产品负责人乔治·李（George Lee）所说，疫情就像是“行动号令”。Facebook旗下各类应用有1.6亿个企业用户，其中大多数是中小型企业，在政府下令许多实体店歇业后，不得不迅速转战线上。

去年5月，Facebook推出了Facebook Shops，让企业可以在其核心社交网络及姊妹应用Instagram上创建一个统一的在线商店。11月，Instagram的主界面多年来首次改版，新增了名为Reels和Shop的标签，推广短视频和在线零售。Facebook旗下包括WhatsApp在内的即时通讯应用可用来联系其平台上的企业，最终可能用于销售。Facebook Live也可以做直播。12月，美国最大的连锁超市沃尔玛在TikTok上举行了名为“节日一起购”的直播活动（两者已建立了合作伙伴关系）。这次活动模仿抖音在中国的做法，让观众可以直接通过TikTok购买网红们展示的时尚商品。

Instagram的维沙尔·沙阿（Vishal Shah）在描述Facebook的目标时区分了“买”（buying）和“逛”（shopping）这两个词——也就是把一个实用性的过程转变成更个人化的体验。其他社交媒体公司也在朝着这个方向走。从2020年起，Snapchat用户可以虚拟试妆试鞋，增强了这款应用所说的“可逛性”。Shopify已与TikTok合作，帮助其100多万商家通过视频营销商品。

和大多数与电子商务有关的事情一样，亚马逊在全渠道销售上也领先一步。它拥有近500家全食超市（Whole Foods Market）门店，并在美国启动了部分Amazon Fresh生鲜服务，向它的一部分Prime订户免费当日送货。但沃尔玛和塔吉特（Target）等大型零售商也在全渠道这一块大踏步向前：警惕新冠病毒的购物者对拥挤的超市过道心存畏惧，使得“网上下单、到店提货”的方式大受欢迎。

并非所有人都认为美国会走上中国开辟的道路。贝恩认为，尽管最近取得了一些进展，但社交商务在美国零售总额中的占比要比在中国小得多。亚马逊国际零售业务负责人罗素·格兰迪内蒂（Russell Grandinetti）表示，消费者在不同的时间有不同的需求。有时候他们只是想快速买好价格不错的东西，没空去捧网红们的场。他说，亚马逊率先推出了某些浏览方式，例如在线书评和“购买该商品的人也购买了以下商品”的提示。他指出，Prime Video和亚马逊的游戏平台Twitch已经为亚马逊的免费送货服务吸引来“数以百万计的客户”，他们原本主要只是对娱乐内容感兴趣。至于直播，“在西方就是还没有像在中国那样流行起来”。

格兰迪内蒂认为直播最终也会在西方盛行。其他观察人士指出，美国实体店的庞大规模降低了线上线下融合的物流成本，这可能会鼓励更多的混合渠道购物模式。在其他方面，美国将走出自己的道路。美国的劳动力价格比中国更高，可能会更快实现线上履单自动化。那里的人们重视隐私更甚于便利性，这可能会削弱购物者在社交媒体上与朋友分享消费习惯的意愿。

而且如火如荼的中国零售业仍有可能失去活力。人口老龄化终将令工资低廉的仓库工人和送货司机供应不足。这可能意味着运费增加，等待时间变长，甚至可能会有工会要求改善工作条件，导致成本进一步增加。对网红的信任度在下降，尤其是那些拿了巨额报酬来推广品牌的人。那些赚得少的主播可能会失去耐心，回归日常工作。“收入前1%的大赚特赚。剩下的都是挨饿的艺人。”PARKLU的惠利说。

西方企业之所以没有马上效仿中国的电子商务，主要可能不是因为它固有的缺陷，而是它们自己过度专业化。从西雅图的亚马逊总部、硅谷的Facebook，到本顿维尔（Bentonville）的沃尔玛，美国公司过去往往都专注于各自的核心业务——无论是电子商务、社交媒体，还是超市。直到最近它们才开始入侵彼此的地盘。假以时日，这可能会让业务的界限变得更加模糊。在最近一次在线小组会议上，Facebook负责电子商务孵化的埃里克·冯（Eric Feng）略带开玩笑地总结道：“中国，你就是指引我们前进的明灯。”■



Economic development

The fruits of growth

Extreme poverty is history in China, officials say

EARLY IN DECEMBER China announced that it had eradicated extreme poverty within its territory. This achievement is breathtaking in scale. By the World Bank's estimate, some 800m people in China have escaped penury in the past four decades. It is a triumph for the ages, too, as state media have noted. Never before in the country's history has destitution come anywhere close to being eliminated.

One of the final places declared poverty-free is Ziyun, a county in the south-western province of Guizhou. "Speaking frankly, it's a lie," says Liang Yong, a gruff villager. The official investigation of Ziyun's economy was, he says, perfunctory. Provincial leaders popped into his village, rendered their verdict that it had left poverty behind and then sped off. "It's a show. In our hearts we all know the truth," he grumbles.

But a hard-headed observer would side with the government. Things are undoubtedly difficult for Mr Liang. Pork is pricey these days, so he eats meat just a couple of times a week. After paying his two children's school fees, he has little money left. To ward off the winter, he sits close to a coal-fired stove. He is poorer than many others in China, especially in its cities. He does not like to see victory over poverty being celebrated when he cannot afford proper medical care for his father, recently diagnosed with lung cancer. But the ability to scrape enough together for meat, education and heating marks Mr Liang as someone who has in fact left extreme poverty—a condition in which basic needs go unmet.

Sceptics understandably ask whether China fiddled its numbers in order

to win what it calls the “battle against poverty”. There are of course still isolated cases of abject deprivation. China, however, set itself a fairly high bar. It has regularly raised the official poverty line, which, accounting for living costs, is about \$2.30 a day at prices prevailing in 2011. (By comparison, the World Bank defines as extremely poor those who make less than \$1.90 a day, as roughly a tenth of human beings do. Poverty lines in rich countries are much higher: the equivalent line in America is about \$72 a day for a four-member household at 2020 prices.) In 1978, shortly after Mao’s death, nearly 98% of those in the countryside lived in extreme poverty, by China’s current standards. By 2016 that was down to less than 5% (see chart on next page).

The government’s biggest contribution was to pull back from central planning and let people make money. It decollectivised agriculture, giving farmers an incentive to produce more. It allowed people to move around the country to find work. It gave more freedom to entrepreneurs. It helped by building roads, investing in education and courting foreign investors. Its goal was to boost the economy; alleviating poverty was a welcome side-effect.

The government’s approach changed in 2015 when Xi Jinping, its leader, vowed to eradicate the last vestiges of extreme poverty by the end of 2020. Officials jumped to it. They tried to encourage personal initiative by rewarding poor people who found ways of bettering their lot (see picture). They spent public money widely. In 2015 central-government funding earmarked for poverty alleviation was an average of 500 yuan (\$77) per extremely poor person. In 2020 the allocation per head was more than 26,000 yuan (see chart).

The imprint of the anti-poverty campaign is visible everywhere in Ziyun. The walls of government offices are covered in murals. One depicts a plant, labelled as the “roots of poverty”, being yanked from the soil. Slogans dot

the main roads—some admirably simple (“Let farmers make more money”), others lofty (“To help people out of poverty, first help them become wise”).

One of the biggest challenges has been the terrain where the poor live. The 832 counties—about 30% of the country’s total—that were designated as poverty-stricken when Mr Xi began his anti-poverty campaign were all mainly rural. Most were mountainous or on inhospitable land. Officials used two basic approaches to help these counties. Both are visible in Ziyun.

The first was to introduce industry—mostly modern agriculture. In Luomai, a village in Ziyun, the government created a 25-hectare zone for growing and processing *shiitake* mushrooms. About 70 locals work there. In the past their only options were either to migrate elsewhere or to eke out a meagre existence farming maize. But the *shiitake* are a cash crop, letting them earn about 80 yuan a day, a decent wage.

There is an irony in this. In the 1980s China broke up communal farms, letting people strike out on their own. Now the government wants them to pool their resources again. Officials often describe it as turning farmers into “shareholders”. Residents get stakes in new rural enterprises, which, all going well, will pay dividends. Big outside companies are often placed in charge of the projects. The Luomai *shiitake* farm is run by China Southern Power Grid, a state-owned firm. But there is a risk that as the anti-poverty campaign fades away, some projects will fizzle.

The second approach to helping hard-up villages was more radical: moving inhabitants to better-connected areas. Between 2016 and 2020 officials relocated about 10m people. China has long moved people around on a huge scale to allow development—for instance clearing out homes to build dams. But in this case resettlement was itself the development project. The government concluded that it was too costly to provide necessary services, from roads to health care, to the most remote villages. It reckoned that

moving residents closer to towns would work better.

A collection of tidy yellow apartment blocks sits in the centre of Ziyun county. It is a settlement for former inhabitants of a poor village some distance away. A frequent problem after moving people into such housing is finding work for them. In this case, the government called on local officials to arrange jobs for at least one member of each household. At the gate to the new compound in Ziyun, women hunch over sewing machines in small workshops. A middle-aged resident says she could not handle that work, so officials gave her a job in a sanitation crew. She is pleased with her new surroundings. There is a good school just across the street, which is far better for her child.

A bigger challenge is relative deprivation, a problem abundantly evident to anyone who has travelled between the glitzy coastal cities and the drabber towns of the hinterland. People may have incomes well above the official poverty line, but they can still feel poor. A recent study by Chinese economists concluded that the “subjective poverty line” in rural areas was about 23 yuan per day, nearly twice the amount below which a person would be officially classified as poor. That conforms with a standard used by many economists, namely setting the relative poverty line at half the median income level. It suggests that about a third of rural Chinese still see themselves as poor.

If poverty is calculated this way it becomes almost impossible to eliminate, since the poverty line steadily rises as the country gets richer. But one virtue of using a relative definition is that it better matches the way people feel. China does not count any poverty in its cities because welfare safeguards supposedly help those without money. But workers who have moved from the countryside lack the right documentation for ready access to urban welfare. And for any city-dweller, support is meagre. In relative terms about a fifth of China’s urban residents can be classified as poor, according to

a recent paper for the National Bureau of Economic Research by Chen Shaohua and Martin Ravallion.

To reduce relative poverty, China needs different tactics from the ones used in its campaign against extreme poverty. It would have to redistribute incomes, for example by imposing heavier taxes on the rich and making it easier for migrants to obtain public services in cities—policies for which it has shown little eagerness.

On the streets of Guiyang, the booming capital of Guizhou, hardship is still a common sight. Men walk with straw baskets strapped to their backs, looking for work as load-carriers. Zhou Weifu, a porter in his 50s, scoffs at the suggestion that poverty is over. “What kind of work is this? I can barely make any money,” he says. China has every right to be proud of its victory over dire poverty. But officials would be wise to keep their celebrations muted. ■



经济发展

增长的果实

官方宣布，极端贫困在中国已成为历史

上月初，中国宣布消除了国内的极端贫困。这是令人惊叹的巨大成就。据世界银行估计，过去40年里中国约有八亿人摆脱了赤贫。正如官方媒体所说，这也是历史性的胜利。在中国历史上，消除贫困从来都是可望不可及的事。

西南省份贵州的紫云县是最后一批宣布脱贫的地点之一。“老实说，这是假的。”村民梁勇（音译）冷冷地说。官方对紫云县经济状况的核查只是走过场，他说。省里的领导突然来村里，宣布紫云县已经脱贫，然后就匆匆离开了。“这都是表演。我们心里都知道是怎么回事。”他咕哝道。

但冷静的观察者还是会站在政府这一边。对梁勇来说，生活无疑很艰难。现在猪肉很贵，他一周只吃两五回。付完两个孩子的学费后，手头的钱已所剩无几。他生煤炉御寒。与中国很多人尤其是城里人相比，他肯定是贫穷的。他父亲最近被查出肺癌，但他没钱给他好好治病。这个时候看到庆祝战胜了贫困，他高兴不起来。但是，能吃上肉、上得起学、取得上暖，表明梁勇实际上已经摆脱了极端贫困，即最基本的需求得到了满足。

中国是否为赢得“脱贫攻坚战”篡改了数据？有人会这么问可以理解。肯定还存在零散的赤贫案例。但是，中国给自己设定的脱贫门槛已经算高了。它一直在不断提高官方贫困线，现在按2011年物价水平（并经生活成本调整）为每人每天约2.3美元。相比之下，世界银行把极端贫困人口定义为每天生活费不足1.9美元的人群，他们约占世界人口的十分之一。富裕国家的贫困线要高得多：美国四口之家的贫困线是按2020年物价水平为每天72美元。以中国目前的标准，1978年也就是毛泽东去世后不久，近98%的农村人口生活在极端贫困中。到2016年，这一比例下降到不足5%（见图表）。

中国政府最大的贡献是废除了中央计划经济，让人们赚钱。它取消了农业集体化，让农民有更多动力生产更多粮食；允许人们到全国各地找工作；给企业家更多自由；通过修建公路、投资教育和吸引外国投资者提供帮助。政府的目标是促进经济发展，减轻贫困则是一个受欢迎的附带成果。

国家领导人习近平在2015年誓言要在2020年底前彻底消除极端贫困，此后政府的做法发生了变化。官员们迅速行动起来。他们对那些找到脱贫路子的穷人予以奖励（见图），试图以此提高个人的积极性。他们大范围支出公共资金。2015年，中央政府划拨的扶贫专项资金达到极端贫困户人均500元。2020年的拨款额人均超过2.6万元（见图表）。

在紫云，脱贫战的印记随处可见。政府机关的墙上贴满了大幅宣传画。其中一幅上是一株写着“穷根子”的植物，正被人从土里拔出来。主干道上到处都是标语，有些非常直白（“让农民多挣钱”），还有一些颇高大上（“扶贫先扶智”）。

贫困人口居住区的地形地貌是最大的挑战之一。习近平启动脱贫战时，认定的832个贫困县——约占全国县城总数的30%——全部以农村为主要构成。它们大多位于山区或居住条件恶劣的地带。官员们对这些县基本的扶贫方法有两种。这两种在紫云都能看到。

第一种是以现代农业为主的产业引进。在紫云县的洛麦村，政府创建了一个25公顷的香菇种植加工区。大约有70名当地人在那里工作。过去，他们只能要么外出打工，要么靠种玉米勉强度日。但香菇是一种经济作物，能让他们每天挣80块钱左右，这已经是不错的收入了。

这种方法有点讽刺。上世纪80年代，中国废除了公社农场，让人们自谋出路。现在政府却希望他们再次把自己的资源汇集起来。官员们经常说这是把农民变成“股东”。村民可以在新型乡镇企业中获得股份，如果一切顺利，这些企业会给他们分红。这些项目通常会安排给外来的大公司负责。比如洛麦香菇农场由国有企业中国南方电网经营。但是随着脱贫战收官，一些项目将面临草草收场的风险。

第二种帮助贫困村庄的方法更激进：把村民搬迁到与外界联系更多的地区。2016年至2020年间，官员们重新安置了约1000万人。长期以来，中国一直大规模迁移人口以给发展腾地，比如拆迁村落建大坝。而在这种情况下，重新安置本身就是个发展项目。政府认为，向最偏远村庄提供从道路到医疗的各种必需服务的成本太高，还是把居民搬到城镇的附近成效更好。

在紫云县城的中心坐落着一幢幢整齐的黄色公寓楼。这是个定居点，居民都来自离这里有点路程的一个贫困村。把村民搬进这样的住所后，为他们找工作便成了个常见问题。在这种情况下，政府号召地方官员为每户家庭至少解决一个人的就业。在通往紫云新定居点的大门口，妇女们趴在小作坊里的缝纫机上。一名中年妇女说自己干不了这活，官员们就给她安排了一份环卫工作。她对新环境很满意。街对面就有一所好学校，这对她的孩子来说比以前好太多了。

一个更大的挑战是相对贫困，这个问题对于任何一个曾在繁华的沿海城市和乏味的内陆城镇间往来过的人来说，都是非常明显的。人们的收入可能远高于官方贫困线，但仍会感到自己很穷。中国经济学家最近的一项研究认为，农村地区的“主观贫困线”约为每天23元，几乎是官方认定的贫困标准的两倍。这符合许多经济学家使用的标准，也就是把相对贫困线设定在收入中值水平的一半。它表明大约三分之一的中国农村人口仍然认为自己是穷人。

如果以这种方式计算，消除贫困会变得几乎无法实现，因为随着中国变得更加富裕，贫困线也会稳步上升。但使用相对定义的一个好处是，它更符合人们的感受。中国没有统计任何城市贫困人口，因为福利保障措施据信应能帮到那些没钱的人。但是，农民工缺乏能便捷地享受到城市福利所需的户籍证明。而且对任何城市居民而言，能得到的帮助也是微薄的。陈绍华和马丁·拉瓦雷（Martin Ravallion）最近为美国国家经济研究局（National Bureau of Economic Research）撰写的一篇论文显示，用相对定义来衡量，中国约有五分之一的城市居民可被列为贫困人口。

为了减少相对贫困，中国需要采取一些有别于在脱贫攻坚战中使用的策略。它将必须重新分配收入，比如向富人多征税，并让农民工更容易获得城市的公共服务——但政府对这些政策似乎一直不太热心。

在蓬勃发展的贵州省会贵阳的街头，困苦之况依然随处可见。背着背篓的男人走在街头，寻找搬运货物的工作。50来岁的搬运工周伟福（音译）对“贫困已经消除”的说法嗤之以鼻。“我这干的都是什么活？我基本上什么钱都挣不到。”他说。中国完全有理由为战胜极端贫困而自豪。但是官员们不那么大张旗鼓地庆祝会是明智之举。 ■



Encyclopedias

Diderot's dream

In praise of Wikipedia

WIKIPEDIA IS CLEAR on the matter: Wikipedia is not a reliable source. Yet on this particular question, few people seem to agree with the world's most popular encyclopedia. The site approaches its 20th birthday, on January 15th, as the 13th-most-visited place on the web, offering more than 55m articles written in 300 languages. Worries about fake news, filter bubbles and market power have soured public opinion on the Utopian promises of the early internet. But Wikipedia—written by amateurs, freely available to all—stands as the great exception. It is the dream that worked.

Or at least, mostly worked. Wikipedia's crowdsourced model remains vulnerable to the occasional hoaxter or chancer. In August it emerged that many articles on the Scots version of the site had been written by an American editor who, by his own admission, was not really a speaker of the dialect. Nor is it free from honest mistakes. That can cause problems: for better or worse, powerful platforms from social-media firms to the World Health Organisation have come to treat it as a wellspring of truth online. All the same, the world is much better off for its existence.

Indeed, familiarity may have dulled the scale of its achievements. As well as being roughly as accurate as old-style encyclopedias, Wikipedia is also incomparably broader. Curious readers can learn about worthy subjects like Homer, general relativity or the Taiping Rebellion. They can also read about Québécois slang, the nature of magic in the “Harry Potter” novels and the fortunes of Yeovil Town Football Club, which toils in obscurity in the fifth tier of the English league. Denis Diderot, the 18th-century editor of the French *Encyclopédie*, hoped to “assemble all the knowledge scattered over

the face of the Earth". Wikipedia would have delighted him.

The project owes much of its success to its unique structure. Funded by donations, Wikipedia earns no profits. It has no venture-capital backers demanding growth at all costs. Without advertisers to satisfy, it can focus exclusively on the interests of its readers and contributors. It is curated and run by people, not machines. There is no recommendation algorithm humming away in the background, choosing what to show readers in order to keep them glued to the site for as long as possible.

Other tech titans should study its success. Relying on algorithms is one reason they have achieved enormous scale with so few employees. Yet the downsides have begun to haunt them. As the social-media giants hire ever more people as moderators, and write ever longer sets of rules about what is allowed, Wikipedia offers a lesson in how to run a human-powered website.

It is also a welcome boost for Enlightenment values, which have suffered at the hands of populism and authoritarian capitalism. If Wikipedia's occasional scandals make people approach it with a little scepticism, all the better, for fair-minded scepticism is a healthy attitude in general. Wikipedia sees itself as a work in progress. If a fact is wrong, it invites users to persuade others so that it can be corrected. Its internal culture holds that knowledge comes from evidence, reason and good-faith debate, not pronouncements from the pulpit or the party.

Like any institution, Wikipedia has flaws. It sometimes fails to live up to its own ideals. The nature of crowdsourcing means its quality varies. The most popular articles receive the most scrutiny, and tend to be the best. That leaves a long tail of obscure entries of lower quality. Articles can be overlong, or too technical. Much of its magic comes from the distinctive culture that has built up among contributors—but cultures can be fragile.

Perhaps its biggest flaw is that, for all its breadth, it is still too narrow. The site's editors are mostly male, and mostly from North America and Europe. A small number do a disproportionate share of the work. That colours both the encyclopedia's choice of entries and the way it covers them. Wikipedians have been trying to change that, but progress has been too slow. A lot is at stake. In rich, liberal countries, where information is widely available, Wikipedia is a convenience. In poorer places, and illiberal ones, it can be quietly revolutionary. ■



百科全书

狄德罗之梦

赞美维基百科

维基百科有一点说得很明白：维基百科不是一个可靠的资料来源。不过对于这一点，似乎没有多少人认同这部全球最受欢迎的百科全书的说法。1月15日，维基百科迎来了自己的20岁生日，此时它是访问量第13大网站，提供以300种语言编写的超过5500万页条目。对假新闻、“过滤气泡”和市场操控的担忧让公众对早期互联网的乌托邦承诺幻想破灭，但由业余人士撰写并免费提供给所有人的维基百科却是个突出的例外。它是梦想得以实现的例子。

或者说，至少大体上实现了。维基百科的众包模式还是会偶尔遇到恶搞或投机。去年8月，有人发现维基百科苏格兰语版上的许多条目其实是由一位美国编辑撰写的，他本人承认自己实际上不怎么会讲这种英语方言。维基百科上也不是没有无心之失。这可能会引发问题，毕竟无论好坏，从社交媒体公司到世界卫生组织的各种强大平台都已把它看做是一个线上真相源泉。尽管如此，世界还是因为维基百科的存在而变得美好了许多。

事实上，人们可能因为司空见惯而没有意识到维基百科实际取得的成就。维基百科不仅在准确度上与旧式百科全书大致相当，内容还无可比拟地广泛。好学的读者可以从中了解荷马、广义相对论或太平天国之乱等有价值的主题。他们还可以读到魁北克俚语、《哈利波特》小说中魔法的特性、英格兰足球第五级联赛中默默无闻的约维尔镇足球俱乐部（Yeovil Town Football Club）的际遇浮沉。18世纪法语《科学、美术与工艺百科全书》（Encyclopédie）的主编德尼·狄德罗（Denis Diderot）希望“把散落在地球上各地的所有知识集合起来”。要是他能看到今天的维基百科，一定会很欣慰。

这个项目的成功很大程度上归功于它独特的结构。维基百科由捐款资助，

不谋求盈利，没有风险资本家在背后要求不惜代价的增长，不需要讨好广告商，因而可以仅专注于其读者和条目编辑者的利益。它由人而非机器策划和运作，没有推荐算法在后台运行来选择向读者显示的内容以求让人长时间沉迷其中。

其他科技巨头应该对维基百科的成功做一番研究。它们用这么少的员工人数达到如此庞大規模的原因之一是依赖算法，但其弊端已开始困扰它们。随着社交媒体巨头聘请越来越多的内容审查员，并制定越来越长的规则来管控用户的行为，维基百科为如何运营由人员驱动的网站提供了借鉴。

启蒙价值观受到了民粹主义和专制资本主义的戕害，维基百科对它的提振也是人们所乐见的。如果说维基百科偶尔出现的丑闻让人们对它抱有一点怀疑，那也是好事，因为合理的怀疑通常是一种健康的态度。维基百科认为自己是一个不断发展的未完成项目。当内容被指有误时，它会邀请用户说服他人，以纠正错误。维基百科的内部文化认为，知识源于证据、理性和善意辩论，而非源于宗教布道或政党宣言。

和任何机构一样，维基百科也有缺陷。它有时无法达致自己的理想。众包的特点意味着内容质量会参差不齐。最受欢迎的条目受到最严格的审查，质量往往最高。但在此之外是大量受关注不多、质量较低的词条。条目内容可能过于冗长或充斥着术语。维基百科的魔力主要来自编辑者们建立起来的独特文化，但文化可能并不牢靠。

或许，维基百科最大的缺陷是：尽管它的内容如此广泛，却还是过于狭隘。该网站的编辑者大多是男性，而且大多来自北美和欧洲。一小批人编撰了内容的一大部分。这会影响到维基百科对条目的选择和诠释方式。维基人一直想改变这种状况，但进展太慢。这里牵涉很多风险。在富裕、自由的国家，信息广泛开放，维基百科提供了一种便利。在较贫穷、不自由的地方，它可以成为悄然革命的工具。 ■



After the pandemic

The big picture

Four authors consider how covid-19 will change the world

IN “THE SEVENTH SEAL”, a film by Ingmar Bergman, a knight returns from the crusades to find his homeland ravaged by the plague. Suffering and devastation have shaken his faith in God. When Death comes for him, the crusader proposes a game of chess in order to eke out enough time to commit one act—any act—that might bring meaning amid the pestilence.

In the teeth of a scourge on the scale of covid-19, the impulse to draw significance from suffering is again strong. However, as is clear from the first of what will surely be shelf-loads of books about the coronavirus, in a secular age a pandemic is principally seen not as a question of inscrutable divine will, but as a test of earthly powers.

All these books have to grapple with the problem that they were written amid great uncertainty. Even now much about covid-19 is still unknown—not just when the pandemic will end and what it will leave behind, but also about the nature of the virus itself. These authors are thus attempting to write the review before the final reel has been loaded into the projector.

The most successful is “Apollo’s Arrow” by Nicholas Christakis, a doctor and sociologist at Yale. He deals with uncertainty by looking back, using history, epidemiology and sociology to put covid-19 in context. This is the book if you want to understand about flattening the curve and herd immunity, or how America’s response fell short in those critical early months of the pandemic because of Trumpian politics, bureaucratic turf wars and the failure to create enough reliable testing.

Dr Christakis's title refers to the pestilence that Apollo visited upon the Greeks for enslaving the daughter of a Trojan priest. And, sure enough, he lays out a litany of human failings—chief among them the struggle to learn from the past. Pandemics are an old enemy that has scarred humanity, but once they abate, he writes, people tend to put the search for meaning aside, pick up their lives and party.

Other authors seek to draw more ambitious conclusions. Yet, because they are erecting their arguments on half-built foundations, they risk being highly speculative. Ivan Krastev, for instance, is a Bulgarian political scientist and a master of the brilliant epigram. In his extended essay on covid-19 he observes how “the strangeness of the pandemic experience is that everything changes but nothing happens”, and how in normal times the elites can afford to travel whereas, “in the time of covid-19, they can afford to stay at home”.

In between pithy observations, Mr Krastev deals with the theme of whether this disease could be the destruction of the European Union—or perhaps its making. When Italians and Spaniards were dying by the thousand, the EU seemed as relevant as the Holy Roman Empire had been when its subjects were unaware that they were even part of it. He worries that populists, despite having a bad pandemic, will come storming back when it is over. But, he goes on to argue, the virus has also taught Europeans that to be safe in a dangerous world, they must stick together—while the EU’s failure has spurred governments to opt for greater integration. Mr Krastev calls this “the great paradox of covid-19”. Readers may think he is having it both ways.

And yet, if analysts seek to avoid too much speculation, they risk being conventional. That is because when the future is extremely uncertain the safest approach is often to extrapolate from the present.

At least, that is the path taken by Fareed Zakaria, a television host and

pundit in America. His “Ten Lessons for a Post-Pandemic World” begins with a rousing warning that this pandemic “is new, upturning many of our daily patterns and presumptions”. But his lessons mostly confirm the things that many commentators—including *The Economist*—were worrying about before the pandemic: the rivalry between America and China, the potency of the digital revolution and the effects of inequality.

Mr Zakaria is a skilful and sober guide on this whistle-stop tour. Along the way, he makes some wise observations: that cities will not fade, because urban life is too rewarding; that globalisation is not dead, because it is too valuable; that experts have their place, so long as they listen to non-experts. But these reasonable points, too, undermine the breathless promise with which the book begins.

Scott Galloway, an entrepreneur and professor at New York University, narrows his field to the coronavirus and business. He conceives of it as a source of disruption and a bringer of rapid change. This allows him to rehearse his theories about the state of business—how products are replacing brands, and how companies are having to choose between selling products at a profit (as Apple does) or selling their users to other businesses (as Google does). Mr Galloway is entertaining and informative on how companies deal with crises, and on the ripeness of health care and university education for disruption. Somehow, though, you get the impression that these were all things he believed before people began to fall ill in a wet market in Wuhan.

One point of agreement among these authors is that government must change—which is also the focus of “The Wake-Up Call”, written by our former editor, John Micklethwait, and our Bagehot columnist, Adrian Wooldridge. And, indeed, few would be against governments that help create a fairer society while also being more effective and smaller. But that is a manifesto rather than a prediction.

The lesson from Bergman is that, when mankind is faced with great suffering, meaning often lies in small things. At the end of the film, when the knight is on the verge of defeat, he distracts Death for a moment by knocking over the chessboard. This gives a minstrel couple, who in an act of kindness had fed him milk and wild strawberries, the chance to escape with their baby—and live. The post-pandemic world will take time to emerge. Chances are that it will first be found in the details. ■



疫情过后

大图景

四位作家探讨新冠疫情将如何改变世界

在英格玛·伯格曼（Ingmar Bergman）的电影作品《第七封印》（The Seventh Seal）中，一位骑士参加十字军东征归来，发现故土瘟疫肆虐。苦难和毁灭动摇了他对上帝的信心。当死神前来时，骑士提议与死神下一盘棋，以尽量拖延时间去完成一件事——任何一件可能在瘟疫中产生意义的事。

面对新冠疫情这种规模的灾难，人们从苦难中追寻意义的冲动再次被激发。关于新冠病毒的书必将充箱盈架，不过从其中第一本就可以清楚地看出，在一个世俗的时代，人们主要把疫情视作对尘世力量的考验，而不是一个高深莫测的神圣意旨的问题。

所有这些书都必须对付的一个问题是，它们是在巨大的不确定性中写就的。即便到现在，新冠病毒的很多方面仍然不为人知——不仅不知道这场疫情何时会结束、会留下什么，也不完全了解病毒本身的特性。因此，这些作者是想要在最后一卷胶片装入放映机之前写完影评。

其中最成功的是耶鲁大学博士、社会学家尼古拉斯·克里斯塔基斯（Nicholas Christakis）所著《阿波罗之箭》（Apollo's Arrow）。他用回溯来解决不确定性的问题，利用历史、流行病学和社会学来把新冠疫情放在宏大背景下讨论。如果你想了解压平曲线和群体免疫，或者想知道在疫情爆发之初关键的几个月里，由于特朗普式政治、官僚集团的争斗以及未能打造出足够可靠的检测手段，美国如何应对不足，你可以读读这本书。

克里斯塔基斯的书名意指阿波罗降瘟疫于希腊人，因为他们俘虏了一位特洛伊祭司的女儿。而且，他果然罗列了一长串人类的弱点——其中最主要的是难以吸取以往的教训。他写道，流行病是人类的宿敌，不断给人们带来创伤，但一旦它们减弱，人们往往就会把对意义的追寻抛诸脑后，重拾

生活，寻欢作乐。

其他作者试图得出更宏大的结论。不过由于立论的基础尚不完备，他们有高度臆测的风险。保加利亚政治学家、警句大师伊万·克拉斯特夫（Ivan Krastev）就是其一。在他关于新冠疫情的长论文中，他观察到“这场疫情的奇怪之处在于，一切都改变了，但什么都没发生”，以及在正常时期，精英们负担得起出门旅行，“而在新冠疫情中，他们负担得起待在家里”。

在一个个言语精辟的观点之间，克拉斯特夫探讨了这样一个主题：这种疾病会毁灭欧盟吗？抑或缔造它？当意大利人和西班牙人成千上万地死去时，欧盟的重要性就好像神圣罗马帝国一般——那时帝国的臣民们甚至意识不到自己是它的一部分。他担心，尽管经历了糟糕的疫情，但到它结束时，民粹主义者又会卷土重来。但是，他接着说，病毒也教会了欧洲人，要在危险的世界里保得平安，他们必须团结一致，而欧盟的失败已经促使各国政府转向更高程度的一体化。克拉斯特夫称之为“新冠的巨大悖论”。读者可能会认为他是想左右逢源。

不过话说回来，如果分析者想要避免过多的臆断，他们又可能陷于保守。因为当未来极其不确定时，最安全的方法往往是基于眼下来推断。

至少，美国电视节目主持人和时事评论员法里德·扎卡里亚（Fareed Zakaria）是这样做的。他的《疫情后世界的十大教训》（Ten Lessons for a Post-Pandemic World）在开篇发出了唤醒众生的警告：这场疫情“是全新的，正在颠覆我们的许多日常模式和假定”。但他总结的教训基本上再度确认了包括《经济学人》在内的许多评论方在疫情爆发前就已经在担心的事：中美对峙、数字革命的威力，以及不平等的影响。

在这次走马观花的旅程中，扎卡里亚是一位经验丰富、头脑清醒的导游。一路上，他得出了一些明智的结论：城市不会褪色，因为城市生活的好处太多了；全球化并没有消亡，因为它太有价值了；专家有自己的一席之地，只要他们倾听非专家的话。但是，这些合理的观点也削弱了这本书开头令人窒息的预言。

企业家、纽约大学教授斯科特·加洛韦（Scott Galloway）把他的研究领域缩小到新冠病毒和商业。他认为病毒会成为颠覆的源头，带来迅速变化。这让他可以重复自己关于商业现状的理论——产品正如何取代品牌，企业又如何不得不在出售产品赚钱（像苹果那样）和把用户卖给其他企业（像谷歌那样）之间做选择。在描述企业怎么应对危机、医疗和大学教育已经到了颠覆的时刻等段落，加洛韦写得很有趣，信息量也很大。但不知怎么的，你会觉得在武汉一个菜市场里有人染病之前他就已经这么想了。

这些作者有一个共同的观点：政府必须做出改变。这也是本刊前总编约翰·米克尔思韦特（John Micklethwait）和白芝浩专栏的作者阿德里安·伍尔德里奇（Adrian Wooldridge）合著的《警钟》（The Wake-Up Call）一书的焦点。其实很少有人会反对能帮助创建更公平的社会、同时又更有成效和更小规模的政府。但这是一种宣言，不是预测。

伯格曼总结的教训是，当人类面对巨大的苦难时，意义往往存在于小事之中。在影片的结尾，当骑士濒临败局，他打翻了棋盘，暂时分散了死神的注意力。这让一对卖艺的夫妇得以带着孩子出逃并活了下去，这对夫妇曾好心地拿牛奶和野草莓给骑士享用。疫情后的世界需要一些时间才会显露真面目。我们很可能会首先在细节中发现它。 ■



The markets in 2021

Melting up

Why the crazy upward march in stock prices might just continue

IN A FAST-CHANGING world, the investment bankers of Wall Street and the City of London have clung to certain rituals. One of these is the annual “outlook”, which lays out the path the economy and financial markets might take over the coming year. These hefty documents start to appear in inboxes a few weeks before the year’s end.

In mid-November a strategist at one bank had just put his outlook to bed with satisfaction. His call on stocks for 2021 was “constructive”: Wall-Street-speak for “bullish, but not mindlessly so”. But a few days later he was feeling a little less pleased with himself. His outlook was not distinctive. Rival strategists too were constructive.

It is not hard to see why. An end to the covid-19 pandemic is in sight. Rich-world governments are rediscovering the joys of fiscal pump-priming. Real interest rates are so low as to make sky-high stocks look cheap. In short, the conditions seem ripe for further stockmarket gains. So ripe, indeed, that a persistent thought keeps surfacing in the minds of strategists. What is to stop stock prices worldwide going on a really crazy run?

Several things could get in the way of a market melt-up. One is the economy. Since April markets have been looking beyond the damage from covid-19 to the post-pandemic recovery. The discovery of workable vaccines seemed to bring that world closer. Economic indicators for America and China towards the end of 2020 were surprisingly strong. But the pandemic is not going quietly. More virulent strains of covid-19 have forced stricter lockdowns in parts of Europe. The harm to the world economy is likely to be more

prolonged than hoped.

Another obstacle is bullish sentiment. The last time fund managers were this optimistic about the scope for stockmarket gains was January 2018, according to a monthly survey by Bank of America done in December. A large majority think the world economy is in the “early-cycle” phase (ie, that there is a long runway of growth ahead). Paradoxically, positive sentiment is often seen as a reason to be wary, and that investors have got ahead of themselves. Indeed, 2018 began with much talk of a market melt-up, but ended with heavy stockmarket losses.

A lot of the current optimism rests on the idea that policy will continue to support the economy. What if policymakers change tack? Continued fiscal support requires political action and agreement, which cannot always be relied upon. A natural concern is that stimulus might be withdrawn abruptly, as it was after 2010. So far, though, there is little sign of this. In America the \$900bn fiscal package passed after Christmas will add two percentage points to GDP growth in 2021, reckon economists at JPMorgan Chase, a bank. The loss of the Republican majority in the Senate may open the door to further fiscal easing. In Europe the boost from the €750bn (\$920bn) recovery fund should start to be felt from the middle of the year.

Yet another risk, and one that keeps some market bulls awake at night, is resurgent inflation. Lockdowns and fiscal transfers have left rich-world consumers with extra savings and a lot of pent-up demand—fuel for a post-pandemic spending spree. Meanwhile recession has also taken out supply capacity: a lot of small firms (and some large ones) have gone under. With enough bottlenecks, a surge in spending could drive up inflation. A dynamic of this kind has been playing out in commodity markets: a revival in industrial demand (notably from China) for copper and iron ore has bumped up against supply constraints and led to a run-up in prices.

A temporary bout of inflation seems plausible. A sustained burst of higher inflation—and one that forces central banks into abruptly raising interest rates—appears less so. Nor is it obvious that bond markets will react so violently as to fatally undermine stock prices. Bond yields have been edging up for months: early this month the ten-year Treasury yield exceeded 1% for the first time since March 2020. This upward creep does reflect higher market expectations of inflation, which are now above 2% in America. But yields on inflation-protected Treasuries have barely budged—and it is these real yields that are the benchmark for stockmarket valuations. If the pattern of modestly above-target inflation expectations, a relaxed Federal Reserve and steady real yields stays intact, it may well boost equity prices, not retard them.

There are other hangover effects from the pandemic to consider. A big one is debt. Companies borrowed heavily to ensure they had enough cash to withstand the revenue losses from lockdowns. The increased debt load will drag on companies' finances and could in turn weigh on equity prices. But it may not be a heavy weight. Central-bank buying of corporate bonds has kept financing costs remarkably low for companies with access to wholesale capital markets: just consider the cost of borrowing for companies with debt rated BBB, the riskiest investment-grade rating. The spread over Treasuries is about as low as it was in 2006, when wider credit conditions were dangerously easy. Such low borrowing costs make debt burdens easier to carry. A related concern is that the explosion in public debt will eventually push up real interest rates. But demand for liquid safe assets tends to stay high after crises. Chief among these are government bonds.

On a closer look, then, many of the obstacles to the stockmarket's upward march do not seem so formidable. A terrible year for the economy still produced positive returns in many stockmarkets. The fact that recession has hurt small unlisted businesses more than large listed firms is one part of the story. The other is the paucity of yields on offer from bonds. In a note this

week Jeremy Grantham, co-founder of GMO, an asset manager, argues that stocks in America have already gone too far. “My best guess as to the longest this bubble might survive is the late spring or early summer,” he writes, and advises seeking refuge in cheap emerging-market stocks.

Mr Grantham’s note is well worth reading. But a thought lingers. The case for owning stocks at these prices depends on low interest rates. This is a global condition. So why would stock prices not melt up elsewhere? Perhaps Wall Street’s year-ahead notes for 2022 will survey the wreckage of a stockmarket bust in America. But it seems as plausible that strategists will be cheering on prices from higher peaks—constructively, of course. ■



2021年的市场

融涨中

为什么股价的疯狂上行可能还会继续

世界瞬息万变，但华尔街和伦敦金融城的投资银行家一直坚持着某些习惯。其中之一就是描绘来年经济和金融市场可能走向的年度“展望”。在年底的那几周，这些厚厚的文件就会开始出现在收件箱中。

一家银行的策略师在11月中旬刚写完令自己满意的展望。他对2021年股市的判断是“具建设性”（constructive）——华尔街表达“看涨，但非盲目看涨”之意的行话。不过几天后，他对自己又没那么满意了。他的观点并非独树一帜。竞争对手银行的策略师的预测同样是“具建设性”。

其中原因不难理解。新冠疫情有望终结。富裕国家的政府正在重新发现用财政手段刺激经济的好处。实际利率如此之低，使得天价股票看起来都很便宜。简而言之，股市进一步上涨的条件似乎已齐备。实际上，这条件成熟到让一个念头在策略师的脑海中挥之不去：有什么能阻挡全球股价疯狂上涨？

妨碍市场融涨的因素可能有几点。一是整体经济。自4月以来，市场已经从关注新冠疫情带来的损失转向展望后疫情时代的复苏。有效疫苗的发现似乎让复苏更近了。2020年底美国和中国的经济指标强劲得令人惊讶。但病毒不会善罢甘休。更具传染力的新冠毒株已迫使欧洲部分地区实施了更加严格的封锁。疫情对世界经济的伤害很可能要比预期更长久。

另一个障碍是看涨情绪。美国银行（Bank of America）12月的月度调查显示，上一次基金公司对股市涨幅如此乐观是在2018年1月。它们之中绝大多数认为世界经济处于“早周期”阶段（即未来的增长道路还很长）。不过矛盾的是，乐观情绪也常被视为需要保持警惕的原因，而投资者已经操之过急了。实际上，2018年以大量关于市场融涨的讨论开局，却以严重的股

市亏损告终。

目前许多乐观情绪都是基于政策将继续支持经济的想法。但如果政策制定者改变方针怎么办？持续的财政支持需要政治上的行动和协议，而这些并不是一直都可靠。人们自然会担心刺激措施可能会突然终止，就像2010年之后发生的那样。不过，到目前为止还没有这种迹象。摩根大通的经济学家估计，美国在圣诞节后通过的9000亿美元财政刺激计划将为2021年的GDP增长增加两个百分点。共和党丢掉了在参议院的多数席位，这可能会为更宽松的财政政策打开大门。在欧洲，年中开始应该能感受到7500亿欧元（9200亿美元）复苏基金的推动作用。

但是，还存在另一个风险，它也让一些看涨派夜不能寐，那就是通胀重新抬头。封锁和财政转移支付给富裕国家的消费者留下了额外的储蓄和大量被抑制的需求，为疫情过后的消费大潮提供了动力。同时，经济衰退又削减了供给能力：许多小公司（也有一些大公司）倒闭了。如果供给瓶颈足够多，支出的激增就可能推高通胀。这种情况已经出现在大宗商品市场中：铜和铁矿石的工业需求（特别是来自中国的）的复苏遭遇了供给吃紧，导致价格上涨。

短暂的一轮通胀上升看起来是有可能的。而持续的连番攀升，乃至要迫使央行突然加息，似乎就没那么可信了。债券市场也不太可能会激烈反应以至于严重摧毁股价。债券收益率几个月来一直在小幅上涨：本月初，十年期美国国债收益率自2020年3月以来首次超过1%。这种缓慢上升的趋势确实反映了市场对通胀的预期上升，目前美国通胀水平已超过2%。但通胀保值国债的收益率几乎没有变化，而这种实际收益率才是股市估值的基准。如果这种略高于目标的通胀预期、美联储政策宽松和实际收益率稳定的格局保持不变，那么它很可能会提振而不是阻碍股价。

还要考虑其他的疫情后续影响。一大问题是债务。为确保有足够的现金来承受封锁带来的收入损失，企业大量举债。债务负担的增加将拖累公司的财务状况，并可能反过来对股价造成压力。但这个压力可能不大。央行购买公司债使得那些能在批发资本市场融资的公司的融资成本非常低：看一下

债务评级为BBB（风险最高的投资级债券）的公司的借贷成本就知道了。公司债和国债收益率的息差大约与2006年时一样低，当时广泛的信贷环境处于危险的宽松水平。这么低的借贷成本让债务更容易承担。一个相关问题是，公共债务激增最终将推高实际利率。但危机过后对流动安全资产的需求往往会长期保持在高水平。这类资产中最主要的一种是政府债券。

因此，细看会发现，股市上行路上的许多拦路虎似乎并不那么令人生畏。过去一年对经济来说是糟糕的，但许多股市仍然产生了正收益。原因之一是衰退对小型非上市公司的伤害甚于大型上市公司。另一个原因是债券的收益率很低。资产管理公司GMO的联合创始人杰里米·格兰瑟姆（Jeremy Grantham）在近期的一份报告中指出，美国股市已经涨得太多。“我估计这泡沫顶多能撑到春末或夏初。”他写到，并建议客户转投廉价的新兴市场股票避险。

格兰瑟姆的报告非常值得一读。但有一个疑问挥之不去。在现在的高价位持有股票的理由是利率低。全球都是这种情况。所以为什么股价不会在其他地方融涨呢？也许华尔街对2022年的年度展望将会评述美国股市泡沫破裂的残局。但是，似乎同样有可能的是，策略师们将为已经冲上了更高点上的价格呐喊助威——当然了，仍会是“具建设性”。 ■



Cryptocurrencies

If you can't beat them

Bitcoin might yet justify a high price. But it will not up-end global finance

THE FIRST surge in the price of bitcoin, to around \$1,000 in 2013, minted cryptocurrency millionaires, provoked declarations of a bubble and left some early fans kicking themselves. One unlucky man in Wales searched a rubbish dump for a hard drive containing 7,500 accidentally discarded bitcoins, whose value had grown from almost nothing to \$7.5m. Since then bitcoin has been on a wild ride. Fuelled by casual speculators and market manipulation, its price surged to about \$19,000 in December 2017; over the next year it fell by more than four-fifths. Bitcoin's most recent ascent has been its giddiest yet. Having tripled in three months its price is now over \$35,000 and somewhere under Newport sits a computer part worth over \$260m.

Today's bitcoin enthusiasm is striking because basement-dwelling libertarians are not the only ones talking it up. Some of Wall Street's finest have joined them. Larry Fink of BlackRock, the world's largest asset manager, said in December that bitcoin could become a "global market". Big hedge funds such as Renaissance Technologies have been punting on cryptocurrencies. Ruchir Sharma, a strategist at Morgan Stanley's investment arm, argues that America's mounting debts may make cryptocurrencies more appealing.

The total value of outstanding bitcoins exceeds that of Canadian dollars, narrowly defined to include banknotes and central-bank reserves. But few of the new crypto converts think it has any chance of replacing government money—the dream of early believers. It is far too inefficient to be of much use for making payments; bitcoin is capable of processing fewer than ten

transactions per second. By contrast, the firms upending consumer finance, like Alipay and Venmo, minimise friction. Were that problem solved, governments would clamp down quickly on any technology that threatened their monetary sovereignty. Regulatory resistance has already forced Facebook's mooted digital currency, Libra, to rebrand (to "Diem") and scale back its early ambition. Meanwhile, the competition is heating up as central banks improve payments systems and launch slick digital currencies of their own.

Bitcoin mania is instead rooted in the possibility that it might eventually offer a safe store of value—like gold, but more convenient (because it is easier to maintain a digital wallet than a physical vault). Then it could win a small but permanent slice of investors' portfolios. Like bitcoin, gold pays no interest or dividend. Unlike bitcoin, gold has fundamental uses, but it is fluctuating demand from investors for the yellow metal, not jewellers and chipmakers, that drives prices. It is therefore conceivable that bitcoin's high price could also prove self-sustaining. If bitcoin became as popular with investors as gold (measured by the market value of their positions) the price would rise to \$146,000, calculates JPMorgan, a bank. Already, millennial investors appear to prefer cryptocurrencies to bullion.

There are plenty of reasons to doubt that bitcoin can emulate gold. Its price is much more volatile and moves with the stockmarket, which is hardly desirable for a supposed haven. The market is illiquid and cryptocurrency trading remains a wild west in which fraud and theft are rampant, and which facilitates crimes such as selling drugs online. Investors in cryptocurrencies must tolerate a large dose of financial and reputational risk. Hedge funds, which thrive on dicey investments, may be piling in but the stolid end of Wall Street, which includes pension funds, is wary.

Yet it would be wrong to dismiss bitcoin's surge out of hand. Eventually, an accommodation with regulators, more liquid trading and clampdowns on

criminal activity—the supposed anonymity of bitcoin is overstated—could give it a wide appeal. Bitcoin was originally sold on the promise of upending the global monetary system. Its success now hinges on finding a more modest role within it. ■



【首文】加密货币

如果打不赢，就.....

比特币或许仍有理由涨价。但它不会颠覆全球金融

比特币价格在2013年首次飙升，达到1000美元左右，造就了一批加密货币百万富翁，引发了泡沫的说法，还让一些早期爱好者捶胸顿足。威尔士的一个倒霉蛋在垃圾堆里苦苦翻找无意间扔掉的硬盘，因为里面有7500个比特币，它们已从几乎分文不值升至750万美元。从那时起，比特币坐上了过山车。在投机散户和市场操纵的推动下，其价格在2017年12月飙升至约19000美元，但在接下来的一年里暴跌超过五分之四。比特币最近一轮上涨是至今最刺激的。其价格在三个月内升至原来的三倍，目前已超过3.5万美元，而被埋在威尔士纽波特城（Newport）某处的那块电脑硬盘现在已值超过2.6亿美元。

眼下这股比特币热令人瞩目，因为推波助澜的不仅仅是那些住地下室的自由意志主义者，连一些华尔街最杰出的公司也加入了其中。全球最大的资产管理公司贝莱德集团（BlackRock）的拉里·芬克（Larry Fink）在12月表示，比特币可能会成为一个“全球市场”。文艺复兴科技（Renaissance Technologies）等大型对冲基金押注加密货币已经有一段时间。摩根士丹利投资部门的策略师鲁奇·夏尔马（Ruchir Sharma）认为，美国不断累积的债务可能令加密货币更具吸引力。

现在流通中的比特币总值超过了加元（仅限纸币和央行储备）。但新近转投加密货币阵营的人很少会像早期的“信徒”那样，梦想比特币会取代政府发行的法货。比特币太低效了，每秒只能处理不到十笔交易，在支付中用处不大。相比之下，支付宝和Venmo等颠覆消费金融的公司能将摩擦降到最低。假如加密货币的这个问题得到解决，各国政府会迅速行动，打击任何威胁到它们对货币的最高控制权的技术。监管阻力已迫使Facebook酝酿的数字货币Libra更名（改为“Diem”），也再不像一开始那样雄心勃勃。同时，随着各国央行改进支付系统并推出自家时髦的数字货币，竞争正在

升温。

这波比特币热实则植根于一种可能性：它最终会成为一种安全的价值存储工具——就像黄金，却更方便（因为数字钱包比实体金库更易于维护）。那么，它就可能会在投资者的投资组合中赢得不大但永久的份额。和比特币一样，黄金不支付利息或股息。和比特币不一样的是，黄金有一些基本用途，但推动其价格变化的是投资者而非珠宝商或芯片制造商对这种黄色金属的需求变化。由此可以想到，比特币的高价或许也可以自我维持。据摩根大通计算，假如比特币变得像黄金一样受到投资者追捧（以其持仓市值衡量），其价格将上升至14.6万美元。比起金条，千禧一代投资者似乎已经更青睐加密货币。

有很多原因让人怀疑比特币能否媲美黄金。比特币的价格波动要大得多，而且随股市的走势变化，并非理想的避险工具。其市场缺乏流动性，加密货币交易仍是一片“狂野西部”，其中欺诈和盗窃猖獗，而且为网络贩毒等犯罪活动提供了便利。加密货币的投资者必须承受大量的财务及声誉风险。依赖高风险投资的对冲基金可能会扎堆进场，但包括养老基金在内的华尔街冷静派态度谨慎。

但轻率地对比特币的暴涨不以为然就错了。如果能和监管机构“和解”，提高交易的流动性，加强打击相关犯罪活动（比特币所谓的匿名性实际是被夸大了），比特币最终可能会获得广泛的吸引力。比特币最初的卖点是承诺颠覆全球货币体系。而现在，它的成功取决于它能否在这个体系之中找到一个更温和的角色。 ■



Deutschland AG in China

Riding high

German companies will keep pouring billions into China, never mind geopolitics

THE IDEA of “political change through trade” has lost its appeal across much of the West as China has grown more, not less, authoritarian under President Xi Jinping. That has not stopped Karl Haeusgen, chairman of Hawe, a maker of hydraulic pumps, from believing in the long-term success of its German version, *Wandel durch Handel*.

Mr Haeusgen has a self-interested reason for optimism. China accounts for about one-quarter of Hawe’s sales. This will grow substantially once a 25,000-square-metre factory in Wuxi near Shanghai is finished. On January 1st Ye Jiang, an engineer who has worked for the family firm since 1999, joined its management board as its first Chinese member.

Many German bosses are in a similar situation. Goods trade between the EU and China grew eight-fold between 2000 and 2019, to €560bn (\$626bn). In 2019 Germany accounted for 37% of that, or €206bn. In the first seven months of 2020 German business helped China edge out America as the EU’s largest trading partner. Between January and September China’s share of German exports rose by one-eighth, year on year, to nearly 8%. China is also Germany’s top supplier; its share of German imports rose to more than 11% in the same period, from less than 10% in 2019.

Although the most China-dependent American companies, like its casino operators and chipmakers, get more of their revenues from the Asian giant than the most exposed German firms, German Sino-dependency is concentrated in its biggest and most powerful industries (see chart). Of Germany’s 15 most valuable listed firms, ten derive at least a tenth of

revenues from China, according to *The Economist's* rough estimates; in America, less than half do.

That is why German business applauded the hasty conclusion last month, in the last days of Germany's rotating presidency of the EU Council, of an investment treaty between the bloc and China. The deal is meant to grant European firms better access to the Chinese market by, for instance, removing the requirement that they form a joint venture with a local firm and creating a more level playing field for investors.

Deutschland AG's peculiar reliance on China also helps explain its reluctance to heed the German government's pleas to diversify markets and supply chains away from the Asian giant. Indeed, many German firms, from medium-sized *Mittelstand* stalwarts like Hawe to its bluest chips, are doubling down on the Middle Kingdom. Hahn Automation, which makes industrial robots, plans to invest millions of euros in new Chinese factories and boost its revenues in China from 10% of the total to 25% in the next five years. BASF is building a gargantuan \$10bn plastics factory in the southern province of Guangdong, the biggest investment in the chemicals giant's 155-year history. "We have to play ball with the Chinese," says Joerg Wuttke, the German head of the EU chamber of commerce in China. "If you are not at the table, you are on the menu," he warns.

The loudest cheerleaders are in Germany's car industry. "China is the present and the future of German carmakers," says Noah Barkin of Rhodium Group, a research firm. As the world's biggest market, China accounts for two in five cars the Volkswagen Group sells globally. Without China it would have been hit harder both by the "Dieselgate" emissions scandal and by the pandemic. China is the biggest foreign market for BMW, a Bavarian rival, whose sales there rose by 31% in the third quarter, year on year. In December Ola Källenius, boss of Daimler (in which two Chinese carmakers hold a

combined 15% stake) hailed a “remarkable” recovery in China, the largest and most lucrative market for its Mercedes-Benz brand, whose sales grew by double digits for six straight months.

German carmakers are also becoming more reliant on China for their capacity to innovate, notes the Mercator Institute for China Studies, a think-tank. In September the new iX3 electric car rolled off the production line in Shenyang, where it was also wholly developed by BMW and its Chinese state-run partner, Brilliance Auto. The joint venture also opened a new battery factory in the northeastern city. Volkswagen and its Chinese partners pledged to invest €15bn into e-mobility in China by 2024. VW recently bought a stake in Gotion High-Tech, a maker of batteries, to bolster its “electrification strategy in China”. Daimler’s latest annual report calls China “a significant market for new technologies”.

No wonder carmakers are genuflecting before China’s Communist Party. According to the *Süddeutsche Zeitung*, a newspaper, in 2012 Volkswagen opened a loss-making plant in the western city of Urumqi, in exchange for permits for new, lucrative factories on the eastern coast. VW denies the accusation. It has kept its Urumqi plant running, despite pressure from activists and politicians in America and Europe to stop doing business in Xinjiang province, where the authorities have been persecuting the Uyghur Muslim minority.

Some voices in corporate Germany are worried that this is short-sighted. Two years ago the BDI, one of the two main German industry associations, published a paper outlining its concerns about high barriers to entry, state subsidies to local firms and other distortions in the Chinese market. Although it now praises the new investment treaty, the BDI warned that its members should be under no illusion: even once the pact is ratified by the European Parliament and implemented, German firms will not have truly free access to the Chinese market.

Chinese firms are also increasingly competing with German ones, particularly in the sort of specialist machinery manufactured in the *Mittelstand*. China is already the world's second-biggest exporter of such kit. With high labour costs at home, "innovation is our only competitive advantage", says Ulrich Ackermann of the VDMA, an association of machinery-makers. And that advantage is being eroded as more Chinese firms follow its electric-car industry in becoming more sophisticated.

German firms' relationship with China has therefore become "a constant walk on a tightrope between systemic competition and business partnerships", says Friedolin Strack of the BDI. No one believes in "political change through trade" in the foreseeable future, admits Wolfgang Niedermark, who until last year headed the German chamber of commerce in Hong Kong. But, it seems, German bosses still believe in trade, through all the political change. ■



德企在中国

高歌猛进

德国企业仍将大手笔投资中国——地缘政治的问题先放放

随着中国在习近平治下威权程度不降反升，“以贸易改变政治”的理念对大部分西方世界来说已变得索然无味。然而，液压泵制造商哈威（Hawe）的董事长卡尔·豪斯根（Karl Haeusgen）依然相信德国版的“以商促变”可以取得长远的成功。

豪斯根的乐观态度包含私心。中国市场约占哈威销售额的四分之一。等到公司在无锡建设的一座2.5万平方米的工厂完工后，这一比例还将大幅提升。工程师叶江自1999年起一直为该家族企业效力，今年1月1日他加入了公司董事会，成为其中的第一个中国人。

许多德国老板的处境类似。2000年至2019年，欧盟与中国之间的货物贸易增长了七倍，达到5600亿欧元（6260亿美元）。2019年的中欧贸易额中，中德贸易为2060亿欧元，占37%。2020年的头七个月，德国商业助推中国取代美国成为欧盟最大的贸易伙伴。1月至9月，中国占德国出口的比例同比增长了八分之一，接近8%。同时，中国也是德国最大的供应国；同期内，中国占德国进口的份额从2019年的不到10%上升至超过11%。

尽管相比最依赖中国的美国公司——例如美国的赌场运营商和芯片制造商——最依赖中国的德国公司从中国赚取的营收占比更低，但德国对这个亚洲巨人的依赖却集中在自身最大最强的一些行业（见图表）。据本刊粗略估计，德国市值最高的15家上市公司中有10家至少有十分之一的收入来自中国，而美国的该比例不到一半。

这就是为什么德国商界要为上个月达成的中欧投资协定叫好。该协定在德国担任欧盟理事会轮值主席国的最后几天里匆忙达成。它意在为欧洲企业进入中国市场创造更好的条件，例如取消与本地公司组建合资企业的要

求，以及为投资者创造更加公平的竞争环境。

德国商界对中国特有的依赖程度还有助解释它为何不愿响应德国政府的呼吁，在这个亚洲巨人之外多元化发展市场和供应链。事实上，从哈威这样的中小型中坚企业到最大的那些蓝筹公司，许多德国公司正加倍押注于中国。生产工业机器人的哈恩自动化（Hahn Automation）计划在中国投资数百万欧元开设新厂，并在五年内将它在中国的收入占比从10%提高到25%。巴斯夫（BASF）正斥资100亿美元在广东建设一座超大型塑料生产基地，这是该化工巨头155年历史中最大的投资。“我们必须与中国合作。”中国欧盟商会的德国籍主席伍德克（Joerg Wuttke）表示。“强为刀俎弱为鱼肉啊。”他警告说。

德国汽车业对此反应最为积极。研究公司荣鼎咨询（Rhodium Group）的诺亚·巴金（Noah Barkin）称，“中国是德国汽车制造商的现在和未来。”作为全球最大的汽车市场，中国占了大众集团全球销量的五分之二；如果没有中国，“排放门”丑闻和疫情对这家公司的打击会更加沉重。中国是大众来自巴伐利亚的竞争对手宝马最大的海外市场，其第三季度在华销量同比增长了31%。12月，戴姆勒（两家中国汽车制造商合计持有该公司15%的股份）的老板康林松（Ola Källenius）称赞了中国经济的“非凡”复苏。中国是该集团旗下梅赛德斯-奔驰品牌最大也是利润最高的市场，其销量已经连续六个月录得双位数增长。

智库墨卡托中国研究中心（Mercator Institute for China Studies）指出，德国汽车制造商也越来越依赖中国的创新能力。去年9月，新款iX3电动汽车在沈阳工厂下线。这款汽车完全由宝马及其中国国有合作伙伴华晨汽车联合开发。该合资企业还在沈阳开设了一家新的电池工厂。大众汽车及其中国合作伙伴承诺在2024年前在中国电动汽车领域投资150亿欧元。大众最近入股了电池制造商国轩高科，以支持自己“在中国的电气化战略”。戴姆勒在最新年报中称中国是“新技术的重要市场”。

难怪汽车制造商会在共产党面前俯首称臣。据《南德意志报》（Süddeutsche Zeitung）报道，2012年大众在西部城市乌鲁木齐开设

了一家亏损的工厂，以换取许可在东部沿海新建利润丰厚的工厂。大众否认了这一指控。尽管面对欧美的活动分子和政界人士要求停止在新疆（政府在迫害当地的维吾尔族穆斯林少数民族）的业务的压力，该公司仍维持着乌鲁木齐工厂的运营。

德国商界也有人担心这是一种短视的做法。两年前，德国两大行业协会之一的德国工业联合会（以下简称BDI）发表文章，列举了中国市场存在的种种问题，包括高准入门槛、政府对本国企业的补贴，以及其他扭曲行为。尽管BDI现在对新的投资协定表示赞赏，但也警告其成员不要抱有幻想：即使该协定获得欧洲议会批准并实施，德国企业也无法真正自由地进入中国市场。

中国企业也日益向德国企业发起竞争挑战，尤其在德国中小企业擅长的专业机械制造领域。中国已经是此类机械的世界第二大出口国。德国机械设备制造业联合会（VDMA）的乌尔里希·阿克曼（Ulrich Ackermann）表示，由于德国劳动力成本高昂，“创新是我们唯一的竞争优势”。而随着电动汽车工业带动越来越多的中国公司变得更加先进，这种优势正在被侵蚀。

因此，德国企业与中国的关系已变得像“在系统性竞争和商业伙伴关系之间来回走钢丝”，BDI的福里多林·施特拉克（Friedolin Strack）认为。在可预见的未来，没有人相信“以贸易改变政治”可以奏效，去年离任香港德国商会主席的宁马克（Wolfgang Niedermark）承认。但是，无论政治如何变迁，德国老板们似乎对贸易仍然笃信不移。 ■



The world economy

Covid-10trn

Totting up the pandemic's price tag

THE ECONOMIC toll of the covid-19 pandemic is incalculable. But let's try anyway. A useful starting point is the semi-annual *Global Economic Prospects* report released this week by the World Bank. It calculates that the world economy probably shrank by 4.3% in 2020, a setback matched only by the Depression and the two world wars. But this dramatic figure still understates the cost. It measures the world economy's fall from where it was before the pandemic, not from where it would have been had the virus not spread.

To calculate that bigger fall, economists need an estimate of how global GDP might have evolved in the absence of covid-19. One simple baseline is the World Bank's projection released this time last year, when it was still blissfully unaware of the lurking viral threat. Back then, it expected global GDP to expand by 2.5% in 2020 to \$86trn. Compared with that figure, the shortfall of global GDP last year was probably more like 6.6%. That is equivalent to about \$5.6trn (at the market exchange rates and prices prevailing in 2010, which the bank uses for analytical convenience).

In 2021 the world economy should grow unusually briskly, the bank projects, helped by the roll-out of vaccines. But even if this expectation is met and no further calamities intrude, the level of output in 2021 will remain 5.3% below the bank's pre-pandemic projections: a further shortfall of almost \$4.7trn (see chart).

Put these two numbers together and the cost of covid-19 this year and last will amount to about \$10.3trn in forgone output: goods and services the

world could have produced had it remained unafflicted. That is, to put it mildly, a big number. Only America and China have an annual GDP greater than \$10trn. And there are 153 economies that produced less than that between them in 2019. Converted into today's money, \$10.3trn is enough to buy the ten biggest listed companies in the world, including Amazon, Apple and Saudi Aramco. It is also enough to buy all the property in New York City nine times over.

Over \$2trn of the cost will be suffered by the euro area. America will bear roughly \$1.7trn. Among developing countries, India is set to endure the biggest loss in dollar terms: about \$950bn (although the bank's forecast for India's growth in 2021 seems unduly pessimistic). Although China's economy is much bigger than that of India, it will suffer a smaller GDP shortfall of about \$680bn.

Even these colossal numbers understate the cost, however. The economic damage, after all, will not be confined to this year and last. The World Bank expects global GDP in 2022 to remain 4.4% below its pre-pandemic predictions. It fears lasting harm to investment, human capital and, therefore, the growth potential of the world economy. It also worries that the debt that governments and companies have issued to help them weather the pandemic may harm growth in the future.

There is another reason why these figures understate the economic tab. If the pandemic had never happened, world GDP would not only have been higher, it would also have been different. Instead of masks, tests, vaccines, Zoom calls and parcel deliveries, the world economy would have produced other items. Because the pandemic is so damaging to health and society, it is worth diverting vast resources to fight it—these efforts are of enormous economic value. But if the virus had never spread, these same efforts would have been unnecessary, making them an expense the world could have been spared. ■

Correction: In last week's story on infrastructure investment (In the works, January 2nd) we mischaracterised CDPQ's green-energy portfolio. The Canadian fund is a big shareholder of Invenergy but does not own it entirely. Sorry. ■



世界经济

新冠损失十万亿

算算疫情的总账

新冠疫情造成的经济损失无法估量。但我们不妨试着算一下。世界银行最近发布了每半年一期的《全球经济展望》报告——这是个不错的入手点。世行预计2020年全球经济可能萎缩了4.3%，这样的衰退只有大萧条和两次世界大战时的情形可以一比。但这一惊人的数字仍然低估了疫情造成的损失。因为世行估算的世界经济下滑程度的参照点是疫情前的水平，而不是假设没有发生疫情的情况下经济所能达到的水平。

要计算出那个更大的降幅，经济学家需要估算出如果没有新冠肺炎，全球GDP可能达到什么水平。一个简单的办法就是对照世行在去年此时发布的预测，当时该机构对潜伏的病毒威胁还浑然不觉。那时候，它预计2020年全球GDP将增长2.5%，达到86万亿美元。与这一数字相比，去年全球GDP的降幅可能更接近6.6%，相当于约5.6万亿美元（为便于分析，世行采用的是2010年的市场汇率和物价）。

世行预计，得益于疫苗的推出，2021年世界经济应该会异常迅速地增长。但是，即使这一预期得以实现，且不再发生其他灾难，2021年的产出水平仍会比世行在疫情前的预测低5.3%，相当于再多出将近4.7万亿美元的损失（见图表）。

把这两个数字加在一起，今年和去年的损失数字将达到约10.3万亿美元，这是因新冠疫情而损失的产出：在没有疫情的情况下世界原本会生产出来、而现在不见了的那部分产品和服务。说得温和一点，这是个大数目。只有美国和中国的年GDP超过10万亿美元。而且在2019年，有153个经济体的GDP加在一起还不到10万亿美元。按现在的汇率和物价换算，10.3万亿美元足以收购包括亚马逊、苹果、沙特阿美在内的全球十大上市公司，也足以买下九个纽约市的所有房地产。

其中，欧元区将损失2万多亿美元。美国将损失约1.7万亿美元。在发展中国家，按美元计算，印度有可能承受的损失最大，约为9500亿美元（不过世行对印度2021年经济增长的预测似乎过于悲观）。尽管中国经济总量远大于印度，但它的GDP损失会更小，约为6800亿美元。

然而，即使是如此庞大的数字依然低估了损失。毕竟，疫情对经济造成的损害不会局限于今年和去年。世行预计，2022年全球GDP仍将比自己在疫情前的估算低4.4%。它担心这会对投资、人力资本、进而对世界经济的增长潜力造成持久的损害。它还担心，各国政府和企业为应对疫情而发行的债券可能会损害未来的经济增长。

之所以说这些数字低估了经济损失还有一个原因。如果新冠疫情从未发生过，世界GDP不仅会更高，其构成也会不同。世界经济原本会产出一些别的东西，而不是口罩、检测设备、疫苗、Zoom会议和快递。鉴于疫情对健康和社会的危害如此之大，调用庞大资源来抗击疫情是值得的——这些努力具有巨大的经济价值。但是，如果新冠病毒从来没有传播过，就不需要付出这些努力，也就可为世界各国省掉这笔费用。





China's stockmarket

Bring out your dead

China wants to clear the dross from its stock exchanges

LIKE MANY Chinese companies on the stockmarket, Gangtai Holding, a jewellery-to-property conglomerate, flaunts its listing. It displays its ticker number, 600687, prominently on its website and in its ads. But not for much longer. On January 7th Gangtai began a 30-day period almost certain to end with its ejection from the Shanghai Stock Exchange. It is one of a growing number of Chinese companies to face delisting at home.

In recent months all the delisting talk has been about the removal—or not—of Chinese companies from American exchanges. Within China, though, a potentially more important kind of delisting is on the agenda: regulators have made it easier to strip lousy firms of their listing status. It is the latest in an array of reforms aimed at modernising the stockmarket, long seen more as a casino than an efficient allocator of capital.

Delistings are a staple of healthy stock exchanges, a mechanism for clearing out the dross. In America a few dozen companies are typically forced off its exchanges every year, often because of low market values. In the early 2000s, after the dotcom bust, annual delistings climbed to nearly 400. China, by contrast, has averaged seven delistings a year over the past decade, despite having more than 4,000 listed companies, nearly as many as America.

Delistings have been so infrequent in China mainly because, relative to demand, listings themselves were hard to come by. “Even if a company is nearly bankrupt, the shell value of being listed is really high. Just by staying alive it can find a buyer,” says Lu Fangzhou of the University of Hong Kong.

This has made for perverse incentives. Listed firms in financial trouble in China are classified as “special treatment”, abbreviated to ST before their ticker name, to warn off investors. Instead, however, it is often an invitation to bid up their prices, as buyers might emerge. ST stocks are volatile, but their returns have occasionally beaten the overall market (see chart).

That has recently begun to change. Regulators relaxed controls over initial public offerings, paving the way for hundreds of new listings. The value of being a shell diminished. The delisting reform, introduced on the final day of 2020, attacks the problem from the other end. Companies with share prices below 1 yuan (\$0.15) for 20 consecutive days will now face automatic delisting. Those that fraudulently overstate their earnings by 100% for three years are on the chopping block, too.

The process will also become much faster, eliminating an intervening trading suspension—when troubled companies could find buyers. China’s delistings could increase to about 50 a year. Some investors complain the rules are still too lenient. For example, Luckin Coffee, a Chinese would-be rival to Starbucks, was kicked off Nasdaq for fabricating transactions; in China its listing probably could have survived. But Zhou Maohua of China Everbright Bank counsels patience, saying the rules will be adjusted over time.

In Gangtai’s case, the company overstretched itself. The gold-miner and jewellery-maker got pulled into property, even planning a skyscraper, and bought Buccellati, an Italian jeweller. But as it racked up huge losses, it defaulted on bonds and sold its best assets. Delisting is its latest humiliation. At least it can console itself that it will soon have plenty of company. ■



中国股市

清理尸骸

中国想要清除其证券交易所里的糟粕

与股市里的许多中国公司一样，业务覆盖珠宝到地产的企业集团刚泰控股也炫耀自己上市公司的地位。它将股票代码600687展示在官网和广告的显著位置。但这没持续太久。1月7日，刚泰进入了为期30天的退市整理期，几乎可以肯定的是，这之后它会被踢出上海证券交易所。除它之外，还有越来越多中国公司在国内面临退市。

近几个月来，所有关于退市的议论说的都是中国公司是否会被踢出美国交易所。不过，在中国国内，一种或许更重要的退市正在被提上日程：监管机构已经把撤销劣质公司的上市公司身份变得更加容易。这是一系列股市现代化改革中最新的一项。长期以来，中国股市更多被视为赌场，而不是有效的资本配置渠道。

退市是健康的证券交易所常见的做法，是一种清理糟粕的机制。在美国，每年通常都有几十家公司被迫退市，往往是因为市值过低。本世纪初，在互联网泡沫破裂后，每年退市的公司一度增至近400家。相比之下，尽管中国有4000多家上市公司，几乎与美国一样多，但过去10年平均每年只有七家退市。

退市在中国如此少见，主要是因为相对于需求而言，上市本身很难得。“即使一家公司濒临破产，上市的空壳价值也非常高。只要能活下去，就能找到买家。”香港大学的卢方舟说。这就导致了反向激励。在中国，出现财务问题的上市公司被列为“特别处理”（Special Treatment），在其股票名称之前会冠以缩写ST以警告投资者。但是，这反而常常会导致人们推高它们的价格，因为可能会出现买家。ST股票波动较大，但回报有时会超过整体市场（见图表）。

这种情况最近开始发生变化。监管机构放松了对IPO的管控，为数百家公司的上市铺平了道路。壳公司的价值降低了。在2020年最后一天推出的退市改革从另一个角度解决这个问题。股票收盘价连续20个交易日低于1元的公司将面临自动退市。连续三年虚报利润超过100%的公司也会被砍掉。

这一进程的推进速度还会大大加快，省去退市前停牌这一步——问题公司可能会在此期间找到买家。中国的退市数量可能会增加到每年约50家。一些投资者抱怨这些规定仍然过于宽松。例如，有志于挑战星巴克的中国公司瑞幸咖啡因伪造交易被纳斯达克踢出，而换在中国，它也许还能保住上市公司的地位。但中国光大银行的周茂华建议要有耐心，他认为随着时间的推移相关规定还会调整。

在刚泰的案例中，这家公司步子迈得太大了。本来经营金矿和珠宝制造的它卷入了房地产行业，甚至计划建造一栋摩天大楼，还收购了意大利珠宝公司布契拉提（Buccellati）。但随着巨额亏损不断累积，它发生了债券违约，并卖掉了自己最好的资产。摘牌是它最新的耻辱。至少它可以聊以自慰的是，很快就会有很多公司与它为伴。 ■



Bartleby

Network effects

The modern economy depends on how well people connect with others

SUCCESS IN MANUFACTURING depends on physical things: creating the best product using the best equipment with components assembled in the most efficient way. Success in the service economy is dependent on the human element: picking the right staff members and motivating them correctly. If manufacturing is akin to science, then services are more like the arts.

Motivating people has an extra complexity. Widgets do not know when they are being manipulated. Workers make connections with their colleagues, for social or work reasons, which the management might not have anticipated.

Marissa King is professor of organisational behaviour at the Yale School of Management, where she tries to make sense of these networks. She attempts a classification in her new book, “Social Chemistry: Decoding The Elements of Human Connection”.

The term “networking” has developed unfortunate connotations, suggesting the kind of person who sucks up to senior staff and ignores colleagues who are unlikely to help them win promotion. Ms King cites a study which found that two-thirds of newly promoted professionals were ambivalent about, or completely resistant to, thinking strategically about their social relationships.

From the point of view of productivity, the most important networks are those formed by employees from different parts of the company. Diverse viewpoints should lead to greater creativity. They are good for workers, too.

A study found that catching up with colleagues in different departments was linked to salary growth and employee satisfaction.

Some employers had the bright idea of encouraging this co-operation by moving to open-plan offices. But research suggests that workers in open-plan layouts are less productive, less creative and less motivated than those in offices with a traditional, room-based design. The quality of interactions is more important than the quantity. The pandemic, by forcing many people to toil away at home, has probably corroded some of these co-operative arrangements.

Ms King says that people tend to construct three types of network. “Expansionists” have a wide set of contacts but their relationships tend to be shallow. “Conveners” have a small number of relationships, but these are more intense. “Brokers” link people from different network types.

On the surface, this categorisation seems reasonable. How useful is it? Readers can take an online test ([at assessyournetwork.com](http://assessyournetwork.com)) to see which category they fall into. Bartleby did so and found (as he expected) that he did not fit into any of them. Indeed, the author’s research shows that one in three people does not have a clearly defined style and 20-25% could be classed as mixed (for example, they are simultaneously brokers and expansionists). In other words, more than half of people cannot be neatly categorised.

To add to the muddle, Ms King introduces sub-categories: co-operative brokers, arbitraging brokers, tortured brokers, and so on. Some people move from one category to another (like a certain Heidi Roizen, who, in a feat of management jargon, “transitioned from an expansionist to a broker to a convening nucleus”). At this point it seems wiser to admit that, to use an old phrase from the north of England, “there’s nowt so queer as folk”. Fortunately, the book is full of wisdom and entertaining anecdotes which

show that stories can give more insight than attempts at scientific categorisation.

Two fun case studies outline a common problem—the tendency for people to have too narrow a focus. In one test, only one in four mobile-phone users noticed a clown who unicycled past them while they were looking at their screens. In another revealing story, Catholic seminarians strode past a distressed bystander while in a hurry to give a lecture on the parable of the good Samaritan. In the right network, the presence of a diverse set of participants may allow the group to see the bigger picture.

Old-fashioned concepts like courtesy can also help, Ms King argues. Simple gestures—a smile, a thank you—make colleagues more likeable and increase co-operation. In contrast, studies of workers who experience incivility find that their effort, time spent at work and commitment to the job all reduce. Ms King invokes the aphorism that “assholes” can be identified by observing how they treat people with less power. “Don’t be an asshole” is not a scientific statement. But it is still a pretty good management motto. ■



巴托比

网络效应

现代经济有赖于人们与他人连接得多好

制造部门的成功取决于实体物件：使用最好的设备，以最高效的方式组装零件，创造出最好的产品。服务经济的成功取决于人的因素：选择合适的员工并恰当地激励他们。如果制造类似于科学，则服务更接近艺术。

激励人员有额外的复杂性。器具在被部署摆弄时无知无觉。而员工会出于社交或工作上的原因与同事联系，这种互动可能是其管理层未曾预料的。

玛丽莎·金（Marissa King）是耶鲁大学管理学院的组织行为学教授。她在该学院开展的研究尝试理解这种人际网络。她在自己的新书《社会化学：解码人际关系的元素》（Social Chemistry: Decoding The Elements of Human Connection）中尝试一种分类法。

“拓展人脉”（networking）一词已发展出令人不适的言外之意，暗示这样一种人：对领导溜须拍马，对不大可能帮到自己晋升的同事视若无睹。金引用的一项研究发现，新近升职的专业人士中，有三分之二对于策略性思考人际关系的做法持模棱两可或完全排斥的态度。

从生产率的角度看，由来自公司不同部门的员工组成的人际网络最为重要。多元化的观点应该能提升创造力。它们也有益于员工本身。一项研究发现，和不同部门的同事互动与工资增长及员工满意度相关联。

一些雇主想出了搬进开放式办公室来促进此类合作的高招。然而研究表明，与分成房间的传统办公室相比，开放式布局中的员工生产率低，创造力差，工作积极性也受影响。人际互动的质比量更重要。新冠疫情迫使许多人在家工作，可能对这种合作架构有些损害。

金说，人们倾向于构建三类网络。“扩张者”交友广泛，但关系往往肤浅。

“召集人”交友数量少但关系更紧密。“中间人”连接不同网络类型的人。

从表面上看，这种分类似乎合情合理。但又有多少用呢？读者可以做一项线上测试（assessyournetwork.com）来看看自己属于哪一类。笔者测试后发现（正如预期的那样）自己不属于其中任何一类。实际上，作者的研究表明，有三分之一的人并没有可明确定义的风格，而20%到25%的人可被归为混合型（比如同时是中间人和扩张者）。换言之，超过一半的人不能被简单归类。

雪上加霜的是，金还引入了子类别：合作型中间人、套利型中间人、受虐型中间人，等等。有些人从一个类别转到另一个（例如某个叫海蒂·罗伊森〔Heidi Roizen〕的人集管理术语于一身，“从扩张者转型为中间人再转型为召集核心”）。走到了这一步，似乎更明智的做法是承认——用英国北部的一句老话来说——“没有东西比凡人更古怪。”所幸，这本书充满了智慧和有趣的轶事，显示相比尝试科学分类，讲故事能给读者带来更多洞察。

两个有趣的研究案例描述了一个常见问题：人们的注意力往往过于狭隘。在一项测试中，只有四分之一的人在看着自己的手机屏幕时注意到了一个小丑骑着独轮车经过。另一个故事也很有揭示性：天主教神学院的教徒们赶着去做关于“好心的撒玛利亚人的寓言”的演讲，大步经过一个痛苦的路人而对其视而不见。在一个恰当的人际网络中，各种各样参与者的存在可能会让团队的视野变得更开阔全面。

金认为，礼貌等老式概念也会有所助益。像微笑、说一声谢谢这种简单的示意会使员工更讨同事喜欢，增进合作。相反，对那些被粗鲁无礼对待的员工的研究发现，他们对工作付出的努力、时间和投入程度都减少了。金援引了一句警句：观察人们如何对待更弱势的人，就可以识别出“混蛋”。“别讨人嫌”不是一种科学表述，但它仍是一个很不错的管理座右铭。■



Business and technology

Bearing fruit

The pandemic has ushered more robots into factories, warehouses and back offices. They are here to stay

MARY BARRA, boss of GM, took to the virtual stage on January 12th to launch BrightDrop. The carmaker's new logistics division will peddle such unsexy things as delivery vans and autonomous electric pallets for use in warehouses. Hardly stuff to set pulses racing.

S suppress your yawn, for Ms Barra's announcement is the latest sign of a quiet but powerful revolution. "The convergence of software and hardware seen in the carpeted parts of enterprises is now seen on factory floors in every industry we serve," says Blake Moret, chief executive of Rockwell Automation, a giant of the industry. His firm runs a full-scale manufacturing facility at its Milwaukee headquarters, to prove that automation enables it to make competitive products despite America's high labour costs. Its share price has risen by 28% in the past year, nearly twice as much as the S&P 500 index of big American firms. Other purveyors have done even better.

Bosses have boasted of automating their operations for years without an awful lot to show for it. Covid-19 has spurred them to put their money where their mouths are. Hernan Saenz of Bain, a consultancy, reckons that between now and 2030 American firms will invest \$10trn in automation. Nigel Vaz, chief executive of Publicis Sapient, a big digital consultancy, says that the downturn offers bosses the perfect cover. "The unrelenting pressure for short-term financial results from investors has temporarily been suspended," he says. "Firms are not just going back pre-pandemic, but completely reimagining how they work," says Susan Lund, co-author of a

forthcoming report from the McKinsey Global Institute, a think-tank. A recent survey by the institute's sister consultancy found that two-thirds of global firms are doubling down on automation.

Robots are the most prominent winner. Robo Global, a research firm, predicts that by the end of 2021 the worldwide installed base of factory robots will exceed 3.2m units, double the level in 2015. The global market for industrial robotics is forecast to rise from \$45bn in 2020 to \$73bn in 2025.

"We have had a catbird seat during the pandemic," says Michael Cicco, the head of the American operations of Fanuc, a Japanese robot-maker. With supply chains whacked, manufacturers were forced to find ways to build flexibility, he says. Companies reshoring production have sought to offset the high cost of human labour with the engineered sort. And robots are becoming much more capable. The most dexterous can now pick delicate objects such as individual strawberries.

Fanuc has seen a surge in demand for material-handling equipment and "collaborative robots", designed to interact with people. These "cobots" are particularly useful in e-commerce, which covid-19 has given a huge boost. The pandemic has, on one informed estimate, led consumer-goods firms to increase buffer stocks by around 5%. To counter this, firms are snapping up robots for use in warehouses, made by companies like GreyOrange and Kiva (which Amazon acquired in 2012 to assist its e-commerce fulfilment).

Right now cobots help with social distancing. But, says Dwight Klappich of Gartner, a research firm, robots that move goods to workers will be a boon for post-pandemic productivity, too (as well as for the morale of humans, by sparing their weary feet). Luke Jensen of Britain's Ocado, an online grocer and robotics pioneer, insists that his low-margin industry must find ways of fulfilling the recent surge in online orders with less labour. His firm already

serves the bulk of its British customers from just three highly automated sites. Kroger, a big American grocer, is now expanding its roll-out of Ocado equipment both in warehouses and at its retail outlets.

A survey of supply-chain executives published on January 13th by Blue Yonder, another consultancy, found that the share of firms with fully automated fulfilment centres may rise by 50% within a year. And, as Sudarshan Seshadri of Blue Yonder puts it, “Automation is just the table stakes.” The pandemic’s bigger long-term impact may be a fuller embrace by firms of data their operations generate, and predictive algorithms to help guide real-time decisions.

Stuart Harris of America’s Emerson, a big automation firm, says that “pervasive sensing”—which combines AI and clever sensors—helped his company’s revenues from remote monitoring grow by 25% last year. Emerson’s clients range from a Singaporean chemicals factory to a Latin American mine. Peter Terwiesch of ABB, a big Swiss-Swedish industrial-technology firm, also reports a boom in remote-operations systems, from marine vessels to paper mills. His firm’s annual sales of such products have doubled to \$400m from pre-pandemic levels. Drishti, an American startup, has come up with a way to apply artificial intelligence (AI) and computer vision to analyse busy video streams of workers on assembly lines. Marco Marinucci of Hella, a big German car-parts supplier, says his firm used Drishti’s kit to analyse and fix problems at a high-volume assembly line. This allowed its throughput to rise by 7% last year. Publicis Sapient automated the inventory forecasting of a division of a big European retailer which found itself repeatedly out of stock amid the change in consumption patterns during the pandemic. The consultancy’s software allowed its client to prevent shortages of its top 100 items 98% of the time.

It isn’t just production floors and warehouses that are being automated.

So are back offices. By one estimate, America's health-care system could save \$150bn a year thanks to automation of paper-pushing. Allied Market Research, a firm of analysts, predicts that the global sales of process-automation products will balloon from \$1.6bn in 2019 to nearly \$20bn in 2027. In December UI Path, a trailblazing Romanian startup in the area, filed for an initial public offering. It may start with a market value of \$20bn. On January 12th Workato, an American rival, said it has raised \$110m in fresh funding.

Last year Alibaba, China's biggest e-emporium, unveiled the results of a more ambitious project, code-named Xunxi ("fast rhino"). Alain Wu, who runs Xunxi, explains that this involved digitising and integrating whole value chains—from product design, parts procurement and manufacturing to logistics and after-sales service. This allowed merchants on Alibaba's e-commerce platforms to fulfil customised orders within days while eliminating excess inventory. Time from production to delivery was reduced from several months to a fortnight.

Sceptics note that history is littered with examples of supposedly world-changing technologies that beguiled bosses, only to fail to live up to the promise. (Remember the blockchain?) Once covid-19 has been defeated, companies' enthusiasm for new technologies may subside. Those that have missed the opportunity to automate—as many have because they were busy trying merely to survive the pandemic recession—will lose the cover that Mr Vaz speaks of.

Optimists counter that this time really may be different. In the past the biggest returns to automation accrued to giant, well-capitalised firms. Today advances in technology and business models allow smaller ones to enjoy similar benefits. That should increase demand for clever systems—and in time reduce their cost further. And so on, in a virtuous, fully automated circle. ■



商业与技术

拾取果实

疫情把更多机器人请进了工厂、仓库和后台办公室。它们会留下来

通用汽车的老板玛丽·博拉（Mary Barra）1月12日在虚拟的舞台上宣布成立新业务部门BrightDrop。这个物流服务部门将销售一些不怎么酷炫的产品，如厢式货车和仓库用无人控制电动托盘。这些东西可不太会让人心潮澎湃。

忍不住要打哈欠？且慢。因为一场浩浩荡荡的革命正悄然上演，而博拉推出的BrightDrop正是这场革命的最新印证。“已经在企业管理部门中发生的软硬件融合如今在我们服务的每个行业的工厂车间里都能看到。”行业巨头罗克韦尔自动化（Rockwell Automation）的首席执行官布莱克·莫雷特（Blake Moret）说。该公司在美国密尔沃基的总部运行一套完备的生产设施，证明了尽管美国劳动力成本高昂，自动化技术令它能够制造出具有竞争力的产品。罗克韦尔的股价在过去一年里上涨了28%，几乎是美国大公司指数标普500的两倍。其他自动化技术供应商的表现甚至还要更好。

企业老板们多年来都号称要实现运营自动化，但一直没多少实质性成果可供展示。新冠疫情促使他们坐言起行，真正向这一块注资。咨询公司贝恩的赫尔南·塞恩斯（Hernan Saenz）估计，从现在到2030年，美国公司将在自动化方面投资10万亿美元。大型数字咨询公司阳狮沙宾特（Publicis Sapient）的首席执行官奈杰尔·瓦斯（Nigel Vaz）表示，这轮衰退为老板们提供了完美掩护。“投资者施加的持续不断的短期财务业绩压力暂时停止了。”他说。“企业并不只是回归疫情前的运作，而是在完全重新设想自身的运营方式。”苏珊·伦德（Susan Lund）表示，她是智库麦肯锡全球研究院（McKinsey Global Institute）即将发布的一份报告的作者之一。该研究院的姐妹咨询公司的一项最新调查发现，三分之二的全球企业正加倍押注自动化。

机器人是最显著的赢家。研究公司Robo Global预测，到2021年底，全球工业机器人的安装量将超过320万台，是2015年的两倍。预计全球工业机器人市场将从2020年的450亿美元上升到2025年的730亿美元。

日本机器人制造商发那科（Fanuc）的美国业务负责人迈克尔·希科（Michael Cicco）说：“我们在疫情期间占得了先机。”由于供应链受打击，制造商被迫设法提升灵活性，他说。把生产迁回本国的公司纷纷利用工程手段来抵消高人力成本。而机器人的能力正变得越来越强。如今最灵巧的机器人可以拾取一些非常娇嫩的东西，比如一颗草莓。

市场对发那科的物料搬运设备和“协作机器人”的需求激增。这些协作机器人专门设计用来与人互动，在电子商务这一受疫情极大推动的行业中特别有用。据知情人士估计，新冠疫情导致消费品企业的缓冲库存增加了5%左右。为了应对这种情况，企业开始抢购由GreyOrange和Kiva（2012年被亚马逊收购以辅助其电商仓配）等公司制造的仓库用机器人。

在目前的情况下，协作机器人有助于保持社交距离。但研究公司高德纳（Gartner）的德怀特·克拉皮奇（Dwight Klappich）表示，能把货物搬到工人手中的机器人对后疫情时代的生产率也将是个福音（在鼓舞士气方面也是，因为机器能让人少受些累）。英国线上杂货商、机器人应用的先行者Ocado的卢克·詹森（Luke Jensen）始终认为超市这种低利润行业必须寻求新方法，以较少的人手满足近来激增的线上订单。Ocado目前已通过三个高度自动化的仓库为其大部分英国客户提供服务。美国大型杂货零售商克罗格（Kroger）目前正在自家仓库和零售店扩大部署Ocado的设备。

另一家咨询公司Blue Yonder在1月13日发布了对供应链高管的一项调查，发现拥有全自动履单中心的企业比例可能在一年内上升50%。而且正如Blue Yonder的苏达桑·萨谢蒂里（Sudarshan Seshadri）所说，“自动化只是行业的最低要求。”疫情更大的长期影响可能是企业将更全面地利用自身业务生成的数据和预测性算法来辅助指导实时决策。

美国大型自动化公司艾默生的斯图尔特·哈里斯（Stuart Harris）表示，结合人工智能和智能传感器的“普适测量”推动其公司的远程监控业务的营收在去年增长了25%。艾默生的客户各种各样，有新加坡的化工厂，也有拉丁美洲的矿山。瑞士和瑞典大型合资工业技术公司ABB的彼特·特尔维施（Peter Terwiesch）也表示，从海洋船舶到造纸厂都在加速应用远程操作系统。ABB此类产品的年销售额达到四亿美元，是疫情前水平的两倍。美国创业公司Drishti研发了一款产品，利用人工智能和计算机视觉来分析流水线上工人作业的大量视频流。德国汽车零部件大型供应商海拉公司（Hella）的马尔科·马里努奇（Marco Marinucci）表示，其公司使用Drishti的工具包来分析和解决一条大批量装配线上出现的问题，去年的产量因此提高了7%。疫情期间消费模式发生变化，欧洲一家大型零售商旗下的一个部门经常缺货，后来在阳狮沙宾特的帮助下把自己的库存预测改为自动化。该咨询公司的软件让这个客户的100种最畅销商品在98%的时间里都不再短缺。

正在实现自动化的不仅仅是生产车间和仓库。后台办公室也是如此。据一项估计，把文书工作自动化可让美国的医疗保健系统每年节省1500亿美元。分析机构联合市场调研公司（Allied Market Research）预测，流程自动化产品的全球销售额将从2019年的16亿美元大增至2027年的近200亿美元。去年12月，该领域的领头羊、罗马尼亚创业公司UI Path申请上市，其市值可能以200亿美元起步。1月12日，其美国竞争对手Workato表示已完成了新一轮1.1亿美元的融资。

中国最大的电商集团阿里巴巴去年公布了一个更雄心勃勃的项目“迅犀”所取得的成果。迅犀的负责人伍学刚解释，项目涉及整个价值链的数字化和整合——从产品设计、零部件采购和制造，到物流和售后服务。这使得阿里巴巴电商平台上的商家可以在十几天内交付定制订单而不必积压多余库存。从生产到交货的时间从几个月缩短至两周。

怀疑者指出，历史上有太多据称能改变世界而令老板们心动不已的技术最终都未能兑现承诺。（还记得区块链吗？）等新冠疫情被击退后，企业对新技术的热情可能就会消退。许多企业都错过了此次推进自动化的良机，

因为它们只顾得上在疫情导致的衰退中努力活下来。它们将失去瓦斯所说的掩护。

乐观者反驳说，这次可能真的不一样。过去，资本雄厚的巨头公司从自动化中获得的回报最大。今天，技术和商业模式的进步让小公司也能享受到类似的好处。这应该会提升市场对智能系统的需求，而这会逐渐让购买这些系统的成本进一步降低，继而又推动需求，进入一个良性的、全自动的循环。 ■



The Big Mac index

Out of joint

What burger prices tell you about currency wars

DESPITE A RECENT bout of weakness, the dollar still looks strong. Consider the Big Mac index, our lighthearted measure of currency valuation. Of the currencies of the 20 trading partners studied by America's Treasury, our measure suggests that all have gained relative to the greenback since July, but that all apart from the Swiss franc are still cheap. That gives the incoming Biden administration, which has promised to take "aggressive trade-enforcement actions" against currency manipulators, lots to chew on.

Our burger-based index is premised on the idea that prices should adjust over the long run, so that the same basket of tradable goods costs the same everywhere. Converting prices into dollars at prevailing exchange rates lets you judge whether a currency is too cheap or too dear. To avoid the problem that people buy different things in different places, we compare the price of just one good: the McDonald's Big Mac. The burgers are not exactly the same across countries—India's Maharaja Mac, for instance, does not contain beef—but they are consistent enough. A burger in Thailand costs 25% less than in America when its price is converted to dollars at prevailing exchange rates, for example, suggesting that the Thai baht is undervalued.

As wages tend to be lower in poor countries, though, Big Macs there may be cheaper. So we also calculate an index that adjusts for GDP per person. On this basis the Thai baht is no longer cheap relative to the dollar. The number of trading partners with undervalued currencies falls to 11.

Is the Big Mac index consistent with recent American policy on currency manipulators? The two do not assess quite the same things. Our index

records outcomes; policymakers, by contrast, try to punish countries that intentionally depress their currencies. America's Commerce Department says it looks unkindly on currencies only if they are cheap because of government action. The Treasury is also concerned with manipulation, not undervaluation; it looks for evidence of intervention, as well as persistent trade imbalances.

Still, given currency gyrations over the past year, the Big Mac index could act as a cross-check on American policy. When covid-19 first spread, investors fled to the dollar, only for the trend to reverse after the Federal Reserve flooded markets with liquidity. Swings in the Mexican peso meant that, according to our index, it went from being 53% undervalued against the dollar to 61% undervalued over the first half of 2020, before the move was unwound. By contrast, the Vietnamese dong remained oddly stable against the dollar in the first half of last year.

Consistent with this, Mexico has escaped penalties from the Treasury and the Commerce Departments; Vietnam has not. On December 16th the Treasury labelled it a currency manipulator, citing its huge goods surplus with America and its intervention in foreign-exchange markets. The Commerce Department has whacked tariffs on imports of tyres from Vietnam, arguing that a depressed dong acted as a subsidy for producers.

On other fronts, though, America's recent actions are at odds with our index. The Treasury also branded Switzerland a manipulator, based partly on its currency intervention of around \$100bn (14% of GDP) in the year to June. Both versions of our index, though, suggest that the Swiss franc is overvalued against the dollar.

The Commerce Department also used manipulation to justify tariffs on imported twist-ties from China, used to seal plastic bags. (The country has not been labelled a manipulator since January 2020, but it is still on the

Treasury's watch list.) Incoming officials may want to note that, after adjusting for GDP, our index suggests the yuan is in fact overvalued relative to the dollar by 2.5%. Food for thought. ■



巨无霸指数

脱节

从汉堡包价格看货币之战

尽管美元近期走软，但看起来依然相当坚挺。这一点可以参考我们衡量货币汇率的趣味指标——巨无霸指数。该指标显示，美国财政部关注的20个贸易伙伴的货币自7月以来全部对美元升值，但除了瑞士法郎之外，这些货币的汇率仍然偏低。这给了刚上台的拜登政府很多值得咀嚼之处，他们已经承诺要对货币操纵国采取“激进的贸易执法行动”。

我们的巨无霸指数基于这样一个前提：价格会在长期内调整，使得同一篮子的可交易商品在各地区的售价大致相同。将价格按现行汇率换算成美元，就可以判断某种货币的汇率是偏低还是偏高。由于世界各地的人们购买的东西各不相同，我们就只比较一种商品的价格：麦当劳的巨无霸。这种汉堡在不同国家也不全然相同——比如说印度的麦王公汉堡里头就没有牛肉，但已经足够一致而可用于比较。例如，按现行汇率将泰铢换算成美元之后，一个巨无霸在泰国的价格要比在美国便宜25%，这就表明泰铢被低估了。

不过，由于贫穷国家的工资往往更低，那里的巨无霸也可能卖得相对便宜些。因此，我们还根据人均GDP数字做调整，计算出一个指数。以此为基础比较，泰铢相对于美元就不再便宜了。货币被低估的贸易伙伴数量也减少到了11个。

巨无霸指数是否与美国近期针对汇率操纵国的政策相一致？两者评估的对象并不完全相同。我们的指数记录的是结果，而政策制定者的出发点是要惩罚那些蓄意压低本币的国家。美国商务部表示，只有当某国货币因政府行为而贬值时才会对其采取严厉态度。美国财政部担心的同样是操纵汇率而非低估汇率，它寻找干预的证据，关注持续的贸易不平衡。

尽管如此，考虑到过去一年里的汇率波动，可以用巨无霸指数来交叉校验美国的政策。当新冠疫情刚开始蔓延时，投资者纷纷涌向美元，等到美联储向市场注入大量流动性后，趋势开始逆转。根据我们的指数，墨西哥比索的汇率先是在2020年上半年从对美元低估53%扩大至低估61%，然后又变回去。相比之下，越南盾对美元汇率却在去年上半年奇怪地保持稳定。

与此相一致的是，墨西哥避过了美国财政部和商务部的处罚，而越南没有。12月16日，财政部将越南列为货币操纵国，理据是它对美国的巨额商品贸易顺差以及对外汇市场的干预。商务部称，被压低的越南盾是对生产商的变相补贴，并以此为由对从越南进口的轮胎加征关税。

然而在其他方面，美国最近的行动与我们的指数并不一致。财政部将瑞士也列为汇率操纵国，原因之一是截至去年6月的一年里瑞士实施了约1000亿美元（占GDP的14%）的货币干预。但我们两个版本的指数都显示瑞士法郎对美元是高估了。

美国商务部还以操纵汇率为由，对从中国进口的用于密封塑料袋的扎带产品加征关税。（自2020年1月以来，中国并没有被列为汇率操纵国，但仍在财政部的观察名单上。）即将上任的政府官员可能会想要了解这一点：经GDP调整后的巨无霸指数显示，人民币对美元实际上被高估了2.5%。品味一番吧。 ■



Carmakers and big tech

Steel and silicon

Detroit loses out to virtual Vegas as cars go electric—and electronic

THE ANNUAL Consumer Electronics Show (CES) in Las Vegas used to be a jamboree for gadgets you can put in your pocket or hang on your wall. This hasn't been true for a few years. As vehicles morph from a lump of mechanical engineering to a digital platform for mobility services, and motor shows wane in importance, carmakers have sought new venues to showcase their wares. At this year's (virtual) CES, which opened on January 11th, they once again joined makers of smartphones, smart toilets and smart dog flaps in showcasing their smartest tech.

CES has risen in significance because vehicles are changing. Bosch, a parts supplier, noted at the show that a typical car had 10m lines of code in 2010; today it has 100m. This month Ford had to idle a factory in Kentucky for a week owing to a global shortage of semiconductors that deprived it of the chips its cars run on.

Electrification of transport will speed up the transformation of vehicles into electronic devices. Battery power requires a new electronic architecture that will come with better integration of hardware and software, and improved connectivity. Harman, a car-tech firm, envisions a "third living space" between home and work, using the development to plug a connectivity gap and offer new in-car services, such as interactive concerts and gaming.

In other ways, though, cars remain a metal box. Although electrification has reduced barriers to entry in the car business—which were formidable for capital-intensive metal-bashing—vehicles are still best made by firms that can manufacture at scale and with a trusted brand.

As a result, car firms are wracking their brains over how much of the software that runs their vehicles' new electronic functions they should develop in-house and how much to outsource to tech firms. At CES Daimler showed off Hyperscreen, a new touchscreen dashboard for its luxury electric models. Mary Barra, boss of GM, delivered a keynote speech reiterating the Detroit stalwart's electric and electronic plans. In the autumn GM said it would invest \$27bn in electric cars by 2025 and launch 30 new models. Ahead of CES it unveiled a new logo, repainted blue to evoke clean skies and with its "M" made to look a bit like a plug. During the event the firm made more announcements about its plans for electrification, including details about its BrightDrop electric delivery van and new electric Cadillacs (as well as, inevitably, a flying-car concept).

Tech firms, for their part, are mulling mobile hardware. Apple's flirtation with electric cars exemplifies the complexities of the relationship. Rumours that it intended to make electric vehicles first surfaced in 2014. Two years later, when the trouble and expense became clear, it dropped the idea. On January 7th a news report of talks with Hyundai to build an Apple car sent the South Korean carmaker's share price up by nearly 20%. Hyundai acknowledged it was in early discussions with the iPhone-maker. Apple has yet to comment. Just as carmakers look to Vegas, it seems, big tech is headed the other way. ■



汽车制造商和科技巨头

钢与硅

随着汽车走向电气化和电子化，底特律让位于虚拟的拉斯维加斯

一年一度的拉斯维加斯消费电子展（CES）上曾经满是各种可以放在口袋里或挂在墙上的小玩意。过去几年不再是这样了。随着汽车逐渐从一台机械工程设备演变为出行服务的数字平台，且车展的重要性也逐渐下降，汽车制造商已经在寻找新的渠道来展示自己的产品。在1月11日开幕的在线CES展上，它们再次加入智能手机、智能马桶和智能狗门制造商的队伍，展示自己最智能的技术。

CES地位提高是因为汽车在变化。零部件供应商博世（Bosch）在本次展览上指出，2010年一辆普通汽车有1000万行代码，现在是一亿行。本月，由于全球半导体供货短缺，福特在肯塔基州的一家工厂因为汽车所需芯片不足不得不停产一周。

运输电气化将加速车辆向电子设备的转变。电池动力需要一种新的电子架构，能够更好地集成硬件和软件，并改进联通性。汽车技术公司哈曼（Harman）构想了在家和办公室的两点一线上的“第三个生活空间”，利用这种技术发展来填补一个联网的空白段，并提供互动音乐会和游戏等新的车载服务。

但在其他方面，汽车仍然是个铁盒子。尽管电气化降低了进入汽车产业的门槛（资本密集型制造业曾经壁垒森严），但能生产出最优质汽车的仍是拥有大规模生产和可信赖品牌的公司。

结果就是汽车公司为了一件事大伤脑筋：那些运行汽车新电子功能的软件有多少该在内部开发，多少该外包给科技公司？戴姆勒在CES上展示了为其豪华电动车型设计的新型触屏仪表盘Hyperscreen。通用汽车的老板玛丽·博拉（Mary Barra）在展会的主题演讲中重申了这家底特律老牌汽车公

司的电气化和电子化计划。去年秋天，通用汽车表示到2025年将在电动汽车上投资270亿美元，推出30款新车型。在CES开幕之前它推出了一个新logo，颜色改为天蓝色，让人联想到纯净的天空，其中的字母“M”看上去有点像个插头。展会期间，通用汽车发布了有关其电气化计划的更多内容，包括BrightDrop电动货车和新型电动凯迪拉克的详细信息（以及不出所料地，一款飞行概念车）。

而科技公司这一边正在琢磨移动硬件。苹果试探电动汽车领域体现了这种关系的复杂性。有关苹果打算制造电动汽车的传言最早出现在2014年。两年后，当其中的麻烦和支出变得明晰之后，苹果放弃了这个想法。1月7日有报道称它正与现代汽车商议生产一款苹果汽车，消息一出这家韩国汽车制造商的股价上涨了近20%。现代承认它正与苹果做初步探讨。苹果方面尚未作出回应。看起来，就在汽车制造商转向拉斯维加斯之时，科技巨头正朝着相反的方向走。 ■



Surging commodities

The mountaineers

Commodity prices are climbing. Is a new supercycle beginning?

THE BIGGEST commodity story of 2020 was one of decline. As the coronavirus pandemic halted travel, oil prices fell off a cliff, then briefly went subterranean: in April a futures contract for West Texas Intermediate was worth less than nothing. Oil began clawing its way above \$45 a barrel in November, supported by optimism about vaccines. For other commodities, however, 2020 was not all bad. Indeed the year may have marked the start of an extraordinary ascent.

In August gold passed \$2,000 an ounce for the first time ever, as low interest rates made the precious metal more attractive. The value of other commodities rose, too, not just from the depths of virus-induced lockdowns in April but from the start of 2020, before the pandemic began (see chart). Commodity assets under management reached a record \$640bn in December, estimates Citigroup, a bank, representing an annual gain of nearly a quarter. By January 11th even the oil-heavy S&PGSCI commodity index had reached the level of a year ago. The debate now is how quickly oil prices will recover, and how high other commodities may soar.

That in turn depends on whether the forces that pushed up certain commodities in 2020 will continue in 2021, or indeed be supplanted by even more powerful engines of growth. Last year China proved a voracious importer as it increased investment and filled strategic stockpiles. Beneficiaries included iron ore and copper, used in steel and electricity projects, as well as soft commodities such as wheat, soyabeans and pork. This coincided with restrained supply. Outbreaks of covid-19 prompted the closure of some iron-ore mines in Brazil. Scant rain in South America,

caused by La Niña, a large-scale cooling of Pacific Ocean temperatures, raised grain prices.

This year has already presented signs of limited supply. On January 11th Argentina lifted a ban on corn exports, but imposed a cap. Russia plans to tax wheat exports from mid-February. Low supply and cold weather have powered Asian prices of liquefied natural gas to a record high of well over \$20 per million British thermal units. Big mines still face risks of restrictions. Protests at Las Bambas copper mine in Peru, for instance, have stoked fears of disruptions.

Meanwhile oil has continued its tentative recovery, alternately inflated by hopes for vaccines and depressed by news of lockdowns. To boost prices, Saudi Arabia has said it will limit output by a further 1m barrels a day in February and March.

Two important developments may provide further support. The roll-out of vaccines across the world's largest economies will eventually inspire higher levels of travel and trade. And a big spending bill by a Democratic American government, together with continued loose monetary policy from the Federal Reserve, would stimulate economic activity and therefore commodity consumption. That might also weaken the dollar, which would make oil and other commodities denominated in dollars cheaper for buyers in emerging markets, lifting demand and pushing commodity prices even higher.

Commodity bulls, led by Jeff Currie of Goldman Sachs, a bank, argue that longer-term trends will support prices through the coming decade. "The pandemic itself is a structural catalyst for a commodity supercycle," Mr Currie contends. In addition to a weaker dollar and the accompanying boost for commodities, the pandemic may help synchronise activity across some of the world's biggest economies.

Governments in America, China and Europe profess to champion green investment and efforts to narrow gaps in income. Assistance for poor households has an outsize effect on consumption, Mr Currie points out, which in turn supports commodity prices. And green investment—in electric-charging stations, for instance, and wind farms—is commodity-intensive. The early years of green spending may even lift oil demand, by boosting employment and economic activity. Goldman estimates that a \$2trn stimulus over the next two years would raise American oil demand by about 200,000 barrels a day, or 1%.

Sceptics expect more muted growth. In the short term, Ed Morse of Citigroup points out, investors' bets on copper are not supported by trends in supply and consumption. The Democrats' slim majority in the Senate hardly guarantees that president Joe Biden's climate plan will be passed. "There is nothing on the demand side that is nearly as commodity-intensive as the first decade of the 21st century," says Mr Morse.

That earlier supercycle was driven by urbanisation, investment and an ascendant middle class in emerging markets—and China, in particular. Governments from Berlin to Beijing now declare that they intend to bring a new type of transformation. The price of commodities in the coming decade depends in large part on whether they do what they say. ■



大宗商品跃升

登山客

大宗商品价格正在攀升。新的超级周期开始了吗？

大宗商品在2020年最重大的事件就是走下坡。随着新冠疫情中止了人们出行，油价跳崖，一度跌穿地面：4月，西德克萨斯中质油（WTI）的期货合约降为负值。11月，受对疫苗的乐观情绪支撑，油价开始爬升至每桶超过45美元。然而对其他大宗商品而言，2020年并不全然是糟糕的一年。事实上，这一年可能标志着一轮非凡上行的开始。

去年8月，金价首次突破每盎司2000美元，因为低利率增加了这种贵金属的吸引力。其他大宗商品的价格也上升了，不是仅仅从4月疫情封锁期间的低谷回弹而已，还高过了2020年初全球疫情尚未爆发时的水平（见图表）。花旗集团估计，去年12月，资产管理者持有的大宗商品资产达到创纪录的6400亿美元，年收益接近25%。到1月11日，即使是以石油为主的标普高盛商品指数也回升到了一年前的水平。目前的争论是油价多快会恢复，以及其他大宗商品价格可能飙升到多高。

而这取决于在2020年推高了某些大宗商品的力量在2021年是否会继续，或者甚至被更强大的增长引擎取代。去年，中国增加投资并补充战略储备，成为“大胃王”进口国。受益的部门包括在钢铁和电力项目中用到的铁矿石和铜，以及小麦、大豆和猪肉等软商品。与此同时供给受限。疫情爆发致使巴西部分铁矿关闭。太平洋温度大规模下降的拉尼娜现象导致南美洲降雨稀少，进而推高了粮食价格。

今年以来已经出现了供给受限的迹象。1月11日，阿根廷取消了玉米出口禁令，但设定了出口上限。俄罗斯计划从2月中旬开始对小麦出口征税。低供应量加上严寒使得亚洲的液化天然气价格创下历史新高，每百万英国热量单位远超过20美元。大型煤矿仍然面临生产受限的风险，例如在秘鲁拉斯邦巴斯铜矿发生的抗议活动引发了人们对生产中断的担忧。

与此同时，石油继续试探复苏之路，时而受疫苗带来的希望鼓舞，时而又因最新的封锁消息受挫。为了提振油价，沙特阿拉伯已表示将在2月和3月每日额外减产100万桶。

有两个重要的动向或许能提供进一步的支持。疫苗在全球最大的那些经济体的推广最终将激发出更高的出行和贸易水平。美国民主党政府的巨额支出法案，加上美联储持续的宽松货币政策，也将刺激经济活动，进而刺激大宗商品的消费。这可能还会削弱美元，使得石油和其他以美元计价的大宗商品对新兴市场的买家变得更便宜，从而提振需求，把大宗商品价格继续推高。

以高盛银行的杰夫·库里（Jeff Currie）为首的人士看涨大宗商品，他们认为，更长期的趋势将在未来十年支撑价格。库里称，“这场疫情本身是对一个大宗商品超级周期的结构性催化剂。”除了美元走软和随之而来的大宗商品受提振之外，疫情可能还有助于让某些全球最大经济体一致行动。

美国、中国和欧洲的政府都宣称支持绿色投资以及缩小收入差距的努力。库里指出，对贫困家庭的援助对消费的影响尤其大，这继而会支撑大宗商品的价格。而对充电站和风力发电场等项目的绿色投资也十分依赖大宗商品。绿色支出在初期阶段甚至可能会通过促进就业和经济活动来提振对石油的需求。高盛估计，未来两年两万亿美元的刺激计划将使美国的石油需求每天增加约20万桶，相当于增加1%。

怀疑论者预计增长要更疲软些。花旗集团的埃德·莫尔斯（Ed Morse）指出，短期内，投资者对铜的押注并不受供给和消费的趋势支撑。民主党在参议院仅勉强获得多数席位，难以保证总统拜登的气候计划会获得通过。莫尔斯表示，“在需求这一端没有哪一块的大宗商品密集度能和21世纪头十年勉强一比。”

先前那个超级周期受到一系列因素的推动：城市化、投资、新兴市场中产阶级的崛起，以及更突出的因素——中国。从柏林到北京，各国政府现在都宣称要实现一种新型的转变。未来十年的大宗商品价格在很大程度上将

取决于它们是否言行一致。 ■



America's recovery

Fire without fury

Will Joe Biden's fiscal stimulus and the Fed's loose monetary policy overheat the American economy?

ON JANUARY 20TH Joe Biden entered the White House during an economic crisis for the second time. On January 14th he unveiled his plan for dealing with the downturn wrought by the pandemic. Viewed from the bottom up, it combines vital spending on vaccines and health care, needed economic relief and other, more debatable handouts. Seen from the top down, it is a huge debt-funded stimulus. Mr Biden's plan is worth about 9% of pre-crisis GDP, nearly twice the size of President Barack Obama's spending package in 2009. And it is big, too, relative to the shortfall in demand that America might suffer once it puts the winter wave of covid-19 behind it, given the stimulus already in place.

A natural question to ask, then, is whether the proposal, admittedly an opening gambit in a negotiation with Congress, might overheat the economy if implemented. The most prominent figure to warn that this may happen is Larry Summers of Harvard University. His criticisms are notable both because he was an adviser to Mr Obama and because he was hitherto perhaps the world's foremost advocate of deficit spending. "If we get covid behind us, we will have an economy that is on fire," he said on January 14th.

There are three main reasons to suspect overheating might be on the cards: emerging evidence that the downturn may prove temporary; generous stimulus; and the Federal Reserve's monetary-policy strategy. Take first the evidence that today's downturn might be more temporary hiatus than prolonged slump. The number of non-farm jobs remains around 10m, or 6.3%, below its pre-pandemic peak—similar to the shortfall seen in 2010.

Yet after the first wave of infections last year, unemployment fell much more rapidly than forecasters expected. If job creation were to return to the average pace achieved between June and November 2020, the pre-pandemic peak in employment would be reconquered in less than a year. It was not until midway through Mr Biden's second vice-presidential term that such a milestone was reached last time.

Bolstering the case for a rapid rebound is the fact that economic disruption appears concentrated in certain sectors, rather than spread widely. America shed jobs, on net, in December, but only because the leisure and hospitality industries were hit by social distancing. The ratio of job openings to unemployed workers remains high and, outside the affected sectors, wage growth has not fallen much. The shortfall in spending is also concentrated. Consumer spending in the week to January 3rd was down by just 2.8% compared with a year earlier, according to Opportunity Insights, a research group. Yet retail spending on goods was 16.5% higher; it is restaurants, transport and entertainment that are in trouble. And stimulus has more than made up the disruption to incomes in 2020. In November Americans' total after-tax income was 4.3% higher than a year ago.

Indeed, the arithmetic of stimulus is a second reason why the economy may heat up. Before December, total fiscal stimulus in 2020 amounted to almost \$3trn (about 14% of GDP in 2019), much more than the probable fall in output. Social-distancing measures meant that much of this cash piled up in bank accounts. According to Fannie Mae, a government-backed housing-finance firm, by mid-December Americans had accumulated about \$1.6trn in excess savings. It is hard to know what might happen to this cash pile; economists typically assume that households are much less likely to spend wealth windfalls (such as the gains from a rise in the stockmarket) than income. But if people instead regard these excess savings as delayed income, then the cash hoard represents stimulus that has not yet gone to work, to be unleashed when the economy fully reopens.

In December President Donald Trump signed into law another \$935bn of deficit spending, which extended unemployment benefits, provided more support for small firms, and sent most Americans a cheque for \$600. This ensured that lost income would continue to be replaced. Mr Biden's proposed \$1.9trn of stimulus, which includes another \$1,400 in cheques, would make the total fiscal boost in 2021 roughly equal to that in 2020.

Jason Furman, another former Obama adviser, calculates that the combined impact of the December package and the Biden plan would be about \$300bn per month for the nine months in 2021 for which the measures will be in effect. By comparison, the shortfall in GDP, compared with its pre-crisis trend, was only about \$80bn in November. Typically, Keynesians argue that fiscal stimulus boosts the economy because of a sizeable "multiplier" effect. But the case for the stimulus to be as large as Mr Biden's proposal "has to be that you think the multiplier in 2021 is really small", says Mr Furman. Otherwise, it seems destined to take total spending in the economy beyond what it can produce next year, resulting in a burst of inflation.

Were the economy to show signs of such overheating, the Fed might typically be expected to raise interest rates to cool things down. Indeed, since January 6th, when the Democrats won the crucial Senate seats in Georgia that might allow them to pass a big stimulus, the ten-year Treasury yield has risen from about 0.9% to around 1.1%. The yields on inflation-linked bonds have risen roughly commensurately, suggesting that bond investors have been expecting higher real interest rates, rather than just higher inflation.

But the Fed is tripping over itself to signal that monetary policy will remain loose—a third reason to expect overheating. The time to raise interest rates is "no time soon", said Jerome Powell, its chairman, on January 14th. He also pooh-poohed the idea that the Fed might soon taper its \$120bn monthly

purchases of Treasuries and mortgage-backed securities. Mr Powell says the Fed has learned the lessons of 2013, when its hints that it might taper asset purchases sent bond markets into a tizz. Monetary policymakers still say that preserving “smooth market functioning” is one of the goals of their purchases, even though no dysfunction has been seen in bond markets since the spring.

The Fed is so willing to keep the pedal to the metal because, in contrast to the recovery from the financial crisis, it is seeking to overshoot its 2% inflation target, in order to make up for continuing shortfalls. The strategy, announced last summer, is still being digested by investors. It is unclear whether policymakers are committed to “average inflation targeting” as an end in itself, or simply as a means to stop inflation expectations from slipping too much during the downturn, argues David Mericle of Goldman Sachs, a bank. Given that inflation expectations have risen recently, that distinction might prove important. Regardless, the Fed has been clear that it will not raise rates until inflation is “on track to moderately exceed 2% for some time”.

Those who are zealously committed to breaking the world economy out of the low-rate, low-inflation trap of the 2010s might welcome the even larger burst of inflation that the current fiscal and monetary policy mix could enable. The Fed, however, is not in that camp. Were overheating to provoke it into earlier rate rises than markets expect, the assumption of cheap money that underpins today’s sky-high asset prices and the sustainability of rocketing public debt might begin to unravel.

Such a scenario remains a tail risk. The most likely outcome is that Congress agrees on a smaller stimulus than Mr Biden has proposed, and that overheating, if it occurs, proves temporary. Beyond that, nobody really knows how fast the economy can grow without setting off inflation. Should economic policy stay in uncharted territory, though, its speed limits may be

tested more frequently. ■



美国的复苏

无怒之火

拜登的财政刺激计划和美联储的宽松货币政策是否会让美国经济过热？

一月二十日，拜登第二次在经济危机期间踏入白宫。1月14日，他公布了一项计划以应对疫情造成的经济衰退。自下而上看，它结合了疫苗和医疗方面的重要支出、必需的经济救济，以及其他更具争议的援助。自上而下看，这是一个依靠举债的庞大刺激计划。拜登的计划规模相当于危机前美国GDP的9%左右，是奥巴马2009年开支计划的近两倍。而且，考虑到已经实施的刺激措施，该计划相对于美国在冬季疫情过去后可能面对的需求不足而言也堪称庞大。

那么人们自然会问，如果该计划真能实施——诚然它只是与国会谈判的开局招数——是否可能让经济过热？警告这种情况可能发生的最著名人物是哈佛大学的拉里·萨默斯。他的评议之所以引人关注，一方面因为他曾是奥巴马的顾问，另一方面是他可能是迄今为止世界最主要的赤字支出倡导者。“如果摆脱了疫情，我们将会面对一个过热失火的经济。”他在1月14日表示。

猜测美国经济也许会过热主要有三个原因：有新证据表明衰退可能是暂时的；大手笔的刺激措施；美联储的货币政策策略。先来看看显示目前的衰退可能更多是暂时下滑而非长期低迷的证据。非农就业岗位的数量仍比疫情前的峰值低1000万左右，即6.3%，与2010年的缺口接近。但是，在去年第一波疫情过后，失业率下降之快远超预测机构的预期。假如创造就业的速度恢复到2020年6月至11月间的平均水平，那么就业率将在不到一年内就重新回到疫情前的高峰。而上一次危机达到这个里程碑时已是拜登第二个副总统任期的中段了。

一个事实支撑了经济会快速反弹的预测：对经济的破坏看起来集中在某些行业而非广泛分布。美国去年12月就业岗位出现净减少，但这只是因为休

休闲与餐旅业受到了社交疏离措施的冲击。职位空缺与失业者之比仍在高位，而在受影响的行业之外工资增长的降幅不大。消费下降也比较集中。据研究组织Opportunity Insights的数据，在到1月3日的一周里消费支出与去年同期相比仅下降了2.8%。但这期间商品零售支出增长了16.5%，陷入困境的是餐饮、交通和娱乐业。而且刺激措施所做的弥补已经超过了2020年的收入损失。11月，美国人的税后总收入同比增加了4.3%。

事实上，刺激措施的账目是美国经济可能会过热的第二个原因。在12月前，2020年的财政刺激措施总额已接近三万亿美元（约为2019年GDP的14%），远高于可能的产出下降。保持社交距离的措施让这些资金大多积聚在人们的银行账户中。据美国政府支持的住房融资公司房利美（Fannie Mae）的数据，到12月中旬，美国人已经积累了约1.6万亿美元的过剩储蓄。很难知道人们会怎么使用这些现金。经济学家通常认为，比起一般收入，家庭对于意外之财（比如股市上涨带来的收益）的花钱意愿要小得多。但如果人们把这些过剩储蓄视为延迟的收入，那么这些囤积的现金就代表尚未发挥作用的刺激力量，将在经济完全重启时释放出来。

特朗普在12月签署了另一项9350亿美元的赤字支出法案，延长失业救济，为小企业提供更多支持，还给大多数美国人发放了600美元的支票。这确保了人们损失的收入将继续得到弥补。拜登提出的1.9万亿美元刺激方案（包括再向个人发放1400美元的支票）将使2021年的财政刺激支出总额与2020年大致相当。

据奥巴马另一位前顾问贾森·弗曼（Jason Furman）计算，把12月的刺激法案和拜登的计划加起来，那么在2021年这些措施生效的九个月内，每月将支出约3000亿美元。相比之下，在去年11月时GDP相较危机前走势仅相差800亿美元左右。通常情况下，凯恩斯主义者认为，财政刺激政策之所以能提振经济是因为存在相当大的“乘数”效应。但要赞成拜登提出的这么庞大的刺激计划，理由“只能是认为2021年的乘数实在很小”，弗曼说。否则，这似乎定然会使美国经济的总支出超过明年可能的产出，导致通胀爆发。

如果经济出现这样的过热迹象，人们通常可能预期美联储会加息来降温。事实上，自1月6日民主党赢得关键的佐治亚州的参议院席位（可能会让它得以通过大规模刺激计划）以来，十年期美国国债收益率已从约0.9%上升至1.1%左右。通胀挂钩债券的收益率的涨幅也大致相当，表明债券投资者已经在预期实际利率会提高，而不仅仅是通胀上升。

但美联储正在给自己使绊子，过于急切地发出信号表明货币政策将保持宽松——这是预计经济会过热的第三个理由。1月14日，美联储主席鲍威尔表示“短期内不会”加息。有人认为美联储可能很快会缩减它每月1200亿美元的国债和抵押贷款证券购买量，鲍威尔对此嗤之以鼻。他表示美联储已经吸取了2013年的教训，当时它暗示可能会缩减资产购买量，结果导致债券市场大乱。货币政策制定者仍表示维护“市场平稳运行”是其购买资产的目标之一，尽管自去年春季以来债券市场并未出现运作失灵的情况。

美联储如此积极地要继续踩油门是因为，与金融危机后的复苏不同，它目前正在努力超额实现其2%的通胀目标，以弥补持续的未达标。对于这一去年夏天宣布的战略，投资者尚未完全消化。高盛的大卫·梅里克（David Mericle）认为，目前还不清楚决策者是执着于“平均通胀目标”这个目的本身，还是仅视之为阻止通胀预期在衰退期过度下滑的手段。鉴于近期通胀预期有所上升，区分这两者可能是重要的。尽管如此，美联储却已经明言，在通胀“有望在一段时间内适度超过2%”之前它是不会加息的。

那些热切想要世界经济摆脱2010年代的低利率、低通胀陷阱的人们可能乐见更大的通胀爆发。目前的财政和货币政策的综合作用可能会导致这种情况。然而美联储并不属于这一阵营。假如经济过热促使美联储早于市场预期加息，那么支撑起如今超高资产价格的对廉价资金的假定和公共债务飙升的可持续性可能就会开始崩塌。

这样的情形仍只是尾部风险。最可能的结果是，国会通过了比拜登的提案规模更小的刺激方案，而即使出现经济过热，也只会是暂时的。超过了这个程度，没人真的知道经济能增长多快而不引发通胀。但如果经济政策一直行驶在未知地域，那么其速度极限可能会经受更频繁的考验。■



Innovation and the state

Fly me to the Moon

Mariana Mazzucato wants to revive the Apollo spirit

IN JULY 1969 America launched three astronauts into space, landed two of them on the surface of the Moon and safely returned all three to Earth. A remarkable demonstration of American might, the achievement still dazzles more than half a century later; no country on Earth could replicate the feat today. The contrast with America's bumbling response to covid-19 could scarcely be more glaring.

In “Mission Economy” Mariana Mazzucato argues that societies ought to abjure tired ideologies and embrace the policy approach that put astronauts on the Moon. By setting grand missions for themselves, she writes, and deploying the power of the state in practical ways, they can become more prosperous and equitable. It is an appealing idea, even if America has rarely looked less capable of purposeful collective action.

Ms Mazzucato is an Italian-born economist of a heterodox bent, whose work has long challenged standard economic thinking about the role of markets and government in generating innovation. Her best-known book, “The Entrepreneurial State” (published in 2013), argued that American technological prowess is owed in large part to the strong influence of the federal government, which funded and bore the risk of the initial development of many critical 20th-century technologies. Conventional economic wisdom remains a target in her latest work, too.

Scepticism among dismal scientists about government involvement in markets is based on faulty assumptions, she insists. Common complaints about state meddling—that governments are less efficient than private

firms, cannot pick winners, and are staffed by self-interested bureaucrats concerned only with their own status—are belied by an impressive record of government successes: developing the foundation of the internet, for instance, or extending financial assistance to Tesla. Not every public investment pays off. But, in Ms Mazzucato's view, neither is the record of privatisation of public assets and outsourcing of public tasks an unmitigated triumph. In America and Britain they have produced plenty of wealthy consultants, she says, but not a revolution in public-service efficiency or vast savings.

A rethink is thus overdue, the author urges—and the Apollo programme reveals many ways in which a capable state can create economic value. The sense of purpose and urgency that infused the programme in the 1960s motivated the government agencies involved to innovate, Ms Mazzucato writes, as well as to improve communication and weed out inefficiencies. Retaining important technological capabilities in-house enabled NASA to engage in a more sophisticated fashion with private contractors and monitor their progress better. It also helped the government retain talent, since working for the state could involve meaningful engineering work, not just banal paper-pushing.

And the programme's technological demands—like the need for smaller, more powerful and more reliable computers than were available at its inception—put pressure on contractors to innovate. They did so, fearlessly, because the state shouldered much of the risk associated with moonshot technologies. The government's demand for cutting-edge kit sowed the seeds of the computing age to come. The MIT Instrumentation Laboratory, tapped to develop guidance and navigation systems for the mission, swept up 60% of America's output of integrated circuits at the peak of the Apollo effort. For its part, NASA helped shape the industrial ecosystem of America's tech sector: to avoid becoming too dependent on any one contractor, it spread business around, implanting know-how across many firms.

These points are compelling. State projects can certainly go wrong, but there is no mistaking the vital role governments played in facilitating the development of rich economies. Conversely, the weakening of state capacity—to provide badly needed infrastructure and basic services, educate citizens, root out corruption, and so on—has hurt America's dynamism and the welfare of its people. There is no shortage of daunting global problems in need of solving; Ms Mazzucato singles out the fight against climate change, campaigns to improve public health and efforts to narrow the digital divide.

Yet in the end it is hard to feel inspired by her book. America launched the Apollo programme at what may well have been the zenith of its state capacity. Not only was the government at its most capable, but state initiatives enjoyed maximum public legitimacy and confidence. That proficiency had been forged during decades of crisis: two world wars, a devastating depression and an existential superpower stand-off against the Soviet Union. The bipartisan consensus that supported a strong state shattered long ago; a new sense of national unity and purpose cannot be conjured out of thin air.

Arresting as Ms Mazzucato's views on economic development are, her book does not really offer a route back to that purpose and cohesion. But that is what America needs most. Sadly, those goals look as remote and inaccessible as the Moon. ■



创新与国家

带我去月球

玛丽安娜·玛祖卡托想要复兴阿波罗精神【《探月经济》书评】

一九六九年七月，美国将三名宇航员送入太空，其中两人登陆了月球表面，最终三人全部安全返回地球。这是美国实力的杰出展示。半个多世纪过去了，这项成就仍然光彩夺目——今天世界上仍没有哪个国家能复制这一壮举。这与美国抗疫不力的对比实在太鲜明。

玛丽安娜·玛祖卡托（Mariana Mazzucato）在《探月经济》（Mission Economy）一书中指出，社会应该摒弃陈旧的意识形态，积极采用那种送宇航员上月球的政策方针。她写道，通过为自己设定宏大的任务，并以务实的方式调配国家力量，社会可以变得更加繁荣和公正。这是一个吸引人的想法，即使美国极少像现在这样看起来缺乏能力去采取有使命感的集体行动。

出生于意大利的玛祖卡托是一位非正统经济学家，她的研究长期以来都在挑战有关市场和政府在推动创新中的作用的标准经济思想。她在自己最著名的《企业家国家》（The Entrepreneurial State, 2013年出版）一书中提出，美国的超强科技实力在很大程度上应归功于联邦政府的强大影响力，是联邦政府资助了20世纪许多关键技术的发展并承担了发展初期的风险。她的新作依然在挑战传统经济理念。

她坚持认为，经济学家对政府介入市场持怀疑态度是基于错误的假设。对政府干预常见的抱怨包括政府的效率不如私营公司、不能筛选出赢家、充斥着只关心自身地位的利己主义官僚等。然而这些说法与政府取得成功的骄人记录相左，比如政府发展了互联网的基础，或向特斯拉提供了财政补贴。并非每一笔公共投资都能取得回报。但玛祖卡托认为，公共资产私有化和公共服务外包的记录也不是满分。它们在美国和英国造就了很多富有的政府顾问，她说，却没有带来公共服务的效率革命或巨额节省。

因此，早就该重新思考国家的作用了，作者敦促道，而阿波罗计划揭示了一个有能力的国家可以有很多方式创造经济价值。玛祖卡托写道，上世纪60年代注入该计划的使命感和紧迫感促使相关政府机构积极创新、改善沟通，消除低效。在内部保留重要技术能力让美国国家航空航天局

(NASA) 可以与私人承包商开展更复杂的合作，并更好地监督它们的进度。它也帮助政府留住了人才，因为为国家工作也能参与到有意义的工程项目中，而不只是干些平淡乏味的行政文书工作。

而阿波罗计划的技术要求给承包商施加了创新压力，比如它需要比项目启动时现有的计算机体积更小、功能更强大、性能更可靠的机型。它们敢于无畏地创新是因为国家承担了开发探月技术的大部分风险。政府对尖端设备的需求为计算机时代的到来播下了种子。受命为阿波罗项目开发制导和导航系统的麻省理工学院仪器实验室 (MIT Instrumentation Laboratory) 在项目顶峰期消耗了美国产集成电路的60%。而NASA帮助塑造了美国科技行业的工业生态系统——为避免过于依赖任何一家承包商，它分散了业务，将技术知识植入了众多公司。

这些观点很有说服力。国家项目当然有可能出问题，但政府在促进富裕国家发展的过程中所发挥的重要作用毋庸置疑。相反地，国家在提供亟需的基础设施和基本服务、教育公民、铲除腐败等方面的能力减弱损害了美国的活力和人民的福祉。这个世界不乏需要解决的艰巨的全球问题，玛祖卡托特别指出了对抗气候变化、改善公共卫生以及缩小数字鸿沟方面的努力。

然而读到最后，很难觉得这本书带来了启发。美国很可能是在国家能力的巅峰期启动了阿波罗计划。不仅政府的能力处于最高水平，而且国家项目享有最大的公众认可和信心。那种能力是经历数十年的危机锤炼出来的：两次世界大战、一场毁灭性的大萧条，以及与苏联的超级大国生死对决。支撑起一个强大政府的两党共识在很久以前就破裂了，新的国家团结和使命感不可能凭空而来。

尽管玛祖卡托对经济发展的看法夺人眼球，但她的书并没有真正给出一条

重塑那种使命感和凝聚力的途径。而这正是美国最需要的。可悲啊，这些目标看起来就像月球一样遥不可及。 ■



Innovation

The roaring 20s?

Pessimism about technological change is giving way to hope—much of it justified

FOR MUCH of the past decade the pace of innovation underwhelmed many people—especially those miserable economists. Productivity growth was lacklustre and the most popular new inventions, the smartphone and social media, did not seem to help much. Their malign side-effects, such as the creation of powerful monopolies and the pollution of the public square, became painfully apparent. Promising technologies stalled, including self-driving cars, making Silicon Valley's evangelists look naive. Security hawks warned that authoritarian China was racing past the West and some gloomy folk warned that the world was finally running out of useful ideas.

Today a dawn of technological optimism is breaking. The speed at which covid-19 vaccines have been produced has made scientists household names. Prominent breakthroughs, a tech investment boom and the adoption of digital technologies during the pandemic are combining to raise hopes of a new era of progress: optimists giddily predict a “roaring Twenties”. Just as the pessimism of the 2010s was overdone—the decade saw many advances, such as in cancer treatment—so predictions of technological Utopia are overblown. But there is a realistic possibility of a new era of innovation that could lift living standards, especially if governments help new technologies to flourish.

In the history of capitalism rapid technological advance has been the norm. The 18th century brought the Industrial Revolution and mechanised factories; the 19th century railways and electricity; the 20th century cars, planes, modern medicine and domestic liberation thanks to washing machines. In the 1970s, though, progress—measured by overall productivity

growth—slowed. The economic impact was masked for a while by women piling into the workforce, and a burst of efficiency gains followed the adoption of personal computers in the 1990s. After 2000, though, growth flagged again.

There are three reasons to think this “great stagnation” might be ending. First is the flurry of recent discoveries with transformative potential. The success of the “messenger RNA” technique behind the Pfizer-BioNTech and Moderna vaccines, and of bespoke antibody treatments, shows how science continues to empower medicine. Humans are increasingly able to bend biology to their will, whether that is to treat disease, edit genes or to grow meat in a lab. Artificial intelligence is at last displaying impressive progress in a range of contexts. A program created by DeepMind, part of Alphabet, has shown a remarkable ability to predict the shapes of proteins; last summer OpenAI unveiled GPT-3, the best natural-language algorithm to date; and since October driverless taxis have ferried the public around Phoenix, Arizona. Spectacular falls in the price of renewable energy are giving governments confidence that their green investments will pay off. Even China now promises carbon neutrality by 2060.

The second reason for optimism is booming investment in technology. In the second and third quarters of 2020 America’s non-residential private sector spent more on computers, software and research and development (R&D) than on buildings and industrial gear for the first time in over a decade. Governments are keen to give more cash to scientists. Having shrunk for years, public R&D spending across 24 OECD countries began to grow again in real terms in 2017. Investors’ enthusiasm for technology now extends to medical diagnostics, logistics, biotechnology and semiconductors. Such is the market’s optimism about electric vehicles that Tesla’s CEO, Elon Musk, who also runs a rocket firm, is the world’s richest man.

The third source of cheer is the rapid adoption of new technologies. It is not just that workers have taken to videoconferencing and consumers to e-commerce—significant as those advances are, for example to easing the constraints on jobseeking posed by housing shortages. The pandemic has also accelerated the adoptions of digital payments, telemedicine and industrial automation. It has been a reminder that adversity often forces societies to advance. The fight against climate change and the great-power competition between America and China could spur further bold steps.

Alas, innovation will not allow economies to shrug off the structural drags on growth. As societies get richer they spend a greater share of their income on labour-intensive services, such as restaurant meals, in which productivity growth is meagre because automation is hard. The ageing of populations will continue to suck workers into low-productivity at-home care. Decarbonising economies will not boost long-term growth unless green energy realises its potential to become cheaper than fossil fuels.

Yet it is reasonable to hope that a fresh wave of innovation might soon reverse the fall in economic dynamism which is responsible for perhaps a fifth of the 21st century's growth slowdown. Over time that would compound into a big rise in living standards. Perhaps still more is achievable because many service industries, including health care and education, would benefit greatly from more innovation. Eventually, synthetic biology, artificial intelligence and robotics could up-end how almost everything is done.

Although the private sector will ultimately determine which innovations succeed or fail, governments also have an important role to play. They should shoulder the risks in more “moonshot” projects. The state can usefully offer more and better subsidies for R&D, such as prizes for solving clearly defined problems. The state also has a big influence over how fast innovations diffuse through the economy. Governments need to make sure

that regulation and lobbying do not slow down disruption, in part by providing an adequate safety-net for those whose livelihoods are upended by it. Innovation is concentrated among too few firms. Ensuring that the whole economy harnesses new technologies will require robust antitrust enforcement and looser intellectual-property regimes. If governments rise to the challenge, then faster growth and higher living standards will be within their reach, allowing them to defy the pessimists. The 2020s began with a cry of pain but, with the right policies, the decade could yet roar. ■



【首文】创新

咆哮的20年代？

对技术变革的悲观情绪正被希望替代——大部分是合理的

过去十年中的大部分时间里，创新的步伐让许多人兴味索然，尤其是那些可怜的经济学家。生产率增长乏善可陈，而最流行的新发明——智能手机和社交媒体——似乎也没有多大帮助。它们的恶性副作用，比如催生强大的垄断企业和污染公共舆论空间等，反倒已经清晰地显现出来，令人烦恼。包括无人驾驶汽车在内的一些大有可为的技术停滞不前，这让硅谷的传教士们显得太过天真。安全鹰派警告说威权主义的中国正在超越西方，还有一些悲观人士告诫称世界终于耗尽了有用的想法。

今天，技术乐观主义的破晓将至。新冠疫苗的研发速度之快令科学家万众敬仰。引人注目的突破、激增的技术投资以及疫情期间对数字技术的采用共同燃起了人们对一个进步新时代将至的希望。乐观主义者兴奋地预言一个“咆哮的20年代”。正如2010年代的悲观主义走过了头（那十年间取得了诸多进步，比如癌症治疗），对技术乌托邦的预测同样是夸大其词。但是，出现一个能提升生活水平的创新新时代的可能性切实存在，尤其如果政府能帮助新技术大展拳脚的话。

在资本主义的历史上，快速的技术进步是一种常态。18世纪发生了工业革命，出现了机械化工厂；19世纪是铁路和电力；20世纪是汽车、飞机、现代医学，以及洗衣机带来的家务解放。但是，到了1970年代，以整体生产率增长来衡量的进步放缓了。这种经济影响一度被两件事掩盖：女性涌入劳动力大军，以及1990年代个人计算机普及带来的一波效率提升。但在2000年之后，增长再度疲软下来。

有三种理由认为这种“大停滞”可能行将结束。首先是最近一系列具变革潜力的发现。辉瑞/BioNTech和Moderna研发的疫苗背后的“信使RNA”技术以及定制抗体疗法的成功都表明科学在继续提升医学水平。无论是治疗疾

病、编辑基因，还是在实验室里种肉，人类都越来越有能力随心所欲地调控生物性状。人工智能终于在各种各样的场景中显现出令人瞩目的进步。由Alphabet旗下DeepMind公司创建的一个程序展现了预测蛋白质形状的杰出能力。去年夏天，OpenAI推出了迄今最好的自然语言算法GPT-3。自10月以来，无人驾驶出租车已在亚利桑那州的凤凰城附近运载民众。可再生能源的价格大跌令政府有信心它们的绿色投资会获得回报。甚至中国现在都承诺到2060年实现碳中和。

乐观的第二个理由是对技术的投资大增。2020年的二、三季度，美国的非住宅私营部门在计算机、软件和研发上的支出超过了对建筑物和工业设备的投入，为十年来首次。各国政府热衷于为科学家提供更多现金。在经过多年缩减后，2017年经合组织24个国家的公共研发支出实质又开始增长。投资者对技术的热情现在扩展到了医疗诊断、物流、生物技术和半导体领域。市场对电动汽车产业是如此看好，以至于特斯拉的首席执行官伊隆·马斯克（也是一家火箭公司的老板）已经晋升全球首富。

欢欣鼓舞的第三个缘由是新技术迅速普及。这说的不仅仅是员工习惯了视频会议、消费者拥抱电子商务——尽管这些进展确实意义重大，比如缓解了住房短缺对求职的限制。疫情也加速了数字支付、远程医疗和工业自动化的采用。这场危机提醒了人们逆境常常迫使社会进步。迎战气候变化和中美间的大国竞争可能会激发更多大胆行动。

可惜的是，创新并不能让经济体摆脱结构性问题对增长的拖累。随着社会变得更富裕，收入更多地花在劳动密集的服务业上，比如在餐馆用餐，而由于这些部门难以实现自动化，生产率的增长也十分可怜。人口老龄化将继续把员工吸纳到生产率低下的居家护理业中。除非绿色能源变得比化石燃料便宜的潜力得以实现，否则经济脱碳将不会促进长期增长。

然而，有理由期盼新一波创新潮可能会很快扭转经济活力的减退——21世纪增长放缓或许有五分之一是因为这种减退导致的。在一段时间后这将累积成生活水平的大幅提高。也许它还能实现更多好处，因为包括医疗和教育在内的许多服务行业都将因创新增加而大受裨益。最终，合成生物学、

人工智能和机器人技术可能会颠覆几乎所有事情的做法。

尽管私营部门将最终决定哪些创新会成功或失败，但政府也需要扮演重要角色。它们应该为更多野心勃勃的“登月项目”承担风险。国家提供更多更好的研发补贴也很有用处，比如为解决明确定义的难题提供奖励。政府对于创新需要多久才能渗透整个经济也具有重大影响力。它们需要确保监管和游说不会拖慢颠覆的步伐，这在一定程度上需要为那些生计被颠覆的人们提供充分的安全网。目前创新集中在为数太少的公司中，要确保整体经济能利用新技术，就需要强有力的反垄断执行以及更宽松的知识产权制度。如果政府迎难而上，更快的增长和更高的生活水平就会触手可及，让他们证明悲观主义者错了。2020年代以痛苦的呼喊开局，但如果用对了政策，这十年仍有机会快意咆哮。 ■



The rural-urban divide

Homecoming

Rural and urban youth are closing the gap. But it remains large

NONE OF THE universities to which Lin Meizi, a farmer's daughter, applied was in her province of Yunnan, one of China's poorest regions. Young people often flee to join millions of other rural migrants seeking work in booming coastal cities. Few look back. Ms Lin got her break when she was accepted to study in a big Chinese city 1,400km away, then clinched a job straight out of university. But she turned down the offer—to return home to run her family's coffee farm.

Ms Lin, now 27, works in the mountains near Pu'er, the heartland of China's small home-grown coffee industry, among papaya trees and chickens. Until recently it was rare for a rural youngster to forgo an urban life. China's countryside has been drained of able-bodied villagers, leaving only the infirm, the very young and the elderly who care for them while their parents toil far away as cooks and cleaners, or in the factory towns of the east. Now a small but growing counterflow of migrants has begun to go home. They are known as *fanxiang qingnian*, or returning youth.

One reason for their return is that provincial China is more inviting. Quality of life has improved. New roads and high-speed railways make for easy travel to big cities from county seats that have themselves been transformed. Nicer apartment blocks, hotels and shops have sprung up, fuelled by growing disposable incomes. Nominal rural wages are rising rapidly, as labour shortages give workers more bargaining power, helping to close the chasm between rural and urban incomes.

More than anything, the internet has brought big-city life to provincial

backwaters. The rural young shop on their phones like the urban young, spending hours on the same social media and video apps. With a few taps, they can get almost anything delivered thanks to the sprawling logistics industry underpinning Chinese e-commerce. Returning youth often find jobs selling stuff from premium tea to tofu. Since mid-2019, over 100,000 livestreamers have tuned in from farms to shift goods on Alibaba, a giant e-shop.

The internet has also brought country living to the town, fostering a new urban romance with rural China. The feeling is encapsulated in *xiangchou*, longing for one's hometown—a Chinese form of “cottagecore”. As young tourists increasingly shun big resorts for rustic retreats, rural youths see urban enthusiasm for their lifestyle. Dong Jianfa, a 29-year-old Yunnanese potter, left the provincial capital of Kunming to return to his family home, where he is reviving the old ceramics trade.

Coffee once held no interest for Ms Lin (pictured). Her family was the first to plant coffee trees in modern China, under a poverty-relief initiative financed by the World Bank in the 1980s. The beans were a way of making ends meet. But her time in the city, where she trained as a barista, showed her that coffee was a mark of urbanity. “My old city friends all envy my job in the mountains,” she says. Live-streaming from the countryside, part of the urban *xiangchou* trend, is wildly popular. It has made celebrities of some. The most famous is Li Ziqi, who posts videos of herself foraging for wild herbs, picking cucumbers and cooking hearty dishes in Sichuan. Live-streamers capitalise on this spiritual need among China’s middle class. Ms Li’s personal food brand makes millions.

Attitudes to work are changing, too. Rural youths are no longer prepared to spend hours toiling on production lines as their parents did. Instead they pick up gigs as couriers or ride-hailing drivers, allowing them to stay closer to home and choose their working hours. The allure of

“BeiShangGuangShen”, as the rich cities of Beijing, Shanghai, Guangzhou and Shenzhen are known, is fading. “Initially everyone thought that if you wanted to make it, you had to go there,” says Linda Qian of Oxford University, who studies rural nostalgia. Returning to one’s township meant failure.

Now rural and urban youth speak of *chengshibing*, or “city disease”: sky-high rents for small digs, bad air and long workdays. All prefer nicer working environments. To persuade more migrants to stay, some factories have gone so far as to set up day-care centres and stage matchmaking events for singles. In the decade to 2019, the proportion of rural migrants under the age of 30 living away from their hometowns almost halved, according to official statistics (though this does not include those moving from villages to thriving local county seats).

Young people can be fussier partly because parents are better able to support them. Few compete with siblings for household savings, built up over decades of economic boom. After attending vocational school until 17, Mr Dong lived at home for two years before he went to Kunming for his first full-time job. Not long ago his family would have sent him out to earn an extra wage after compulsory schooling, which ends at 15 in China.

State support helps. Rural revitalisation is a pet project of Xi Jinping, who has urged young teachers to go to backwaters. The Communist Youth League is helping 100,000 migrant youths return home to work by 2022. Netizens mock this as a revival of the brutal “sending-down” of urban youth to the countryside under Mao. The parallel is instructive. When the party praises rural life, it wants to create an outlet for millions of young dissatisfied migrants. Their retreat from big cities is an indictment of rampant inequality, and a sign of how hard it is to be upwardly mobile.

In China the urban-rural gap is codified through the *hukou* system of household registration. Some 60% of the population are urban, but only 44% hold an urban *hukou*. Those registered to live in villages are effectively barred from settling full-time in cities and sidelined at school. So rural and urban youth take distinct educational paths. In 2015 over 80% of all 15- to 17-year-olds were in school, up from half a decade earlier. But in rural areas many attend low-quality vocational schools, note Scott Rozelle and Natalie Hell of Stanford University in a book, “Invisible China”. Mr Dong is not looking for better-paid work because he feels unqualified, despite studying architecture at a vocational school.

Young people are newly aware of rural-urban divides. Ms Lin was struck that her father earned less for 1kg of beans than the cost of a single cup of coffee in the city. “I thought, that’s just not fair,” she says. In 2020 she helped set up the Yunnan Speciality Coffee Community, a trade association to give young farmers more clout. Ferrying packages and food around town, working-class youths are more visible to city kids. When they strike to demand unpaid wages, sympathetic urban peers support them online.

One gap that gained nationwide attention last year was period poverty. An image was circulated on social media of 100 sanitary towels being sold online for under \$3. Two crowdfunding campaigns to send safe pads to rural teens raised over \$300,000. After a rural school placed these pads in a box outside the girls’ toilets, students in better-off places began to do the same. In the process, many learnt that poor sex education and the stigma around menstruation are not inherently rural issues.

Another is domestic abuse. Last autumn Lhamo, a young Tibetan live-streamer, died from burns after being attacked by her husband during a broadcast. Fans tuned in to her videos because they showed the unglamorous yet sunny sides of a life of scarcity. Hundreds of thousands took to Weibo to back a “Lhamo Act” to give victims of domestic violence

better legal protection. It was another example of a scourge that crosses the urban-rural divide, but disproportionately hurts rural women.

Other inequalities go unnoticed. Graduates from rural families are twice as likely to be unemployed as city dwellers. The government reserves slots for graduates in the civil service and the army. But rural youths without a degree fare worst. They bore the brunt of covid-19 when villages were sealed off. The informal economy to which so many flock gives no job security or benefits. Urbanites rely on personal connections far more than their rural counterparts do. Mr Dong felt forced to settle for a job in Kunming delivering bottles of *baijiu*, a Chinese firewater, for 14 hours a day. Having gone to the city with high hopes, he left it feeling bitter.

The deepest divide has arisen because a preference for sons means that many baby girls were aborted under the one-child policy, skewing sex ratios. They are most unequal in the countryside: among those born in the 1990s, there are 117 boys for every 100 girls—the largest this gap has been for Chinese of marriageable age. As many as 40m young men have no chance of finding a mate, reckons Mr Rozelle. They are known as *guanggun*, or “bare branches” on the family tree. Unmarried and unemployed, these young men could one day be a destabilising social force.

For now, polls find that China’s working class is not disaffected. Eileen Yuk-ha Tsang of the Chinese University of Hong Kong says that *guanggun* seek an outlet in brothels, often spending three-quarters of their wages on sex (as a temporary bartender in Guangdong, Ms Tsang interviewed 100 of them). Other studies suggest that populations with a large male surplus end up with greater rates of violence, crime and rape than the norm. Yet stiff punishment may deter many from such a path, Mr Rozelle thinks.

The Communist Party also offers a potent distraction: a heightened sense of national solidarity, encouraging people to grin and bear things, as they did

under lockdown. As this report will explain, the party is hoping to co-opt restless youth by pandering to such patriotism. ■



城乡鸿沟

返乡

城乡青年之间的差距在缩小，但依然很大【专题报道《中国青年》系列】

林美姿（音译）是农民的女儿。她报考的大学没有一个位于她所在的云南省这个中国最贫困的地区之一。年轻人往往像其他数以百万计的农民工一样逃离农村，寻求在发展迅速的沿海城市找工作。很少有人回头。林女士运气不错，考到了1400公里外的一个大城市，一毕业就找到了工作。但是，她放弃了这个工作机会，回到家乡经营家里的咖啡农场。

现年27岁的林女士在普洱市附近的山区工作，这里遍布木瓜树和鸡，是中国小规模自产咖啡产业的心脏地带。一直到近期，农村的年轻人很少放弃城市生活。中国农村中的壮劳力已经枯竭，只剩下体弱者、小孩和照顾他们的老人，而孩子的父母在远方做厨师和清洁工，或者在东部的工厂城工作。如今，一批在外务工人员开始回流，人数虽少却在增长。他们被称为“返乡青年”。

他们返回的原因之一是乡土中国更有吸引力。生活水平已经提高。新建的道路和高速铁路使人们可以轻松地从本身已经转变的县城前往大城市。由于可支配收入的增加，更漂亮的公寓楼、酒店和商店如雨后春笋般涌现。劳动力短缺让工人有了更强的议价能力，农村名义工资正在迅速上涨，这有助于消除城乡收入之间的鸿沟。

最重要的是，互联网为偏僻的落后地区带来了大城市的生活。农村的年轻人和城市的年轻人一样在手机上购物，在相同的社交媒体和视频应用里每天花上好几个小时。只需轻轻点几下，他们几乎可以让任何东西送货上门，这要归功于受蓬勃发展的物流业支撑的中国电子商务。返乡的年轻人往往会去干销售，卖从高档茶叶到豆腐等各种东西。自2019年年中以来，已有超过10万名农村用户在大型网上商城阿里巴巴上直播带货。

互联网也把乡村生活带入了城市，发展出一种都市对乡土中国的新的浪漫

情怀。这种感觉可以用“乡愁”一词来概括——这是中国版的“田园美学”。随着年轻游客越来越多地躲开热门景点，选择到乡村僻静地度假，农村青年看到了城市对他们的生活方式的热情。29岁的云南陶工董建发离开省会昆明返回家乡，重操古老的陶瓷行当。

林美姿（如图）一度对咖啡毫无兴趣。1980年代，在由世界银行资助的脱贫举措下，她的家人是第一批在现代中国种植咖啡树的人。咖啡豆是维持生计的一种方式。但她在城市里接受的咖啡师培训告诉她，咖啡是城市生活的标志。她说：“我在城里的老朋友都羡慕我在山里的工作。”来自农村的直播非常受欢迎，这是城市乡愁潮流的一部分。它已经造就了一些名人，其中最有名的是李子柒，她发布了自己在四川采野菜、摘黄瓜和烹饪丰盛菜肴的视频。直播者把中国中产阶级的这种精神需求变了现——李子柒的个人食品品牌赚了几百上千万。

工作态度也在变化。农村青年不再准备像父母那样在生产线上一干就是几个小时，而是选择做快递员或网约车司机等零活，这让他们可以离家更近且工作时间灵活。“北上广深”（即北京、上海、广州和深圳等富裕城市）的魅力正在逐渐消退。牛津大学研究乡村怀旧情结的钱琳达（音译）说：“起初，每个人都认为要想成功，就必须去那里。”回到乡镇老家意味着失败。

现在，农村和城市的年轻人都在谈论“城市病”：蜗居的天价租金、空气不好、工作时间长。所有人都喜欢更好的工作环境。为了说服更多的流动人口留下来，一些工厂甚至设立了日托中心并为单身人士举办婚介活动。根据官方统计，在到2019年为止的十年里，30岁以下远离家乡的农村流动人口的比例几乎减少了一半（尽管这不包括从村庄迁移到繁荣的当地县城的人口）。

年轻人可能会更挑剔的部分原因是父母如今能够更好地支持他们。很少有人需要与兄弟姐妹争夺在几十年的经济繁荣中积累的家庭财富。董先生17岁从职校毕业，在家里待了两年才去昆明做第一份全职工作。换做前些年的话，他的家人会在他完成义务教育后（在中国是15岁）就让他出去挣

钱。

国家支持很有用。乡村振兴是习近平重视的项目，他呼吁年轻教师回乡。共青团正在帮助10万名在外青年于2022年前返乡就业。网民嘲笑这是对毛时代残酷的城市青年“下乡”运动的复兴。这种比较很能说明问题。当党赞美农村生活时，它想为数千万不满的在外青年创造一个出口。他们从大城市撤退表明不平等现象日益加剧，也显示了要向社会上层流动有多么难。

在中国，户籍制度把城乡差距写进了法律。大约60%的人口是城市居民，但只有44%的人口有城市户口。农村户口的人相当于被禁止完全在城市中安顿下来，而且上学难。因此，农村和城市青年有着不同的受教育道路。2015年，所有15至17岁的年轻人中有超过80%在上学，比五年前的比例要高。但斯坦福大学的斯科特·罗泽尔（Scott Rozelle）和娜塔莉·海尔（Natalie Hell）在《看不见的中国》（Invisible China）一书中指出，在农村地区，许多人上的是劣质的职业学校。尽管在一所职业学校学习建筑学，但董先生并没有寻找高薪工作，因为他觉得自己不够格。

年轻人最近意识到了城乡差距。林女士的父亲卖1公斤咖啡豆挣的钱还不如城里的一杯咖啡，这让她感到震惊。她说：“我认为这完全不公平。”2020年，她帮助建立了云南精品咖啡社区，这是一个贸易协会，寻求让年轻农民获得更大的影响力。在城镇里四处递送包裹和外卖的工薪阶级青年更容易被城市孩子看到。当他们罢工要求付清被拖欠的工资时，同情他们的城市同龄人会在网上声援他们。

去年引起全国关注的一个差距是月经贫困。一张图片在社交媒体上流传，网上有出售100片卫生巾的价格不到3美元。向农村青少年提供安全卫生巾的两项众筹活动筹集了30多万美元。在一所农村学校将这些卫生巾放在女厕所外面的盒子里后，富裕地区的学生也开始这样做。在此过程中，许多人了解到，性教育匮乏和对月经的污名化也并不完全是农村问题。

另一个是家庭暴力。去年秋天，年轻的藏族网红拉姆在直播时被丈夫袭击，后因烧伤而死亡。粉丝们观看她的视频，是因为它们展现了物质稀缺

的生活中平淡却阳光的一面。几十万人到微博支持“拉姆法案”，以向家庭暴力的受害者提供更好的法律保护。家暴是又一个不分城乡、但对农村女性伤害更深的祸害。

其他不平等现象则未引起注意。来自农村家庭的毕业生失业的可能性是城市人口的两倍。政府在公务员和军队中为毕业生预留了位置。但是没有学位的农村青年境遇最差。当村子被封锁时，他们首当其冲遭受了疫情的冲击，许多人蜂拥进入的非正规经济并不提供工作保障或福利。城市居民对人际关系的依赖远远超过农村人。董先生感觉自己是被迫接受了一份在昆明递送白酒的工作，每天要干14个小时。他满怀希望地进城，却心怀愤恨地离去。

最大的鸿沟源自重男轻女，这让许多女婴在独生子女政策下被流产，从而扭曲了性别比例。这个比例在农村地区最为失衡：在1990年代出生的人中，每100个女孩就有117个男孩——这是中国有史以来最高的婚龄人口性别比。罗泽尔（Rozelle）估计，多达4000万年轻男性没有机会找到伴侣。他们被称为家族树上的“光棍”。失业的未婚青年有一天可能成为破坏稳定的社会力量。

目前而言，民意调查发现中国的劳工阶级并没有因此而感到不满。香港中文大学的曾玉霞说，光棍们在妓院里找出口，他们经常把四分之三的工资花在性服务上（曾女士在广东做酒吧招待临时工，采访了其中的100位）。其他研究表明，有大量富余男性人口的人群的暴力、犯罪和强奸率会高于正常水平。不过，罗泽尔认为，严厉的惩罚可能会阻止许多人走上这条路。

共产党也提供了一种强效的分散注意力的方法：增强民族团结感，鼓励人们逆来顺受，就像他们在封锁时那样。正如本报道将解释的那样，党希望通过迎合这种爱国主义来笼络躁动不安的青年。 ■



Values, identity and activism

The lives of others

Individualism reigns—and with it, more social responsibility

AT THE GoZeroWaste workshop in Suzhou, a canal town near Shanghai, a dozen young people learn to hand-sew face masks. The single-use, surgical sort are hardly in short supply, as no country makes more masks than China. Yet the masks, which contain plastics, are rarely recycled; and Suzhou's apprentices want to be greener. One participant says she is trying out vegetarianism, joining a tiny but growing group in China. Another "buys less stuff" since shopping binges began to "stress her out". A third says "we are tired of consuming. We want to produce something, too."

With China being the world's largest polluter, environmental awareness is rising among the young. Lots use Ant Forest, a carbon-account scheme set up by Alipay, a payments giant, that tracks green spending and grants credits towards planting trees. More donate old clothes to Feimayi, an online charity, and buy from Xianyu, a website owned by Alibaba that sells second-hand goods. Plant-based meat is finding fans. Vegan nuggets at a KFC branch in Shanghai sold out within an hour last year. Dicos, a local rival, has launched meatless patties in over 2,600 stores since October. The young say the pandemic has attuned them to their health and even to animal rights.

The *jiulinghou* are the first generation in China to have grown up amid consumerism. To their credit, many now seek to improve society. They proudly exhibit their values by dressing in home-grown brands or job-hopping to find work that suits them. Do-gooding is often part of the mix. To elders, taught in the Mao era to renounce individual dreams for collective goals, young people seem eccentric and headstrong. In their childhoods, eating meat was a rare indulgence and a stable income was a blessing. They

call the young cohort “the lucky generation”.

Youths object that they have heavy burdens of their own, from the *gaokao* university-entrance exam to bleak job prospects and unaffordable housing. In Beijing and Shanghai, average house prices are 23 times median incomes, twice the ratio in London. That is a source of particular anxiety for young men, because home-ownership is often seen as a prerequisite for marriage. Youngsters worry about the burden of caring for ageing parents, since China has few nursing homes and pensions are low. When asked in surveys to name their greatest source of happiness, having healthy parents comes second to having a stable income.

Much young resentment comes from a sense of having lost out on both the boom years and the government’s former largesse. A widely shared joke encapsulates this: “The state gave houses to our parents, and now we pay for them; it raised the retirement age when we started working; the stockmarket crashed as we started buying; and when we thought we could enjoy being adults, the state told us to have a second child”. (In 2016 China introduced a two-child rule, reversing its one-child policy.) The rags-to-riches stories that captivated their parents’ generation feel distant.

One way to cope is to vent about this. Millions share memes and jokes online that sum up their frustrations. A new favourite is *neijuan*, or “involution”, an academic term for the process when extra input no longer yields more output. Young people use it to describe the meaningless competition in which they take part, from the educational rat-race to the fight for a white-collar job. Office workers joke that they are *dagong ren* (primarily manual labourers) to deplore the monotony of their jobs. They are tired of working overtime and of China’s “996” regime, a work schedule of 9am to 9pm, six days a week, usually without extra pay.

As disillusionment sets in, young people question Chinese societal norms.

Many tune into Qipa Shuo, a hit debating show. Its topics range from, “Should I stay in a city to pursue my career even if the air is polluted?” and “A job I like requires me to work ‘996’: should I quit?” to, “Would you choose to be an unmarried mother?” and “Is it a waste for a highly educated woman to be a full-time housewife?” Among fans the debate often continues, online and offline, after each episode.

Such themes reflect rapidly changing mindsets. A survey asking *jiulinghou* about dating and marriage found that more than half were happy to rent their homes as newlyweds. Seven in ten singletons said income was not the most important criterion in choosing a partner. Most said that the basis of marriage was a life shared by two like-minded people—a radical turn, considering that elders saw it as a contract between two sets of parents. In a society that for centuries held that a woman’s place was in the home, young mothers now increasingly reject old child-rearing norms.

Discrimination against women is on the rise, partly as the state tries to stimulate a baby boom. Government bodies have popularised a term for those unmarried beyond the age of 27: *shengnu* (leftover women). A backlash from young women has created a new genre of “she era” films that cheer for independent women. Last year’s hits included “Nothing But Thirty”, in which three heroines navigate far-from-perfect lives; and “Sisters Who Make Waves”, a reality show starring female celebrities over 30.

One outcome of the one-child policy is that families with daughters poured their resources into them. This has nurtured a generation of educated young women who balk at gender inequalities or personal injustices. They demand investigations into harassment by male bosses and teachers, sometimes with success.

Several young people interviewed for this report said that seeing rescue efforts after an earthquake in Sichuan in 2008 killed 70,000 people gave

them more sense of social responsibility. Many praised the *jiulinghou* for their acts of service during the covid-19 pandemic as doctors, teachers and volunteers. Young ethnic Mongols in Inner Mongolia and elsewhere set up O9, a bilingual WeChat account, to translate official advice into Mongolian.

Young people are testing the limits of a regime that has long been suspicious of citizen-led movements. In 2019 anger over 996 sparked an online movement by office workers to demand more humane hours. Feminism and LGBT rights have found vocal champions in the *jiulinghou*, no mean feat when the party insists on traditional family values as the basis for a harmonious society.

Activism has become harder under Xi Jinping. Many NGOs have been closed, notably on university campuses. In those that remain, monitors report on outspoken members to their university's party authorities. In 2018 members of Marxist university clubs went to Shenzhen to support disgruntled workers trying to form an independent union (China bans them). Police arrested them. Women's rights activists, known as the "feminist five", were detained in 2015 for distributing leaflets decrying sexual harassment on public transport.

In 2012 two of the five walked with another friend through Beijing dressed in wedding gowns splattered with fake blood to raise awareness of domestic violence. They occupied men's toilets to protest that women's loos were too small. The press was sympathetic; some cities promised to install more cubicles. But as the movement grew, the authorities clamped down.

Among the few still taking to the streets is Ou Hongyi, an 18-year-old from Guangxi widely dubbed China's first climate striker. Ms Ou protests in cities for Fridays For Future, a global green youth movement that calls on governments to take action. Some young people chat to her. But others "think we are threatening", she says. "They tell us it looks like we want to

overthrow the government.” She was briefly detained in September.

Young activists also campaign online. When millions were confined to their homes by covid-19, Guo Jing, a young feminist, set up “Vaccines Against Domestic Violence”. The initiative called on volunteers to listen out for abuse. LGBT advocates used China’s decennial census-taking in November to increase recognition for gay couples with a campaign called, “They are not my roommate, they are my partner”, encouraging gay couples to tick the “Other” box to describe their relationship.

Legal challenges have grown. Ms Guo was the first jobseeker to win a gender-discrimination case in 2014. A court in Beijing is hearing a case on sexual harassment brought by Zhou Xiaoxuan, a 27-year-old, against a television host. Ms Zhou is a frequent commentator on #MeToo issues. Courts have accepted cases by students over homophobia in textbooks. In October Ou Jiayong, a 23-year-old, lost a suit against the education ministry, but a hashtag on Weibo got 27m views. The professionalisation of China’s judiciary makes it harder for low-level officials to snuff out cases, says Darius Longarino of Yale University.

Volunteers are left alone if they fill gaps in state provision, as with covid-19. Yet they must work within confines set by the government. Police officers signed up to O9 in Inner Mongolia as “volunteers”; organisers felt they could not refuse them. Ms Ou approached green NGOs only to be turned away as too radical. Despite the risks, could young Chinese yet become a political challenge? ■



价值、身份和行动主义

他人的生活

个人主义盛行——但随之而来的是更多的社会责任【专题报道《中国青年》系列】

在上海附近的运河城市苏州，十来个年轻人在“零垃圾”（GoZeroWaste）工作坊里学习手工缝制口罩。中国生产的口罩比任何国家都多，所以一次性外科手术口罩并不短缺。但这种含有塑料的口罩极少被回收利用，于是这些苏州的“学徒”想把这个环节变得更环保。一个参与者说她正在尝试素食主义，中国的这个群体规模还很小但正在扩大。另一个说她开始“减少购物”，因为大肆购物“让她压力山大”。第三个人说，“我们厌倦了消费。我们也想生产点什么。”

随着中国成为世界最大的污染源，这里年轻人的环保意识在提升。许多人都在用“蚂蚁森林”，这是支付巨头支付宝设立的碳帐户，它跟踪人们的绿色消费行为，授予碳积分用于植树。越来越多人把旧衣服捐给线上慈善机构飞蚂蚁，并从阿里巴巴旗下出售二手商品的网站闲鱼买东西。植物肉已经赢得了一批拥趸。去年上海一家肯德基门店推出的全素炸鸡块在一小时内销售一空。自10月以来，它的本地竞争对手德克士已经在2600多家门店推出了植物肉汉堡。年轻人说，疫情让他们开始重视自身健康甚至动物权益。

“90后”是在消费主义中成长起来的第一代中国人。值得赞扬的是，他们中的许多人如今寻求改造社会。他们穿本土品牌，频频跳槽以寻找适合自己的工作，以此自豪地展现自己的价值观。行善往往是这其中的一部分。他们在年长一代看来古怪又任性。这些长辈们生长于毛时代，被教育应放弃个人梦想以实现集体目标。在他们的童年时代，吃肉是一种罕见的奢侈，有稳定的收入是一种福分。他们说年轻人是“幸运的一代”。

年轻人反驳说自己也有沉重的负担：从高考到黯淡的工作前景，再到买不起的房子。北京和上海的平均房价是收入中位数的23倍，是伦敦这一比例

的两倍。这尤其给年轻人造成了焦虑，因为拥有住房常常被视为结婚的先决条件。年轻人也担心要承担照顾老去的父母的重担，因为中国的养老院很少，养老金也低。当在调查中被问到幸福感主要源于何处时，他们把父母身体健康列在仅次于有稳定收入的位置。

年轻人的不满有很大一部分源于他们既没赶上经济腾飞大潮，也没享受到政府过去慷慨的福利制度。一个广为流传的段子对此做了一番总结：“过去父母分房，现在我们买房；我们工作了，退休延后了；我们进场了，股市崩盘了；终于可以歇口气了，国家说生二胎吧。”（2016年中国逆转了独生子女政策，开始实行二胎政策。）白手起家的致富故事令他们的父母一代着迷，在他们听来却遥远而陌生。

一个应对的方式是发泄。成百上千万人在网上分享总结这代人沮丧心境的表情包和段子。一个新的流行语是“内卷”——这个学术词汇指的是额外投入已不再带来更多产出的过程。年轻人用它来描述他们身处其中的毫无意义的竞争，从你死我活的学业竞赛到争抢一份白领工作。办公室职员自嘲“打工人”来哀叹工作的单调乏味。他们对加班和中国的“996”工作制感到厌倦。“996”指从上午九点工作到晚上九点，一周六天，通常没有加班费。

随着幻想破灭，年轻人开始质疑中国的社会常规。许多人收看大热辩论节目《奇葩说》。它的辩题涉及各种社会问题，比如：“奋斗城市污染严重，走吗？”“感兴趣的工作总是996，我该不该886？”“是你，会不会做单身妈妈？”“高学历女生做全职太太是浪费吗？”每期节目播完，忠实观众们常常在线上线下继续争论。

这些议题反映出观念模式的快速转变。对90后约会和婚姻状况的一项调查发现，超过一半人愿意租房结婚。七成单身人士表示在选择伴侣时不会把收入状况作为最重要的考量。大多数人说婚姻的基础是两个志同道合的人一起生活——这是一种根本性的转变，鉴于老一辈把婚姻视为两对父母之间的契约。在这个千百年来都认为女性的位置就是在家中的社会里，今天的年轻妈妈们越来越抗拒有关养儿育女的陈规旧习。

对女性的歧视在增多，部分原因是国家试图刺激生育潮。政府机构普及了一种对27岁以上未婚女性的称呼：剩女。来自年轻女性的反弹催生了“她时代”的新影视剧类型，为独立女性加油喝彩。去年的热门剧集包括描写三位女主角探索不完美生活的《三十而已》和30岁以上女星真人秀《乘风破浪的姐姐》。

独生子女政策的一个结果是生女儿的家庭把资源都投到她们身上。这培育出了一代受过教育的年轻女性，不愿继续接受性别不平等或个体不公。她们要求调查男上司和男教师性骚扰事件，有时会成功。

就本报道接受采访的几位年轻人说，目睹2008年造成七万人丧生的四川地震后的救援工作让他们产生了更多社会责任感。许多人称赞90后在新冠疫情期间作为医生、教师和志愿者提供的服务。内蒙古等地的年轻蒙古族人创建了双语微信号“O9”，把官方建议翻译成蒙古语。

年轻人正在试探一个长期忌讳民众领导运动的政权的容忍底线。2019年，对996工作制的愤怒激发了上班族的一次线上运动，要求更人道的工作时长。女权主义和LGBT权益在90后这个群体中找到了声援者，这在党坚持把传统家庭价值作为构建和谐社会的基础之时绝非易事。

在习近平治下，行动主义变得难上加难。许多非政府组织关门大吉，特别是在大学校园内。在尚存的那些组织中，直言不讳的成员会被网络监督员举报到学校党组织。2018年，一些大学的马克思主义社团成员前往深圳声援一批试图组建独立工会的不满的工人（中国禁止工人成立独立工会），结果被警方拘捕。被称为“女权五姐妹”的女性权益活动人士在2015年因散发传单谴责公交车上的性骚扰被拘留。

2012年，五人中的两人与另一个朋友一起穿上“染血”的婚纱走上北京街头，呼吁人们重视家暴现象。她们占领了男厕所，以抗议女厕所太小。媒体表达了支持。一些城市承诺增加女厕隔间数量。但这项行动进一步发展时被当局压制。

少数还在“上街”的人当中有来自广西的18岁的欧泓奕，她被普遍称为中国

“为气候罢课第一人”。她加入了呼吁政府对气候问题采取行动的全球青年运动“周五护未来”（Fridays For Future），在一些城市的街头抗议。一些年轻人和她聊天。但其他人“认为我们是一种威胁”，她说。“他们说我们看起来像是想要颠覆政府。”她在9月被短暂拘留。

年轻的活动分子也在线上开展运动。当数以百万计的人因为疫情被困家中，年轻的女权主义者郭晶发起了“反家暴小疫苗”活动，号召志愿者们留心觉察虐待行为。LGBT权益倡导者在11月借由中国十年一次的人口普查提高社会对同性伴侣的认可，这项名为“TA不是我室友，而是我伴侣”的行动鼓励同性伴侣在调查表的“其他”一栏中写明真实关系。

从法律上发起的挑战增多了。郭晶在2014年打赢了第一宗求职者状告性别歧视案。北京一个法院正在审理27岁的周晓璇对一位电视主持人提起的性骚扰诉讼。周晓璇经常在#MeToo议题上发表评论。法院已经受理了一些学生就教科书中的恐同内容提起的诉讼。10月，23岁的欧嘉咏（音译）在状告教育部的诉讼中败诉，但在微博上的一个标签话题收获了2700万阅读量。耶鲁大学的达留斯·隆加里诺（Darius Longarino）表示，中国司法系统的专业化使得低级别官员更难把官司“灭掉”了。

如果志愿者填补了公共服务的空白，就像在疫情中那样，那么他们不会被官方干预。但他们必须在政府设定的限制内工作。警察在内蒙古的“O9”项目中申请为“志愿者”，组织者感到无法拒绝他们。欧泓奕曾向非政府环保组织寻求支持，但被视为太过激进而遭拒绝。尽管要面对风险，中国年轻人会成为一股政治挑战力量吗？ ■



Views of the world

A bale of sea turtles

As attitudes to the West sour, students turn home

BAI SHUANG stayed overseas longer than most. After a degree in Paris, Ms Bai worked for a French company, then went to London for a Master's and got another job. By 2017 two forces pulled her home. First was her salary, which Ms Bai thought too low; she heard she could earn more in Shanghai's startup scene. The second was her parents, who were aghast at the terrorist attacks that rocked both her adoptive cities. China was safe, they said, and Ms Bai could "shine" here. "If there is a place where you can have it all, then why not?" Ms Bai reasoned. She bought a ticket home.

Ms Bai is a "sea turtle", a play on the Chinese homonym *haigui*, meaning "to return from abroad". Of the 6.2m Chinese who left to study overseas between 2000 and 2019, more than 4m have returned, says the education ministry. The rate of return has picked up. In 2001 just 14% went home. But in every year since 2013, China has welcomed back at least four in five overseas graduates. Amid the unusual stresses of covid-19, it is thought that 800,000 came home in the first nine months of 2020, up from 580,000 in 2019.

The pandemic has cut short stints abroad. When it is over, educational flows should pick up again. But a new confluence of factors had already been turning well-educated Chinese away from the West, and America in particular. More than just covid-19 and terrorist incidents are making the West seem unsafe and hostile. Trips to America by Chinese students fell by 70% in the first nine months of 2020 over a year earlier. But only 50% fewer Taiwanese and 56% fewer South Korean students went to America, despite the fact that both places beat back covid-19 as effectively as China.

One reason is that America is making it harder for Chinese graduates to stay. In 2018 it cut from five years to one the validity of visas issued to those in sensitive fields of study, including computer science. In September America revoked visas of 1,000 students and researchers whom it deemed security threats. Donald Trump repeatedly accused Chinese students of stealing American technology. In the words of Christopher Wray, his FBI director, China is no longer just a “whole-of-government” threat, but a “whole-of-society” one.

It is little surprise that young Chinese wonder if they are welcome. Last year over half of American youths polled by the Pew Research Centre expressed negative views of China. Across the population this number hit an all-time high of 73%. The feeling seems mutual. In a survey of 20,000 Chinese run by Cary Wu of Toronto University last April, four in five respondents under 30 said that they did not trust Americans.

The experiences of covid-19 and Mr Trump have formed views in young Chinese that will linger long after both are gone. Mr Trump threatened to ban Huawei, a national champion; TikTok, a winning export; and WeChat, a lifeline to family back home for those overseas. A popular joke online is that Mr Trump encouraged the Chinese to rally round the flag. In nationalistic circles he was even praised for laying bare America’s hypocrisy on espousing liberal values and openness.

Hate crimes against Asian-Americans in America have risen. Anti-Chinese sentiment can persuade Chinese overseas students—cosmopolitan, politically liberal types—to stick up for China. A study by Jennifer Pan and Yiqing Xu of Stanford University conducted in elite American universities found that students who encountered racist taunts were more likely to back China’s political system. Those who had previously been least nationalistic showed the biggest rise in support for Chinese authoritarianism.

At home and overseas, young Chinese were appalled by how Western democracies botched their response to covid-19, when tough measures in China stopped it in its tracks. A survey last year by researchers at the University of California, San Diego, found that university-educated Chinese youths displayed the largest jump in support for Xi Jinping's regime. In a post-covid world its competence, public order and efficiency look attractive. This has been manna for propagandists, who have censored news of the early cover-up and suffering in Wuhan, where the virus was first found. One of those who wrote bravely about these themes was Fang Fang, a 65-year-old novelist. Millions rushed to read her online diary before censors took it down. Then news broke that her account was to be translated and published in America. The fiercest backlash came among young, keen readers of her work. After state media attacked Fang Fang, many felt she had "turned her pen into a knife, and handed it to the West".

The young pit the starry-eyed admiration of Fang Fang's generation for the West against their own clear-eyed confidence. They think China is best served by picking aspects of Western culture that suit it. "Lots of young people think that America is declining, and that its flaws could be solved with a Chinese political arrangement," notes Feng Chucheng of Plenum, a think-tank in Beijing. "They are more confident that we do not have to follow the same path—in fact, that our path might be better."

The thinking was that students abroad might embrace Western values. Now it often goes the other way. A saying popular with Chinese students overseas is: "Pretty mountains, pretty lakes, pretty boring", expressing their longing for China's efficient, clean and fast-paced cities. When Dylan Zhou arrived in San Francisco for a PhD in physics in 2017, he thought America was "really fantastic, really liberal". With time, Mr Zhou liked it less: its courts were too lenient, its policies for minorities too indulgent, and American investors would crack jokes he did not understand. Mr Zhou is returning to China early, to set up a fintech company.

Like Mr Zhou and Ms Bai, who runs an online-learning startup, many are lured by China's zingy tech sector. Earlier returnees are credited with getting it off the ground, building local versions of Facebook and Twitter. Now Facebook and the rest steal ideas from pioneering Chinese apps, a source of pride for young Chinese. Financing from venture-capital funds is easier to come by. And if returnees have influential parents, their *guanxi*, or personal connections, can give children a head start.

A lack of sympathy for liberal values is becoming evident closer to home. Many of the grievances that drive Hong Kongers to protest, such as graduate unemployment and high house prices, once resonated with mainlanders. Luqiu Luwei, a journalism professor at Hong Kong Baptist University, says her mainland students were "full of curiosity" during the mass sit-ins of the "umbrella movement" in 2014, rushing to observe and even join them. But the protests that roiled Hong Kong in 2019 left them cold. "Why are they allowed to be so disruptive?" her students asked. Police on the mainland called some students' parents to warn their children to stay clear of the protests. But Ms Luqiu also observes that few seek out news from sources other than Chinese media, which have vilified the protesters as separatists. This is despite the fact that Hong Kong's internet is open, so they do not need to use unauthorised virtual private networks to access foreign news sites, unlike on the mainland. Powerful domestic platforms such as Weibo, WeChat and Douyin mean few form the habit to read widely, thinks Ms Luqiu.

And what of young views of Taiwan, which China claims as its own? In 2011 China allowed students to study in Taiwan at a time of warmer ties with a China-friendly government. Thousands have thus been able to see democracy up-close in a place with a familiar language and culture. A few, like 27-year-old Anderson Yu, who arrived in 2011 from southern Guangdong province, relish the experience. "I love this place," says Mr Yu, who hears out pro-independence Taiwanese friends even if he is "sceptical".

Lots of other young Chinese flock to the island for trinkets and pop culture.

But many experience discrimination from locals and barriers that stop them from applying for grants or staying on to work. Taiwanese youths mistrust China more than their elders do. Chinese students also make no effort to mix, says Mr Yu. Attitudes have hardened since Tsai Ing-wen was elected president in 2016 (and re-elected in 2020). Many are “upset that Taiwan is not grateful to China for the freedoms it has granted the region,” says Mr Yu.

Soft power matters in shaping opinion. Older Chinese grew up listening to Cantonese songs and watching Taiwanese films, forming a special admiration for both territories. Youngsters do not have the same bond, says Fang Kecheng of the Chinese University of Hong Kong. They now watch their own shows—and Hong Kong youths tune in. This appreciation for home-grown culture can be a force for good. Many overseas students echo Ms Bai, the startup founder, when she says she returned to China “because if I am here, then I can change something”. Whether on debating shows or through home-grown rap music, young people are creating new identities. The next chapter delves into some of them. ■



世界观

一群海龟

随着对西方的看法变糟，学生们回家了【专题报道《中国青年》系列】

白双在海外的时间比大多数人都长。在巴黎获得学位后，她在一家法国公司工作，然后去了伦敦攻读硕士学位，又找了一份工作。到了2017年，两股力量将她带回了家。首先是工资，她觉得太低了。她听说可以在上海的创业圈子里赚到更多。其次是父母，他们听说这两个接纳她的城市遭受了恐怖袭击后吓坏了。他们说，中国很安全，她可以在这里“发光发亮”。“如果有一个地方可以解决一切问题，那为什么不去呢？”白双这样想到。她买票回了国。

白双是个“海龟”，这个称呼在中文里和“海归”谐音，意为“从海外归来”。教育部说，在2000年至2019年之间有620万中国人留学海外，其中有400多万已返回。回国率已经提高：2001年只有14%回国，但自2013年以来，中国每年都会迎接至少五分之四的海外毕业生回国。在新冠疫情不同寻常的压力下，据信2020年前九个月有80万人回国，而2019年为58万人。

疫情缩短了在国外逗留的时间。疫情结束后，留学人数应该会再次增加。但是，一股新的各种因素的合流已使受过良好教育的中国人远离西方，尤其是美国。使西方看起来不安全且不友好的不仅仅是新冠疫情和恐怖袭击。2020年前九个月，中国大陆学生前往美国的旅行同比下降了70%。但是，去往美国的台湾学生和韩国学生分别仅下降50%和56%，尽管这两个地方抗疫和中国大陆一样高效。

原因之一是美国的政策使得中国的毕业生更难留下来。2018年，发放给包括计算机科学在内的敏感研究领域人员的签证有效期从五年缩短至一年。当年9月，美国撤销了1000名它认为构成了安全威胁的学生和研究人员的签证。特朗普曾多次指责中国学生窃取美国技术。用他的联邦调查局局长克里斯托弗·雷（Christopher Wray）的话来说，中国不再只是对“整个政

府”的威胁，而是对“整个社会”的威胁。

毫不意外，中国青年开始怀疑自己是否受欢迎。去年，皮尤研究中心调查的美国青年中，有一半以上对中国持负面看法。在整个人口中，这一数字创下了73%的历史新高。这种感觉似乎是相互的。多伦多的约克大学的吴志明于去年4月对两万名中国人的调查显示，五分之四的30岁以下受访者说自己不信任美国人。

中国青年在新冠疫情和特朗普任期中形成的一些看法将在这二者消失之后长久遗留下。特朗普威胁封杀中国的领军企业华为、成功的出口产品TikTok以及海外华人与家人联系的生命线微信。网上一个流行的笑话是特朗普让中国人更团结一致了。在民族主义的圈子里，人们甚至赞扬他揭露了美国在拥护自由价值观和开放性上的虚伪。

在美国，针对亚裔美国人的仇恨犯罪有所增加。反华情绪可以说服中国留学生——见过世面的、政治自由派的那些——为中国辩护。斯坦福大学的潘婕和徐轶青在美国精英大学进行的一项研究发现，遭受过种族主义嘲弄的学生更有可能支持中国的政治体系，而之前民族主义程度最低的学生对中国威权主义的支持上升最为显著。

在中国采取强硬措施遏制了疫情蔓延时，西方民主国家应对疫情的拙劣表现让国内外的中国青年都感到震惊。去年，加州大学圣地亚哥分校的研究人员进行的一项调查发现，受过大学教育的中国青年对习近平政权的支持表现出了最大的飞跃。在疫情后的世界里，其能力、公共秩序和效率看起来很有吸引力。这对于政治宣传者来说可谓天赐福音，而这些人打压了有关最早发现病毒的武汉在早期隐瞒疫情和经受苦难的新闻。65岁的小说家方方就是其中一个勇敢地书写这些主题的人。在审查将其屏蔽之前，数百万人蜂拥追读她的在线日记。然后有消息传出她的记叙将在美国翻译出版。最强烈的反弹来自于她的那些年轻热情的读者。在官方媒体攻讦方方之后，许多人都觉得她是“给西方递刀子”。

年轻人拿方方这一代人对西方天真的向往与自己清醒的信心一较高下。他

们认为，选择西方文化中适合自己的那部分对中国最好。“很多年轻人认为美国正在衰退，其缺陷可以通过中国式的政治安排来解决，”北京智囊团Plenum的冯楚成指出，“他们更有信心我们不必遵循同一条道路——实际上，他们认为我们的道路可能会更好。”

过去人们以为留学生可能会拥抱西方的价值观。现在往往是反过来。海外的中国学生中流行一句话：“好山好水好无聊”，说出了他们对中国高效、清洁和快节奏城市的渴望。当迪伦·周（Dylan Zhou，音译）2017年抵达旧金山攻读物理学博士时，他认为美国“真的很棒，真的很自由”。随着时间的流逝，他不那么喜欢它了：法院太宽容了；对少数族裔的政策太放纵了；美国投资者会开他听不懂的玩笑。他早早返回了中国，要成立一家金融科技公司。

就像周先生和经营在线学习创业公司的白双一样，许多人被中国充满活力的科技行业吸引。早年的海归被视为让这个行业起步的功臣，搭建出了本地版本的Facebook和推特。现在，Facebook和其他公司则从中国青年引以为傲的开创性中国应用中偷点子。风投的资金也更容易拿到。而如果海归的父母很有影响力，他们的“关系”可以让孩子先人一步。

在离家更近的地方，对自由主义价值观缺乏认同这一点正在清晰显现。许多引发香港人抗议的不满情绪，例如毕业生失业率和高房价，曾经引起大陆人的共鸣。香港浸会大学新闻学教授闾丘露薇表示，她的大陆学生2014年时对“雨伞运动”的大规模静坐示威“充满了好奇心”，急于观察甚至加入。但对2019年令香港陷入动荡的抗议活动冷眼旁观。“为什么他们可以这样搞破坏？”她的学生们问。大陆警方呼吁一些学生的父母警告自己的孩子远离抗议活动。但闾丘露薇还观察到，尽管香港的互联网是开放的，不像在大陆需要使用VPN才能访问外国新闻站点，但这些学生很少会去大陆媒体之外的地方找新闻看，而这些媒体把抗议者污蔑为港独分子。闾丘露薇认为，微博、微信和抖音等强大的国内平台意味着很少有人养成广泛阅读的习惯。

那么，年轻人对于中国说属于自己的台湾又有何看法呢？在与亲大陆的台

湾当局关系热络的2011年，中国允许学生去台湾学习。成千上万的人由此能够在有熟悉的语言和文化的地方近距离看到民主。一些人很珍惜这段经历，比如27岁的安德森·于（Anderson Yu，音译），他2011年从广东省南部来到台湾。“我很喜欢这里。”他说。即使他“持怀疑态度”，他也愿意倾听支持独立的台湾朋友的声音。中国许多年轻人涌向台湾岛，购买小物件并体验流行文化。

但是，许多人遭到当地人的歧视，还有令他们无法申请款项或留下来工作的障碍。台湾的年轻人比他们的长辈更不信任中国。于先生说，中国学生也没有做出任何融入的努力。自从蔡英文在2016年当选台湾地区领导人（并于2020年连任）后，各方态度变得强硬。于先生说，许多人“因为台湾并不感激中国给予该地区的自由而感到愤愤不平”。

软实力对塑造观念至关重要。年龄稍长的中国人是听着粤语歌、看着台湾电影长大的，这让他们对两个地区都带有特别的好感。香港中文大学的方可成说，年轻人没有类似的纽带。现在他们看自己的节目——而香港年轻人也点进来看。这种对本土文化的欣赏可以成为一种有益的力量。创业者白双说她回到中国是“因为如果我在这里，我就能改变些什么”。许多海外留学生也有这样的想法。无论是通过辩论节目还是通过本土的说唱音乐，年轻人都在创造新的身份。下一篇将深入探讨其中的一些。 ■



Anime films in Japan

Record slayer

The right film at the right time helps Japan confront its demons

FOR NEARLY 20 years “Spirited Away”, an Oscar-winning animation, reigned unchallenged as Japan’s highest-earning film. But in the last days of 2020 the title was, well, spirited away by “Demon Slayer: Mugen Train”, an adaptation of a hit *manga* (comic book). Set in the early 20th century, “Demon Slayer” follows a young boy, Tanjiro, as he and his comrades battle a band of demons who have killed his family and turned his sister into one of them, as demons do. “Spirited Away” took more than eight months to reach ticket sales of ¥30bn (\$247m at the time); “Demon Slayer” passed that mark in less than two (there was hardly any inflation in the intervening period). Box office receipts currently stand at ¥36bn (\$349m).

The film is one of several hits from the same storyline. The original *manga* series ran in the popular *Weekly Shonen Jump* from 2016 until 2020. Subsequent compilations have sold over 100m copies. A television show based on the series was named *anime* of the year in 2020 at the Tokyo Anime Awards Festival, an animation industry powwow. The series’ theme song topped the pop charts. Marketing tie-ups saw “Demon Slayer” characters deployed to sell everything from rice balls to toy swords. Products linked to the series have brought in ¥270bn, according to the Dai-ichi Life Research Institute, a think-tank.

The series has permeated all walks of life. Suga Yoshihide, the 72-year-old prime minister, reportedly referred to one of its signature phrases—“total concentration breathing”—during a cabinet meeting. Primary-school pupils named Tanjiro their most admired person in a survey in November, just pipping their mothers (who came second) but well ahead of their fathers

(who came a lowly fifth).

In part, “Demon Slayer” has covid-19 to thank for its success. The *manga* concluded in the early days of the pandemic, as many Japanese hunkered down at home. That fuelled fresh interest in earlier issues and in the television series released in 2019. Unlike longer-running series with daunting tomes of back issues, such as “Dragon Ball” or “Doraemon”, the new and relatively compact “Demon Slayer” proved perfect for quarantine-era bingeing. The film’s release, in turn, coincided with the lifting of restrictions on audience sizes at Japanese cinemas. Moreover, Hollywood studios were holding off releasing blockbusters at the time. “It launched when entertainment was limited, so people flocked to it,” says Sudo Tadashi, an *anime* critic.

The story itself also carried a moral suited to the pandemic: good triumphs over evil, but only after great hardship. Some commentators even argued that the *oni*, or demons, in the series evoke those associated with plagues in the past, making their defeat especially sweet.

The success of the series also reflects big changes in the *manga* and *anime* business. For one thing, its creator, who uses an alias, is thought to be a young woman, a rarity in a largely male industry. The female characters are less passive than in many other *manga*, says Ijima Yuka of Daito Bunka University: “In the past, women and girls were to be protected, not portrayed as fighters; in “Demon Slayer” women and girls fight.” The more varied protagonists appeal to a wider range of viewers. “There are lots of characters and each one had individual flair, so everyone could find someone to empathise with,” Mr Sudo says.

“Demon Slayer” also heralds a turn away from the all-controlling directors and closed distribution networks of old, argues Matt Alt, author of “Pure Invention: How Japan’s Pop Culture Conquered the World”: “Streaming is

unsettling the traditional giants.” The *anime* version of “Demon Slayer” launched simultaneously on 20 television channels and 22 streaming platforms, including Netflix, Hulu and Amazon Prime Video, which helped it build a broader fan base, says Mr Sudo. It was not the creation of a single, driving figure, unlike “Spirited Away”, which was written and directed by Miyazaki Hayao. He is one of the dwindling ranks of Japanese who have yet to see “Demon Slayer”. ■



日本动画电影

屠榜之刃

在合适的时间拍出合适的电影，帮助日本直面困境

奥斯卡获奖动画片《千与千寻》（Spirited Away）稳居日本最高票房电影的宝座长达近20年。但在2020年的最后几天，这顶桂冠如同少女千寻一般，被改编自热门漫画的《鬼灭之刃：无限列车篇》（Demon Slayer: Mugen Train）悄然掠走。《鬼灭之刃》的背景设定在20世纪初，讲述了少年炭治郎在家人被鬼杀死、妹妹被变成鬼后和伙伴们一起斩鬼的故事。

《千与千寻》当初达成300亿日元票房用了八个多月（当时合2.47亿美元），而《鬼灭之刃》不到两个月就破此记录（在这些年几乎没有通货膨胀）。目前后者的票房收入为360亿日元（3.49亿美元）。

这部电影是源自同一则故事的多个热门产品之一。其原作漫画系列从2016年到2020年在人气杂志《周刊少年Jump》上连载。合集版本的销量超一亿册。2020年，在动漫行业盛会东京动画奖（Tokyo Anime Awards Festival）上，根据该系列改编的电视动画片当选“年度最佳动画”。电视主题曲也登上流行音乐榜榜首。营销合作使得《鬼灭之刃》的人物角色出现在从饭团到玩具剑的各种商品上。根据智库日本第一生命经济研究所（Dai-ichi Life Research Institute）的数据，《鬼灭之刃》系列周边已经带来了2700亿日元的收入。

《鬼灭之刃》系列已经渗透至社会各界。72岁的日本首相菅义伟据称在一次内阁会议上引用了作品中的标志性台词之一“全集中呼吸”。在11月的一项调查中，小学生将炭治郎列为他们最崇拜的人，略高于他们的母亲（位居第二），但遥遥领先于他们的父亲（仅排名第五）。

在某种程度上，《鬼灭之刃》的成功要归功于疫情。原著漫画完结于疫情之初，当时很多日本人正困守家中。这让人们对往期漫画及在2019年推出的电视剧集产生了新的兴趣。《龙珠》或《哆啦A梦》之类的漫画连载多

年，大量过刊令人望而生畏，而相对紧凑的新作《鬼灭之刃》则不同，最适合在隔离时期一口气刷完。同名电影的上映时间又恰逢日本影院解除对观影人数的限制，再加上那会儿好莱坞大片纷纷推迟发行。动漫评论家数土直志表示：“它在娱乐方式有限的时候上映，所以人们蜂拥而至。”

故事本身的寓意也很适合疫情：正义会战胜邪恶，但必须先经历艰难险阻。一些评论家甚至认为，该系列中的鬼让人联想到与过去的瘟疫有关的鬼怪，这让鬼的战败尤其大快人心。

该系列的成功也反映出漫画和动画行业内的重大变化。首先，人们认为使用化名的创作者是一位年轻女性，这在一个很大程度上由男性主导的行业中十分罕见。大东文化大学（Daito Bunka University）的井岛由香说，与其他许多漫画相比，这部作品中的女性角色没那么被动。“以前，女人和女孩是被保护的对象，不会被描绘成战士，而在《鬼灭之刃》中她们能战斗。”主要角色更加多样化也吸引了更多观众。数土直志说，“故事中的人物很多，而且各具特色，所以人人都能找到有共鸣的角色。”

《纯粹的发明：日本流行文化如何征服世界》（*Pure Invention: How Japan's Pop Culture Conquered the World*）一书的作者马特·阿尔特（Matt Alt）认为，《鬼灭之刃》也预示着行业将开始背离导演总揽全局和旧有的封闭分销网络的模式，“流媒体正让传统巨头感到不安。”数土直志表示，《鬼灭之刃》剧集版在20个电视频道和奈飞（Netflix）、Hulu及亚马逊Prime Video等22个流媒体平台上同时推出，这帮助它建立起更广泛的粉丝群。与宫崎骏创作并执导的《千与千寻》不同，它并非某一个有强大影响力的人的创造物。而宫崎骏是越来越少的还没看过《鬼灭之刃》的日本人之一。■



Carmaking

A Stellantis is born

A long-awaited mega-merger may give rise to an industry star

FIAT CHRYSLER AUTOMOBILES (FCA), an Italian-American carmaker, and PSA Group, the French owner of Citroën and Peugeot, do not like to dwell on their shared past. When PSA acquired Chrysler Europe in 1978 for a nominal \$1 it picked up some struggling British and French marques and a heap of debt. That tie-up crashed a few years later with the demise of Talbot, the brand created from these motoring scraps. On January 4th shareholders of both firms voted to give it another go, acceding to a mega-merger agreed in 2019. Hopes seem higher this time. The name of the combined firm, Stellantis, is derived from the Latin for “brightens with stars”.

Stardust is sadly lacking from an industry that, along with many others, has taken a beating in the pandemic. But the creation of the world’s fifth-largest carmaker by vehicles produced (see chart) is well set to deal with the effects of covid-19—and to navigate the other difficulties facing the automotive business.

The pandemic has sent screeching into reverse an industry that was already going backwards, as demand slumped in car-mad China. Annual worldwide sales fell from 94m units in 2017 to 90m in 2019. Covid-19 depressed sales by 15% in 2020, to 76.5m, according to IHS Markit, a data firm.

On the bright side, they are expected to rebound sharply this year. The signs are encouraging. Monthly Chinese sales have exceeded last year’s in the second half of 2020. General Motors has led America’s recovery, with sales up by 5% in the fourth quarter, year on year. And electric vehicles are booming, helping Tesla make good on Elon Musk’s pre-pandemic forecast of

delivering 500,000 cars in 2020.

Despite the rebound, the industry is not likely to get back to its size in 2019 before 2023. What does that mean for Stellantis (whose largest shareholder, Exor, part-owns *The Economist's* parent company)? Size will let it spread the costs of new technology. The savings, forecast at €5bn (\$6.2bn) a year, are more important than ever while the industry recovers. Cash reserves will be shored up by the decision of FCA's investors in September to accept a reduction in the special dividend that was part of the deal, by nearly half, to €2.9bn.

Stellantis also has Carlos Tavares. He has already turned round two loss-making firms: PSA, which he has led since 2014, and then Opel, acquired from General Motors in 2017. His task now is to revive the Fiat brand, which is dependent on Europe and was starved of investment after the merger with Chrysler in 2014. Only the ageing 500 supermini is selling well.

The reticence of both Mr Tavares and Sergio Marchionne, FCA's late boss, to rush headlong into electrification may also prove wise. Other carmakers had poured cash into electric cars that did not sell well. Now that they are becoming more popular, Stellantis's plans, including PSA's new architecture for electric vehicles due by 2023, have more chance of success.

The deal also affords the opportunity to reset strategy, says Jefferies, a bank. The firms are strong regionally, PSA in Europe and FCA in America, but lack global clout. Neither has much presence in China. And in an industry where complexity is now a dirty word, Stellantis will have 15 brands. Volkswagen's 11 are seen as unwieldy.

Mr Tavares needs to make Jeep a worldwide profit machine like VW's Audi and Porsche, and to decide what to do about underperforming premium brands. Maserati and Alfa Romeo have defied numerous relaunches to stay

peripheral. DS is profitable but has little presence outside France.

Stellantis's boss must also overcome the clashes of culture that have brought down many a car-industry merger. Marchionne made FCA work through force of personality and the width of the Atlantic, which let him keep the subsidiaries at arm's length. Mr Tavares does not have that luxury, or Marchionne's charisma. But his stellar track record shows he has the character to make it happen. ■



汽车制造

繁星联盟诞生

一场期待已久的强强联合或将造就行业新星

意大利与美国合资汽车制造商菲亚特克莱斯勒（FCA）和法国汽车制造商标致雪铁龙集团（PSA）不喜欢回顾共同的过往。1978年，PSA用象征性的1美元收购了克莱斯勒的欧洲业务，接手了它一些深陷困境的英国和法国品牌以及巨额债务。几年后，随着用这堆汽车废品创建的品牌塔伯特（Talbot）倒闭，这项合作也宣告失败。1月4日，两家公司的股东投票决定再试一次，同意推进在2019年达成的大型合并协议。这次的期望似乎更高了。合并后的公司名称斯特兰蒂斯（Stellantis）源自拉丁语，意为“用繁星照亮”。

遗憾的是，汽车行业和其他许多行业一道受到疫情重创，星光晦暗。但是，上述协议造就的以产量计全球第五大汽车制造商（见图表）已做好准备应对新冠的影响——以及克服汽车企业面临的其他难关。

由于对汽车狂热的中国需求锐减，疫情让这个原本就在倒退的行业雪上加霜。全球年销量从2017年的9400万辆跌至2019年的9000万辆。根据数据公司埃信华迈（IHS Markit）的统计，2020年，疫情导致销量下降了15%，至7650万辆。

乐观地看，今年销量预计会强势反弹。种种迹象鼓舞人心。2020年下半年，中国月销量已超过上年水平。通用汽车引领了美国的复苏，第四季度销量同比增长5%。而电动汽车的蓬勃发展帮助特斯拉达成了伊隆·马斯克在疫情前预测的目标，在2020年交付了50万辆车。

尽管行业回暖，但在2023年之前不大可能恢复到2019年的规模。这对斯特兰蒂斯（其最大股东Exor集团部分持有本刊母公司）意味着什么？合并后的规模将会让它摊薄使用新技术的成本。预计每年可由此节省50亿欧元

(62亿美元)，行业还在复苏，这笔钱比以往任何时候都更重要。FCA的投资者在9月份决定接受将合并协议中拟定的特别股息削减近一半至29亿欧元，这将支撑现金储备。

斯特兰蒂斯还有唐唯实（Carlos Tavares）。他已经让两家亏损的公司扭转乾坤：先是是他自2014年起领导的PSA，后是2017年从通用汽车收购的欧宝（Opel）。他目前的任务是重振菲亚特，这个依赖欧洲的品牌在2014年与克莱斯勒合并后投资严重不足，唯一畅销的产品是陈旧的500微型车。

唐唯实和FCA的已故前老板塞尔吉奥·马尔乔内（Sergio Marchionne）都对一头扎进电气化有所保留，这可能也很明智。其他汽车制造商当初砸钱造电动汽车，但销量并不理想。如今电动汽车越来越受欢迎，斯特兰蒂斯的计划（包括PSA将在2023年前推出新型电动汽车架构）有更大的几率获得成功。

投行杰富瑞（Jefferies）表示，合并协议还为重新制定战略提供了机会。两家公司都有地区优势：PSA在欧洲，FCA在美国，但它们也都缺乏全球影响力，在中国也没多大存在感。汽车产业如今非常忌讳复杂的结构，而斯特兰蒂斯将有15个品牌。大众有11个品牌就已被视为尾大不掉。

唐唯实需要将Jeep打造成像大众的奥迪和保时捷那样的全球盈利机器，并决定要拿表现不佳的高端品牌怎么办。玛莎拉蒂和阿尔法·罗密欧尽管经历多番重新亮相，却依然处于视线边缘。DS虽然有所盈利，但在法国以外影响甚微。

斯特兰蒂斯的老板还必须克服曾导致许多车企合并失败的文化冲突。马尔乔内带领FCA获得成功靠的是人格力量和大西洋的宽广，后者让他能与子公司保持一定距离。唐唯实既没有这种优势，也没有马尔乔内的个人魅力。但他闪耀的业绩表明，他有毅力实现目标。■



Investing in infrastructure

Infrastruggles

Every country wants to build more bridges, roads and renewable-power grids. It won't be easy

IN 1916 CINCINNATI decided to construct a magnificent new subway system. After decades of cock-ups it was abandoned in 1948, and today there are two miles of tunnels beneath the city that have never been used. That cautionary tale is still relevant. Politicians everywhere are calling for more infrastructure spending. Yet few industries have a worse record of coming through on time and on budget. If the incipient boom is to produce better results, governments and firms must learn to adopt best practice from around the world.

Most countries have enacted short-term stimulus plans to deal with the pandemic. Former President Donald Trump signed on December 27th a \$900bn spending bill. But there is also appetite to binge on infrastructure. President Joe Biden wants to spend \$2trn on roads, power grids and railways, and hopes to win bipartisan support for his plans. The European Union has just approved a €1.8trn (\$2.2trn) budget, a slug of which is for digital and energy investments.

The new infrastructure infatuation is understandable. Public and private investment has stagnated at 3-4% of GDP worldwide. That is too little to maintain ageing assets in developed countries—a third of American bridges are creaky—or to provide enough clean water and electricity in the emerging world. Low interest rates mean financing is cheap, and many economists think that the payback from infrastructure is attractive. Meanwhile, climate change and the digitisation of the economy are creating vast demand for renewable-energy systems and connectivity, including 5G networks.

In practice, however, infrastructure's record is as potholed as a Mumbai motorway. Cost-overruns often exceed 25%. Two-thirds of foreign bribery cases involve infrastructure deals. China spends more than anyone else, but perhaps half of its investments have destroyed economic value. India had a boom in the 2000s which ended in a mire of debt. Even Germany struggles to get it right. All this reflects some deep underlying problems. Most projects have a time horizon beyond that of politicians and voters. Often they are one of a kind: China has just Three Gorges to dam, not six. And the full economic benefits created by a road, say, are not captured by the organisation paying for it.

Yet bitter experience does at least suggest two universal lessons. First, governments should select projects systematically by creating a single list and picking those with the highest payback. This assessment should factor in externalities, including the impact on carbon emissions, and delays, which are a big source of cost overruns. And it should be carried out by bodies that are independent from those that build and run assets. Often the projects selected will not be the glittering new temples that politicians like their names on, but humble repairs and maintenance.

The second lesson is to harness the private sector. Not only is it a source of capital—global infrastructure funds have over \$200bn waiting to be deployed—but projects with private investors also tend to be managed better. That means developing standardised contracts and independent regulators that protect taxpayers but also give investors reasonable certainty of an adequate return.

Both lessons might seem obvious. A few places, such as Chile and Norway, get infrastructure right. But over half of the countries surveyed by the IMF do not maintain a national pipeline of projects. And in most the record is staggeringly erratic. America is splurging on 5G but has squalid airports and too little renewable energy. Europe has shiny airports and wind farms but

is in the stone age on 5G. Infrastructure is one of the last local industries left where easy gains are still to be had by copying others around the world. If you benchmark public investment in over 100 countries, adopting best practice could make spending 33% more efficient. The prize is huge. Just don't expect a subway in Cincinnati. ■



【首文】投资基建

基建不易建

每个国家都想修建更多的桥梁、道路和可再生能源电网。但这并不容易

一九一六年，辛辛那提决定建造一个宏伟的新地铁系统。接下来的二三十年里这个项目的进展一团糟，最终于1948年放弃。今天这座城市的地下还有两英里长的从未使用过的隧道。这在今天依然应引以为戒。世界各地的政客都在呼吁增加基础设施支出，然而在按时、按预算完工这方面，很少有行业比基建部门的记录更糟糕的了。眼下刚刚露头的热潮若要产生更好的结果，政府和企业就必须学会采纳世界各地的最佳实践。

大多数国家都已经制定了短期的刺激计划来应对疫情。美国前总统特朗普在12月27日签署了一项9000亿美元的支出法案。但大笔投资基础设施的欲望也已被点燃。总统拜登想在道路、电网和铁路上投入两万亿美元，希望自己的计划能赢得两党的支持。欧盟刚刚批准了1.8万亿欧元（2.2万亿美元）的预算，其中一部分会用于数字和能源投资。

对基础设施再度倾心是可以理解的。这部分公共和私人投资占全球GDP的比例常年在3%到4%之间徘徊。这个数字对于维护发达国家日益老化的资产来说太少了——美国三分之一的桥梁都年久失修，而对于在新兴世界提供足够的清洁水和电力而言同样严重不足。利率低使得融资成本很低，而且许多经济学家都认为基础设施的回报很有吸引力。与此同时，气候变化和经济数字化正在创造对可再生能源系统和包括5G在内的网络连接的巨大需求。

然而在实践中，基建过往的业绩就如同孟买的高速公路那般坑洼遍布。成本超支经常超过25%。三分之二的跨国行贿案件涉及基建协议。中国的基建投入比其他任何国家都多，但可能其中一半的投资破坏了经济价值。印度在本世纪头十年兴起了基建热潮，最终却陷入债务泥潭。就连德国也做不好这件事。所有这些都反映出一些深层次问题。大多数项目的时间跨度

都比政客的任期和选民的展望要长。它们常常是独一无二的：中国修的是“三”峡大坝而不是“六”峡。另外，一项基础设施（例如一条公路）创造的全部经济效益并不由为它买单的组织获得。

不过，苦涩的经历确实给出了至少两条普遍适用的经验。首先，政府应该系统性地甄选项目，方法是创建一个单一的清单，从中选择回报最高的项目。这个评估过程应将碳排放影响等外部性以及工程延误考虑在内，后者是成本超支的一大根源。此外，评估的执行机构应该独立于资产的建设和运营方。被选中的项目通常不会是熠熠生辉的崭新神殿——让政客们愿意用来给自己贴金的那种，而是不起眼的维修和保养工作。

第二条经验是利用私营部门。它不仅是一个资本来源——全球基建基金有超过2000亿美元等待部署——而且有私人投资者参与的项目往往也管理得更好。这就需要开发标准化的合同并引入独立的监管机构，从而既保护纳税人，又让投资者有一定的把握获得足够的回报。

这两条经验似乎都是明摆着的。在少数地方，如智利和挪威，基建做得不错。但在国际货币基金组织调查的国家中，超过一半都没有国家级的项目储备，而且大多数国家的基建发展都极不平衡。美国在5G上大把撒钱，机场却破破烂烂，可再生能源也少之又少。欧洲有锃光瓦亮的机场和风力发电场，但在5G上却还处于石器时代。现在已经没有几个地方产业还可以通过照抄世界其他地方的做法来轻松获益了，基建是一个。如果以100多个国家的公共投资为基准，采用最佳实践有可能使开支的效率提高33%。回报是巨大的。只是别指望辛辛那提的地铁会修成了。■



Data storage

Re-record, not fade away

Magnetic tape is an old-fashioned technology with a promising future

THE WHIRR of spooling magnetic tape is more likely to evoke feelings of nostalgia than technological awe. Yet tape remains important for data storage, with millions of kilometres of the stuff coiled up in the world's data centres. Indirectly, says Mark Lantz of IBM, most computer users thus rely on tape every day.

Though tape may seem archaic, it is still getting better. In 2015 Dr Lantz's team unveiled a version capable of squirrelling away 123 gigabytes per square inch (19Gb per square centimetre, but tapemakers still use Imperial units). In 2017 they reached 201Gb/in². And on December 15th they revealed a design that has a density of 317Gb/in². That rate of growth is unmatched by any of tape's competitors.

Tape's heyday as a data-storage medium for computers was in the 1950s. Hard disks, introduced in 1956, were quickly seen as superior because they required no time-consuming spooling. Decades of selective investment mean they now also have a better density of information storage than tape. The best can manage more than 1,000Gb/in². As a result they are in high demand—2018 saw the sale of more than 800bn gigabytes-worth, which is eight times the figure for tape. But disks have drawbacks. They are costlier than tape, have shorter lifespans and their spinning platters generate far more unwanted heat.

This leads to tape being the medium of choice for the so-called “cold” storage of data that need to be looked at only infrequently. And disks' advantages elsewhere may be slipping. In the 1990s hard-disk storage

densities doubled every year. Over the past decade that rate of growth has dropped to 7.6%, as manufacturers run out of headroom. Smaller magnetic particles need more energy to keep them in line, and the magnets which provide this are approaching the theoretical limits of their strength. The storage density of magnetic tape, by contrast, has been increasing steadily, by 34% a year for nearly three decades. As a consequence, tape may catch up with hard disks within five years.

To maintain this blistering rate of growth, Dr Lantz's team concentrated on three matters. First, they reduced the size of the magnetic grains that form a tape's recording surface, by substituting strontium ferrite for the current industry standard of barium ferrite. Second, they shrank the size of the read heads by a factor of 30, permitting data to be packed onto narrower tracks. Third, they developed systems able to track and correct the position of the tape with nanometre accuracy as it flowed under the smaller heads, stopping it going off-track and distorting the signal. Though it may take a decade for these technological improvements to make their way into products, this sort of progress bolsters confidence in tape's long-term utility.

Other innovations may be coming, too. Ohkoshi Shin-ichi of the University of Tokyo, for example, advocates using particles of epsilon iron oxide. This material is particularly magnetically stable, meaning its grain-size can be reduced (and thus storage density increased) without any risk of the field flipping randomly and thus changing what is encoded.

Demand for more storage will certainly be there. Estimates suggest that four times more data will be generated in 2025 than in 2019. In the part of the data-storage market where tape currently reigns supreme, it is likely to remain so for a while.

The biggest threat to tape comes from the flash-drive technology used in SD

cards and USB sticks. Flash relies on a flow of electrons through transistors, rather than on magnetised particles read by mechanical components, so it is capable of better data densities even than hard disks. Lack of moving parts also makes such solid-state devices faster at writing and retrieving information. Flash drives are, however, more costly than magnetic storage and do not last as long. This makes them ten times more expensive per byte per year of storage than hard disks, and nearly 50 times more expensive than tape. They are therefore too dear to use for anything but the most important jewels in the data vault. Until that changes, the reel is likely to continue. ■



数据存储

重录，还在

磁带是一种很有前途的老式技术

磁带绕着卷轴转动的嗡嗡声唤起的可能更多是怀旧之情，而不是技术上的敬畏。不过磁带仍然是重要的数据存储介质，长达数百万公里的磁带盘绕在世界各地的数据中心里。IBM的马克·兰茨（Mark Lantz）说，所以大多数计算机用户每天都在间接依赖磁带。

尽管磁带好像已经是老古董了，但它仍在不断改进。2015年，兰茨的团队推出了一种每平方英寸可存储123Gb（每平方厘米19Gb，但磁带制造商仍沿用英制单位）的版本。到2017年，存储能力达到每平方英寸201Gb。去年12月15日，他们公布了一种密度达每平方英寸317Gb的设计。这样的增长速度是磁带的任何竞争对手都无法比拟的。

磁带为计算机充当数据存储介质的全盛时期是上世纪50年代。1956年硬盘问世，人们很快就觉得硬盘更好，因为不需要耗时卷磁带。几十年的选择性投资意味着它们现在的信息存储密度也比磁带大。硬盘的存储密度最多可达每平方英寸1000Gb以上。因此它们的需求量很大——2018年硬盘销量超过8000亿Gb，是磁带销量的八倍。但硬盘也有缺点。它们比磁带更贵，寿命更短，而且它们旋转的碟片生成的无用热量也多得多。

这让磁带成了数据“冷”存储的首选介质，所谓“冷存储”是指所存储的数据只需要偶尔查看。而且硬盘在其他方面的优势可能正在缩小。在上世纪90年代硬盘的存储密度每年翻一倍。过去十年里，这一增速已经降到了7.6%，因为制造商们已经没有了发展空间。更小的磁粒子需要更多能量来让它们保持一致的方向，而提供这种能量的磁体正接近它们的理论强度极限。相比之下，磁带的存储密度一直在稳步增长——近30年来每年增长34%。因此，磁带可能在五年内赶上硬盘。

为了保持这种迅猛的增速，兰茨的团队专注于做三件事。首先，他们用锶

铁氧体代替了目前工业标准的钡铁氧体，缩小了形成磁带记录表面的磁性颗粒的尺寸。其次，他们将读取磁头的尺寸缩小到原来的三十分之一，这样数据就可以被存储到更窄的轨道上。第三，他们开发了一套系统，以纳米级的精度跟踪并纠正从更小的磁头下经过的磁带的位置，防止它偏离轨道或扭曲信号。尽管这些技术上的改进可能要花上十年才能真正应用到产品中，但这种进步增强了人们对长期使用磁带的信心。

其他的创新也可能到来。例如，东京大学的大越慎一提出使用 ϵ 氧化铁粒子。这种材料的磁性特别稳定，意味着它的颗粒还可以更小（从而增加存储密度），还不会有磁场随机翻转从而改变存储内容的风险。

对更多存储空间的需求肯定会存在。据估计，2025年产生的数据将是2019年的四倍。在目前磁带占主导地位的那一块数据存储市场，这种情况很可能还会持续一段时间。

对磁带最大的威胁来自SD卡和U盘中使用的闪存技术。闪存依靠的是通过晶体管的电子流，而不是机械部件读取的磁化粒子，因此它的数据密度甚至比硬盘还要高。没有转动的部件也让这种静态设备能够更快地写入和检索信息。不过，闪存比磁存储更贵，存储期更短。这使得它们每字节每年的存储成本是硬盘的10倍、磁带的近50倍。它们太贵了，所以只能用来存储数据库中最宝贵的信息。除非这一点发生变化，否则磁带应该还会继续转下去。■



...and in China

Feuding film stars

Kuaishou takes on TikTok and its Chinese sibling

“WE AIM TO be the most customer-obsessed company in the world,” declares the opening line in the 700-page prospectus from Kuaishou, a Chinese video app. The firm, launched a decade ago by a former software engineer at Google and another at Hewlett-Packard, boasts more than 250m daily active users, up from an average of just 67m in 2017. Kuaishou is expected to hit a valuation of around \$50bn when it goes public this month in Hong Kong. That would lift it above better-known social-media titans like Twitter (worth \$37bn).

Kuaishou’s revenues have soared in recent years, reaching 25bn yuan (\$3.6bn) in the first six months of 2020, up by nearly half on the previous year. Just over two-thirds of this came from what the firm calls “live-stream gifting”. It hosted nearly 1bn live-streaming sessions in that period, taking a cut on “tips” that viewers shower on their favourite live-streamers. A tip can be as small as 10 fen (1.5 cents) or as generous as 2,000 yuan. Performers film themselves singing, dancing, otherwise prancing or just sunbathing. (Pornography is strictly prohibited.) New stars can expect to fork half of their tips over to the platform.

Amid this exuberance two threats loom. The first comes from China’s increasingly hands-on regulators. In November they mandated that video apps like Kuaishou impose daily and monthly limits on the amount that users can tip live-streamers. Moreover, to prevent impressionable minors from being coaxed into sponsoring cunning broadcasters, platforms have been instructed to perform tougher background checks on users with such tools as facial-recognition technology. Bureaucrats in Beijing have yet to

work out precisely what Kuaishou's daily and monthly ceilings ought to be. But growth will probably slow down once the details are hashed out.

Douyin, TikTok's Chinese sister app and Kuaishou's arch-rival, is better insulated from the regulatory crackdown. Like Kuaishou, it operates a live-streaming business. But unlike its competitor, it earns most of its revenues from online ads, which the new rules do not affect. For comparison, adverts accounted for just 28% of Kuaishou's revenue mix in the first half of 2020. The company may now try to raise that share. To do so Kuaishou will have to overcome the somewhat outdated perception that its users are disproportionately folk living in small cities and rural areas with less money to buy advertised wares.

The second threat is the potential for a price war between Kuaishou and Douyin. For both platforms, user growth is largely a function of the appeal of their video content, which in turn depends on the calibre of the producers behind it. A race to the bottom, whereby each firm lowers its "take rate" on tips and ad sales to lure popular broadcasters from the other app, would depress margins.

At the moment neither company has a particular incentive to shatter the cosy duopoly, points out Jeffrey Young of Grandly Asset Management, a broker. But the possible arrival of a big competitor—not inconceivable in China's effervescent e-economy—could disrupt this equilibrium, Mr Young suggests.

Despite its domestic challenges (or maybe because of them), Kuaishou is proceeding apace with its global ambitions. The international version of its app, Kwai, claims "tens of millions" of users in markets from Brazil and Colombia to Malaysia and Vietnam. It still lacks the name-recognition of TikTok, though that may prove to be a blessing in disguise. Kwai has thus far avoided the sort of political scrutiny that its better-known rival has attracted

in many foreign markets. ■



.....在中国 死对头影星

快手挑战TikTok和抖音

“我们致力于成为全球最痴迷于为客户创造价值的公司”，中国视频应用快手在它700页的招股说明书的开篇如是宣告。十年前，两位分别曾在谷歌和惠普任职的软件工程师创立了这家公司，如今它的日活跃用户已超过2.5亿，在2017年时还只是日均6700万。到快手本月在香港上市时，它的市值预计将达到500亿美元左右。这可能会让它超过推特（市值370亿美元）等更知名的社交媒体巨头。

近年来快手的营收大幅增长，2020年上半年达250亿元，同比增长近一半。其中略多于三分之二来自该公司所谓的“直播打赏”。在此期间快手上举行了近10亿次直播，从观众为他们喜爱的主播慷慨“打赏”中抽成。一次打赏少则一毛，多则2000元。表演者们拍摄自己唱歌、跳舞，或者神气活现地跳来蹦去，甚至只是躺平晒日光浴。（色情内容被严格禁止。）新的明星主播可能要把所得打赏的一半交给平台。

一派繁荣之下，两大威胁若隐若现。首先是来自中国越来越事必躬亲的监管机构。去年11月，它们要求快手等视频应用对用户每日及每月最高打赏金额设定限制。而且，为了防止一些狡猾的主播引诱易受人影响的未成年人打赏，监管机构要求平台利用人脸识别技术等工具对用户展开更加严格的背景调查。北京的官员们还没有明确快手每日及每月的打赏上限应该是多少。但一旦细节敲定，快手的增长很可能会放缓。

快手的主要竞争对手抖音（TikTok是其国际版）能更好地隔绝这次监管打击。和快手一样，抖音也经营直播业务。但与其对手不同的是，抖音的大部分收入来自在线广告，而新规并不涉及这一块。相比之下，2020年上半年广告收入仅贡献了快手总收入的28%。快手现在可能要试图提高这一份额。要做到这一点，快手必须克服一个多少有些过时的观念——认为自己

的用户更多来自小城市和农村地区，没有多少钱购买广告上的商品。

第二个威胁是快手和抖音之间可能爆发价格战。对于这两个平台来说，用户增长在很大程度上取决于其视频内容的吸引力，而这种吸引力又取决于背后制作人的才能。如果两家公司都降低打赏和广告销售的“抽成”，以吸引红人主播从另一家跳槽过来，那么这样的逐底竞争将压低利润。

经纪公司冠力资产管理有限公司（Grandly Asset Management）的杰弗里·杨（Jeffrey Young）指出，目前两家公司都没有什么特定的动机来打破这种舒适的双头垄断。但他认为，也许会出现一个强大的竞争对手来打破这种平衡——这在中国生机勃勃的电子经济中并非不可想象。

尽管在国内面临这些挑战（或许也正因如此），快手正在快速推进它的全球野心。它的国际版Kwai声称在从巴西和哥伦比亚到马来西亚和越南等市场拥有“数千万”用户。它还没有TikTok那样的知名度，但这可能倒是件好事。Kwai至今尚未像这位更知名的竞争对手那样，在许多外国市场受到政治上的审查。 ■



Space-age materials

Hardy, non-perennial

Making satellites out of wood

THE SPACE age was built on clever materials. The business ends of rocket engines are composed of Inconel, a family of heat-and-corrosion-resistant nickel-chromium alloys developed in the 1940s. The “gold foil” adorning many satellites is, in fact, a form of insulation made from layers of Kapton and metallised Mylar, a pair of artificial polymers from the 1950s and 1960s. SpaceX’s Dragon spacecraft use a heat shield made of phenolic-impregnated carbon to protect astronauts during atmospheric re-entry.

But it is not just humans in lab coats who can come up with whizzy substances. Sumitomo Forestry, a Japanese firm, and Kyoto University are pondering the idea of building satellites out of an advanced, high-performance composite made from cellulose and lignin, a pair of complex polymers which are strong in tension and compression respectively. This material is both cheap and abundant. It is self-assembling and requires only simple chemical inputs. Manufacture can be entirely automated, requiring no human oversight. Translated from chemist-speak, they want to make satellites out of wood.

The research team argue that wood offers two advantages. Unlike metal, seasoned timber is easily penetrated by radio waves. That means communication antennas, sensors and the like could be kept inside the body of the satellite. This, they hope, will simplify construction. The second advantage is that, on atmospheric re-entry, the wooden parts of the satellite should burn up entirely, making disposal cleaner.

The researchers hope to launch a prototype version of what they have

dubbed a LignoSat by 2023. Space is both extremely cold and very hot, and can switch quickly between the two as a spacecraft moves from shade into direct sunlight. Processing wood to cope with such extremes will be crucial to success. Sumitomo has said merely that its way of doing this is an “R&D secret”.

Sending wood into space is not Sumitomo’s only ambition for the material. It hopes that lessons from the satellite project might assist its plan to build the world’s tallest wooden skyscraper, in Tokyo. This building, dubbed W350, would celebrate the firm’s 350th birthday in 2041, and would, therefore, be 350 metres tall—roughly as high as the Empire State Building without its spire. ■



太空时代材料

耐极温，不残留

用木头造卫星

太空时代建基于精妙的材料之上。火箭发动机的关键部分由因科耐尔合金组成，这是上世纪40年代研制的一种耐高温、耐腐蚀的镍铬合金。装饰在许多卫星上的“金箔”实际上是一种多层绝缘体，由聚酰亚胺和金属化聚酯薄膜制成，这两种人造聚合物分别研发于上世纪50和60年代。SpaceX的龙飞船使用的防热罩由酚醛浸渍碳制成，在重返大气层时保护宇航员。

但是，并不是只有套着实验室大褂的人才能捣鼓出尖端材料。日本住友林业株式会社（Sumitomo Forestry）和京都大学正在考虑使用一种先进的高性能复合材料来制造卫星。这种复合材料由纤维素和木质素制成，这两种复杂聚合物分别具有很强的抗拉和抗压性能。这种材料既便宜又供应充足。它可以自组装，并且只需简单的化学辅料。其生产可以完全自动化，不需要人类监督。把这些化学行话翻译过来就是，他们想用木头造卫星。

研究小组认为用木材有两大优势。和金属不同，经干燥处理的木材很容易被无线电波穿透。这意味着可以把通信天线、传感器等装置放在木制卫星内部。他们希望由此简化卫星的构造。第二个优点是，在重返大气层时，卫星的木制部分应该能完全燃烧掉，让废弃卫星的处理更加环保。

研究人员将这种卫星命名为LignoSat，希望在2023年发射一颗原型。太空既极寒又酷热，当宇宙飞船从背阴处运行到阳光直射处时，就是在这两种气温环境间急剧转换。把木材处理得能够经受这样的极端变化是成功的关键。住友林业只表示其解决方案是个“研发机密”。

把木头送进太空并不是住友林业对这种材料的唯一追求。它希望从这个卫星项目中获得经验，帮助自己在东京建造世界上最高的木制大厦。这座被称为W350的建筑计划在2041年落成，以庆祝这家公司350岁生日，它的高度也因此被定为350米——和帝国大厦去掉尖顶差不多高。■



Semiconductors

A new architecture

The global chip industry is becoming at once more diverse and more concentrated. The effects will be anything but nanoscopic

ON JANUARY 13TH Honda, a Japanese carmaker, said it had to shut its factory in Swindon, a town in southern England, for a while. Not because of Brexit, or workers sick with covid-19. The reason was a shortage of microchips. Other car firms are suffering, too. Volkswagen, which produces more vehicles than any other firm, has said it will make 100,000 fewer this quarter as a result. Like just about everything else these days—from banks to combine harvesters—cars cannot run without computers.

The chipmaking industry is booming. The market capitalisation of the world's listed semiconductor firms now exceeds \$4trn, four times what they were worth five years ago (see chart 1). Chipmakers' share prices have surged during the covid-19 pandemic, as work moved online and consumers turned to streaming and video games for succour.

This has propelled a wave of dealmaking. In September Nvidia, which designs powerful chips for gaming and artificial intelligence (AI), said it would buy Arm, a Britain-based company whose blueprints are used in nearly all smartphones, for \$40bn. In October AMD, which makes blueprints for graphics and general-purpose chips, announced another megadeal—to acquire Xilinx, a maker of reprogrammable chips, for \$35bn.

Capital spending, too, is rising. Samsung, a South Korean conglomerate, wants to invest more than \$100bn over ten years in its chip business (although some of that will go to its memory chips used in things like flash drives rather than microprocessors). On January 14th Taiwan

Semiconductor Manufacturing Company (TSMC)—which turns blueprints into silicon on behalf of firms like AMD and Nvidia—stunned markets when it increased its planned capital spending for 2021 from \$17.2bn to as much as \$28bn, in anticipation of strong demand. That is one of the largest budgets of any private firm in the world.

All this is happening amid a confluence of big trends that are realigning chipmaking. At one end the industry is a hive of competition and innovation. Established chip designs, including those from AMD, Nvidia and Intel, the world's biggest chipmaker by revenue, are being challenged by new creations. Web giants such as Amazon and Google, big customers of the incumbents, are cooking up their own designs. They are joined by a gaggle of startups, eager to capitalise on demand for hardware tuned for the needs of AI, networking or other specialist applications.

All this would be unequivocally great news for everyone, were it not for what is happening at the other end—in the factories where those designs are turned into electronic circuits etched on shards of silicon. The ballooning costs of keeping up with advancing technology mean that the explosion of chip designs is being funnelled through a shrinking number of companies capable of actually manufacturing them (see chart 2). Only three firms in the world are able to make advanced processors: Intel, TSMC, whose home is an earthquake-prone island which China claims as its territory, and Samsung of South Korea, with a nuclear-armed despotic neighbour to the north. The Semiconductor Industry Association, an American trade body, reckons that 80% of global chipmaking capacity now resides in Asia.

The vanguard may soon be down to two. Intel, which has pushed the industry's cutting edge for 30 years, has stumbled. On January 18th news reports suggested that the company (which was due to report its latest quarterly results on January 21st, after *The Economist* went to press) may begin outsourcing some of its own production to TSMC, which has

overtaken it.

And the world economy's foundational industry looks poised to polarise further, into ever greater effervescence in design and ever more concentrated production. This new architecture has far-reaching consequences for chipmakers and their customers—which, in this day and age, includes virtually everyone.

Start with the diversification. For years technology companies bought chips off the shelf. In its 44-year history Apple has procured microprocessors for its desktops and laptops from MOS Technology, Motorola, IBM, and finally Intel. Soon after the launch of the original iPhone in 2007, however, the firm decided to go it alone. Later iterations of the smartphone employed its own designs, manufactured first by Samsung, and later by TSMC. That approach proved so successful that in 2020 Apple announced that it would replace Intel's products with tailor-made ones in its immobile Mac computers, too.

Two years earlier Amazon Web Services, the e-commerce giant's cloud-computing unit, began replacing some Intel chips in its data centres with its own "Graviton" designs. Amazon claims its chips are up to 40% more cost-efficient than Intel's. Around the same time Google began offering its custom "Tensor Processing Unit" chip, designed to boost AI calculations, to its cloud clients. Baidu, a Chinese search giant, claims its "Kunlun" AI chips outpace offerings from Nvidia. Microsoft, the third member of the Western cloud-computing triumvirate, is rumoured to be working on chip designs of its own.

Clever startups in the field are securing billion-dollar valuations. Cerebras, an American firm which designs AI chips, has earned one of \$1.2bn. A British rival called Graphcore, which has been working with Microsoft, was valued at \$2.8bn in December. On January 13th Qualcomm, a firm best-known for its smartphone chips, paid \$1.4bn for Nuvia, a startup staffed by

veterans of Apple's in-house chip-design team.

Custom silicon was an iffy proposition a decade ago. General-purpose chips were getting better quickly thanks to Moore's law, which holds that the number of components that can be crammed into a silicon chip should double every two years or so. Today the Moorean metronome is breaking down, as quirks of fundamental physics interfere with components measured in nanometres (billions of a metre). Each tick now takes closer to three years than two, notes Linley Gwennap, who runs the Linley Group, a research firm, and offers fewer benefits than it used to.

That makes tweaking designs to eke out performance gains more attractive, especially for big, vertically integrated firms. No one knows better than Apple exactly how its chips will interact with the rest of an iPhone's hardware and software. Cloud-computing giants have reams of data about exactly how their hardware is used, and can tweak their designs to match.

And whereas designing your own chips once meant having to make them as well, that is no longer true. These days most designers outsource the manufacturing process to specialists such as TSMC or GlobalFoundries, an American firm. Removing the need to own factories cuts costs drastically. A raft of automated tools smooths the process. "It's not quite as simple as designing a custom T-shirt on Etsy," says Malcolm Penn, who runs Future Horizons, another chip-industry analyst. But it isn't a world away, either.

Although designing chips is now easier than ever, making them has never been harder. Keeping up with Moore's law, even as it slows, requires spending vast—and growing—sums on factories stuffed with ultra-advanced equipment: plasma-etching kit, vapour-deposition devices and 180-tonne lithography machines the size of a double-decker bus. After falling as a proportion of overall revenue, the chip industry's capital spending is ticking up again (see chart 3). In absolute terms, the cost of high-

tech “fabs”, as chip factories are known, has grown relentlessly—with no end in sight.

Today’s state-of-the-art is five-nanometre chips (though “5nm” no longer refers to the actual size of transistors as earlier generations did). Both Samsung and TSMC began churning them out in 2020. Their 3nm successors are due in 2022, with 2nm pencilled in a few years later.

At the turn of the millennium, a cutting-edge factory might have cost \$1bn. A report in 2011 from McKinsey, a firm of management consultants, put the typical cost of an advanced fab at \$3bn-4bn. More recently, TSMC’s 3nm factory, completed in 2020, in southern Taiwan, cost \$19.5bn. The firm is already pondering another for 2nm chips, which will almost certainly be more. Intel’s stumbles have left it marooned at 10nm—and its boss, Bob Swan, out of a job. His incoming replacement, Pat Gelsinger, will need to decide if the company, which, unlike TSMC, also designs its chips, wants to keep making them. Potential new entrants face enormous barriers to entry. The economics of fabs pushes these up higher with every technological advance.

That matters. Not all chipmaking requires cutting-edge technology. Cars mostly use older, duller semiconductors. Miniaturisation may seem less of an imperative in roomy data centres. But it is crucial: there are some computations that only the most powerful chips can tackle.

And demand for these is likely to grow as silicon infuses products from thermostats to tractors in the uber-connected “Internet of Things”. Between them TSMC and Samsung customers are already a “Who’s Who” of big tech—Apple, Amazon, Google, Nvidia, Qualcomm (and soon, if the news reports are true, Intel itself). As things like cars become more computerised and go electric, the chips that go into them will become more advanced, too.

Tesla, an American maker of electric cars, already relies on TSMC's 7nm fabs to make its in-house self-driving chips.

Asia's nanoscale duopoly remains fiercely competitive, as Samsung and TSMC keep each other on their toes. The Taiwanese firm's operating margins have been more or less steady since 2005, when 15 other firms were operating at the cutting edge. But the logical endpoint of the relentless rise in manufacturing costs is that, at some point, one company, in all likelihood TSMC, could be the last advanced fab standing. For years, says an industry veteran, tech bosses mostly ignored the problem in the hope it would go away. It has not.

Those worries are sharpened by the industry's growing political importance. As part of its economic war against China, America has sought to deny Chinese firms the ability to build leading-edge chip factories of their own. China has put semiconductors at the core of a multibillion-dollar plan to become self-sufficient in critical technologies by 2025—especially now that American sanctions have deprived it of some foreign imports.

The structural forces behind increased concentration are here to stay. America, worried about losing access to the most advanced factories, has given handouts to TSMC in return for a fab in Arizona. Samsung may expand the one it runs in Texas. Another package of subsidies and incentives is awaiting funding from Congress. The European Union, which has pockets of high technology in Belgium and the Netherlands, wants more of them. In December 17 EU countries agreed to spend tens of billions in post-pandemic stimulus cash to try to create leading-edge factories by the middle of the decade. The chip industry's history suggests these sums will only get more eye-watering with time. ■



半导体

新架构

全球芯片业正变得既更多元又更集中。其影响绝不会微乎其微

日本汽车制造商本田1月13日宣布不得不暂时关闭它在英格兰南部小镇斯温顿（Swindon）的工厂。原因不是英国脱欧或有工人感染新冠肺炎，而是微芯片短缺。其他汽车公司也遭遇了同样的难题。产量最大的大众表示，本季度将因此减产10万辆车。和如今从银行到联合收割机的几乎万事万物一样，离了计算机，汽车就无法运转。

芯片制造业景气大好。全球上市半导体公司的总市值已超过四万亿美元，是五年前的四倍（见图表1）。疫情期间，随着工作转移到线上、消费者转向流媒体和电子游戏寻求慰藉，芯片制造商的股价飙升。

这推动了一轮交易潮。去年9月，为游戏和人工智能（AI）设计高性能芯片的英伟达（Nvidia）表示，将以400亿美元的价格收购总部位于英国的安谋（Arm）。几乎所有智能手机都使用安谋的芯片设计。10月，为图形和通用芯片提供蓝图的AMD宣布了另一项巨额交易——以350亿美元的价格收购制造可编程芯片的赛灵思（Xilinx）。

资本支出也在攀升。韩国企业集团三星希望在未来十年对其芯片业务投资超过1000亿美元（不过其中一部分将投入到用于闪存驱动器等设备的存储芯片而非微处理器上）。1月14日，为AMD和英伟达等公司代工、将蓝图变成芯片的台积电宣布，由于预期需求强劲，将把2021年的计划资本支出从172亿美元猛增至280亿美元，令市场震惊。如此规模的预算在世界上所有私人公司中位列前茅。

这一切发生之时，几大正在重组芯片制造业的趋势在汇集。在行业的一端，竞争激烈，创新不断。AMD、英伟达和英特尔等全球收入最高的芯片制造商的既有设计正面临新设计的挑战。它们的大客户亚马逊和谷歌等网

络巨头正在酝酿自己的设计。一大波创业公司也加入进来，迫切想要迎合市场需求，开发专为AI、联网或其他专门应用而设计的硬件。

要不是因为在行业的另一端——那些在硅片上刻蚀电路来实现设计的工厂——正在发生的事，那么对于所有人来说这一切无疑都会是大好消息。要跟上技术进步的制造成本在飞涨，其结果是，虽然芯片设计呈爆炸式增长，有能力真的把它们造出来的公司却越来越少（见图表2）。目前世界上只有三家公司能够生产先进处理器：英特尔、台积电（位于中国宣誓主权的地震多发的海岛上）和韩国的三星（它北边的邻居是一个拥有核武器的专制国家）。据美国的行业组织半导体行业协会（Semiconductor Industry Association）估计，如今全球芯片制造产能的80%集中在亚洲。

三个领头羊可能很快会减少到两个。30年来一直在推动行业前沿发展的英特尔如今举步维艰。根据1月18日的新闻报道，该公司（在本期《经济学人》付印后的1月21日公布其最新季度业绩）可能会开始将自己的部分芯片生产外包给台积电。台积电的市值已经超过了英特尔。

而这一世界经济的基础产业看起来势必将进一步两极分化：设计会更活跃，生产会更集中。这种新的架构将对芯片制造商及其客户产生深远影响——在今时今日，也就是对几乎所有人都有深远影响。

先说多元化。科技公司多年来都是购买成品芯片。在苹果44年的历史中，它先后从MOS科技、摩托罗拉、IBM，最后是英特尔购买用于台式电脑和笔记本电脑的微处理器。但在2007年推出首款iPhone后不久，苹果决定自己研制芯片。后续的iPhone都采用了苹果自己的设计，先是由三星制造，后转为台积电。这种做法如此成功，苹果在2020年宣布还将在台式Mac电脑中用自己的定制芯片代替英特尔的成品。

两年前，电子商务巨头亚马逊的云计算部门AWS开始用自己的“Graviton”设计替换其数据中心中的部分英特尔芯片。亚马逊称其芯片的性价比高出英特尔芯片40%。大约在同一时间，谷歌开始向其云客户提供定制的旨在提高AI计算能力的“张量处理单元”（TPU）芯片。中国的搜索巨头百度称

其“昆仑”AI芯片比英伟达的产品速度更快。有传言称，在西方云计算三巨头中排行老三的微软正在加紧设计自己的芯片。

这个领域里出色的创业公司正在取得数十亿美元的估值。设计AI芯片的美国公司Cerebras已获得12亿美元的估值。它的英国竞争对手Graphcore一直在与微软合作，在12月估值28亿美元。1月13日，以智能手机芯片闻名的高通公司以14亿美元收购了Nuvia，后者是由苹果芯片设计团队的前资深成员组建的一家创业公司。

定制芯片在十年前还是个让人拿不准的主张。根据摩尔定律，每个芯片上可容纳的元件数量应该能够每两年左右增加一倍，通用芯片的性能因而迅速提升。如今摩尔定律正在失效，因为尺度以纳米（十亿分之一米）计的元件正在受到基础物理学规律的限制。研究公司Linley Group的主管林利·格温纳普（Linley Gwennap）指出，现在芯片制程升级一次所需的时间不是两年，而是接近三年，而且带来的好处也变少了。

这使得改进设计以维持性能的提升变得更具吸引力，尤其是对于垂直整合的大公司而言。没有谁比苹果更确切了解自己的芯片将如何与iPhone其他的硬件和软件交互作用。云计算巨头拥有大量有关自身硬件运作的确切数据，因而可以据此调整设计来匹配需求。

此外，从前自己设计芯片意味着生产也得自己来，但如今不再如此。现在大多数设计公司都将制造外包给台积电或美国公司格芯（GlobalFoundries）等专业工厂。不需要自建工厂大大降低了成本。大量自动化工具让生产过程变得更顺畅。“倒也不像在Etsy上设计定制T恤那么简单。”另一家芯片行业分析公司Future Horizons的主管马尔科姆·佩恩（Malcolm Penn）说。但也不是难于登天。

尽管现在设计芯片比以往任何时候都容易，但生产芯片却变得前所未有地难。即便是要跟上摩尔定律业已放缓的速度，也得投入巨额资金（且数额还在不断上升）来建设配备最尖端设备的工厂。这些设备包括离子蚀刻机、气相沉积设备，以及180吨重、有双层巴士那么大的光刻机等。芯片

行业的资本支出占总收入的比例一度下降，现在又开始回升（见图表3）。从绝对数字看，被称作fab的高科技芯片代工厂的成本不断增长，而且看不到头。

当今最先进的是5纳米制程芯片（尽管“5纳米”不再像前几代制程那样指晶体管的实际尺寸）。三星和台积电都在2020年开始量产这种芯片。3纳米版本芯片预定2022年量产，2纳米定于几年后。

世纪之交时，一座尖端代工厂的造价可能在10亿美元。管理咨询公司麦肯锡2011年的一份报告称，一座先进代工厂的成本一般为三四十亿美元。更近些时候，台积电于2020年在台湾南部建成的3纳米工厂耗资195亿美元。台积电已经在考虑为2纳米芯片另外兴建一个工厂，几乎可以肯定会花费更多。英特尔的失误让它在10纳米制程上打转，也让老板鲍勃·斯旺（Bob Swan）丢了工作。即将接任的帕特·格辛格（Pat Gelsinger）将需要决定公司是否还想继续生产芯片——与台积电不同，英特尔同时还设计芯片。潜在的新进者面临巨大的壁垒。随着每一次技术进步，代工厂的巨大成本还在不断加高这些壁垒。

这一点很重要。并非所有芯片制造都需要尖端技术。汽车大多使用技术较旧、智能程度较低的半导体。数据中心空间充足，微型化看起来似乎不是紧要任务。但它确实非常关键，因为有些计算只能由最强大的芯片来处理。

而随着芯片进入从恒温器到拖拉机等高度互联的各种物联网产品中，对这类最强大芯片的需求应该会增长。台积电和三星的客户包括苹果、亚马逊、谷歌、英伟达、高通，已然是大型科技公司的“名企榜”（如果那些新闻报道属实，不久后英特尔也将成为其中之一）。随着汽车等产品变得更加计算机化和电动化，植入其中的芯片也将变得更先进。美国电动汽车制造商特斯拉已经将自己设计的无人驾驶芯片交给台积电的7纳米代工厂生产。

由于三星和台积电相互较劲不得放松，这一亚洲的纳米级双寡头继续激烈

竞争。台积电的营业利润自2005年以来基本保持稳定，在那一年有其他15家公司同处于前沿地位。但随着制造成本不断攀升，一个合逻辑的结果是到了某个时候可能只剩下一家仍然存活的先进代工厂——十有八九是台积电。一位业内资深人士说，多年来，科技公司的老板们大多不理会这个问题，寄希望于它自行消失。然而并没有。

芯片业在政治上日益重要，更加剧了这些担忧。作为对华经济战的一部分，美国试图让中国公司无法建立自己的尖端芯片工厂。中国制定了耗资数千亿美元的投资计划，以求在2025年之前实现关键技术的自给自足，半导体在其中占据核心地位——目前美国的制裁让中国无法从国外进口某些芯片，更令这一块变得尤为重要。

在背后推动生产集中度的结构性力量将继续存在。由于担心会无法使用最先进的代工厂，美国已向台积电提供优惠政策，换取它在亚利桑那州投资建厂。三星可能会扩大它在得克萨斯州的工厂。另一套补贴和激励措施正在等待国会拨款。欧盟在比利时和荷兰有一批高科技公司，它希望能出现更多。12月，欧盟17个成员国达成一致，在欧盟的疫情后刺激资金中支出数百亿欧元，试图在2025年之前建成先进的代工厂。芯片业的历史表明，未来这些投资数字只会变得更加高不可攀。 ■



Carmaking

Electric shock and awe

A Tesla bull debates a Tesla bear

TESLA'S SHARE price will travel in only one direction—up. Despite accelerating in “ludicrous” mode, by more than 700% in 2020, Tesla has plenty left in the tank, to borrow a phrase that the firm is consigning to history. Its impact on the car industry cannot be overstated. But it is a mistake to judge it by the standards of the firms it will leave in its tracks. Tesla is a technology firm, set to disrupt not just carmaking but personal transport, energy (thanks to its battery technology and solar power), robotics, health care and more besides.

Its valuation is justified by its potential to dominate the future of mobility alone. Operating margins were close to 7% in the first nine months of 2020, higher than any big rival's—and rising. Its market is exploding. Electric vehicles (EVs) now make up around 3% of all car sales, of which Tesla accounts for a fifth. As regulations tighten and ranks of climate-worriers swell, a third of all cars sold globally will be electric by 2030—rising to over half ten years later. Even if Tesla won't make 20m EVs a year by 2030, as its boss, Elon Musk, hopes, it could control 25-30% of the EV market.

Tesla's “production hell” is in the past. It just about hit a pre-pandemic delivery target of 500,000 cars in 2020 and rapidly erected a new factory in China—which on January 18th delivered its first Model Y, a small SUV. Another will come online shortly in Germany. So will a new battery “gigafactory” in Texas. This, and the ease with which it raised \$12bn of capital amid the covid-19 crisis, shows it can expand at will.

The firm's proven knack for speedy innovation will let it keep an

unassailable technology lead over both established carmakers, struggling to free themselves of the legacy of internal combustion, and newcomers looking to steal its crown. Like other tech Goliaths such as Apple, its products will continue to define the category. Mr Musk has remade the car into a connected electronics device that will soon drive itself. Autonomous technology is already fitted to many Teslas, awaiting regulators to approve it. This will put Mr Musk in the front seat of the robotaxi as the world moves towards mobility services.

Tesla's greatest asset is Mr Musk, a visionary spearheading rocket trips to Mars, neuroscience, grid-scale batteries and other transformational technologies. Investing in Tesla is a bet on his genius for turning the future into dollars.

TESLA'S SHARE price can travel in only one direction—reverse. A market value of \$800bn, equal to that of the next eight biggest carmakers combined, is predicated on Elon Musk's shake-up of the industry. Building a brand swiftly and making electric cars trendy is a real achievement. But Tesla's revenues come from selling cars. Sales are rising—yet would need to swell seven-fold to match Toyota's. Good luck.

Yes, Tesla missed a delivery target of 500,000 cars in 2020 by a mere whisker. But it once said it would be making 1m a year by now. A goal of 20m electric cars by 2030 looks like another wild over-promise. Mr Musk has admitted that unless costs are contained the share price may be “crushed like a soufflé under a sledgehammer”.

Competition is getting fiercer. Big firms dragged their feet on electrification for a reason. Batteries were costly—and electric cars, niche products for the rich. But prices have fallen, regulations have tightened and buyers want electric vehicles (EVs). The giants promise a traffic jam's worth: General

Motors says it will have 30 models on the market by 2025; Volkswagen Group is eyeing 70 by 2030. Startups, many in China, are powering up. Mr Musk's technology lead is running out of road.

Rising profits in 2020 might reassure investors, but come mostly from selling carbon credits. And Tesla is not immune to the traditional forces that govern carmaking. Some models are ageing. Sales of Model S and Model X are falling and the firm is losing market share in Europe. In the first nine months of 2020 VW, Renault-Nissan-Mitsubishi and Hyundai-Kia all sold more EVs in Europe than Tesla did, according to Schmidt Automotive Research.

The hype about autonomous cars has worn off as developing self-driving systems has proven tricky. Tesla's pseudo-autonomous system requires constant monitoring by the driver. The full autonomy that would give robotaxis the freedom of the open road is years away. All this suggests Tesla will remain a niche luxury firm.

Then there is Mr Musk. He has toned down erratic tweets, like the one in 2018 implying Tesla was about to go private, which got him into hot water with regulators. But he is spreading himself too thinly between Tesla, SpaceX's rocketry and other ventures. The strains from Tesla's expansion could again bring out his demons—and spell disaster for shareholders. ■



汽车制造

电击与震慑

特斯拉看涨与看跌之辩

特斯拉的股价走势将只有一个方向——涨。尽管它以“狂暴”模式在2020年上行超过700%，但用一句正在被这家公司踢进历史的话来说，它“油箱里的油还多着呢”。特斯拉对汽车产业的影响怎么说都不为过。但用那些将被它碾压的公司的标准来评判它是不对的。它是一家科技公司，要颠覆的不仅仅是汽车制造，还有个人交通、能源（得益于它的电池技术和太阳能）、机器人、医疗，以及其他很多。

单是有潜力主导未来的出行这一点就可证明特斯拉的市值是合理的。2020年前九个月，它的营运利润率接近7%，高于所有大型竞争对手——而且还在上升。它的市场呈爆发式增长。目前，电动汽车约占汽车总销量的3%，而特斯拉又占其中的五分之一。随着法规的收紧以及担忧气候变化的群体扩大，到2030年电动汽车将占到全球汽车总销量的三分之一——再过十年将增长到一半以上。即使特斯拉不能像它的老板伊隆·马斯克所希望的那样，到2030年年产2000万辆电动汽车，它也可能掌控电动汽车市场的25%到30%。

特斯拉的“生产地狱”已经成为过去。它在2020年基本实现了新冠疫情爆发前制定的50万辆的交付目标，并迅速在中国新建了一家工厂——于1月18日交付了第一辆小型SUV“Model Y”。另一家工厂很快将在德国投产。还有一家新的电池“超级工厂”也将在得克萨斯投产。以上种种，加上它在新冠危机期间轻松融资120亿美元，显示了它随心所欲扩张规模的能力。

特斯拉已经证明了自己在快速创新上的天分，而这将让它保持牢不可破的技术领先优势，无论是对难以摆脱内燃机遗产的老牌汽车制造商，还是对觊觎它领导地位的新来者。与苹果等科技巨头一样，它的产品将继续定义一个行业。马斯克已经将汽车改造成了一种很快就能自动驾驶的联网电子

设备。许多特斯拉车型都已配备了无人驾驶技术，只待监管机构批准。这让马斯克在世界朝着出行服务行进之时坐上了无人出租车的前排座椅。

富有远见卓识的马斯克是特斯拉最宝贵的资产，他引领着造火箭上火星、神经科学、电网级电池和其他革命性技术。投资特斯拉就是押注马斯克把未来转化为美元的天赋。

特斯拉的股价走势只会有一个方向——跌。它8000亿美元的市值——相当于紧随其后的八大汽车制造商的总和——是基于对马斯克颠覆汽车产业的预期。能迅速建立一个品牌并让电动汽车流行起来，它确实成就斐然。但特斯拉的收入来自销售汽车。尽管销量在增长，但需要增长七倍才能与丰田匹敌。祝它好运。

确实，特斯拉距实现2020年交付50万辆车的目标只差毫厘。但它曾经表示到此时的年产量会是100万辆。实现2030年年产2000万辆的目标看上去又像是满嘴跑火车。马斯克也已承认，除非成本得到控制，否则股价可能会“像大锤下的蛋奶酥一样被砸个稀烂”。

竞争日趋激烈。过去大公司在电气化上裹足不前是有原因的。电池很贵，电动汽车因此只是富人喜欢的小众产品。但电池价格已经下降，而法规收紧了，买车的人想要电动车了。巨头们如今的行动势将造成“大堵车”：通用汽车表示到2025年将有30款车型上市，大众计划到2030年共推出70款。包括很多中国企业在内的创业公司正开足马力。马斯克的技术领先优势正在渐渐丧失。

特斯拉在2020年持续增长的利润可能会让投资者安心，但这些利润主要来自出售碳信用额度。特斯拉并不对支配汽车制造的传统因素免疫。它的一些车型正在老化。Model S和Model X的销量都在下降，公司在欧洲的市场份额也在缩减。根据施密特汽车研究公司（Schmidt Automotive Research）的数据，2020年前九个月，大众、雷诺-日产-三菱以及现代起亚在欧洲的电动汽车销量都超过了特斯拉。

事实证明无人驾驶系统的研发绝非易事，对无人车的大肆炒作因而也渐平息。特斯拉的伪自主系统需要司机全程监控。能让机器人出租车自由行驶在开放道路上的那种完全自主系统还需要等待多年。所有这些都表明特斯拉仍将是一家小众豪华车公司。

还有马斯克自己。他已经不再像过去那样在推特上口不择言，比如在2018年发推暗示特斯拉将私有化就让他惹来了监管麻烦。但是，他现在要兼顾特斯拉、SpaceX的火箭技术和其他项目，精力过于分散。特斯拉扩张带来的压力可能会再次释放他体内的小恶魔，给股东们带来灾难。 ■



Vaccination

Gift of the jab

Vaccination campaigns are hard

AS NEW VARIANTS of SARS-CoV-2 take off, it seems increasingly likely that vaccination is the only way the pandemic will be brought under control. In theory, the high efficacy shown in clinical trials should be sufficient to stop the virus cold. Yet only a few vaccines have ever brought epidemics to an abrupt halt. Even in modern times, many campaigns have fallen short of the impact covid-19 jabs will need to have for pre-pandemic lifestyles to resume.

The first efforts to make humans in the West immune to common diseases were ineffective. By the 15th century, Chinese doctors were grinding up dried smallpox scabs and blowing them into the nostrils of healthy children. In the early 1700s Lady Mary Wortley Montagu, an English aristocrat, saw women in Ottoman Istanbul conducting variolation—a process designed to induce a mild infection and then immunity, in which pus taken from smallpox blisters is applied to scratches on the skin.

Montagu variolated both of her children, who survived. She later argued successfully for the procedure to become widespread. Yet during the next 80 years, the share of deaths in London caused by smallpox actually rose to nearly 9%, from just over 6% in 1640-1720. Variolation could cause deadly infections; among the victims were two sons of King George III.

Real progress only began when Edward Jenner, a physician who was apprenticed to a country doctor as a boy, began to wonder why dairymaids who had contracted cowpox rarely caught smallpox. In 1796 he used cowpox lesions from an infected maid to produce the first true vaccine—one that

creates immunity without infection.

Although Jenner's method worked, it still took decades for England to vanquish the disease. At the start, public scepticism and inconsistent quality control and distribution hampered vaccination efforts. By 1830, however, smallpox was responsible for only 2-3% of deaths in London. The disease was mostly defeated by 1890.

In the mid-20th century, advances in immunology and public-sector logistics enabled vaccines to bring about faster results. In just a few years, Jonas Salk's vaccine all but eliminated deaths in America caused by polio. There are now around 25 diseases for which vaccines are used in humans. In many cases, their impact has been recent: since 1990 annual deaths from measles and tetanus have fallen by nearly 90%.

Some common diseases, however, have proven stubbornly resistant. Tuberculosis still claims 1.4m lives a year, mostly in poor countries; researchers have yet to improve upon the BCG vaccine, which is only moderately effective against TB. In other cases, gains have proven fragile. Nigeria slashed its measles rate by vaccinating nearly 60m children in 2005-06, but saw deaths from the disease creep up five years later, because inoculation did not become routine.

With governments around the world making vaccination against SARS-CoV-2 their top priority, it is likely that the decline in deaths caused by it in 2020-21 will be even more precipitous than that of polio in 1955-56. Yet it will take years to learn if covid-19 vaccines confer lifelong immunity, or whether constant vigilance will be required to keep the world protected. ■



接种

一针立效

疫苗接种推行不易

新冠病毒变种开始流行之际，接种疫苗似乎越发可能是控制住疫情的唯一方法。理论上，疫苗在临床试验中显现出的高效力应该足以迅速遏制住病毒。然而，历史上只有少数疫苗曾令疫病的传播戛然而止。即使在现代，许多接种行动的效果也没达到新冠疫苗要恢复疫情前生活方式所需的遏制力度。

西方最早寻求人类对常见疾病免疫的努力未见成效。到了15世纪，中国的医师把天花痘痂磨碎，将粉末吹入健康儿童的鼻孔。18世纪初，英国贵族玛丽·沃特利·蒙塔古夫人（Lady Mary Wortley Montagu）目睹了奥斯曼帝国的妇女采用人痘接种术——从天花水泡中提取脓水涂到皮肤的抓痕上，目的是引发轻度感染，然后获得免疫。

蒙塔古给自己的两个孩子接种了人痘，他们都活了下来。之后，她普及这种方法的主张得到了响应。然而，在接下来的80年里，伦敦因天花死亡的比例实际上从1640到1720年间的略高于6%升至近9%。接种人痘可能导致致命感染，国王乔治三世的两个儿子就是受害者。

到了爱德华·詹纳（Edward Jenner）这里，事情才取得了实质性进展。他是一名内科医生，小时候曾给一名乡村医生当学徒。他思索为什么感染了牛痘的挤奶女工很少得天花。1796年，他利用一名受感染女工身上的牛痘病灶研发出了首个真正的疫苗——一种不用感染就能激发免疫力的疫苗。

虽然詹纳的方法奏效了，但英国还是花了几十年才彻底战胜这种疾病。一开始，公众的怀疑、质控和分发的不连贯阻碍了接种进展。不过到了1830年，天花病例已经只占到伦敦总死亡人数的2%到3%。到1890年，这种疾病基本被消灭。

在20世纪中期，得益于免疫学和公共部门物流的进步，疫苗开始更快地显现效力。短短几年内，乔纳斯·索尔克（Jonas Salk）的疫苗在美国几乎根除了脊髓灰质炎致死。如今人们用疫苗预防大约25种疾病。在许多案例中，它们发挥作用是比较近期的事：自1990年以来，麻疹和破伤风的年死亡数下降了近90%。

然而，一些常见的疾病被证明极其顽固。结核病每年仍夺去140万人的生命，大部分是在贫穷国家。卡介苗对抗结核病的效果只能算中等，仍有待研究人员改进。而在其他案例中，疫苗取得的成果是脆弱的。2005年至2006年间，尼日利亚为近6000万名儿童接种了麻疹疫苗，大幅降低了麻疹发病率，但五年后，由于接种疫苗并未成为常规，死于麻疹的人数逐步上升。

鉴于世界各地的政府都把接种新冠疫苗作为首要任务，2020到2021年的新冠死亡人数的下降速度很可能比1955到1956年脊髓灰质炎的死亡数降速还要快。不过，还要过好几年才能知道新冠疫苗是否能带来终身免疫，还是需要时刻保持警惕才能保护世人。 ■



Buy American

Building block

Joe Biden's executive order may not have its intended effect

AMERICAN TAXPAYERS' dollars should be spent on American goods made by American workers and with American-made parts. So says President Joe Biden, newly installed in the White House. On January 25th he signed an executive order meant to pull more of the \$600bn of annual federal-procurement spending into American hands. The order was protectionist in spirit: more home-made components means fewer foreign ones. But America's international commitments also mean that Mr Biden's measures may not have much effect.

America's efforts to restrict access to procurement go back nearly 100 years. In 1933 Herbert Hoover signed the Buy American Act (BAA), which attempts to generate American jobs by restricting how direct federal purchases are made. It says that agencies must prefer domestic bidders for American-based contracts worth more than \$10,000, as long as at least 50% of their products are home-made, and (for big businesses) they are no more than 6% more expensive than the cheapest foreign alternative. More recently, President Donald Trump signed as many as ten executive orders in his attempt to push out foreign suppliers. As a result from February 22nd, in order to qualify for preferred status, iron and steel products will have to be 95% home-made. Other products will have to be at least 55% home-made. And the pricing advantage will go up to 20%.

Mr Biden could accept these new thresholds or raise them even higher. He also wants to ensure that qualifying production really does support American jobs (though it is unclear how he could do this). Companies seeking waivers will have their requests made public. Agencies will scout

for small firms to fill gaps. And officials will review the list of products treated as exempt from the BAA because they are not available in sufficient quantities in America, which includes personal-protective equipment, tungsten and cobra venom.

What do the changes mean for firms? Contractors have grown weary of promises to push out foreign suppliers. Jimmy Christianson of the Associated General Contractors of America (AGC) says that, unless something happens on the ground, his members “don’t really care”. Whereas some wanted Mr Trump’s changes to go further, others were far from thrilled. A representative of Netzschr Pumps North America, for instance, complained that finding home-made components would be hard, and force up prices. With only 30% of their business serving government markets, the extra burden “will definitely kill our ability to compete in markets outside the US”.

Mr Biden’s changes to the waiver process sound complicated, reckons Jean Grier, a government-procurement expert. Mr Christianson notes that they could have a “chilling effect” on the number granted. If the federal government tries to funnel dollars quickly towards products without developed supply chains in America, a clogged waiver process could delay projects. That is what happened in 2009, says Brian Turmail, also of AGC, when states were told to spend federal dollars on American water infrastructure, but some components were unavailable.

All this might look like a snub to America’s trading partners. In practice, though, the rule-changes may not affect big contracts much. Any worth more than \$182,000 are open to the 20 other members of the Government Procurement Agreement (GPA), which includes Australia, Canada, the European Union and Japan, as well as members of other trade deals. The Government Accountability Office estimated that around \$5bn of the \$291bn of the federal-procurement spending they measured went to firms

in the six biggest supplying countries in 2014-15. Another estimate puts the value of imports (including components) higher, at 9%. Without legislative changes—and those to the GPA—it will be tricky to deprive foreigners of their slice of federal procurement.

Mr Biden has said that he wants to work with trading partners to “modernise international trade rules, including those relating to government procurement”. But that too will prove difficult: when in November the Trump administration tried to remove some medical products from the GPA, it was scolded by Britain, Switzerland and the EU. Leaving the GPA, Ms Grier warns, could shut America off from services procurement overseas.

Some trading partners worry that, fed up with tweaking rules on federal spending, Mr Biden could attach blunt conditions on how states spend stimulus dollars, which falls outside the GPA’s remit. That, though, could create problems by slicing through supply chains. After first shutting Canada out of stimulus spending in 2009, for instance, the reality of integrated North American production meant that the Obama administration carved out an exception for them. Protectionist talk on the campaign trail is easy. Putting it into practice is another matter. ■



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拜登的行政令可能无法达到预期效果

美国纳税人的钱应该花在由美国工人用美国产零件制造的美国商品上。这是刚入主白宫的美国总统拜登的话。1月25日，他签署了一项行政令，要把每年6000亿美元的联邦采购支出的更大份额放进美国人的口袋。这条行政令在精神上是保护主义的：更多的美国产部件意味着更少的外国产部件。但美国已有的对国际社会的承诺也意味着拜登的这些措施可能收效不大。

美国政府的采购限制可追溯到近一百年前。1933年，胡佛签署了《购买美国产品法》（Buy American Act），试图通过限制联邦直接采购为美国创造就业岗位。该法令规定，联邦政府机构凡用于美国内而价值超过一万美元的采购合同，只要国内投标商的产品至少有50%是在美国本土制造，且（如果是大企业的话）价格不超过最便宜的外国替代品6%，则必须优先选择国内投标商。近期，特朗普签署了多达十项行政令，试图排挤外国供应商。结果是从2月22日开始，钢铁产品必须有95%以上在美国制造才能享受在联邦采购招投标中的优先待遇。其他产品则至少要有55%在美国制造，而价差上限将升至20%。

拜登可能会接受这些新门槛，或者把它们提得更高。他还想要确保符合条件的产品确实支持了美国的就业（尽管还不清楚他将如何做到这一点）。寻求豁免的公司将公示它们的申请。联邦机构将寻找小公司填补一些缺口。官员们将审查因美国本土产量不足而被《购买美国产品法》豁免的产品清单，其中包括个人防护装备、钨和眼镜蛇毒。

对企业而言，这些变化意味着什么？美国供应商对政府排挤外国供应商的承诺已感到厌倦。美国总承包商协会（Associated General Contractors of America，以下简称AGC）的吉米·克里斯蒂安森（Jimmy Christianson）

说，除非有实质性行动，否则协会成员“没什么所谓”。虽然一些人希望在特朗普修改规则的基础上走得更远，另一些人对此却难言欣喜。例如，耐驰泵业北美公司（Netzsch Pumps North America）的一位代表抱怨说，寻找美国本土产的零部件会很不容易，这将迫使价格上涨。其业务只有30%服务于政府市场，这外加的负担“肯定会扼杀我们在美国以外市场的竞争力”。

政府采购专家吉恩·格里尔（Jean Grier）认为，拜登对豁免程序的改动听起来很复杂。克里斯蒂安森指出，这些调整可能对获准豁免的数量产生“寒蝉效应”。如果联邦政府试图将资金迅速投向在美国缺乏成熟供应链的产品，那么豁免程序不畅可能会延误这些项目。同样来自AGC的布莱恩·图梅尔（Brian Turmail）表示，在2009年就发生了这种情况，当时美国各州政府收到指示，要把联邦资金用于本土水务基建设备，但美国国内无法供应其中一些部件。

这一切看起来可能都像是对美国贸易伙伴的冷落。但实际上，规则改变对大额合同可能没太大影响。任何价值超过18.2万美元的合同都对《政府采购协议》（Government Procurement Agreement）的其余20个成员（包括澳大利亚、加拿大、欧盟、日本等）以及其他贸易协定的成员开放。据美国政府问责局（Government Accountability Office）估计，在它统计的2014至2015年间的2910亿美元联邦采购支出中，约有50亿美元流向了六个最大供应国的公司。另一项估算认为实际进口额（包括进口部件）更高，比例为9%。如果不改变立法（并且改变《政府采购协议》），要削减联邦采购中的外国供货份额很不容易。

拜登已表示希望与贸易伙伴一道“把国际贸易规则现代化，包括与政府采购相关的规则”。但这也将是一道难题：去年11月，特朗普政府试图把一些医疗产品从《政府采购协议》中剔除，但受到英国、瑞士和欧盟指责。格里尔警告说，脱离《政府采购协议》可能导致海外服务采购对美国关上大门。

一些贸易伙伴担心，等到拜登对修修补联邦支出规则不胜其烦，他可能

会转而对各州如何使用经济刺激资金突然附加条件，因为这些资金不受《政府采购协议》的限制。但这可能会切断供应链，从而带来问题。例如，2009年美国先是把加拿大排除在经济刺激支出之外，但后来为了北美生产一体化的现实需要，奥巴马政府又不得不为之网开一面。在竞选时高谈保护主义不难，付诸实践又是另一回事了。■



Human capital

Trouble in the country

The biggest obstacle to China's rise is poorly educated rural children

THE CHINA that most foreigners see is modern and metropolitan. The skyscrapers glitter. The bullet trains are fast and comfortable. Anyone who visits only Beijing, Shanghai or Shenzhen would conclude that China was already a rich country.

Yet there is another China: poor, rural and scarcely visible to outsiders, especially when covid-19 has made travel so hard. Toilets can be holes in the dirt, tricky to find in the dark. Women sometimes break river ice to wash clothes by hand. In many villages, most working-age adults have moved to the cities, where they lay bricks, deliver packages and only occasionally return to see their children. “It’s a hard life being away from your family so much,” one migrant in Hebei province told this reviewer.

Granted, rural Chinese are far better off than they used to be. In the 1950s, when Mao Zedong forced them onto collective farms, tens of millions starved to death. Now they generally have enough to eat, and proudly insist that guests in their draughty homes have second helpings of oily noodles. But a crisis is brewing in these villages, argue Scott Rozelle of Stanford University and Natalie Hell, a Californian researcher, that could prevent China from attaining Xi Jinping’s dream of widespread prosperity. Two-thirds of Chinese children are rural, partly because rural parents have more babies than urban ones. And rural Chinese children—the workforce of the future—are doing terribly at school.

China has invested huge amounts in physical infrastructure, but neglected its human capital. Do not be fooled by league tables, such as the OECD’s PISA

rankings, that show Chinese high-school students outperforming those of nearly every other country. The Chinese figures are not for the whole country, but only for the better schools in the richer cities.

The children of rural migrants are barred from such schools, thanks to China's brutal *hukou* (household registration) system, which excludes people with rural origins from many public services in big cities. Migrant workers' children must either pay to attend awful urban private schools or stay back in the countryside with grandma and go to a mediocre government school there. Such discrimination is keenly resented.

After decades of research, Mr Rozelle and Ms Hell present some startling data. Their team gave an IQ-like test to thousands of rural Chinese toddlers. They found that more than 50% were cognitively delayed and unlikely to reach an IQ of 90 (in a typical population, only 16% score so poorly). There were several reasons for this.

Half of rural babies are undernourished. Caregivers (often illiterate grandmothers) cram them with rice, noodles and steamed buns, not realising that they also need micronutrients. Studies in 2016 and 2017 found that a quarter of rural children in central and western China suffer from anaemia (lack of iron), which makes it hard for them to concentrate in school. Two-fifths of rural children in parts of southern China have intestinal worms, which sap their energy. A third of rural 11- and 12-year-olds have poor vision but no glasses, so struggle to read their schoolbooks.

Some of these problems would be laughably cheap to fix. A pair of glasses costs \$30. Multivitamin pills are a few cents. De-worming tablets cost \$2 per child each year. One reason the problems persist is that harmful myths abound. Many rural folk believe that—as a grandmother told this reviewer—glasses are bad for children's eyesight. Some fret that de-worming pills reduce fertility in girls. A recent study found that 99% of

Chinese farmers gave their pigs de-worming drugs, but hardly any did the same for their children.

Rural children fall behind long before they are old enough to go to school. Whereas urban parents constantly talk to their babies, rural grandmothers often strap them to their backs while they work in the fields, keeping them safe but barely stimulating their minds. The segregation of rural children into second-class schools then widens the gulf between the two Chinas.

Among the entire labour force in 2010, 44% of urban and 11% of rural Chinese had graduated from high school. Among the current crop of students, the figures are much better: 97% of urban students graduated from high school in 2015, and 80% of rural children went to a high school of some sort. But the rural “high schools” were often dreadful, opened rapidly to meet official targets and staffed by teachers with little interest in teaching. The authors tested thousands of children at “vocational” rural high schools, and found that 91% had learned practically nothing: they scored the same or worse on tests at the end of a year of schooling as at the beginning.

Currently, 70% of the Chinese workforce is unskilled. Such labourers can do repetitive factory work, but as their wages rise, those jobs will move to poorer countries such as Vietnam. To escape from what economists call the “middle-income trap”, China needs rapidly to improve its people’s skills, so that they can handle more complex tasks. Yet its workers are far less educated than those in other middle-income countries, such as Mexico, Turkey and South Africa. They are also less educated than workers were in countries that recently grew rich, such as Taiwan and South Korea, when those places were no better off than China is today.

Much of the blame for all this rests with Mao, whose Cultural Revolution was “perhaps the largest intentional destruction of human capital the world has ever seen”. But the authors also blame “an almost unbelievable

oversight" on the part of China's more recent leaders. Correcting that is arguably the most important challenge facing China's current rulers. They have the resources to succeed. A country that invests a whopping 43% of GDP can surely afford to spend a bit less on bridges and a bit more on its people's brains. The authors offer sound prescriptions: improve rural schools, end discrimination against rural children, teach rural parents to read to their babies (instead of policing how many they may have), and so on.

If rural Chinese do not learn essential cognitive skills, the authors predict mass unemployment, social unrest and perhaps a crash that would "lead to huge economic shocks around the world". China's rulers should order crates of de-worming pills—and copies of this book. ■



人力资本

忧患在乡间

中国崛起的最大障碍是农村儿童的教育水平低下【《看不见的中国》书评】

在大多数外国人眼里，中国是现代化、都市化的。闪亮的摩天大楼鳞次栉比。舒适的高速铁路风驰电掣。如果你只去过北京、上海或深圳，可能会认定中国已经是一个富裕国家。

然而，还有另外一个中国：那些贫穷的农村，几乎不为外人所见，尤其是在新冠疫情让旅行变得极不便利之时。在那里，厕所可能就是在地上挖出的坑，昏暗之中难以找到。女人们有时要敲碎河面的冰块才能手洗衣服。在许多村子里，大部分成年劳动力都已流向城市，在那里砌砖、送包裹，只能偶尔回来看看自己的孩子。“长时间离家的日子太难过了。”河北一名外来工人对笔者说。

诚然，中国农民的生活比过去好太多了。上世纪50年代，毛泽东强迫农民参加农业合作社，数千万人饿死。现在农民基本都能吃饱饭，有人来透风的家里做客时，也会神气地坚持要给客人再盛一碗油汪汪的面条。但斯坦福大学的斯科特·罗泽尔（Scott Rozelle）和加州的研究人员娜塔莉·黑尔（Natalie Hell）认为，在这些村庄中正酝酿着一场危机，可能会成为中国实现习近平共同繁荣梦想的绊脚石。三分之二的中国儿童来自农村，原因之一是农村家庭比城市家庭生养更多子女。而作为中国未来的劳动力，农村孩子在学校里的表现着实堪忧。

中国在实体基础设施上投入了巨额资金，却忽视了人力资本。经合组织的PISA（国际学生能力评估）等排名显示，中国高中生的表现优于几乎所有其他国家。但不要被这些排名迷惑。中国的数字并不代表全国，而只是较富裕的城市里更好的学校而已。

由于中国无情的户籍制度，农村出身的人无法享受大城市的许多公共服务，他们的孩子也被排斥在这些学校之外。外来工的子女要么花钱在城市

里读条件糟糕的民办学校，要么跟奶奶留在乡下，读一所普普通通的公办学校。这种歧视引起了强烈的不满。

历经数十年研究，罗泽尔和黑尔给出了一些惊人的数据。他们的团队对成千上万名中国农村幼儿做了类似测智商的测试。他们发现超过50%的幼儿认知发育迟缓，智商可能达不到90（在一般人群中只有16%的人会得到如此低分）。原因有几个。

一半的农村婴儿营养不良。看护者（通常是目不识丁的祖母）用米饭、面条和馒头填饱他们的肚子，全然不知他们也需要微量元素。2016和2017年的研究发现，中国中西部四分之一的农村儿童患有贫血（缺铁），这使得他们上课时难以集中注意力。华南部分地区有五分之二的农村儿童患有肠道寄生虫，令他们萎靡不振。11到12岁的农村儿童有三分之一视力不佳但不戴眼镜，阅读课本时很吃力。

其中一些问题解决起来便宜得可笑。一副眼镜需要30美元。复合维生素片几美分。每个孩子每年的驱虫药只要两美元。但问题仍然长期存在，有害的荒诞观念充斥是原因之一。正如一位祖母对笔者所言，许多农村人认为戴眼镜对孩子的视力有害。有些人担心驱虫药会影响女孩的生育能力。最近一项研究发现，99%的中国农民会给猪喂驱虫药，但几乎没人给自己的孩子打虫。

在还没上学之前很久，农村的孩子就已经落在了后头。城里的父母会不停地和婴孩说话，而农村的祖母们经常把他们绑在背上去地里干活，保证了孩子的安全，但极少刺激孩子的心智发展。农村孩子只能进入二流学校，进一步扩大了两个中国之间的鸿沟。

在2010年，城市劳动人口中受过高中教育的比例为44%，农村劳动人口的该比例为11%。在目前的学生群体中，这些数字已经大大改善：2015年，97%的城市学生高中毕业，80%的农村孩子上过某种类型的高中。但农村的“高中”往往条件糟糕，只是为了完成官方目标而草草开设，配备的教师对教学也兴趣寥寥。两位作者对成千上万农村“职业”高中的孩子测试发

现，91%的孩子实际上什么也没学到，他们在学年结束时的测试成绩与刚开学时一样，甚至还更差。

目前70%的中国劳动力都是非技术型的。他们能从事重复性的工厂工作，但随着工资上涨，这些工作将转移到越南等较贫穷的国家。为了摆脱经济学家所说的“中等收入陷阱”，中国需要迅速提高国民的技能，让他们能够胜任更复杂的工作。然而，中国工人的受教育程度远远低于墨西哥、土耳其和南非等其他中等收入国家，同时也低于台湾和韩国等后来发达起来的地区在生活水平尚未超过现在的中国之时工人的受教育水平。

这一切有很大一部分责任在毛泽东，他的文化大革命“可能是全球有史以来对人力资本最大的蓄意破坏”。但两位作者也将责任归咎于更近期的中国领导人“几乎难以置信的疏忽”。纠正这一点可说是中国现任领导层面临的最重要挑战。他们有足够的资源取得成功。在一个投资占GDP之比高达43%的国家，肯定能负担得起在桥梁上少花一点，在人民的头脑上多花一点。作者给出了合理的建议：改善农村学校，终结对农村儿童的歧视，教导农村父母读书给他们的幼儿听（而不是监督他们生了多少个孩子），诸如此类。

作者预测，如果中国农村人口不能学习基本的认知技能，将会出现大规模失业、社会动荡，或许还会引发一场“给全球带来巨大经济冲击”的崩溃。中国的领导人应该大量下单驱虫药——和这本书。 ■



The Economist film

Mining the deep sea - trailer

The remotest part of the planet has attracted massive interest from one of the biggest global industries.



经济学人视频

深海采矿 - 预告片

地球上最偏远的地方吸引了全球最大行业之一的兴趣。



China's property market

The great escape

Long seen as a bubble, China's housing market now looks stable. Can that hold?

LOTTERY WINNERS normally win money. In China the big prize is being allowed to spend it. Demand for new homes in good locations is so high, and supply so limited, that several cities use lotteries to allocate them, some with odds as low as one in 60. When his number was chosen, John Chen, an engineer in Shanghai, had two minutes to decide whether to drop 9.6m yuan (\$1.5m) on a house. "It emptied my bank account. But I did not hesitate," he says. Yang Yang, a 38-year-old businessman in Hangzhou, lost out in three draws before finally winning one last spring. "It was even more nerve-racking than my university entrance exams," he jokes.

Even being able to enter the housing lotteries is a matter of good luck, because entrants must be registered as residents of the booming cities, which places them on the right side of China's wealth gap. By contrast, large swathes of the country have the opposite problem: overbuilt apartment blocks, sputtering economies and few people buying property. Hegang, a town near the border with Russia, briefly found itself in the spotlight after homes there were advertised for just 20,000 yuan, less than the cost of a square metre in Shanghai. It was an extreme example of the glut of empty homes in many small towns.

Similar splits are common around the world, with prices high in large cities and low in small towns. But the degree of the divergence in China, multiplied by the sheer size and growth of its market, means that understanding property is essential if you want to get to grips with what is happening in the economy. Every year China starts building about 15m new homes, more than quintuple the amount in America and Europe combined.

The property sector—both the direct impact of construction and its indirect effect on everything from concrete to curtains—makes up a quarter of China's GDP. The financial implications are profound, too. In 2021 Chinese developers are on the hook for more than \$100bn in bond repayments, according to Moody's, a rating agency. For the world as a whole, roughly a tenth of outstanding bank loans to non-financial clients have gone to China's property sector, whether as financing for developers or mortgages for homebuyers.

One commonly heard view is that all this adds up to a ticking time-bomb. And some of the facts are alarming. Fully one-fifth of Chinese homes are vacant, finds a widely cited survey. Housing investment equates to about a tenth of GDP annually, higher than the prodigious levels reached in Japan before its bubble popped three decades ago. Debt has soared for buyers and builders alike. Evergrande, China's biggest developer, has borrowed a cool \$120bn, a 56-fold increase in the past decade alone.

Yet it is only fair to note that such concerns are nothing new. As far back as 2009 Jim Chanos, a hedge-fund manager, said China was “Dubai on steroids”, predicting that its property sector would implode spectacularly. Since then prices have doubled, and enough homes have been built for 250m people. The longevity of the boom suggests that the market is more complex than its depictions as a bubble suggest.

The main explanation for its success—or, put differently, its failure to collapse—is the skein of regulations aimed at forestalling the prophesies of doom. Some have long been in place, such as the rule that down-payments for mortgages must be at least 30% of the purchase price for a home. With so much equity in their houses, homeowners are strongly incentivised to make their monthly mortgage payments, limiting the risk of a vicious cycle of defaults, forced sales and collapsing prices. In many of the most populous

cities demand is also tightly restricted, because a *hukou*—a local residency permit—is a prerequisite for buying a home.

As the property sector has swollen, the government has pledged to develop what it calls “a long-term mechanism” for stabilising prices and investment. The property market is, in its view, too important to be left to the market alone. In practice this has meant layering on ever more rules. Cities such as Shanghai and Hangzhou started requiring developers to run lotteries for new flats, with priority given to people who do not own homes. Many others have all but barred people from buying second homes. These often make for cat-and-mouse games. Since the second-home ban applies to families, not just individuals, some couples have obtained fake divorces in order to buy another house. On January 21st Shanghai ruled that divorcees must wait three years to count as first-time buyers if they had owned a home when married.

The government is also now reining in the most indebted real-estate firms. Late last year the central bank and the housing ministry said they would start assessing developers’ leverage on the basis of “three red lines”—one, for example, is that their liabilities should not exceed 70% of their assets. Only 11 of the biggest 100 developers would be given a passing grade on all three measures, according to Plenum, a consultancy. The others need to find a way to get inside the lines; if not, they will face strict caps on future financing.

The resulting dynamic offers a case study in how regulation changes the shape of the market. Some developers are working to pare their leverage by attracting new investors or by spinning off subsidiaries, such as their property-management arms. For many, though, the obvious first step is to boost cashflow by selling more houses more quickly, leading them to cut prices.

R&F is one of the big developers feeling the pinch. At one of its new developments in Jiangmen, a city in the southern province of Guangdong, it has cut prices by 20% in recent months. Sales, once slow, have soared—averaging about 15 homes per day. Even on a weekday afternoon a steady flow of prospective customers walks gingerly around construction debris to check out the flats still being built. One agent, his hair coiffed like a South Korean pop idol, boasts that he alone sold 18m yuan worth of units in December, though that was only enough to rank third among his colleagues.

Viewed narrowly, the many interventions have worked. In the biggest cities prices have basically been flat in inflation-adjusted terms over the past four years. Annual property sales nationwide have remained at the same level during that time, while new starts have been broadly in line with sales. A scheme to demolish old rickety homes and give their owners cash to buy new ones helped mop up unsold units in small towns. It would take just about ten months to clear all inventory at the current sales rate. “The property sector really is healthier than it used to be. The government has so many levers now,” says Zhang Sisi of Jinan University in Guangzhou.

But this calm engenders a different kind of concern. The many rules have not just made for a healthier market; they have made the market. Take the price stability. When developers win land auctions in big cities, they must set prices within a range prescribed by the government. A perverse outcome is that new homes can be a third cheaper than second-hand ones in the same neighbourhoods. Hence yet another rule: to stop people flipping their new homes for a tidy profit, several major cities have slapped a penalty on owners who sell within five years of buying. The lotteries, meanwhile, act as quotas to dictate the size of the market. Prices may be under control, but much demand is simply going unmet.

From this vantage, the becalmed market begins to look less like a success story and more like a pressure cooker. So in yet another intervention,

officials are trying to let steam out of the biggest cities by guiding people to smaller ones—specifically, in the clusters of satellite towns being built up just outside metropolises. These towns are linked to the cities by high-speed trains but have much lower thresholds for newcomers wanting a *hukou*. To make them attractive, the government is also investing more in hospitals and schools. “Sometimes it takes the education ministry, not the housing ministry, to fix problems in the housing market,” says Ms Zhang.

Developers seem to be responding to this policy push. The most fertile ground for the city clusters are four prosperous coastal provinces (Guangdong, Fujian, Zhejiang and Jiangsu). Last year these made up 34% of all property investment in China, compared with 26% a decade ago. Developers are “no longer buying up big parcels of land anywhere in the country”, says Xiao Wenxiao of CRIC Research, a consultancy. “Now they are focusing on smaller plots in prime areas.” The flow of new homes in China, in other words, appears to be better situated than the stock.

A key question, then, is just how much scope there still is for China’s housing stock to grow. A 22% vacancy rate—the result of a well-respected survey by the Southwestern University of Finance and Economics in 2017—would suggest that the market is more than saturated. China’s demographics also point to weakening demand. The working-age population, the cohort that buys the most homes, is already shrinking. And the pace of rural-to-urban migration, another big source of demand in cities, has started to slow, too.

Nothing about the Chinese housing market is ever so straightforward, though. The 22% vacancy rate largely reflects the overbuilding of small towns. In and around big cities vacancy rates may be less than 10%, low by international standards, according to China International Capital Corp, an investment bank. Much of the housing stock is still shabby. A tenth of flats in cities do not include their own toilet. And many among the growing

middle class, having spent a good portion of the past year locked down, are deciding that they want slightly larger homes.

Totting this all up, the baseline forecast of China Index Academy, the country's largest property-research organisation, is that housing sales will fall by 4% or so annually in the coming half-decade, going from roughly 15m units sold in 2020 to 13m in 2025. That would be a challenge for China; long a pillar of growth, the property sector would become a drag. At the same time, it would be a gradual slope down, not a collapse, for the once-vertiginous market. If you listen closely enough, the ticking of the time-bomb sounds a little fainter. ■



中国的房市 胜利大逃亡

长期被视为泡沫的中国房地产市场现在看似稳定。这能维持吗？

中奖一般都是赢钱。在中国，大奖是准你花钱。对位置优越的新房需求高涨，而供应十分有限，于是有些城市用摇号的方式来分配购房名额，摇中几率有时低至六十分之一。上海一位陈姓工程师在摇中之后，只有两分钟时间来决定是否要花960万元买房。“我的银行帐户都掏空了。但我没犹豫。”他说。杭州38岁的商人杨洋（音译）三次摇号未中后，去年春天总算中了一次。“比考大学的时候还紧张。”他说笑道。

就连获得摇号资格也是一种运气，因为参加摇号的人必须在这些蓬勃发展的城市有本地户口，有这样的户口就站到了中国贫富差距鸿沟有利的那一边。相比之下，中国大部分地区的情况正相反：公寓楼建设过度，经济发展无力，买房者寥寥无几。毗邻俄罗斯的小城鹤岗曾一度引起关注——那里有房屋广告标价两万元一套，还不到上海一平米的价格。这是许多小城市空置房过剩的一个极端例子。

大城市房价高企，小城镇房价低迷，类似的两极分化在世界各地都很常见。但由于市场规模巨大且快速增长，中国的房价差异更是被成倍地放大了。因此，要弄清楚中国经济的动向，理解房地产这个部门至关重要。中国每年新开工建设约1500万套房，是美国和欧洲加起来的五倍还多。房地产业（包括直接关联的建筑业和从混凝土到窗帘等所有间接关联的行业）占中国GDP的比重达四分之一。它在金融方面的影响也很深远。评级机构穆迪（Moody's）的数据显示，2021年，中国开发商要偿付的到期债券超过1000亿美元。全球非金融客户的未偿还银行贷款中，约有十分之一发放到了中国的房地产市场，要么为开发商提供融资，要么为购房者提供抵押贷款。

一个常见观点认为，所有这些加在一起构成了一枚定时炸弹。有些事实令

人担忧。一项被广泛引用的调查发现中国有足足五分之一的房屋空置。每年的住房投资相当于GDP的十分之一，高于日本在30年前泡沫破灭之前达到的惊人水平。购房者和开发商的债务双双飙升。中国最大的开发商恒大的贷款高达1200亿美元，仅过去十年就增长了56倍。

但是，必须指出这种担忧并不是新鲜事。早在2009年，对冲基金经理吉姆·查诺斯（Jim Chanos）就表示，中国就像是“打了激素的迪拜”，他预测中国的房地产业将会轰然崩塌。自那以来，房价已经翻了一番，建好的房子够2.5亿人居住。房地产市场的持续繁荣表明这个市场并不是泡沫这个词能简单概括的。

对何以能取得这种成功（或者换个说法，就是市场没有崩盘）的主要解释是，为了防止泡沫破灭的预言成真施行了一系列盘根错节的法规。有些法规由来已久，例如要求房贷首付比例至少三成。既然为买房已经投入了这么多，房主就有足够的动力坚持每月还贷，从而限制了堕入违约、拍卖和价格下跌这种恶性循环的风险。在人口密度最高的很多城市，需求也受到严格限制，因为本地户口是购房的先决条件。

随着房地产业的膨胀，政府承诺发展所谓的“长效机制”来稳定价格和投资。政府认为，房地产市场太过重要，不能单由市场来决定其发展。在实践中，这意味着层层加码的规定越来越多。上海和杭州等城市开始要求开发商对新房实行摇号认购，优先供首次购房者购买。其他许多城市几乎完全禁止购买第二套房。这些规定往往引发猫鼠游戏。由于对购买第二套房的限制针对家庭而非个人，一些夫妻为了再买一套房而假离婚。1月21日，上海规定，如果婚内已有一套房，夫妻离异后要等三年才能算首次购房者。

政府现在也开始约束那些负债最多的房地产公司。去年底，人行和住建部表示将开始根据“三条红线”来评估开发商的杠杆率，其中一条是它们的负债不应超过资产的70%。咨询公司Plenum称，最大的100家开发商中只有11家未触及全部三条红线。其他公司需要想办法退到红线以内，否则未来

将面临严格的融资限制。

由此生成的局面可以用作研究案例，来观察监管是如何改变市场形态的。一些开发商正努力通过吸引新投资者或分拆子公司（例如物业管理部门）的方式来降低杠杆率。但对许多公司来说，显而易见的第一步是更快更多地卖房以增加现金流，于是它们开始降价。

富力是感觉到政策收紧压力的大型开发商之一。它在南部省份广东的江门市的一个新开发项目近几个月已将价格下调了20%。一度缓慢的销售已经猛增，平均每天约售出15套房。即使是在工作日的下午，也不断有潜在客户小心翼翼地绕开建筑垃圾，查看还在建造中的楼盘。一位留着韩国流行偶像发型的销售夸耀，光是他一个人在12月卖掉的房子总价就达1800万，即便如此，他在同事中也只排名第三。

从狭隘的视角看，使用这么多干预措施奏效了。扣除通胀因素后，过去四年最大城市的房价走势基本持平。同期，全国房地产年销售量一直保持在相同水平，而新开工建设面积与销售面积走势基本一致。在小城镇拆除老旧房屋并给业主现金购买新房的做法帮助清理了当地的库存商品房。以当前的销售速度，清掉所有库存大约只需十个月。“房地产行业确实比以前更健康。政府现在手段很多。”广州暨南大学的张思思说。

但这种平稳引发了另一种担忧。种种规定不仅仅是让市场变得更健康了，它们实际上塑造了市场。以稳定价格为例。开发商在大城市通过拍卖拿到土地后，必须在政府规定的范围内为自己的楼盘定价。一个不合理的结果就是，在同一地段新房价格可能比二手房还便宜三分之一。为此又出台了另一条规定：为防止人们转售新房以获得可观利润，一些大城市要求在买房后五年之内转让的业主缴纳一大笔惩罚性税费。与此同时，摇号起到了配额的作用，限定了市场规模。房价可能得到了控制，但大量需求却没得到满足。

从这个角度看，平静下来的市场开始不再像一个成功故事，而更像一口高压锅。于是又一项干预措施应运而生：官员们试图通过引导人们移居较小

城镇（特别是在大都市外围兴建的卫星城镇群）来给最大城市这口锅放气减压。这些城镇通过高铁与大城市相连，但对新移民的落户门槛要低得多。为了让这些卫星城更具吸引力，政府也对医院和学校加大了投资。“有时候，要解决房地产市场中的问题得让教育部来，而不是住建部。”张思思说。

开发商似乎正在响应这一政策推动。最适合发展城市集群的地方是四个繁荣的沿海省份（广东、福建、浙江和江苏）。去年，这四省占中国房地产投资总额的34%，十年前是26%。开发商“不再是在全国随便一个地方大块买地了，”咨询公司克而瑞的肖文晓说，“现在，它们盯着黄金地段的小块土地。”换句话说，中国的新房流动似乎比股市更合理。

那么关键问题就是，中国的住房存量还有多大的增长空间。西南财经大学在2017年开展的一项备受推崇的调查显示住房空置率为22%，这么看来市场已经处于过饱和状态。中国的人口结构也显示需求在减弱。作为购房主力军的劳动年龄人口已经在减少。而农村人口向城市迁移（城市住房的另一大需求来源）的速度也已开始放缓。

但中国的房地产市场可没那么简单。22%的空置率在很大程度上反映的是小城镇房地产开发过度。投行中金公司的数据显示，大城市及其周边的空置率可能不到10%，按照国际标准来看是低的。多数存量房仍然很破旧。城市里有十分之一的住房没有独立卫生间。在不断壮大的中产阶级中，有许多人去年因为封城在家待了很久，现在决定要买更大一点的房子。

综合上述所有因素，中国最大的房地产研究机构中国指数研究院给出的基准预测是，未来五年房屋销量每年将以约4%的速度下降，从2020年的售出约1500万套下降至2025年的1300万套。这对中国经济将是一个挑战，因为长期都是增长支柱之一的房地产将变成一个拖累。而同时，曾经疯狂的楼市将面临的是逐渐下滑，而非崩盘。竖起耳朵仔细听，定时炸弹的滴答声似乎微弱了一些。 ■



Business schools

The class of covid-19

Once endangered, the MBA is emerging stronger from the pandemic

EDIEAL PINKER, deputy dean of the Yale School of Management, bristles at the suggestion that the MBA, long seen as a stepping stone to corporate success, has been made less relevant by the covid-19 crisis. The traditional two-year degree remains vital, he insists. “Do you think the problems the pandemic created for society and the economy are narrow specialised problems or complex ones that cut across sectors and disciplines?”

His words would have sounded odd a year ago. The MBA was falling out of fashion. With the global economy booming, the opportunity cost of this pricey degree (top schools charge \$100,000 or more a year) did not seem worthwhile to many. Some schools could not cover their expenses. In 2019 the University of Illinois said it would end its residential MBA programme. Dozens of middling schools have done the same in recent years.

Surely Mr Pinker’s defence of the MBA seems even odder in the new pandemic reality? On the contrary. “Students held up and schools stepped up,” says Sangeet Chowfla, head of the Graduate Management Admission Council (GMAC), an industry body. GMAC’s latest annual global survey of more than 300 business schools found that 66% of programmes saw applications rise. Has covid-19 saved the MBA?

At first the virus looked lethal. Lectures moved online, team exercises became socially distant and study-trips abroad were cancelled. That diminished the value of the MBA experience, which is “greatly enhanced by the opportunity to expand and diversify one’s professional network through in-person interactions”, says Scott DeRue, dean of the University of

Michigan's Ross School of Business. Covid-19 restrictions hurt what Ilian Mihov, dean of INSEAD, a French school with campuses in Fontainebleau, Singapore and Abu Dhabi, calls "horizontal learning"—working in teams or discussing the day's lessons over coffee. Ominously, INSEAD's most popular MBA course last year was "Psychological Issues in Management". "[I miss] interacting and having fun," laments a student at New York University's Stern School of Business. Columbia Business School has disciplined 70 students who violated covid-19 rules on socialising by travelling to Turks and Caicos for the autumn break.

Some students, angry about social isolation and online education, demanded refunds. Many foreigners, a cash cow for Western schools, stayed away (see chart). Mr Chowfla points to the "one-flight dynamic": horror stories about students kicked out of dorms getting stranded on layovers while returning home put many Asians off American schools.

America's loss was Europe's gain. With more direct connections to Asia, London Business School, HEC Paris and other top European schools reported rises in applications. Some Asian schools, too, benefited. They kept their doors open to international students, thanks to their countries' better handling of the pandemic. Hong Kong University Business School (HKUBS) saw a surge in applications from North America and Europe in March. They tended to be students who aimed for MBAs in the West but picked Asia at the last moment, says Sachin Tipnis of HKUBS. Memories of the SARS epidemic of 2003 spurred HKUBS to act early. Rapid processing of visa applications and moving classes to larger lecture theatres allowed 90-95% of students to attend in person.

Travel and visa complications boosted domestic applications everywhere. In 2020 mainland applicants to China Europe International Business School (CEIBS), a top-rated business school in Shanghai, rose by 30%. The wish

to stay local is driven by two things, explains Ding Yuan, its dean. The first is China's economy, which grew last year while others shrank. That has made America and Europe a less attractive destination in general for ambitious managers. The second is a sense that the post-Trump West is less welcoming to Chinese.

Most surprising of all, given all that, American schools look poised for a banner 2021. After a few years of declining applications, MIT's Sloan School of Management, Columbia Business School, the Wharton School of the University of Pennsylvania and other top American programmes now report double-digit growth. "We enrolled the largest full-time MBA class ever," beams Madhav Rajan, dean of the University of Chicago Booth School of Business.

MBA applications typically rise in recessions, when a weaker job market means lower forgone salaries. But business schools deserve credit for adapting their business models—as their professors preach others to do. Many delayed the start of semesters, offered generous scholarships, waived exam requirements and liberalised policies on deferrals. Harvard Business School allowed students it admitted to postpone studies for one or two years. GMAC reckons that deferrals globally have shot up from about 3% to 7%.

Schools also boosted online and flexible degrees, which are surging, and integrated digital teaching into core MBA courses. Far from being "giant killers", says Vijay Govindarajan of Dartmouth College's Tuck School of Business, digital technology can help a top school "ensure its gold-plated MBA programme shines even brighter". The Ross School is using tools akin to Netflix's bespoke recommendations to create "personalised leadership and career development journeys" for students. And to graduates' relief, recruiters are back. GMAC's survey of firms that recruit at business schools found that 89% intended to hire MBAs in 2021, up from 77% last year. ■



商学院

新冠班

一度濒危的MBA在疫情中东山再起

MBA课程长久以来都被视为通向企业成功的垫脚石，但有人认为它因为新冠危机地位下降了。对此，耶鲁大学管理学院的副院长埃迪尔·平克（Edieal Pinker）有点恼火。他坚持认为这一传统的两年制学位仍然至关重要。“你认为疫情给社会和经济造成的问题是狭隘的专业问题，还是跨部门、跨学科的复杂问题？”

如果是在一年前，他的话听起来会很奇怪。MBA那时正渐渐过时。全球经济繁荣之时，这一昂贵学位的机会成本（顶级商学院每年收费10万美元甚至更多）对许多人来说似乎并不划算。一些商学院入不敷出。2019年，伊利诺伊大学表示将停办全日制MBA项目。近年来，已经有几十家中游的商学院这么做了。

在疫情肆虐的新局面中，平克为MBA所做的辩护想必会更显奇怪吧？恰恰相反。“学生们坚持住了，学校再上层楼。”行业团体美国管理专业研究生入学考试委员会（GMAC）的负责人桑吉特·乔弗拉（Sangeet Chowfla）表示。GMAC对全球300多所商学院的最新年度调查表明，66%的课程申请人数上升。新冠病毒拯救了MBA吗？

起初，新冠病毒看起来有致命影响。讲座转到了线上，小组练习要保持社交距离，去国外的游学也取消了。这些限制损害了修读MBA的价值，这种价值“因为让人有机会通过面对面互动来扩大并多样化自身职业人脉而获得极大提升”，密歇根大学罗斯商学院的院长斯科特·德鲁（Scott DeRue）表示。新冠的限制损害了欧洲工商管理学院（INSEAD）院长伊利安·米霍夫（Ilian Mihov）所说的“横向学习”，也就是团队合作，或是一边喝咖啡一边讨论当天的课程。这家法国商学院在枫丹白露、新加坡和阿布扎比都有校区。欧洲工商管理学院去年最受欢迎的MBA课程是“管理中的心理问

题”，仿佛是个不祥的预兆。“（我怀念）与人交流、享受乐趣。”纽约大学斯特恩商学院的一位学员哀叹道。哥伦比亚商学院处罚了70名违反新冠社交规定的学员，因为他们在秋假期间前往特克斯和凯科斯群岛（Turks and Caicos）旅游。

一些学员对社交疏离和线上修课感到愤怒，要求退款。许多外国人退却了，他们可是西方商学院的摇钱树（见图表）。乔弗拉指出“单次航程动力”是其原由：学生被赶出宿舍、在归家途中滞留被困的恐怖故事让许多亚洲人对美国的商学院望而却步。

美国之失正是欧洲之得。随着和亚洲的直接联系越来越多，伦敦商学院、巴黎高等商学院和其他欧洲顶级商学院的申请人数都有所上升。一些亚洲的商学院也从中受益。它们所在的国家更好地应对了疫情，因此它们向国际学生持续敞开大门。3月，香港大学商学院收到的来自北美和欧洲的申请激增。该院的萨钦·蒂普尼斯（Sachin Tipnis）表示，这些学生原本大多计划申请西方的MBA课程，但在最后一刻选择了亚洲。对2003年SARS疫情的记忆促使该学院一早采取行动。快速处理签证申请，以及把课堂转移到更大的教室，让90%至95%的学生得以实地上课。

旅行和签证的复杂性促使各地的国内申请增长。2020年，位于上海的顶级商学院中欧国际工商学院的大陆学生申请人数增加了30%。院长丁远解释说，学生希望留在本地有两个原因。一是因为中国经济，去年其他国家经济萎缩时中国仍在增长。这让美国和欧洲对于雄心勃勃的管理者来说吸引力减退。二是感觉到特朗普时代之后的西方社会不那么欢迎中国人了。

最令人惊讶的是，即便如此，美国商学院在2021年看起来还是将大放异彩。在连续几年申请人数下降之后，麻省理工学院斯隆管理学院、哥伦比亚商学院、宾夕法尼亚大学沃顿商学院和其他美国顶级商学院现在都录得两位数增长。芝加哥大学布斯商学院的院长马德哈夫·拉詹（Madhav Rajan）眉开眼笑地说：“我们招收了有史以来规模最大的全日制MBA班。”

MBA申请人数通常会在经济衰退时上升，因为就业市场疲软意味着所放弃的薪水也会减少。但是，值得称赞的是商学院调整了自身的商业模式——正如商学院教授们告诫其他人应做的那样。许多商学院推迟了开学时间，提供了丰厚的奖学金，免除了考试要求，并且放宽了延期政策。哈佛商学院允许已录取的学生推迟一到两年入学。GMAC估计全球延期率已经从3%飙升至7%。

商学院也在大力发展线上和灵活的学位课程，这类课程正在激增，它们还把数字化教学整合到核心MBA课程中。达特茅斯学院塔克商学院的维贾伊·戈文达拉扬（Vijay Govindarajan）表示，数字技术非但不是“巨人杀手”，反而可以帮助顶级商学院“确保它的MBA金字招牌更加闪亮”。罗斯商学院正在使用类似奈飞（Netflix）定制推荐的工具，为学生打造“个性化领导力和职业发展之旅”。而让毕业生们觉得欣慰的是，招聘企业又回来了。GMAC对在商学院招人的企业的调查发现，其中89%打算在2021年招聘MBA毕业生，而去年是77%。 ■



Bartleby

Hear, hear

The secrets of successful listening

“WHEN PEOPLE talk, listen completely.” Those words of Ernest Hemingway might be a pretty good guiding principle for many managers, as might the dictum enunciated by Zeno of Citium, a Greek philosopher: “We have two ears and one mouth, so we should listen more than we say.” For people like being listened to.

Some firms use a technique known as a “listening circle” in which participants are encouraged to talk openly and honestly about the issues they face (such as problems with colleagues). In such a circle, only one person can talk at a time and there is no interruption. A study cited in the *Harvard Business Review* found that employees who had taken part in a listening circle subsequently suffered less social anxiety and had fewer worries about work-related matters than those who did not.

Listening has been critical to the career of Richard Mullender, who was a British police officer for 30 years. Eventually he became a hostage negotiator, dealing with everything from suicide interventions to international kidnaps. By the end of his stint in uniform, he was the lead trainer for the Metropolitan Police’s hostage-negotiation unit.

When he left the force in 2007, he realised that his skills might be applicable in the business world. So he set up a firm called the Listening Institute. Mr Mullender defines listening as “the identification, selection and interpretation of the key words that turn information into intelligence”. It is crucial to all effective communication.

Plenty of people think that good listening is about nodding your head or

keeping eye contact. But that is not really listening, Mr Mullender argues. A good listener is always looking for facts, emotions and indications of the interlocutor's values. And when it comes to a negotiation, people are looking for an outcome. The aim of listening is to ascertain what the other side is trying to achieve.

Another important point to bear in mind is that, when you talk, you are not listening. "Every time you share an opinion, you give out information about yourself," Mr Mullender says. In contrast, a good listener, by keeping quiet, gains an edge over his or her counterpart.

Hostage negotiators usually work in teams, but the lead negotiator is the only one who talks. "What we teach is that the second person in the team doesn't really talk at all, because if they are busy thinking about the next question to ask, they aren't really listening," Mr Mullender explains.

The mistake many people make is to ask too many questions, rather than letting the other person talk. The listener's focus should be on analysis. If you are trying to persuade someone to do something, you need to know what their beliefs are. If someone is upset, you need to assess their emotional state.

Of course, a listener needs to speak occasionally. One approach is to make an assessment of what the other person is telling you and then check it with them ("It seems to me that what you want is X"). That gives the other party a sense that they are being understood. The fundamental aim is to build up a relationship so the other person likes you and trusts you, Mr Mullender says.

The pandemic has meant that most business conversations now take place on the phone or online. Precious few in-person meetings occur. Some might think this makes listening more difficult; it is harder to pick up the subtle

cues that people reveal in their facial expressions and body language.

But Mr Mullender says that too much is made of body language. It is much easier to understand someone if you can hear them but not see them, than if you can see but not hear them. He prefers to negotiate by telephone.

Another key to good listening is paying attention and avoiding distraction. In the information age, it is all too easy for focus to drift to a news headline, a TikTok video or the latest outrage on Twitter. In another study in the *Harvard Business Review*, participants paired with distracted listeners felt more anxious than those who received full attention.

The lockdown has increased the need for managers to listen to workers, since the opportunities for casual conversation have dwindled. Mr Mullender thinks that many people have become frustrated in their isolation, which can lead to stress and anger. He thinks there may be a business opportunity in helping managers listen more efficiently, so they can enhance employee well-being. After a year of isolation, many workers would probably love the chance to be heard. ■



巴托比

你听，你细听

成功倾听的秘诀

“别人说话时，你要从头听到尾。”海明威的这句话对许多管理者来说可能是个很好的指导原则，希腊哲学家基提翁的芝诺（Zeno）的格言可能也是：“我们有两只耳朵一张嘴，所以我们应该多听少说。”因为人们喜欢被倾听。

有些公司使用一种名为“倾听圈”的方法，鼓励参与者开诚布公地诉说自己面对的问题，例如与同事的矛盾。在这样的圈子里，每次只能有一人说话，而且不会被打断。《哈佛商业评论》（*Harvard Business Review*）引用的一项研究发现，相比其他雇员，参加过倾听圈的雇员在此后的社交中焦虑感更低，对工作事务的担忧也更少。

在理查德·穆伦德（Richard Mullender）的职业生涯中，倾听一直至关重要。他曾在英国警界工作30年，最后成为一名人质谈判专家，处理自杀干预以至国际绑架等各种事件。在脱下警服前，他是伦敦警察厅人质谈判组的首席培训师。

在2007年离开警队后，他意识到自己的技能可能适用于商界，于是成立了一家名为“倾听学院”（Listening Institute）的公司。穆伦德把倾听定义为“识别、选择和解读那些令信息转化为情报的关键词”。这是一切有效沟通的关键。

很多人认为，善于倾听就是不断点头或保持眼神交流。但穆伦德认为这并非真正的倾听。一个好的倾听者总在寻找真相、情感，以及透露对话人价值观的蛛丝马迹。至于谈判时，人们是在寻求一个结果。倾听的目的是确认对方想达到什么目的。

另一个需要牢记的要点是，你一开口说，你就没在听。“每当你分享观

点，你都会透露有关自己的信息。”穆伦德说。相反，好的倾听者通过保持沉默获得面对对手的优势。

人质谈判通常以团队为单位，但首席谈判员是唯一开口说话的人。“我们是这样教学员的，团队中从第二个人往下就完全不开口了，因为如果他们忙着思考接下来该问什么，他们就没在真正听对方说了。” 穆伦德解释道。

很多人犯的错误是问太多问题，而不让对方多说。倾听者的重点应放在分析上。如果你想说服某人做什么，你需要知道他们的信念是什么。如果有人不高兴，你需要评估其情绪状态。

当然，一个倾听者间或也需要开口说话。一种方法是在评估对方所说的内容后向他们确认（“在我看来，你想要的是X”）。这样可以让对方感到自己被理解。最根本的目的是建立起连结，让对方喜欢你、信任你，穆伦德说。

新冠疫情导致现在大多数商务会谈都在电话或网络上进行。面对面会议少得可怜。有些人可能觉得这让倾听变得更难了，因为更难捕捉到人们的面部表情和肢体语言中透露的细微线索。

但穆伦德说，人们过于关注肢体语言了。要理解别人，听到看不到远好过看到听不到。他就更喜欢通过电话谈判。

好的倾听的另一个关键是专心，避免分散注意力。在信息时代，人们的注意力很容易被新闻头条、抖音视频或推特上的最新爆料牵扯。《哈佛商业评论》引用的另一项研究发现，相比获得全部注意力的参与者，面对心不在焉的听众的参与者感到更加焦虑。

封城措施使得管理者更加需要倾听员工，毕竟闲聊的机会减少了。穆伦德觉察到许多人在隔离生活中变得沮丧，这可能导致焦虑和愤怒。他认为在这方面可能存在商机：帮助主管们更有效地倾听，从而提升员工的福祉。经历了一年的孤军奋战后，许多员工可能都很乐意被听到心声。 ■



Music in space

We are the world

A project aims to beam a musical message to other planets—and back to this one

IN THE CASCADE mountains of northern California, a cluster of 42 radio telescopes points towards the stars, scanning for signs of life. The Search for Extraterrestrial Intelligence (SETI) Institute has been listening for a signal here and elsewhere since it was founded in 1984. In that time it has scoured only a minuscule fraction of space, equivalent to a glass of water in all the world's oceans. But Jill Tarter, its co-founder, is undaunted. A renowned astrophysicist—and the model for Jodie Foster's character in the alien-encounter film “Contact”—Ms Tarter says the programme's aim is not just to communicate with remote civilisations. It is also to remind humanity of its own modest, fragile place in the cosmos. Which is why, for the first time, SETI is cocking its ear towards Earth.

It is looking for the same thing on this planet that it routinely seeks from others: a signal that can be beamed into space to represent the species. Felipe Pérez Santiago, a Mexican musician and composer—and artist in residence at the institute—has an idea of what might work. Since song, like the human voice, is common to all languages and nations, he and Ms Tarter have devised the “Earthling Project”: a call to people everywhere to upload snippets of song that he plans to meld into a collective human chorus. An initial composition will be launched into space this summer, inscribed on a virtually indestructible disk alongside Wikipedia and the Rosetta Project, a sampling of 1,500 human languages. Future plans and dreams include an eventual dispatch to Mars.

Some composers, most famously Gustav Holst, have tried to capture the grandeur of space in sound. And human music has been sent to the heavens,

notably on two Voyager probes that were launched in 1977 and are now more than 11bn miles from Earth. Distant beings can in theory already enjoy Peruvian panpipes, a Navajo chant, Bach, Beethoven and more. But no previous offering, and perhaps no composition undertaken anywhere, has tried to encompass the entire variety of human song.

If anyone is equipped for this galactic challenge, it is Mr Santiago. He wrote his first ditty at the age of four, trained in Mexico City and then studied for five years at Rotterdam's conservatory. There he was exposed to "Turkish, Indian, Caribbean music, everything from tango to gamelan to flamenco". The maestro has since worked in Paris, Munich, Barcelona and Amsterdam, composing for choirs, films and ensembles of all kinds, including the Kronos Quartet and Harlem Dance Theatre. His back catalogue is exuberant, combining the clarity of classical technique with an energy he attributes to the rock bands he enjoyed in his youth.

The first piece he produces for SETI will probably resemble a "wall of sound", the composer says, incorporating as many as 10,000 unaccompanied voices. But later he proposes to craft an "earthling symphony", a piece that will doubtless reflect his peripatetic background and eclectic passions. As thrilling as it may seem to send his work into space, Mr Santiago says he is just as excited about bringing together contributors from around the globe.

For the music is intended to be not just a message to the universe, but a mirror—a chance, as Ms Tarter has put it, to say "See, we're all the same." Mr Santiago raises his hands and his eyebrows as he summarises the goal: "Can we unite humanity with 30 seconds of singing?"

Some elemental melodies endure for centuries: lullabies, mourning chants, songs of love or celebration, age-old tunes that lighten toil or praise a god. Like those giant Californian dishes, the project's app stands ready to receive all these, and whatever else earthlings anywhere choose to contribute.

Unlike other recordings sent into space, says Mr Santiago, “everyone’s invited. You don’t have to be one of the main composers of our history like Beethoven, just someone singing in their shower.” Download the app, warble up to three songs of 30 seconds each, and your voice will be dispatched into the firmament.

Mr Santiago pledges to use every submission. The ultimate plan is to throw open the whole database for musicians anywhere to sample. Understanding that all earthlings share a common planet “is crucial for our long future,” Ms Tarter says. “We face challenges that have to be solved by co-operating across the globe.” In a small but symbolic way, the Earthling Project is meant to set an example.

It is helping to build bridges in another way, too. Astronomers and biologists, like artists, use imagination to conceive of new things, formulating questions, taking risks, experimenting and collaborating across borders. But often the worlds of art and science seem disconnected. The artists’ programme at SETI encourages co-operation between disciplines—resulting in artwork that gives tangible shape to abstract data. The first participant, Charles Lindsay, investigated interspecies communication through the song of humpback whales; another, Scott Kildall, created a virtual-reality tour of all the known exoplanets. Rachel Sussman presented an image of the cosmic background radiation generated by the Big Bang—“the baby picture of the universe”—as a sand mandala.

As Mr Santiago notes, “nothing has united humanity like this pandemic.” At a dark time, he and the institute aim to foster a more uplifting sense of communion. “If we can send this unified message,” he says, “our mission is accomplished.” ■



太空中的音乐

天下一家

一个项目想把一则音乐信息发送给其他星球——也传回给我们自己这颗

在加州北部的喀斯喀特山脉，42台射电望远镜组成的阵列指向星空，搜寻生命的迹象。自1984年成立以来，搜寻地外文明（SETI）研究院一直在这里和其他地方监听某种信号。当时它只搜索了太空的极小一部分，对浩瀚宇宙来说只是沧海一粟。但它的联合创始人吉尔·塔尔特（Jill Tarter）并不气馁。她是一位著名的天体物理学家，也是讲述与外星人邂逅的影片

《超时空接触》（Contact）中朱迪·福斯特所饰角色的原型。她说，该项目并不仅仅是为了与遥远的文明交流，也是要提醒人类自己在宇宙中的位置有多平凡和脆弱。这也是为什么SETI现在第一次对地球竖起了耳朵。

该项目在地球上寻觅的东西和它惯常从其他星球上寻觅的一样：一个可以发射到太空、代表本星球生命物种的信号。墨西哥音乐家兼作曲家、同时也是SETI驻院艺术家的费利佩·佩雷斯·圣地亚哥（Felipe Pérez Santiago）有个想法或许可行。歌曲和人类的声音一样，是所有语言和民族共有的，因此，他和塔尔特构想出了一个“地球人计划”（Earthling Project）：号召世界各地的人们上传歌曲片段。他计划将这些片段融合成一首全人类的大合唱。首个作品将与维基百科和汇集了1500种人类语言样本的罗塞塔项目（Rosetta Project）一道，刻录在一个几乎坚不可摧的光盘上，于今年夏天发送到太空。未来的计划和梦想包括把这些信息最终发送到火星上去。

已有一些作曲家试着用声音来表达宇宙的壮美，最著名的就是古斯塔夫·霍尔斯特（Gustav Holst）。而人类的乐声也已被送上云霄，最突出的就是1977年发射的两个“旅行者”探测器搭载的乐曲，现在它们已距离地球超过110亿英里。理论上，遥远的生命已经可以欣赏到秘鲁的排箫、纳瓦霍人的吟唱、巴赫和贝多芬的作品等等。但是，先前送上天的任何作品，或是地球上任何已有的创作，都不曾尝试把所有种类的人类歌曲都囊括在内。

如果有谁能胜任这项天大的挑战，那就非圣地亚哥莫属了。他四岁时写下了第一首曲子，在墨西哥城接受了训练，后来又在鹿特丹的音乐学院学习了五年。在那里，他接触了“土耳其、印度、加勒比音乐，从探戈到甘美兰再到弗拉门戈，什么都体验过了。”这位艺术大师先后在巴黎、慕尼黑、巴塞罗纳和阿姆斯特丹工作，为合唱团、电影和包括克罗那斯四重奏（Kronos Quartet）和哈林舞蹈剧院（Harlem Dance Theatre）在内的各种表演团体作曲。他创作成果丰硕，既具古典音乐技巧的明晰，又富有能量——他将后者归功于自己年轻时爱听的摇滚乐队。

这位作曲家说，他为SETI创作的第一首曲子很可能会像一堵“音墙”，融合了多达一万条无伴奏声音。但后来他提议创作一曲“地球人交响乐”。这首曲子无疑会体现他云游四方的经历和不拘一格的音乐趣味。尽管把自己的作品送上太空看上去可能挺令人激动，但圣地亚哥说，能把五湖四海的人聚集起来为这个项目出力，一样让他兴奋。

这是因为这段音乐不仅仅是要传递给宇宙的信息，而是一面镜子——正如塔尔特所言，是一个向人类传达“看吧，我们都一样”的机会。圣地亚哥手舞足蹈、眉飞色舞地总结了项目的目标：“我们能不能用30秒的歌唱让人类团结起来呢？”

一些基本的旋律历经千百年经久不衰：摇篮曲、哀歌、情歌或庆典歌曲、舒缓辛劳或赞美神灵的古老曲调。就像加州那些接收信号的超级望远镜一样，“地球人计划”的应用对所有这些音乐来者不拒，除此之外也欢迎任何地方的地球人的任何其他贡献。圣地亚哥说，与其他送入太空的录音不同，这一次“人人都受邀。不需要是贝多芬那样的人类历史上的大作曲家，在淋浴时哼哼的人也行。”下载该应用，引吭高歌最多三首曲目，每首30秒，你的声音就将被送入苍穹。

圣地亚哥保证，提交的素材全部都会用上。最终的计划是开放整个数据库，任何地方的音乐家都可以来采样。全体地球人共享同一颗星球，了解这一点“对我们长远的未来至关重要”，塔尔特说。“我们面临的挑战必须通过全球合作才可解决。”地球人计划意欲用一个不算宏伟但具象征性的

方式做个榜样。

该项目也有助于以另外一种方式搭建桥梁。跟艺术家一样，天文学家和生物学家也运用想象力构思新事物、阐述问题、冒险、开展实验和跨国合作。但艺术界和科学界似乎总是脱节的。SETI的驻院艺术家项目鼓励跨学科合作，由此创造出了赋予抽象数据具体形态的艺术作品。第一个参与进来的查尔斯·林赛（Charles Lindsay）通过座头鲸的鲸歌研究种间交流；另一名参与者斯科特·基尔达尔（Scott Kildall）设计了一趟游览所有已知系外行星的虚拟现实之旅；雷切尔·苏斯曼（Rachel Sussman）以一幅坛城沙画展示了大爆炸产生的宇宙背景辐射景象——相当于“宇宙还是个宝宝时的照片”。

正如圣地亚哥所指出的，“从来没有什么像这场疫情一样把人类团结在一起。”在黑暗的日子里，他和SETI力图促成一种更能振奋人心的交融之感。“如果能把这个彰显天下一家的信息传递出去，”他说，“那我们的使命就完成了。”■



Nutrition and health

The meat spot

The Japanese may owe some of their unusual longevity to a Goldilocks diet

TANAKA KANE is one of humanity's great outliers. On January 2nd she became the third person ever to turn 118, according to the Gerontology Research Group, a team of academics. She is also the first citizen of Japan to reach 118—but is unlikely to be the last. The country has the world's longest life expectancy, and 80,000 centenarians.

Mrs Tanaka is an outlier for another reason, too. She claims to love chocolate and fizzy drinks, setting her apart from most of her compatriots. Japan has long had one of the lowest sugar-consumption rates in the OECD, a club of mainly wealthy countries.

The unusual longevity enjoyed in Japan is often credited to diet. Yet the idea that the country has extended lifespans by entirely avoiding the West's sinful culinary delights may be too simple. In fact, recent studies imply that one key to its success may be that its people's diets have shifted over time towards Western eating patterns.

Japan was not always a longevity champion. In 1970 its age-adjusted mortality rates were average for the OECD. Although its levels of cancer and heart disease were relatively low, it also had the OECD's highest frequency of cerebrovascular deaths, caused by blood failing to reach the brain.

In 1970-90, however, Japan's cerebrovascular mortality rate fell towards the OECD average. With world-beating numbers on heart disease and fewer strokes, Japan soared up the longevity league table.

How did Japan overcome its cerebrovascular woes? Some of its gains simply

mirror better treatments and reductions in blood pressure around the world, notes Thomas Truelsen of the University of Copenhagen.

However, another cause may be diets. Japan largely banned meat for 1,200 years, and still consumes relatively little meat and dairy. Too much of these can be damaging, since they contain saturated fatty acids, which correlate to heart disease. Studies have also tied eating lots of processed red meat to a greater risk of stroke. But too little may be unwise as well, because they provide cholesterol that may be needed for blood-vessel walls. In a study of 48,000 Britons, vegetarians were unusually resistant to heart disease, but prone to strokes.

In theory, a dearth of animal-based food could have contributed to Japan's historical cerebrovascular mortality. In 1960-2013, as the country's deaths from strokes tumbled, its annual meat intake rose from near zero to 52kg per person (45% of America's level). Tsugane Shoichiro of the National Cancer Centre in Tokyo says that his compatriots may need meat and dairy to keep their blood vessels robust—though not so much that those vessels get clogged.

Some empirical evidence supports this view. One paper from the 1990s found that the parts of Japan where diets had changed most also had the biggest drops in cerebrovascular mortality. Another study, which tracked 80,000 Japanese people in 1995-2009, showed that strokes were most common among those who ate the least chops and cream. Although Japan's decline in cerebrovascular deaths could stem entirely from other causes, these data suggest that nutritional shifts may have helped.

The unhappy irony is that Japan's health gains, paired with a low birth rate, threaten its economy. By 2060, 40% of Japanese could be 60 or older. That would yield more birthday cakes with 118 candles—and fewer great-grandchildren to blow them out. ■



营养与健康

加一点肉

日本人突出的寿命可能部分源于一种“正正好”的肉食习惯

田中力子可是一个非常不普通的人。根据学术团体老年学研究组织（Gerontology Research Group）的数据，1月2日，她成为全球迄今为止第三个年满118岁的人。她也是日本第一个年满118岁的公民——但不太可能是最后一个。日本是世界上平均寿命最长的国家，目前有八万名百岁老人。

田中之所以不普通，还有一个原因。她声称自己喜欢巧克力和汽水，这让她和大多数日本人不同。在成员主要为富裕国家的经合组织中，日本长期以来都是糖摄入量最低的国家之一。

人们常把日本人非同寻常的长寿归功于饮食。然而，认为日本人得以延年益寿是因为完全不碰西方那些让人有罪恶感的美味，可能还是过于简单了。事实上，近期的研究表明，日本成为长寿之国的其中一个关键因素可能是日本人的饮食习惯逐渐西化。

日本并非从来都是长寿冠军。1970年，该国经年龄调整死亡率处于经合组织的平均水平。尽管日本的癌症和心脏病的死亡率相对较低，但它因血液无法到达大脑而引发的脑血管疾病死亡率却是经合组织中最高的。

不过从1970至1990年，日本的脑血管疾病死亡率下降至接近经合组织的平均水平。加之心脏病死亡率降至世界最低以及中风减少，日本在长寿排行榜上大幅跃升。

日本是如何战胜脑血管疾病的？哥本哈根大学的托马斯·特鲁尔森（Thomas Truelsen）指出，一定程度上这只是全世界医疗进步和血压下降的一部分。

然而，另一个原因可能是饮食。日本在1200年的时间里基本上禁止吃肉，现在肉和奶制品的消费量仍然相对很少。这些东西吃得太多可能损害健康，因为它们含有与心脏病有关联的饱和脂肪酸。还有研究表明，食用大量加工过的红肉会增加中风的风险。但吃得太少可能也不明智，因为它们提供的胆固醇可能是血管壁需要的。一项对4.8万名英国人的研究表明，素食者对心脏病有非同一般的抵抗力，却容易发生中风。

理论上，动物性食品摄入不足可能是日本历史上脑血管疾病死亡高发的原因之一。1960至2013年，日本中风死亡人数大幅下降，而期间它每年的肉类摄入量从接近零上升到人均52公斤（是美国的45%）。东京国家癌症中心（National Cancer Centre）的津金昌一郎表示，要保持血管强健，日本人可能需要肉类和奶制品——不过不要多到让血管阻塞的程度。

这个观点得到了一些实证的支持。上世纪90年代的一篇论文发现，在日本饮食习惯变化最大的地区，脑血管疾病死亡率的降幅也最大。另一项在1995至2009年追踪八万日本人的研究表明，在排骨和奶油吃得最少的人群中中风最多发。尽管日本脑血管疾病死亡率的下降可能是完全缘于其他原因，但这些数据表明营养摄入的改变可能有所助益。

令人遗憾的讽刺是，日本人健康水平的提高，和低出生率一起，对本国经济构成了威胁。到2060年，日本60岁及以上的人口将占到40%。如此就会出现更多插着118根蜡烛的生日蛋糕，却不再有那么多曾孙一起把这些蜡烛吹灭了。■



Immigration

The best of both worlds

Two books look at how migrants affect the countries they move to

IN 1885 A penniless, sickly German draft-dodger arrived in New York. Official records listed him as “Friedr. Trumpf”. Occupation: “none”. America had no immigration restrictions in those days, so he was allowed in. He made a fortune running restaurants and brothels in the gold-rush era. He then moved back to Germany, but since he had evaded military service, he was stripped of German citizenship and deported. He returned to the United States and founded a dynasty.

His grandson, Donald Trump, spent the past four years trying to lock immigrants like his grandfather out of America. One of his last trips as president, on January 12th, was to admire his wall on the southern border and denigrate the foreigners it is meant to exclude. “They may be murderers. They may be cartel heads. They may be some really vicious people,” he warned.

Joe Biden takes a different view. He had barely arrived in the Oval Office when he revoked several of Mr Trump’s curbs on immigration (such as a ban on arrivals from a list of mostly Muslim countries) and proposed legislation to let more people become citizens. Mr Biden understands that centuries of sucking in foreign talent have made America rich and dynamic. He would like to open up the country again, at least a bit. But two things make that tricky. One is the pandemic: until it abates, global mobility is on hold. The other is that in America and elsewhere many voters—including some who, like Mr Trump, are themselves descendants of immigrants—share his belief that letting in more of them would make their countries worse.

The evidence suggests otherwise, as two new books make clear. “Them and Us” by Philippe Legrain, a former *Economist* journalist, sets out the benefits of migration and asks how newcomers and locals can get along better. “Wretched Refuse?” by Alex Nowrasteh and Benjamin Powell, a think-tanker and an academic, asks a crucial question: might immigration from poor, corrupt countries undermine the institutions of rich, well-governed ones?

Mr Legrain’s book is the more accessible: though underpinned by scholarship it is chatty, entertaining and full of anecdotes, such as the one with which this review begins. He breezily rebuts popular arguments for closed borders, and turns populist slogans upside down.

Complaints that immigrants are not “like us” miss the point, he insists. If they were identical to natives, “they would bring nothing extra to the party except additional bodies”. In practice they bring skills and contacts that the host nation lacks, and new perspectives that enhance their interactions with locals. For instance, a percentage-point bump in the share of American graduates who were born abroad raises patent applications by a whopping 15%. One study found that immigrants with a background in science, technology, engineering or maths accounted for 30-50% of the improvement in American productivity between 1990 and 2010. A study by the IMF found that by increasing the diversity of skills and ideas, migration has boosted living standards by 30% or so in both Britain and America.

Unskilled immigrants, too, are different from unskilled locals in ways that benefit the host nation. They are more mobile, so they can revive decaying cities. They have different priorities. For example, natives typically shun fruit-picking because it is seasonal and they want permanent jobs. For migrants, by contrast, seasonality is often appealing: many want to earn money quickly and then return to their families.

Mr Legrain’s book fizzes with practical ideas. Though they generally pay

their way, immigrants are often perceived as a burden, he observes. This is because public services respond too slowly to changes in population, so schools and doctors' waiting rooms become crowded. This suggests that governments should learn from the private sector, which adapts far more quickly. "Nobody blames migrants for shortages at local supermarkets—because there aren't normally any," he notes.

Facts matter, but so do words, he argues. People who oppose immigration in the abstract often change their tune when asked about specific types of immigrant, such as doctors, students or foreigners who marry locals. As for those who complain about a "brain drain" from poor countries—this is like labelling women's entry to the labour force the "family abandonment rate".

"Wretched Refuse?" is a denser book, full of charts and regression analysis. It is also highly original, and takes a chainsaw to the most intellectually respectable case against immigration. No serious economist denies that when people move from poor countries to rich ones, they become more productive and their wages soar. It seems likely, therefore, that more migration would make the world much richer. However, some scholars think that too large an influx from, say, Congo to Canada would make Canada more like Congo—ie, the immigrants would import Congolese habits, and gradually make Canadian institutions more like the corrupt and lawless ones that keep Congo poor. Yet remarkably little effort has been made to test this hypothesis. Messrs Nowrasteh and Powell do so as rigorously as they can.

Disentangling cause and effect is tricky. Simply pointing out that countries with lots of immigrants tend to be rich, peaceful and free is not enough. People move to places like Canada and Australia precisely because they are agreeable. To get round this, the authors examine all the countries for which they can find data, noting both the stock of immigrants (as a share of population) in the 1990s and the inflow over the next two decades.

Then they look at how those countries changed over that period on a variety of measures, such as economic freedom and corruption. They find no evidence that higher stocks or flows of immigrants made host countries less free, more corrupt, or less trusting. Indeed, they find modest improvements on a number of scores.

It is plausible, they argue, that a country that grows more free or less corrupt might attract bigger inflows of migrants, but that effect would not be retroactive; it would not change the stock of immigrants at the start of the period in question. They conclude that the doomsayers are wrong. Migrants do not undermine the institutions of the places they move to. Some move because they are fed up with corruption. Others soon assimilate to rich-country norms. This makes sense. Graft in Congo is seldom punished and often pays; in Canada, honesty delivers more reliable rewards.

The debate is far from over, the authors admit. No doubt, if a billion migrants were to arrive in a single year, rich countries' institutions might buckle. But they demolish a big argument against existing levels of immigration, and suggest that most rich countries would benefit from being more open. Mr Biden and his advisers should devour their book. ■



移民

两全其美

两本书探讨移民对接收国的影响【《他们和我们》、《可悲的拒绝？》书评】

一八八五年，一个身无分文、病恹恹的德国男子为逃避兵役来到纽约。在官方记录上，他登记的名字是弗里德里希·特朗普（Friedr. Trumpf），职业为“无业”。当时美国没有移民限制，所以他可以自由入境。他在淘金热中经营餐馆和妓院发家致富。之后他搬回德国，但因为曾逃避兵役，被剥夺德国国籍并驱逐出境。他重返美国，在那里创建了一个商业王朝。

他的孙子唐纳德·特朗普在过去四年一直竭力要把像他爷爷那样的移民拒之于美国国门之外。在他以总统身份开展的最后一轮行程中，他于1月12日视察了他下令修建的南部边境墙，并贬低了一番这堵墙要隔绝的外国人。“他们可能是杀人犯，可能是黑帮头目，还可能是些穷凶极恶的家伙。”他警告道。

拜登不这么看。甫一进入椭圆办公室，他就撤销了特朗普的多项移民限制措施，如撤销对一系列国家（多为穆斯林国家）公民的入境禁令，并提案让更多人入籍美国。拜登明白，这几个世纪以来吸纳外国人让美国变得富裕而有活力。他希望再次打开国门，至少打开一点点。但这里有两大障碍。一是新冠疫情：疫情不消退，全球人员流动就会继续停摆。另一个是在美国和其他地方的许多选民（其中包括一些像特朗普那样本身就是移民后裔的人）都和特朗普一样，认为接收更多移民会让自己的国家变得更糟。

但证据显示情况并非如此，两本新书阐明了这一点。曾任本刊记者的菲利普·勒格林（Philippe Legrain）所著的《他们和我们》（Them and Us）罗列了移民的好处，并探讨新移民和本地人如何能更和谐地共处。在智库任职的亚历克斯·诺拉斯特（Alex Nowrasteh）与学者本杰明·鲍威尔（Benjamin Powell）合著的《可悲的拒绝？》（Wretched Refuse?）提出

了一个关键问题：来自贫穷、腐败国家的移民有可能破坏富裕的、治理良好的国家的制度吗？

勒格林的书更易懂：虽然以学术研究为支撑，但写得通俗、有趣，充满奇闻轶事，比如本文开头提到的故事。他举重若轻地反驳了支持关闭边境的流行观点，瓦解了各种民粹主义口号。

勒格林坚持认为，说移民不“像我们”的抱怨不得要领。如果移民和本地人完全一样，那么“他们只会增加人口，而不能带来任何别的东西”。而实际上，移民带来了接收国缺乏的技能和人脉，也带了新的观点视角，并由此提升了与本地人的互动。举例来说，在美国毕业生当中外国出生人数的比例每提高一个百分点，美国的专利申请数就提高15%之多。一项研究发现，在1990年至2010年间，具有科学、技术、工程或数学学历背景的移民贡献了美国生产率上升的30%至50%。国际货币基金组织的一项研究发现，移民增加了技能和创意的多样性，使英美两国的生活水平都提升了30%左右。

非技术工人移民对接收国的益处也有别于本地非熟练工。这类移民的流动性更强，可令颓败的城市重焕生机。他们看重的东西也不一样。例如，本地人通常不愿意干采摘水果的活，因为这是季节性短工，而他们想要长期工作。移民却相反，他们喜欢打季节工：许多人都想快点挣些钱，然后回家团聚。

勒格林的书里有大量实用的点子。他发现，虽然移民一般都能自食其力，却往往被视为负担。这是因为公共服务对人口变化的反应太慢，所以学校和医院候诊室变得拥挤。这表明政府应该向应变速度快得多的私营部门学习。“没人因为本地超市里商品短缺而怪移民，因为超市通常都不会发生供货短缺。”他指出。

事实很重要，勒格林说，但表达也一样。当那些笼统地反移民的人被问及具体类型的移民时——比如医生、学生或与当地人结婚的外国人——往往就会改变语气。至于有人抱怨穷国“人才外流”，这就好比给出门工作的女

性贴上“抛家弃子”的标签。

《可悲的拒绝？》信息量更大更深奥，包含大量图表和回归分析。它也具高度原创性，向最理性的反移民理论挥刀。当人们从穷国移居富国，其生产率会提高，工资也会飙升，这是任何严肃经济学家都不会否认的。因此，更多人移民似乎可能令世界变得更加富裕。然而，一些学者认为，如果移民人数太多，比如大量移民从刚果涌入加拿大，那加拿大就会变得越来越像刚果，也就是说，这些移民会带来刚果人的习惯，逐渐令加拿大的制度变得腐败而缺乏法治，而正是这样的制度让刚果陷于贫穷。然而鲜少有人花力气去检验这一假设。诺拉斯特和鲍威尔尽可能严谨地做了一番检验。

要厘清因果关系有难度。单单指出有大量移民的国家往往是富裕、和平和自由的，是不够的。人们移居加拿大和澳大利亚这类地方恰恰是因为它们本身就讨人喜欢。为解决这个问题，两位作者研究了他们能找到数据的所有国家，特别留意它们在1990年代的移民存量（占人口比例）和之后20年的移民流入量。

然后，他们分析了这段时期里这些国家在经济自由度和腐败等各种指标上的变化。他们没发现任何证据表明更高的移民存量或流入量使移民接收国更不自由、更腐败或更不易信任人。事实上，他们发现在某些指标上还略有改善。

他们论证道，一个国家自由度提升或腐败减轻可能会吸引更多移民流入，这似乎说得通。但是，这种影响没有追溯性，也就是说，它并不能改变这段时期初始的移民存量。他们的结论是，灾难预言者的论调是错的。移民并没有破坏接收国的制度。有些人恰恰是因为厌倦了腐败而选择移居。另一些人很快被富裕国家的规范同化。这言之有理。在刚果，贪污很少受惩罚还往往有好处，但在加拿大，诚实会带来更可靠的回报。

两位作者承认争论远未结束。诚然，如果一年内涌入十亿移民，富裕国的制度可能会崩溃。但两人推翻了反对现有移民水平的一个重要理由，指出

大多数富裕国家会从加大开放中获益。拜登和他的顾问们应该好好研读这本书。 ■



The Economist film

Mining the deep sea: the true cost to the planet

Mining companies and governments will soon be allowed to extract minerals from the deep-ocean floor. These rare metals are vital for a more environmentally sustainable future on land, but at what cost to the health of the ocean?



经济学人视频

深海采矿：对地球的真实代价

采矿公司和政府机构很快将准许从深海海床开采矿物。这些稀有金属将有助于人类在陆地上的可持续生活，但海洋会付出怎样的代价？



Family firms

Mittelstand-off

All families argue. Some of the most explosive rows happen inside Germany's powerhouse companies

GERMAN FIRMS have, like their country itself, a reputation for being staid. Look closer, though, and many brim with intrigue. Albert Darboven, a coffee tycoon, pushed his own son Arthur out of JJ Darboven and tried to adopt a friend as his heir and successor. The five children from the first marriage of Rudolf-August Oetker, grandson of the eponymous founder of a pudding dynasty, and the three offspring from his third have been at each other's throats for years. The feud among the billionaire scions of the Tengelmann retail empire led to speculation that Karl-Erivan Haub, the group's fifth-generation CEO, faked his own death in a skiing accident. Last month his brother, Georg Haub, reportedly withdrew the application to have him declared dead.

Apart from ripping families apart and tearing down reputations, such feuds destroy shareholder value—including that accruing to the warring clans. Hermann Simon, a management consultant to many powerhouses in Germany's Mittelstand of medium-sized firms, says succession is their biggest problem. Families that quarrel risk a split, a sale to a rival or bankruptcy. With early planning and discussions many rows could be avoided. Yet most founders prefer to keep their options open. And few wish to contemplate retirement.

More than 90% of German firms are family companies. Unusually, that includes many multinationals across a range of industries: appliances (Miele), carmaking (BMW, Continental and Volkswagen), chemicals (Henkel), engineering (Bosch, Heraeus, Knorr-Bremse), food (Oetker), media

(Bertelsmann), medicines (Merck) and retail (Aldi and Schwarz, which owns Lidl grocers). Fully 30% of companies with more than 500 employees are in the hands of their founding clans.

The profusion of family companies is partly a function of inheritance tax. This has historically been high in America and France but modest in Germany—and, crucially, waived for heirs who keep their family business running for at least seven years, and protect jobs and wages. Another explanation is culture. Whereas Americans admire self-made men, Germans respect old money. *Neureiche* (newly rich) are dismissed as arriviste vulgarians.

Whatever the reasons, the upshot is ubiquitous strife. For conflict is built into family businesses, says Arist von Schlippe of the Wittener Institute for Family Companies, a think-tank. Each is a paradox, he says, combining the inclusive logic of a family with the selective logic of business. As an example, he recalls advising a founder who wanted each of his four sons to inherit one-quarter of the family concern, while also encouraging all of them to strive for the qualifications to become its next boss. That is a recipe for discord.

Succession is easier when there is only one descendant, or when others show little interest in business. It gets complicated in dynasties with plenty of children from multiple marriages. Ferdinand Piëch, a former boss of Volkswagen Group and grandson of the carmaker's founder, Ferdinand Porsche, had six daughters and seven sons from three marriages and a couple of liaisons. Ever since Piëch died in 2019 his 13 children have been fighting in court with his last wife. An estimated €1.5bn (\$1.8bn) in family wealth is at stake.

The trickiest succession is from the first generation to the second. If a family can pull that off without bad blood, subsequent handovers are likelier to

succeed, says Kirsten Baus of the Institute for Family Strategy, a think-tank in Stuttgart. In America 70% of family firms fold or get sold before the second generation gets a look-in. Just 10% remain privately held going concerns into the third generation, according to a study in the *Harvard Business Review*. In Germany 16% of small or medium-sized companies say that they will probably close down when the boss retires (though this does not count firms that go bust). Most would like to stay in the family but are unable to persuade a relative to take over.

Conflict is often not chiefly over money. Relatives spar because they have different aspirations for the business, or feel they are being mistreated. Arthur Darboven was pushed out by his father, and stripped of a part of his stake. Among other things, Mr Darboven reportedly disapproved of his son's launch of a racy new brand called Coffee-Erotic. At the age of 83 Albert Darboven remains at the helm of his firm. (After a court denied his adoption strategy, he is reportedly pondering creating a foundation to control the firm.)

To avert such to-dos, some clans organise an annual family day, holiday camps for their youngsters and even dedicate a house to family reunions, often the home of the founder. Most also draw up codes of conduct, says Herbert Wettig, an adviser of family companies. The 680 members of the Haniel clan (who until recently owned Metro supermarkets) have an 80-page code, which stipulates that no family member can work for the company, not even as an intern. The Reimanns, billionaire owners of JAB, a coffee-to-cosmetics group, have a similar rule. The Trumpfs have a code that covers succession and the sale of shares in the firm, but also includes guidelines for religious tolerance, modesty and respect for others.

No charter is foolproof; the Oetker codex did not stop them clashing. Some families unable to find agreement decide to sell out or, if they are large enough, go public. In 2017 Wirtgen, a construction firm with annual sales

of €3bn, was sold to John Deere for \$5.2bn. The founder's sons worried they would be too old to run a company by the time their children could take over. After falling out bitterly with his only son, Heinz Herrmann Thiele listed one-third of Knorr-Bremse, the company he built into a leading purveyor of train and lorry brakes, on the Frankfurt stock exchange in 2018. He and his daughter raked in €3.9bn with the flotation.

Or quarrelsome clans can go their separate ways. Some of corporate Germany's biggest names are the result of break-ups. A fight between the shoemaking Dassler brothers led in 1948 to the creation of Adidas and Puma, each of which now makes pricey trainers. A feud in 1960 between the Albrecht brothers over whether to sell cigarettes also resulted in a bifurcation: Aldi Nord operates in northern Germany and a number of other, mostly western and central European countries; Aldi Süd covers southern Germany, remaining parts of Europe, plus Australia and China.

A split may make sense for groups with diverse interests, says Klaus-Heiner Röhl of the German Economic Institute, another think-tank. But it weakens specialist firms of the sort that populate the Mittelstand. The latest generation of Aldi Nord heirs has fought over money and power for a decade. The row is preventing a sensible re-merger of the Aldis. Never mind that it would help both businesses. ■



家族企业

中小型对峙

没有不吵架的家庭。一些最火爆的争执发生在德国成功企业的内部

德国公司和它们的国家一样，素以庄重古板著称。但许多企业内部实则充满明争暗斗。咖啡大亨阿尔伯特·达波文（Albert Darboven）把亲生儿子亚瑟（Arthur）逐出了JJ Darboven公司，并试图认一位朋友做养子来当他的继承人和接班人。鲁道夫·奥古斯特·欧特克（Rudolf-August Oetker）是以家族名命名的布丁巨头的第三代掌门人，他第一次婚姻所生的五个孩子和第三次婚姻的三个孩子多年来争得你死我活。零售帝国腾格尔曼（Tengelmann）的豪阔子弟之间长期不和，因此有人猜测该集团第五代CEO卡尔·埃里温·豪布（Karl Erivan Haub）制造了自己在滑雪事故中死亡的假象。据报道，上月他的兄弟格奥尔格·豪布（Georg Haub）已经撤回了宣告卡尔死亡的申请。

除了导致家族不和及名誉受损，这种长期争斗还会破坏股东价值——包括属于这些争斗家族的那部分。为德国许多成功的中型企业担任管理顾问的赫尔曼·西蒙（Hermann Simon）表示，继任是它们最大的问题。纷争不休的家族可能分崩离析、卖给竞争对手，或者破产。如果尽早规划和讨论，很多争端或可避免。然而，大多数创始人都倾向于保留选择余地。而且很少有人愿意考虑退休。

超过90%的德国公司都是家族企业。不同寻常的是，它们当中有许多跨国公司，涉及众多行业：家电（美诺）、汽车制造（宝马、大陆和大众）、化工（汉高）、工程（博世、贺利氏、克诺尔）、食品（欧特家）、传媒（贝塔斯曼）、医药（默克）和零售（阿尔迪以及拥有连锁超市利德的施瓦茨）。员工超过500人的公司有足足三成掌握在创始家族手里。

家族企业大量存在的原因之一是遗产税。历史上，美国和法国的遗产税率一直很高，在德国却适中——而且关键的一点是，如果继承人保持家族企

业的运营不少于七年并且保障职位和工资，可免于缴纳遗产税。另一种解释是文化。美国人崇尚白手起家，德国人推崇贵族世家。新贵会被视为庸俗的暴发户而遭受冷眼。

无论原因为何，其结果就是冲突无处不在。智库威特纳家族企业研究所（Wittener Institute for Family Companies）的阿里斯特·冯·施利普（Arist von Schlippe）认为，这是由于家族企业本身所固有的矛盾。他说，家族企业将家庭的包容性逻辑与商业的选择性逻辑结合在一起，因此每家都是一个悖论。举个例子，他记得曾给一位创始人提供咨询，这位老板想让四个儿子各自继承四分之一的家业，但同时又鼓励他们力争成为下一任掌门人。这样自然会导致不和。

如果只有一名后裔，或者其他后裔对做生意不感兴趣时，安排继承就会容易一些。在因多次婚姻而有众多子女的大家族里，情况往往十分复杂。大众集团前老板费迪南德·皮耶希（Ferdinand Piëch）是大众创始人费迪南德·保时捷（Ferdinand Porsche）的孙子，他的三段婚姻和几段婚外情带来了六个女儿和七个儿子。自皮耶希于2019年去世以来，他的13个孩子一直在法庭上与他的最后一任妻子争斗不休。涉及的家族财富估计有15亿欧元（18亿美元）。

最棘手的传承是从第一代到第二代。斯图加特智库家族战略研究所（Institute for Family Strategy）的克尔斯滕·鲍斯（Kirsten Baus）说，如果一个家族能够在没有不和的情况下完成第一棒交接，那么将来就更有可能顺利传承。在美国，70%的家族企业在第二代有机会接手之前就已经倒闭或出售。《哈佛商业评论》的一项研究显示，只有10%的企业能维持为一家私人持有的活跃运营的公司到第三代。在德国，16%的中小企业表示等老板退休时可能就会关门（而这并不包括破产的公司）。多数企业都想要保持由家族经营，但苦于无法说服一位家族成员接手。

矛盾往往并不主要在金钱。家族成员不和是因为他们对生意的抱负不同，或者觉得自己受到不公平的对待。亚瑟·达波文被父亲逐出公司，并被剥夺了部分股份。据称达波文对儿子有诸多不满，其中包括儿子推出的一个

名为“情色咖啡”的有点不雅的新品牌。现年83岁的阿尔伯特·达波文仍然执掌自己的公司。（一家法院否决了他的收养策略后，据说他正在考虑成立一个基金会来控制公司。）

为避免这种混乱，一些家族会组织年度家庭日活动，为年轻人举办度假营，甚至拿出一栋房子专门用于家庭聚会，通常是在创始人的家里。家族企业顾问赫伯特·维蒂格（Herbert Wettig）表示，大多数家族还制定了行为准则。哈尼尔家族（Haniel，不久之前还持有麦德龙超市）的680名成员有一份80页的准则，其中规定任何家族成员都不得在自家公司工作，包括实习。拥有主营咖啡到化妆品的JAB集团、身家亿万的莱曼家族

（Reimann）也有类似的规定。特伦普夫（Trumpf）家族的行为准则不仅涵盖继承和出售公司股份，还包括宗教宽容、谦逊和尊重他人等指引。

没有什么章程能写得滴水不漏；欧特家的守则也并没能避免内部冲突。有些无法达成一致的家族会决定把公司卖掉，或者如果体量足够大就上市。2017年，年销售额达30亿欧元的建筑公司维特根（Wirtgen）以52亿美元卖给了约翰迪尔（John Deere）。公司创始人的几个儿子担心，等到自己的孩子长大能接手时，他们恐怕已经老得管理不动公司了。海因茨·赫尔曼·蒂勒（Heinz Herrmann Thiele）把他创建的克诺尔（Knorr-Bremse）发展成了领先的火车和卡车制动器供应商，在和唯一的儿子闹翻之后，于2018年把公司的三分之一拿到法兰克福证券交易所上市，为自己和女儿赚得39亿欧元。

又或者，争执不休的家族可以一拍两散，分道扬镳。德国一些响当当的大品牌正是家族分裂的结果。做制鞋生意的达斯勒（Dassler）两兄弟反目后，于1948年诞生了阿迪达斯和彪马两家企业，现在都还经营高端运动鞋。1960年，阿尔布雷希特（Albrecht）兄弟在是否销售香烟的问题上相持不下，也导致公司一分为二：北阿尔迪（Aldi Nord）在德国北部以及主要在西欧和中欧的一些国家开展业务；南阿尔迪（Aldi Süd）覆盖德国南部、欧洲其余地区，以及澳大利亚和中国。

另一家智库德国经济研究所（German Economic Institute）的克劳斯-海纳

·罗尔（Klaus-Heiner Röhl）表示，对于内部有多元利益追求的集团来说，分家也许是合理的。但这会削弱构成了德国中小企业界的专业公司的实力。北阿尔迪的最新一代继承人十年来一直在争权夺利。这种争斗阻碍了两家阿尔迪重新合体的明智走向，即便这原本对双方都有益。 ■



Charlemagne

Eastern Europe's brain gain

How the pandemic has reversed old migration patterns

AFTER A DECADE in Britain, it took Alexej Kirillov barely 24 hours to decide to leave. In March 2020, as Europe's borders slammed shut, Mr Kirillov, a 31-year-old strategy consultant, had a choice: lockdown in a costly, lonely London flat or go home to the Czech Republic and be close to family. “I was not planning to leave for another five years, or longer, or never,” he says. But covid-19 changed his mind. Nearly a year on, he has set up shop in his homeland. A temporary return has become permanent. “Now I’m back, I think why didn’t I move back sooner?”

He was not alone. In 2020 Europe saw a great reverse migration, as those who had sought work abroad returned home. Exact numbers are hard to come by. An estimated 1.3m Romanians went back to Romania—equivalent to three times the population of its second-biggest city. Perhaps 500,000 Bulgarians returned to Bulgaria—a huge number for a country of 7m. Lithuania has seen more citizens arriving than leaving for the first time in years. Other measures show the same. In Warsaw, dating apps brim with returning Poles looking for socially undistanced fun. Politicians in eastern Europe had long complained of a “brain drain” as their brightest left in search of higher wages in the west. Now the pandemic, a shifting economy and changing work patterns are bringing many of them back. A “brain gain” has begun.

Migration vexes European politicians. Freedom of movement—the ability to move to any country in the EU—is among the most popular benefits of belonging to the club. It is especially cherished by citizens of former communist countries, who have grim memories of being prevented from

travelling by their own rulers. However, although most Europeans believe in freedom of movement for themselves, some are less sure about granting it to others. (Hence Brexit.) And governments of countries that lose lots of clever, enterprising young people tend to lament this fact. Graphics on Lithuanian government websites show the population dwindling from 3.7m in 1990 to 2.8m in 2019, thanks to emigration and low birth rates. About 2m Poles—or 5% of the country's population—live elsewhere in Europe. Often, it is the most qualified. Doctors and nurses quitting Romania are a particular bugbear. Migration creates a clash of interests between individuals, who want to better their own lot, and governments, who would often prefer them to stick around and pay taxes. Ivan Krastev, a Bulgarian writer, observes that “It is easier to go to Germany than to make Bulgaria function like Germany.” And so people do.

Yet even before the pandemic, this process had started to reverse in some places. Emigrants from the Baltic states have been heading back, having earned a nest-egg or picked up useful skills in western Europe. Homeward-bound Estonians have outstripped leaving Estonians since 2017. A government programme to help returning Lithuanians had 215 consultations in 2015; this ballooned to nearly 9,000 by 2019. Similar tales can be heard in bigger countries. In 2018 the number of Poles abroad started to fall for the first time in nearly a decade and has steadily declined ever since, according to the Polish Economic Institute, a think-tank. Dedicated schemes—ranging from glossy propaganda about life in the Baltics to free Polish lessons for children born abroad—are common.

Migration anywhere in the world is often temporary. In Europe several factors are pushing and pulling people homewards. Liam Patuzzi of the Migration Policy Institute Europe, a think-tank, notes that the economic gap between east and west is closing. Labour markets in eastern Europe are hot. Before the pandemic, the unemployment rate in the Czech Republic was about 2%, the lowest in the bloc, down from almost 9% when it joined in

2004. Wage gaps, though still large, are falling. In 2010 a Romanian who moved to Italy could expect to earn five times more; in 2019, only three times. For the highly skilled the gap is narrower still. Throw in perks such as Romanian software developers being exempt from income tax, and a job in Bucharest can trump one in Brussels.

Remote working alters the calculation, too. A new grey economy has sprung up across the EU, with white-collar staff living in one country but illicitly working in another (and paying tax in the wrong place, as a result). Often these people are expats in their own country, physically at home, but telecommuting across a border. Headhunters now dangle the prospect of working anywhere, says a Romanian private-equity executive. Once the taxman catches up, however, those grey workers will have to choose: stay or go.

Blue-collar workers typically have fewer choices. Waiters and cleaners, many of whom are migrants, cannot work remotely. Some 700,000 foreign workers have left London during the pandemic, deciding that the occasional glimpse of the Thames did not make up for high rents and the sudden collapse of job opportunities. But for white-collar workers the link between opportunity and location could be drastically weakened, spelling another shift in migration patterns. Greece, which saw phalanxes of youngsters leave during its bail-out, is eager to attract them back. If the sun is not tempting enough, the tax breaks help. Workers who move to the country can have their tax bill halved for the first seven years.

The number of people flowing back to eastern Europe is still much smaller than the number who originally left. And those who went home because of the pandemic may head off again when the lockdowns ease. About two-thirds of the Bulgarians who returned plan to migrate again, according to the European Council on Foreign Relations, a think-tank. In the long run, even as wage gaps close, some people will always seek adventure in foreign

lands. Open borders in Europe allow people to choose where to live, which inevitably means that less attractive places will lose population. But nothing remains the same. Countries can grow more appealing, and people can change their minds quite suddenly about where they want to live. Ask Mr Kirillov. ■



查理曼

人才回流东欧

疫情扭转了旧有人口迁移模式

在英国待了十年之后，阿列克谢·基里洛夫（Alexej Kirillov）只用了24小时就做出了离开的决定。2020年3月，随着欧洲各国的国门重重关上，这位31岁的战略咨询顾问面临着一个选择：要么孤身一人困在伦敦昂贵的寓所里，要么回到捷克的家人身边。“我本来打算过五年或更久些再走，或者永远不走的。”他说。但新冠肺炎让他改变了想法。现在将近一年过去了，他已经在祖国拥有了自己的公司。暂时回国变成了长久定居。“现在我回来了，我在想为什么没早点回来呢？”

基里洛夫并非个例。2020年，随着那些出国找工作的人返回家乡，欧洲出现了大规模人口回流。确切数字难以获得。估计有130万罗马尼亚人回国——相当于该国第二大城市人口的三倍。或许有50万保加利亚人回国——对于一个人口仅700万的国家来说是个巨大的数字。立陶宛的回国人数多年来首次超过了出国人数。其他指标也显示出同样的结果。在华沙，交友软件上满是回国的波兰人在寻找无需保持社交距离的乐趣。长期以来，东欧的政客一直在抱怨“人才流失”，因为他们国家最聪明的人为了高工资去了西欧。现在，受新冠疫情、经济转型和工作方式转变等因素的影响，他们中的很多人正在往回走。“人才回流”的大幕已经开启。

移民问题一直困扰着欧洲的政客。加入欧盟最受欢迎的好处之一是迁移自由，即可以迁移到欧盟的任何一个国家。这一点尤其受到前社会主义国家公民的珍视，他们的记忆中还留有本国统治者不准他们出国的阴影。然而，尽管大多数欧洲人相信自己应该拥有迁移的自由，但在同意其他人自由迁移上，一些人却没那么确定了。（英国脱欧就是这么来的。）而在那些流失了大量聪明的、有进取心的年轻人的国家，政府常常在哀叹这种现实。立陶宛政府网站上的图表显示，由于人口流失和低出生率，立陶宛的人口从1990年的370万减少到2019年的280万。大约200万波兰人也就是该

国5%的人口都生活在欧洲其他地方。这些人通常是资质最高的群体。罗马尼亚医生和护士的流失尤其令该国烦恼。人口迁移造成了个人和政府之间的利益冲突，前者希望改善自己的生活状况，而后者往往更希望他们留下来纳税。保加利亚作家伊万·克拉斯特夫（Ivan Krastev）说，“直接去德国比让保加利亚像德国一样运转更容易。”人们确实就这么做了。

然而，即使是在疫情爆发之前，这种局面在一些地方就已开始逆转。来自波罗的海国家的人在西欧攒下一笔钱或掌握了有用的技能后，纷纷回国。自2017年以来，爱沙尼亚的回国人数已经超过了出国人数。一个为回归的立陶宛人提供帮助的政府项目在2015年收到215人次咨询，到2019年已猛涨到近9000人次。类似的趋势也在更大的国家上演。根据智库波兰经济研究所（Polish Economic Institute）的数据，2018年，在国外的波兰人数量近十年来首次下降，此后持续稳步下跌。各种专项方案随处可见，包括对波罗的海国家生活的华丽宣传、为海外出生的孩子提供免费的波兰语课程等等。

人口迁移在世界任何地方经常都是暂时的。在欧洲，几个因素正在推动或吸引人口回流母国。智库欧洲移民政策研究所（Migration Policy Institute Europe）的利亚姆·帕图兹（Liam Patuzzi）指出，东西欧之间的经济差距正在缩小。东欧的劳动力市场很活跃。捷克2004年加入欧盟时的失业率将近9%，而到疫情爆发之前已降到约2%，为欧盟最低。尽管工资差距仍然很大，但正在缩小。2010年，到意大利工作的罗马尼亚人有望挣到本国收入的五倍以上，到了2019年就只有三倍了。对于高技能人才来说差距就变得更小了。给予一些额外的福利，比如让罗马尼亚软件开发人员免缴所得税，就会让布加勒斯特的一份工作比布鲁塞尔的更有吸引力了。

远程工作也改变了人们对去留的盘算。欧盟各地兴起了一种新型灰色经济——白领们在一个国家生活，在另一个国家非正规打工（结果就是没在该纳税的地方纳税）。这些人常常成了身在母国的外派人员：人在国内，但跨国远程办公。一位罗马尼亚私募股权公司的高管说，现在猎头常以工作不受地域限制为诱饵。然而，一旦税务人员查上门来，这些在灰色地带的人将不得不在走或留之间做出选择。

蓝领工人通常选择余地较少。移民人口众多的服务员和清洁工无法远程工作。大约70万外籍劳工在疫情期间离开了伦敦，他们认为偶尔看看泰晤士河并不能弥补昂贵的房租和工作机会骤减带来的损失。但对白领来说，工作机会和工作地点之间的关联可能极大地削弱，意味着人口迁移模式的又一次转变。希腊现在迫切希望能把在债务危机期间离开的大批年轻人吸引回来。如果这里的阳光不够有吸引力，那么减免税会有帮助。从国外搬到希腊工作的人可以在前七年里享受税款减半。

相比当初离开的人数，如今返回东欧的队伍仍然要小得多。而当封锁措施放松时，那些因疫情回国的人可能会再次掉头离开。智库欧洲外交关系协会（European Council on Foreign Relations）称，大约三分之二回到保加利亚的人打算再次出国。从长远来看，就算工资差距缩小，总还是会有人去国外冒险。欧洲开放的边境让人们可以选择居住地，这就不可避免地会导致吸引力较小的地方人口流失。但没有什么是一成不变的。国家可以变得更有吸引力，民众可以随时改变想法，决定去哪里生活。不信问问基里洛夫。 ■



African students

School's out

The pandemic disrupts China's rise as a destination for foreign scholars

WHEN HIBA BOUROUQIA won a Chinese government scholarship to study international trade, she was “full of hope, full of life”. Now, however, “I just sit and cry,” says the 19-year-old Moroccan. China’s strict quarantine measures have forced her to study remotely from her home near Casablanca. Ms Bourouqia considered giving up and applying for a Moroccan university. But she says the academic standards are not up to China’s, so she is persevering.

Around the world the dreams of many international students have been shattered by the pandemic. The virus has also damaged China’s hopes to continue as a major destination for international students. In 2019 it was third globally, receiving almost 500,000 foreign students, just behind Britain, though still only half the number going to America. Now, however, China’s tough border controls have made it almost impossible for overseas students to enter the country. Many are furious.

Africa has been a big target of Chinese efforts to enhance its global “soft power”. More than 80,000 Africans were studying there before the pandemic struck. China has surpassed America (47,000) and Britain (29,000) as the destination of choice for African students and is now closing on the traditional frontrunner, France (112,000). The Chinese government has showered the continent with bursaries. One education charity estimates that 43% of all scholarships to sub-Saharan Africa are provided by the Chinese government.

Unlike Western students, who usually study in China for a year at most,

many Africans live from enrolment to graduation on campus. And for all China's largesse with scholarships, about 85% of them are self-funded, so they feel heavily invested. They also worry about job prospects. "Would you employ a person who did civil engineering online?" asks Davine, a third-year undergraduate who is stuck in his home country, Zimbabwe.

Many African students have joined an international social-media campaign, #TakeUsBackToChina. It accuses China of ignoring their pleas to be allowed back, even though they are prepared to take necessary tests for covid-19 and submit to quarantine. They have written a petition saying they cannot continue to pay fees for poor online lessons that often require them to be up in the middle of their night.

The grievances of African students have been compounded by a spate of racist incidents in China early last year. In the southern city of Guangzhou, dozens of Africans, including students, were evicted from their homes after several Nigerians tested positive for covid-19.

But in spite of the current problems China's universities are likely to keep attracting Africans. A year at a leading Chinese college, many of which are rising up global league tables, costs no more than \$4,000 in fees, one-tenth of the cost in Europe or America. Mostapha El-Salamony, an Egyptian doctoral student in aerodynamics at Peking University, says it is also easier to gain admission to Chinese universities and, in normal times, to secure a visa. He says he works with top-class scientists and equipment, and most classes for international students are taught in English. Says Ms Bourouqia, "China was and still is the best choice." ■



非洲学生

无法入校

中国成为外国大学生主要留学目的地的进程被疫情扰乱

当席巴·波罗奇亚（Hiba Bourouquia）获得中国政府奖学金学习国际贸易时，她“充满了希望，充满了活力”。但是现在，“我只能坐着哭。”这个19岁的摩洛哥女孩说。中国严格的检疫措施迫使她只能在卡萨布兰卡附近的家里远程学习。波罗奇亚想过放弃，申请一所摩洛哥大学。但她说那里的学术水平比不上中国，所以她还在坚持。

环顾全球，许多国际学生的梦想都被疫情粉碎。新冠病毒也破坏了中国继续作为国际学生主要目的地的希望。2019年，中国接收了近50万名外国学生，在全球排名第三，略少于英国，尽管还只有美国的一半。然而，现在中国严格的边境管制让海外学生几乎不可能进入中国。许多人感到愤怒。

非洲一直是中国寻求提升自己全球“软实力”的一大目标。疫情爆发之前有八万多名非洲人在中国学习。中国已经超过美国（47,000人）和英国（29,000人）成为非洲留学生的主要目的地，且开始追赶传统的领头羊法国（112,000人）。中国政府向非洲提供了大量奖学金。一家教育慈善机构估计，撒哈拉以南非洲地区获得的奖学金中有43%由中国政府提供。

西方学生通常在中国最多学习一年，而许多非洲学生从入学到毕业都住在校内。尽管中国在奖学金上已经很慷慨，但仍有约85%的学生是自费的，因此他们自觉投入巨大。他们也担心就业前景。“你会雇用一个在网上学土木工程的人吗？”被困在祖国津巴布韦的大三学生达瓦恩（Davine）问道。

许多非洲学生加入了社交媒体上的一个国际运动“#带我们回中国”（#TakeUsBackToChina）。该运动指责中国无视学生们要求返校的请求，尽管他们已经准备好接受必要的核酸检测并配合隔离。他们已经写了一份请愿书，表示不能继续为糟糕的在线课程付费，这些课程常常要求他

们半夜起床。

去年初中国发生的一系列种族主义事件加剧了非洲学生的不满情绪。在广州，在几名尼日利亚人检测出新冠阳性后，包括一些学生在内的几十个非洲人被逐出住处。

但是，尽管有眼下这些问题，中国的大学看来仍会吸引非洲学生。中国的顶尖大学有很多在全球的排名不断上升，在那里读一年的费用不超过4000美元，是欧洲或美国高校的十分之一。北京大学空气动力学博士生、埃及人穆斯塔法·埃尔-萨拉莫尼（Mostapha El-Salamony）表示，申请中国的大学也更容易录取，在正常时期也更容易获得签证。他说他和一流的科学家一起工作，使用一流的设备，大多数国际学生的课程用英语授课。“中国过去是，现在仍然是最好的选择。”波罗奇亚说。 ■



Job titles

Hail to the “chiefs”

An epidemic of new corporate roles

WHEN MEETING big new challenges, chief executive officers often resort to a convenient tool: creating fresh executive roles. This helps channel resources to pressing problems and attract talent. It signals to staff and the wider world that bosses understand what really matters (and care about it).

Sometimes, it ends up looking farcical—remember the proliferation of “chief listening officers” a decade ago, as companies sought to react to social-media chatter? But certain newfangled C-suite roles do catch on; no self-respecting corporation can do without a chief sustainability officer these days. A few corporate positions that have gained prominence during a particularly tumultuous 2020 are almost certainly here to stay.

The most obvious example is “chief medical officer”. Long common in industries where safety is an abiding concern (mining, say), health supremos are now being recruited more widely, says Tony Lee of the Society for Human Resource Management, a trade association. The pandemic is far from over, red tape around sick leave is becoming more tangled as a result of it, and mental-health problems among employees are likely to outlive the plague.

Another emerging role is that of “chief remote officer”, responsible for designing policies and disseminating best practices for home-working. Succeeding could therefore mean making oneself redundant. Mr Lee thinks this role will eventually disappear, especially at smaller companies (though it may hang around at bigger ones with more complicated and dispersed workforces). As Bhushan Sethi of PwC, a consultancy, points out, something

similar happened to chief digital officers, whom firms have recruited with gusto over the past decades. Digital honchos' ranks are beginning to thin now that digital technology has become part of most companies' bread and butter.

Indeed, recruitment trends show that it is bread and butter that continues to preoccupy bosses. Hiring of "chief revenue officers" and "chief growth officers", charged with co-ordinating firms' sales-generating activities, has accelerated as pandemic lockdowns simultaneously restrict economies' supply and demand sides, according to a survey by LinkedIn, a professional social network (see chart). Their share of C-suite hires is now, respectively, twice and nearly three times what it was in 2017.

However, last year's hottest executive recruits had nothing to do with covid-19. As protests against racial injustice rocked America last summer, companies rushed to enlist chief diversity officers, who ensure their workforce is representative of society at large.

One risk to diversity chiefs' future job security is that most of them have not been invited to sit at the corporate top table. Most lack a direct line to the CEO. At worst, the post becomes "a ceremonial role", with no authority, resources or structure, warns Michael Hyter of Korn Ferry, a consultancy. At best, like other modish corporate roles, it may eventually become redundant. ■



职位头衔

向“首席们”致意

新高管职位大流行

每当遇到重大的新挑战，首席执行官们往往会拾起一个趁手的工具：创造新的高管职位。这有助于把资源导向那些急迫的问题，又能吸引人才。这是向员工和外界发出信号，表明老板明白真正要紧的事情是什么（并且很关心它）。

有时，结果会显得荒诞可笑——还记得十年前企业为应对社交媒体上的各种闲言碎语纷纷增设“首席倾听官”吗？但某些新奇的“首席”职位确实普及了。如今，“首席可持续发展官”成了任何一家体面的公司都不能缺少的职位。一些在异常动荡的2020年异军突起的高管职位几乎肯定会保留下去。

最明显的例子就是“首席医疗官”。长期以来，在一些安全问题挥之不去的行业（如采矿业），医疗高管是常设职位，而现在越来越多的行业都在招聘这方面的高管，行业组织人力资源管理协会（Society for Human Resource Management）的托尼·李（Tony Lee）表示。疫情远未结束，病假审批手续正因此而变得更复杂，而且在疫情消退后，员工的心理健康问题也很可能长期存在。

另一个新兴头衔是“首席远程官”，负责为居家办公制定政策和推广最佳做法。所以等到工作成功完成，自己的岗位可能也就多余了。李认为这个职位最终会消失，尤其是在较小的公司（在员工构成更复杂分散的大企业可能还会保留一段时间。）咨询公司普华永道的布尚·塞提（Bhushan Sethi）指出，过去几十年里企业大举招聘的“首席数字官”也是类似的情形。如今数字技术已经成为大多数公司的主要收入组成，数字高管的队伍规模开始缩减。

事实上，招聘趋势表明，公司的生计所系是老板们始终最关注的。职业社交网站领英的调查显示，在疫情封锁措施令经济体的供需双侧同时受限的

大环境下，负责协调公司创造收入的活动的“首席营收官”和“首席增长官”的招聘呈现加速趋势（见图表）。目前，两者在C级高管职位招聘中的占比分别是2017年时的两倍和近三倍。

不过，去年最热门的高管职位与新冠疫情无关。随着去年夏天美国爆发大规模反种族歧视抗议活动，企业连忙征召“首席多元化官”以确保自己的员工队伍能体现社会整体的多元性。

首席多元化官的未来职业保障存在一个风险，那就是他们大多在董事会没有位置，也并不直接向首席执行官汇报。咨询公司光辉国际（Korn Ferry）的迈克尔·海特（Michael Hyter）提醒道，最糟糕的情况是这个职位会沦为没有实权、资源或结构支撑的“花瓶角色”。最好的情况下，它可能最终还是会变得多余，就像其他流行一时的高管角色一样。■



The new intermediaries

Pay-per trade

The rise of high-speed marketmakers and payment for order flow

FROM ONE perspective, retail stock traders have never had it so good. There is fierce competition among brokers, including the likes of Charles Schwab and Fidelity, for their business. This broke out into an all-out price war in 2019 when these firms cut stock-trading commissions to zero, four years after Robinhood, a startup promising commission-free trading, came on the scene. Retail participation in stock trading is at a new high.

This happy picture is somewhat muddied by the practice of payment for order flow (PFOF). Instead of charging users for each trade, brokers are paid by marketmakers to direct users' trades—or “order flow”—through them. Marketmakers take small profits on the difference between the price that a broker's user pays and that at which a share is offered for sale in the market. The mania around GameStop, a seller of video games, has put the practice, and its practitioners, in the spotlight.

On January 28th Robinhood decided to suspend buy orders for GameStop, after the retailer went viral in a forum on Reddit, a social-media site, and its shares spiked in value. The decision outraged users and was condemned by lawmakers on both sides of the aisle. Robinhood contends the decision reflected its obligations to the DTCC, a clearing-house that settles most equity trades. There is a two-day lag between an equity trade and its settlement, when the buyer gets their share and the seller receives their cash. In the interim, brokers must post collateral for users' trades.

Vladimir Tenev, one of Robinhood's founders, said he received a “nerve-wracking” call from the DTCC as GameStop prices surged, asking him to post

\$3bn in collateral. To meet these demands, the firm drew down its credit lines with banks and raised \$1bn in capital. (It has since raised a further \$2.4bn.) And to limit the amount of collateral it would have to post, it also temporarily halted buy orders for certain stocks.

Users decried the decision. Robinhood earned around \$200m from PFOF in the fourth quarter of 2020 (see chart). Last year most of its orders flowed through Citadel Securities, a marketmaker run by Ken Griffin, a Chicago-based billionaire. The same parent company owns Citadel, a hedge fund. It had bailed out Melvin Capital, one of the funds short-selling GameStop, which had been targeted by the army of retail investors.

Users have questioned whether these links played some part in Robinhood's decision to halt buy orders. (As has Elon Musk, the boss of Tesla, who nicknamed Mr Tenev "Vlad the stock impaler" when he interviewed him about the decision on social media on January 31st.) Mr Tenev has said "we absolutely did not do this at the direction of any marketmaker or hedge fund." And Citadel has said it is not involved in, or responsible for, any retail broker's decision to stop trading.

But questions about the ethics and prevalence of the practice, which is banned in Britain and Canada, are likely to linger. The GameStop episode has drawn attention to a group of tech-savvy high-frequency marketmakers, notably Citadel, that has largely replaced banks as the main intermediaries of stockmarkets. They stand in between market participants and stock exchanges, matching trades in microseconds. Though they take orders from all sorts of institutions, including hedge funds and pension funds, they typically only pay for orders from retail brokers.

That in itself is not necessarily suspicious: marketmakers regard retail order flow as "friendly". Institutions might "run over" a marketmaker by placing

orders in several places simultaneously, or place an “iceberg” order, one much larger than it first appears. Both strategies make it hard for the marketmaker to profit on trades. Retail orders carry no such risk.

Much of the scrutiny, though, is likely to rest on Robinhood. The online broker earns a lot more from marketmakers than its peers do. This is because it charges more: for every 100 shares Robinhood’s users traded in companies listed in the S&P 500 in the fourth quarter of 2020, it collected an average of 41.8 cents from marketmakers. Charles Schwab, by contrast, collected just 11.7 cents.

Robinhood has been in trouble with regulators before. In December the Securities and Exchange Commission told it off for not telling users it made money from PFOF. The commission also found the broker failed in its duty to execute users’ trades at the best possible price. Robinhood paid \$65m to settle the charges. (It has said the fine relates to historical practices.)

Mr Tenev is due to testify in front of the House Financial Services Committee on February 18th. The subject of PFOF will inevitably come up. As its share price tumbles, GameStop’s time in the spotlight may soon be over. For Robinhood and PFOF, though, this is perhaps just the start. ■



新式中介

每笔交易返点

高频做市商与订单流返点的崛起

从某种角度看，股票投资散户迎来了前所未有的好日子。嘉信理财（Charles Schwab）和富达（Fidelity）等券商激烈争夺他们。2019年，在承诺零佣金交易的创业公司罗宾侠（Robinhood）打入市场的四年后，这些公司把股票交易佣金降为零，打响了全面价格战。如今，参与股票交易的散户创下新高。

但这番美好图景有些被“订单流返点”（以下简称PFOF）这种操作蒙上了阴影。券商并不是就每笔交易向用户收取费用，而是通过把用户的交易——也就是“订单流”——导给做市商，从做市商那里获得付费。做市商从券商用户支付的价格和市场出售股票的价格差额中获取小额利润。围绕电子游戏销售商游戏驿站（GameStop）的交易狂潮让PFOF及其操作者成为了焦点。

此前，散户在社交网站Reddit的一个讨论板上迅速抱团，推动游戏驿站的股价飙升。1月28日，罗宾侠决定暂时禁止用户买入该公司股票。此举引发用户激愤，也招来了美国两党议员的一致谴责。罗宾侠辩称，该决定体现了自己对美国证券托管结算公司（以下简称DTCC）这个结算美国大部分证券交易的机构负有的义务。证券交易和最终结算（即买方获得股票，卖方收到钱）之间有两天的时间差，在此期间券商必须为用户的交易提供担保。

罗宾侠的创始人之一弗拉基米尔·特涅夫（Vladimir Tenev）表示，游戏驿站股价飙升之际，DTCC提出了“令人头痛”的要求，要他提供30亿美元的担保。为满足这一要求，罗宾侠通过提取银行信贷额度筹集到10亿美元的资金（此后又筹集了24亿美元）。为限制须提供的担保额，罗宾侠还暂停了某些股票的买入订单。

用户高声谴责该决定。2020年第四季度，罗宾侠通过PFOF赚取了约两亿美元（见图表）。去年，其大部分订单都由芝加哥亿万富翁肯·格里芬（Ken Griffin）经营的做市商Citadel证券（Citadel Securities）成交。Citadel证券的母公司旗下还有对冲基金Citadel，该基金曾为梅尔文资本（Melvin Capital）纾困，后者是做空游戏驿站的基金之一，已经成为散户大军的逼空目标。

用户质疑这些关联是否影响到罗宾侠做出了暂停交易的决定。（特斯拉的老板马斯克也是这样想的。1月31日他在社交媒体上对话特涅夫讨论他的这项决定时，称他为“股市吸血鬼弗拉德”。）特涅夫表示：“我们绝对不是在任何做市商或对冲基金的指示下这么做的。”而Citadel也表示并未参与或主使任何散户券商暂停交易的决定。

但对这种做法（在英国和加拿大是被禁止的）道德与否及其普遍性的质疑很可能继续下去。游戏驿站事件引起了人们对Citadel等一批高科技高频做市商的关注，它们在很大程度上已经取代银行，成为了股票市场的主要中介方。它们居于市场参与者和证券交易所之间，在微秒之间匹配交易。尽管它们接受包括对冲基金和养老基金在内的各类机构投资者的订单，但通常只对来自散户券商的订单付费。

这本身未必有什么问题：做市商认为散户订单流“友好”。机构投资者可能会通过同时在多处下单来“复核”做市商，或者下“冰山”单（即比一开始看起来大得多的订单）。这两种策略都会使做市商难以在交易中获利。散户订单没有这类风险。

但更多的审视可能会落到罗宾侠身上。这家线上券商从做市商那里赚到的钱比其同行多得多。这是因为它收费更高：2020年第四季度，罗宾侠的用户每交易100股标普500公司的股票，就能从做市商那里平均收取41.8美分。相比之下，嘉信理财仅收取11.7美分。

罗宾侠之前也被监管机构盯上过。去年12月，它因在未告知用户的情况下通过PFOF获利而遭美国证监会（SEC）调查。该机构还发现它没有尽责以

最佳价格为用户执行交易。罗宾侠支付了6500万美元达成和解。（它声称这笔罚款涉及的是历史行为。）

特涅夫将于2月18日在美国众议院金融服务委员会（House Financial Services Committee）前作证。PFOF的议题会无可避免地被提起讨论。随着股价下跌，游戏驿站的高光时刻可能会很快结束。但对于罗宾侠和PFOF而言，或许一切才刚刚开始。 ■



The death of age

Who wants to live for ever?

Ageing can be cured—and, in part, it soon will be

“OLD AGE is a massacre,” wrote Philip Roth, long before the pandemic underscored its hazards. Even those who count as young must often watch the ineluctable drift of loved ones into decrepitude. Andrew Steele has a hopeful message for all those facing this prospect (ie, everyone). Old age needn’t be a massacre; in fact, old age needn’t even be old.

Mr Steele’s thesis in “Ageless” is that ageing can be cured—and, at least in part, that it very soon will be. The giant tortoises of the Galapagos Islands show no age-related decline, in some ways seeming as youthful at 170 as at 30. Mr Steele thinks this phenomenon, known as negligible senescence, is within humanity’s grasp, too.

Whether or not readers are persuaded that ageless humans could ever be more than a theoretical possibility—and it is a stretch—this book will convince them that discounting the theoretical possibility altogether is based on nothing but prejudice. Western art may have something to do with it, bristling as it is with morality tales about the folly of wanting to turn back the clock; but there is actually no good reason to assume an upper limit to longevity, or that ageing must come with decline. And there is quite a lot of evidence to the contrary. Without the rich world’s denizens really noticing, a life that ends after the biblical three score years and ten has already come to seem a life cut short; instead, 90 is now seen as a good innings.

This prejudice held back the field of biogerontology for a very long time, but in the past few decades some scientists have cast it aside. This has enabled them to see that the real folly lies in the attempt to cure the diseases

of old age one by one, rather than tackling their underlying cause—ageing itself. Now they are trying to understand that process in all its extraordinary complexity, and to intervene much earlier.

They have many tools at their disposal, and Mr Steele, who has a background in computational biology, evaluates them expertly and with verve. They range from drugs that mimic the life-extending effects of dietary restriction to gene-editing tools such as CRISPR and computer models that simulate whole biological systems. Such models may eventually prove the key that unlocks the inner Methuselah in everyone, by revealing both the limits to these systems and their redundancies: what can be tweaked, and what had best be left alone.

Temporarily—and with a bitter irony—covid-19 has slammed the brakes on this burgeoning area of research. But Mr Steele thinks its first dividends will emerge within a couple of years, perhaps in the form of senolytic drugs that clear the accumulating cellular detritus of a long life. He makes the valid point that if, for every year of scientific endeavour, a year could be added to the average human lifespan, old age would recede into the future at the same rate as today's population approached it. That would itself be quite a milestone on the road to negligible senescence.

This interim goal is easily within reach, he claims. Many scientists agree—and are among those who have chosen to take experimental anti-ageing drugs. For some of these treatments they have calculated that the risks are small, compared with the potential benefits. The true sign that a scientific revolution is in the offing is that the scientists themselves have bought into it. Whether that revolution is desirable is a different question, which it may fall to a new generation of artists to answer. ■



年龄之死

谁人欲永生？

衰老可以被治愈——而且从某种程度上来说很快就可以【《无龄》书评】

“老年是一场大屠杀。”在新冠疫情突显老年之风险前很久，菲利普·罗斯（Philip Roth）就曾这样写道。即使是那些被划分为年轻人的人也常常要目睹至亲至爱之人不可避免地滑向衰老。安德鲁·斯蒂尔（Andrew Steele）有一个充满希望的消息要传达给所有面对这种前景的人（也就是每个人）。老年不一定是一场大屠杀，事实上，老年甚至不必定是衰老的。

斯蒂尔在《无龄》（Ageless）一书中的论点是衰老可以被治愈——而且至少在某种程度上能很快被治愈。加拉帕戈斯群岛的巨型陆龟并没有显现出与年龄相关的衰退，它们在170岁时在某些方面看起来还和30岁时一样年轻。斯蒂尔认为人类身上也能够实现这种被称为“可忽略衰老”的现象。

这本书未必能说服读者相信“无龄之人”不仅仅在理论上是可能的（这确实有点强人所难了），但会让他们确信，一股脑地漠视这种理论可能性仅仅是基于偏见。西方艺术可能脱不了干系——它有一大堆的道德故事讥讽妄图让时光倒流的蠢行。然而事实上并没有什么靠谱的理由认定寿命是有上限的，或认为老龄必然伴随着机能衰退。而且有相当多的证据证明事实正相反。古语云“人生七十古来稀”，而在富裕世界里，不知不觉中70岁过世已被认为是早逝了；现在90岁作古才算得上是终其天年。

在漫长的历史中，这种偏见阻碍了生物老年学领域的发展，但在过去的几十年里，一些科学家已将它抛诸一边。这让他们得以认识到，真正的蠢行是试图把各种老年疾病逐一治愈，而不尝试解决其背后的根本原因——衰老本身。现在他们正尝试理解这一极端复杂的过程，好早早出手干预。

他们有许多工具可用。拥有计算生物学背景的斯蒂尔热情洋溢、游刃有余地评估了这些工具。它们多种多样，从模拟饮食限制之延年益寿功效的药

物，到CRISPR等基因编辑工具，再到模拟整个生物系统的计算机模型。这些模型可揭示各个生物系统的局限和冗余，指导科学家哪些可以微调，哪些最好不要去管。这让它们最终可能成为一把钥匙，激活每个人内在的那个千岁人瑞。

新冠肺炎暂时令这一新兴研究领域的进程戛然而止，这颇具苦涩的讽刺。但斯蒂尔认为，该领域的第一波红利将在两三年内显现，具体可能表现为“返老药”的出现，它能够清除人们体内在漫长岁月中累积起来的细胞碎屑。斯蒂尔提出了一个合理观点：如果科研人员每年的努力能让人类的平均寿命增加一年，那么在今天的人们向老年靠近之时，老年的坐标会以同样的速度向后退。这本身就堪称通往“可忽略衰老”的道路上的一座里程碑。

他声称这个中期目标很容易实现。许多科学家也同意这一点——选择服用实验性抗衰老药物的人当中就有他们自己。他们已经估算出，其中某些疗法的风险与潜在的好处相比不算大。一场科学革命即将到来的可靠征兆是科学家们以身试药。至于这场革命是否可取就是另一个问题了，恐怕得留给新一代的艺术家们去回答。 ■



The future of Amazon

Life after Jeff

The online giant's larger-than-life founder is a tough act to follow. Does Andy Jassy have the chops?

ON FEBRUARY 2ND Amazon, America's third-most-valuable public company, announced its best-ever quarter. Propelled by the covid-19 pandemic, which has confined consumers to their homes, the firm reported that quarterly sales had risen 44% year on year, and exceeded \$100bn for the first time. It was a barnstorming performance. But it was not the main story. On the same day the firm announced that Jeff Bezos, its boss and founder, will step down as chief executive this summer after nearly three decades in charge.

Mr Bezos will not leave the company. He plans to boot himself upstairs to become executive chairman. That role, he said, will allow him to remain "engaged in important Amazon initiatives", but also give him more time to focus on other interests, notably space travel, fighting climate change and the *Washington Post*, a newspaper he bought in 2013. His replacement as CEO will be Andy Jassy, a long-serving Amazon employee who built and runs Amazon Web Services (AWS), the firm's highly profitable cloud-computing division.

The news prompted gushing tributes to a man who began selling books online in 1994 with a recycled wooden door for a desk. Bernstein, a broker, described Mr Bezos as the "greatest of all time". Mr Bezos has certainly made a mark. In 2019 Amazon delivered 3.5bn parcels, one for every other human being on the planet—and that was before the pandemic turbocharged online shopping. His rigorous, tight-fisted insistence that Amazon's employees treat every day as if it were "day one" at a hard-pressed startup has helped

the firm move into new lines of business, from smart speakers and video-streaming to advertising and cloud-computing. Its valuation has risen 3,000-fold since its market debut in 1997.

Mr Jassy, in other words, will take control of a firm in an enviable position. Amazon is not without problems—it has struggled in some overseas markets, and faces attention from trustbusters in America and elsewhere. Still, few firms are in better nick to face those challenges down.

Founders often find it hard to let go. One immediate question is therefore how much control Mr Bezos will actually cede. “I think it’s inevitable that there will be at least a bit of back-seat driving for the first few years,” says Nick McQuire of CCS Insight, a research firm. But Mr Bezos may not need day-to-day involvement to see his company carry on in his image. “Amazon has the most codified culture of any big tech firm,” says Aaron Levie, the boss of Box, a cloud-computing company. “It is built to outlast its founder.”

Mr Jassy is in any case more of a continuity candidate than a revolutionary. Brian Olsavsky, Amazon’s finance chief, reassured analysts on the earnings call that “He’s been here almost as long as Jeff.” Mr Jassy joined in the year Amazon went public and has been close to Mr Bezos since. He comes across as detail-oriented and more than a little nerdy—much like Mr Bezos in his first couple of decades in charge.

That does not mean that nothing will change. Although Bernstein expects Amazon’s retail-related revenues to remain at roughly two-thirds of the total in the next few years, by 2024 digital adverts may be its biggest source of profits, overtaking cloud computing; retail may actually add materially to the bottom line (see chart). Last year Jeff Wilke, who ran the mammoth retail arm, said he would leave the company, depriving Mr Jassy of an able lieutenant.

Customers in America are beginning to grumble that Amazon is becoming a flea market, with ever shoddier products juiced with faked reviews. This has yet to stop them shopping there, as the latest results attest. But it could turn into a problem. Abroad, where sales grew briskly last year, the incoming boss will have to decide whether to pursue expansion in places like South America and India, where Amazon faces stiff local competition.

At least one investor worries that Mr Jassy's background in cloud-computing may leave him struggling to direct the firm's retail arm. Meanwhile, those who would prefer to see the money-spinning AWS hived off into a separate company may wonder if the man who created it has any more appetite for such a radical move than Mr Bezos did.

Those aren't the only dilemmas in Mr Jassy's in-tray. Amazon's demands on workers in its warehouses and at times intrusive surveillance have come under scrutiny. The firm has spent heavily on improved working conditions and pays a \$15 minimum wage in America. But it continues to attract criticism, especially as it resists unionisation among logistics workers. Many of AWS's well-paid programmers empathise with their colleagues on the warehouse floor. In May Tim Bray, an AWS executive, quit in disgust over what he described as Amazon's "chickenshit" sacking of workers who had complained about poor safety during the pandemic.

Amid a general souring on the Utopian promises of big tech, Amazon's success has also attracted attention from American trustbusters. They worry it may be using sales data from the third-party sellers on its platform to inform the development of in-house products which then drive those sellers out of business. A congressional report in 2020 cited claims that Amazon used the rich profits from AWS to subsidise its unlucrative retail operations—but said that the firm had not provided the data necessary to decide one way or another. Some politicians have talked of barring Amazon from competing with its third-party sellers, or even of splitting it up.

Amazon denies doing anything wrong.

Some speculate that such looming political awkwardness may have influenced the timing of Mr Bezos's decision to stand back. Perhaps. Mr Bezos, for his part, gives every indication of being a man with a higher calling. When Bill Gates stepped down as the boss of Microsoft in 2000, he threw himself wholeheartedly into the Gates Foundation, which, as the world's biggest private charity, funds everything from malaria-prevention to AIDS research.

Mr Bezos, whose near-\$200bn fortune is even larger than Mr Gates's, may be planning a similar change of focus. He is sympathetic to at least some environmental concerns: he has said before that growing resource consumption is not compatible with a finite planet. Of his many other businesses, Blue Origin, his rocketry firm, is widely reckoned to be his favourite. Like Elon Musk, who this year overtook him as the world's richest man, Mr Bezos is a fully paid-up space cadet. Blue Origin is already involved in America's plans to return astronauts to the moon.

In 2019 Mr Bezos sketched out a vision of the future in which a trillion humans live in gigantic, artificial space-going habitats, relieving the pressure on a crowded Earth. It is an apocalyptic idea—and, to put it mildly, a bold one. To Mr Bezos it may seem more fun than running an online department store with a sideline in server farms and virtual billboards—even one as era-defining as Amazon. ■



亚马逊的未来

后贝索斯时代

要继承这家网络巨头的传奇创始人的衣钵殊为不易。安迪·贾西能耐几何？

美国市值第三大的上市公司亚马逊2月2日公布了有史以来最好的季度业绩。新冠疫情迫使消费者深居简出，推动该公司季度销售额同比增长44%，首次突破千亿美元大关。如此亮眼的业绩却非故事主线。同一天，公司宣布其老板及创始人杰夫·贝索斯在掌管公司近30年之后，将于今年夏天卸任首席执行官。

贝索斯并不会离开公司。他计划把自己挪到执行董事长一职。他表示在这个职位上将可继续“参与亚马逊的重要计划”，同时又可以有更多时间投身于其他事业，特别是太空旅行、对抗气候变化，以及他在2013年收购的《华盛顿邮报》。安迪·贾西（Andy Jassy）将接任首席执行官。他在亚马逊工作多年，创建并管理亚马逊利润丰厚的云计算部门AWS。

消息传出后，人们毫不吝啬地对贝索斯献上了溢美之词。这个传奇人物用回收的门板做公司办公桌，从1994年开始在网上卖书。经纪公司盛博（Bernstein）称他是“有史以来最伟大的人物”。贝索斯无疑已经留下了光辉印记。2019年，亚马逊递送了35亿个包裹，相当于地球上每两个人就收到一个——而那还是在全球疫情大力推动了网购风潮之前。他厉行节俭，严格要求员工把亚马逊看作一家条件艰苦的创业公司，把每一天都当成创业“第一天”。在这种鞭策下，公司挺进一个又一个新业务领域，从智能音箱、视频流媒体，到广告和云计算。自1997年上市以来，公司市值已经增长了3000倍。

这也就是说，贾西将接手一家状况令人艳羡的公司。亚马逊并非无懈可击——它在一些海外市场举步维艰，还面对来自美国和其他地方的反垄断调查。尽管如此，没有哪家公司比它更有能力应对这些挑战。

创始人往往很难做到撒手不管。因此首当其冲的问题之一是贝索斯实际会

交出多少权力。研究公司CCS Insight的尼克·麦奎尔（Nick McQuire）表示：“我认为至少在头几年里，一点点幕后操纵是不可避免的。”但是，可能无需贝索斯插手日常运作，公司也会围绕他的想法转。“在所有大型科技公司中，亚马逊的文化是最规范、成体系的，”云计算公司Box的老板亚伦·列维（Aaron Levie）表示，“其设计就是离开了创始人它也能基业长青。”

无论如何，贾西的继任更多会是一种延续而非变革。亚马逊首席财务官布莱恩·奥尔萨夫斯基（Brian Olsavsky）在财报会议上让分析师们放心：“他在这儿的时间和贝索斯差不多了。”贾西在亚马逊上市那年加入公司，自此一直与贝索斯关系密切。他给人的印象是注重细节，且书呆子气十足——与贝索斯执掌公司的头20年十分相似。

这并不是说不会有任何改变。盛博预计，亚马逊的零售相关收入在未来几年内仍将保持在总营收的三分之二左右，但到2024年，数字广告可能会取代云计算成为它最大的利润来源；零售的实际利润贡献也可能会大大增加（见图表）。掌管庞大零售业务的杰夫·威尔克（Jeff Wilke）去年表示将离开公司，这会让贾西失去一员干将。

美国消费者开始抱怨亚马逊正在沦为跳蚤市场，销售的商品越来越劣质，靠虚假评价美化。从最新业绩数字看，他们还没有因此而减少在亚马逊购物。但未来这可能是个问题。去年海外销售额快速增长，但在南美和印度等地面临激烈的本地竞争，即将上任的掌门人将必须决定是否要在这些地区寻求扩张。

不止一位投资者担心，云计算出身的贾西会在统领公司的零售部门时力不从心。与此同时，那些希望将赚钱机器AWS分拆为一家独立公司的人可能会想，亲手创建了AWS的贾西恐怕不会比贝索斯更加支持这种激进的做法。

贾西面临的难题不止这些。亚马逊对仓库工人的诸多要求以及有时颇有侵入性的监控都已受到审视。公司已经投入巨资改善工作条件，并将美国工

人的最低时薪提高到15美元。但它仍然引来批评，特别是它反对物流工人成立工会的立场。许多拿高薪的AWS程序员同情他们在仓库工作的同事。去年5月，AWS高管蒂姆·布雷（Tim Bray）愤然辞职，称亚马逊解雇那些抱怨疫情期间安全措施不足的工人是一种“懦夫”行为。

在大型科技公司乌托邦式的承诺纷纷破灭之际，亚马逊的成功也引起了美国反垄断机构的注意。它们担心亚马逊可能会利用平台上第三方卖家的销售数据来帮助它开发内部产品，然后再将第三方卖家挤出市场。美国国会2020年的一份报告指出，有人声称亚马逊利用AWS的丰厚利润来补贴不赚钱的零售业务。但该报告称亚马逊并未提供能拿来做判断的必要数据。一些政客已经声言要禁止亚马逊与其第三方卖家竞争，甚至要将它拆分。亚马逊否认有任何不当行为。

有人猜测，正是这种日渐迫近的政治压力导致贝索斯决定在此时宣布退居幕后。有这种可能性。而贝索斯本人的种种举动流露出他志存高远。比尔·盖茨在2000年从微软退位后，全身心地投入了盖茨基金会，这家世界上最大的私人慈善机构资助着从预防疟疾到艾滋病研究的各种项目。

贝索斯个人身家接近2000亿美元，比盖茨还多，他可能也在谋划着类似的重心转移。他至少对一些环境问题感兴趣：他曾说过，不断增长的资源需求将超过地球有限的供应。在他的众多其他业务中，普遍认为火箭公司蓝色起源（Blue Origin）是他的最爱。与今年取代他成为全球首富的伊隆·马斯克一样，贝索斯也是不折不扣的太空迷。蓝色起源已经参与了美国宇航员重返月球的计划。

贝索斯在2019年勾勒过未来的愿景：一万亿人生活在巨大的人造太空栖息地，以缓解拥挤不堪的地球的压力。这是个天启式的创想——说得轻些，也是个大胆的想法。在贝索斯看来，这可能比经营一家以服务器机房和虚拟广告牌为副业的线上百货商店更有意思——即便是亚马逊这样划时代的百货公司。 ■



Retail investing

Transfer of power

Stockmarkets may be nearly frictionless, but a new epoch for retail investors is just beginning. Technology is making all kinds of asset markets more liquid

FOR NEARLY a fortnight, the world was mesmerised by the fortunes of GameStop. Shares in the beleaguered brick-and-mortar purveyor of video games soared from a few dollars in 2020 to above \$480 on January 28th, before sinking as low as \$81 on February 2nd. A firm that was worth \$200m in April last year was briefly valued at \$30bn before falling back to Earth. The gyrations, fuelled by an army of day traders that dwells on forums on Reddit, a social-media site, have been chronicled on every front page and ruffled the feathers of regulators and politicians in Washington, DC.

Look beyond the memes and the mania, though, and the story tells you something about the deep structural changes in financial markets. The fact that the fast-paced frenzy was possible is a testament to just how frictionless trading stocks has become, aided by technological advances. Shares can be bought on an app while you queue for a coffee, at a price that is whisker-close to the wholesale price.

Progress towards unfettered stockmarket access began in 1975, with the abolition of huge fixed commissions and the entry of discount brokers like Charles Schwab, says Yakov Amihud of New York University. Then came automated trading and the decimalisation of share prices. By the 2010s, high-frequency traders had risen to dominate share trading. “At each stop along the road, the market offloaded some trading costs and liquidity improved,” says Mr Amihud.

Trading costs tumbled, and the quantity of shares traded ballooned. The more participants piled in, the quicker and cheaper it became to trade, in

turn (see chart 1). In 2015 Robinhood, the online broker through which many GameStop trades would flow, was launched, becoming the first platform to charge users no fees at all. That, and the pandemic, which freed up time and provided stimulus cheques as starter funds, have spurred retail participation to new heights. Retail investors made up a tenth of trading volumes in America in 2019. By January this year their share had risen to a quarter.

As frictions were sanded down, powerful institutional investors that had padded their bottom lines by charging meaty fees for exposure to stocks saw the assets they control slip away. Now they compete with a range of vastly cheaper offerings: index funds that track the market; exchange-traded funds (ETFs), which offer access to baskets of assets; and robo-advisers, which allocate cash among cheap funds according to portfolio-management theories. Such innovations, possible thanks to advances in computing power and machine learning, have probably saved investors \$1trn or more in fees since 1975.

Outside stocks, fat fees and thin volumes still gum up markets, resulting in slow-motion transactions and deterring traders. But the same forces that pushed down trading costs and drove up liquidity in the stockmarket are poised to disrupt all manner of assets, from corporate bonds to property, and even Picassos and classic cars. As happened with stocks, this will eventually empower individuals at the expense of established intermediaries.

Wherever you look, technology has helped create new, liquid markets. “The market for knick-knacks in the attic was once illiquid,” says Alvin Roth, a Nobel-prize-winning economist. “The internet made it possible to have your lawn sale on eBay.” GPS and smartphones made ride-sharing apps—which create thick markets for journeys—possible.

Examples in financial markets abound. In 19th-century America buyers travelled from farm to farm testing wheat before striking a deal with a single farmer. Then railways made it possible to move grains cheaply in silo cars. But these silos also made it wasteful to store farmers' grains separately. So in 1848 the Chicago Board of Trade started classifying wheat by quality (1 the best, 5 the worst) and by type (red or white, soft or hard, winter or spring). Standardisation brought down the cost of moving and shopping for grains, making the market more efficient. The process was so effective that the word commodity is now synonymous with standardisation.

But building a liquid market for an asset is not easy. To see why, compare the markets for bonds and property with equities. They are broadly comparable in size (see chart 2). Yet bonds and buildings change hands in different ways. This is largely the result of fragmentation. There are 4,400 listed firms in America. An investor buying a share in AT&T does not care which one they hold—it is as if they were picking from a set of identical marbles. Now imagine they want to buy an AT&T bond. It is as if a single marble had been smashed into hundreds of pieces, each of them different. There are 224 AT&T bonds alone: each pay different coupons, mature at different times and are worth different amounts. And there are 300,000 distinct corporate bonds in America. Now imagine the investor wants to buy property. All those marble fragments have been ground into sand. Available figures suggest there are 5m-6m commercial buildings and more than 140m dwellings in America, each unique.

Fragmentation chills trading activity. The market for stocks is bustling. AT&T shares change hands 40m times a day (though some investors will hold for years, and high-frequency traders might hold for less than a second). Small-cap stocks—recent action in GameStop aside—tend to trade less frequently.

Bonds are stickier and dearer to trade. Even the most liquid of AT&T's bonds only trades a few hundred times a day. "Some bonds are like museum pieces: they get put away in insurance companies' portfolios, never to trade again," says Richard Schiffman of MarketAxess, a trading platform.

At the stickiest end is property. A slice of real-estate investment is offered to the masses, via listed trusts. But the big investments, managed by private-equity firms, are open only to institutions like pension funds or wealthy individuals. Houses, too, turn over slowly. Buyers and sellers must be painstakingly matched. Sellers in America pay a meaty 5-6% commission. Just 5% of homes change hands a year.

Low transaction volumes make it difficult to price assets. The price of a share in AT&T can be arrived at instantly. Some bonds, like recently issued Treasuries, are easy to price too. Older issuances are trickier. Traders either attempt to match a seller with a buyer, or look at recent transactions in similar bonds as a guide. Pricing property is a similar, but more glacial, process.

Fragmentation long seemed a hurdle to making the bond market as rapid-fire as the stockmarket. An institutional investor wanting to buy a bond would talk to two or three big banks or brokers that dominate the market. But this is starting to change thanks, in large part, to open-ended fixed-income ETFs, funds that hold diversified baskets of bonds. These enhance price discovery and trading volumes in two ways.

The first is through their design. Some of the fixed-income ETFs offered by BlackRock, an asset manager, have 8,000 or more different bonds in them. As demand for an ETF rises, it begins to trade above the fair value of its component bonds (ie, at a premium). "When one of our ETFs trades at a premium we expect to see creation activity," says Samara Cohen of BlackRock. The firm works with a handful of marketmakers, which have an

incentive to expand the size of the ETF when it trades at a premium. Jane Street Capital, one such marketmaker, might offer BlackRock a portfolio of 400 bonds to add to its ETF, pushing the price back towards fair value. Jane Street gets to keep the difference—it bought those 400 bonds at market price, and sells them at the implied premium at which the ETF was trading. When the ETF gets cheaper, the reverse occurs. Jane Street redeems units of the ETF for its component bonds at a discount and sells them for market prices (again, pocketing the spread). All this activity, which is increasingly automatic, enhances price discovery.

The second effect is through the wider trading of an ETF. Each time it trades, a reference for its component parts is created, which helps price other bonds. And ETFs trade far more frequently than their components. In March 2020, as volatility shook markets, BlackRock's biggest investment-grade corporate-bond ETF traded 90,000 times a day. The top five holdings of the fund traded just 37 times. Price accuracy means lower trading costs—a step towards frictionless markets.

Trading technology is also improving. MarketAxess was set up to make it easier for investors to contact all the big banks' bond desks and brokerage firms—around 20 firms in total—at once. But the platform has since introduced open trading, which functions almost like an exchange, letting all participants interact with each other. The result is that trading need not be solely dependent on banks for liquidity, says Mr Schiffman. Around a third of the transactions MarketAxess facilitates on its platform are such “all-to-all” transactions.

The next phase might be automating bond trading. Overbond, a fixed-income analytics firm, consolidates trading data that it plugs into a machine-learning algorithm. The algorithm finds recent transactions in similar bonds and spits out implied prices. It was the arrival of fast

serverless cloud computing that helped the algorithm mimic a human trader in real time, says Vuk Magdelinic of Overbond.

In less liquid assets, like private equity and property, the seeds of change have just been planted. To smaller investors, illiquidity can be a curse: nervous regulators try to restrict access to illiquid assets. But for institutions, it is a boon. Private-equity pitch books chatter about the “illiquidity premium” their investments earn. The result is that private markets hold appeal for certain types of investors that are willing and able to lock their money up, but not others. A quarter of university endowments and a sixth of sovereign-wealth funds’ capital are invested in them. By contrast, insurers and retail investors plough just 1% of their capital into private markets.

This too could eventually change. For one, firms in private markets are beginning to create funds that can expand or shrink as they gain or lose clients, an innovation that echoes that of bond ETFs. Investors typically buy into private markets when a fund manager raises capital. The capital is locked up for a decade or more, and used to buy 20 or so companies or real-estate investments over several years. But in January Hamilton Lane, an asset manager, launched a private-equity and private-credit fund that circumvents this dynamic by ditching the fundraising cycle.

“When a [private-equity] fund manager buys a company for their fund they may ask us to partner with them for the equity for the project,” says Drew Schardt of Hamilton Lane. This is a cheaper way of getting access, he notes: direct or co-investment deals do not have any underlying fees attached to them. These deals come along fairly regularly, allowing the fund to grow with demand. It can also shrink: the fund is structured so that its investments mature regularly. They should do so at a rate of 20% a year, fulfilling the limited redemptions the firm plans to offer. It also plans to match those keen to exit the fund with others buying in, using third-party

valuations.

Other startups want to go even further. Regulation is helping them. Only accredited investors can invest in property, venture-capital funds or hedge funds. “Accredited” once meant the rich, those earning more than \$200,000, or worth more than \$1m. But a rule change in 2017 means that those with professional experience or knowledge are now eligible too.

This change has fuelled the growth of startups offering property investments to the masses. One such firm is Cadre, set up in 2014. Ryan Williams, its co-founder, who previously worked at Blackstone, an alternative asset-manager, wants to build an exchange for commercial property that allows people to trade stakes in buildings, almost like a “digital stockmarket”.

Cadre finds an investment opportunity with a life of around five or seven years and lists it on its platform. Investors can buy pieces of it through the site. Every quarter, rental income is paid out and investors can choose to cash out through a trading system. “We provide a quarterly valuation for their investment, and they can choose to sell all or some of their stake at a range of prices,” says Mr Williams. This secondary market typically clears quickly.

Low fees are likely to be part of the draw. Cadre charges a 1% fee on any cash deposited on the platform and an annual management fee of 1.5%. This is just a quarter of what an investor might pay a traditional alternative-asset manager. The firm’s clients include the establishment: Goldman Sachs, a bank, is spending \$250m on behalf of its wealth-management clients. But individuals are stepping in, too.

Yieldstreet, which was founded in 2015, offers property investments as well as those in snazzier alternatives like art, marine finance (such as the

funding of container ships) and private credit. In 2015 the Securities and Exchange Commission changed its rules on “mini” initial public offerings (IPOs), increasing the amount that can be raised to \$50m. A clutch of firms have since listed artworks and classic cars.

Even in residential property, the most sluggish and expensive market of all, firms are using technology to improve efficiency. “When we thought about what makes a properly functioning marketplace, it all came down to price discovery and data,” says Rich Barton, the founder of Zillow, an “i-buying” firm, which acts like a marketmaker for houses. After a decade gathering data on every home in America, it can now plug a property’s characteristics into machine-learning algorithms to price them, just as Mr Magdelinic plugs in characteristics of bonds. Zillow buys homes based on the algorithm’s assessment, taking them onto its balance-sheet. It then sells these on its platform.

There is evidence this is pushing down agents’ fees. Commissions are dropping quickly in areas in which i-buyers operate. A study by Mike DelPrete of the University of Colorado suggests that the fees i-buyers pay to buyers’ agents are falling. In places such as Phoenix, Dallas, and Raleigh the fees paid to agents have dropped by around 0.5-1 percentage points in a little over a year. In Atlanta they have fallen by half in just two years.

Bring these developments across disparate markets together, and it seems clear that technology is making it possible for liquidity, price transparency and competition to crop up in a variety of financial markets. True, the markets for art, bonds and houses will never be quite as frictionless as the stockmarket. Mr Schiffman thinks Tesla’s bonds are unlikely to be as exciting as its shares. The clue is in the name. “It is fixed income!” he laughs. No one will make a snap decision to buy or sell a house—because they have to live in it.

Yet the oncoming rush of liquidity should worry institutional investors. Many help their customers gain exposure to a basket of small companies, or to commercial property. But that often comes as part of a pricey package deal: clients must also buy the slick advice that comes with it. Once it became possible to buy exposure alone in the stockmarket, many of them ditched their stock-pickers.

Now price transparency and liquidity seem bound to deliver fierce fee competition in other asset markets. Retail investors may one day be able to stuff their cash into a portfolio of low-fee funds in everything from stocks and bonds to art and property. It is this, rather than gyrations in GameStop stock, that will give retail investors more power over Wall Street. ■



散户投资

权力转移

股市可能基本没有摩擦，但是散户的新纪元才刚刚开始。科技正让各种资产市场都更具流动性

有那么两周，游戏驿站（GameStop）命运的跌宕起伏让全球目瞪口呆。这个陷入危机的电子游戏实体零售商的股价在2020年还只有几美元，在1月28日急剧突破480美元，到2月2日又跌至81美元。去年4月它的市值是2亿美元，此间一度冲到300亿美元，之后又大幅跌落。这过山车般的行情由在社交媒体网站Reddit论坛上聚集的日内交易大军推动，引得媒体纷纷在头版追踪报道，并引发了华盛顿的监管机构和政客的不安。

不过，除了散户的疯炒和狂热之外，这个故事还揭示出金融市场一些深刻的结构性变化。快节奏的疯炒已然成为可能，这证明了在技术进步的助力下，股票交易已经变得多么畅通无阻。散户排队买咖啡的功夫就可以在应用上以近乎批量交易的价格买入股票。

纽约大学的雅科夫·阿米胡德（Yakov Amihud）说，股票市场向自由进出发展的进程始于1975年，那时废除了高额固定佣金，嘉信理财（Charles Schwab）这样的折扣经纪商进入市场。后来出现了自动交易和股价报价的十进制转换。2010年代后，高频交易员崛起，主导了股票交易市场。“在这一路上的每个节点，市场都卸掉了一些交易成本，提高了流动性。”阿米胡德说。

交易成本大幅下降，股票交易量激增。市场参与者越多，交易速度就越快，成本就越低（见图表1）。2015年，罗宾侠（Robinhood）上线，成为第一家零佣金在线经纪平台，游戏驿站的许多交易就是在这个平台上进行的。有了免费平台，加上疫情让人们有了富余时间，而且还领到了政府刺激经济的救助支票用作启动资金，散户的参与度被推至新高。2019年，散户占美国股票交易量的十分之一；到今年1月，他们的占比已上升到四分之一。

以前，强大的机构投资者可以就股票投资收取丰厚佣金来增加利润，而随着市场摩擦逐渐减小，它们管理的资产规模逐渐减少。现在，它们要跟一系列收费低得多的产品竞争，比如追踪市场的指数基金、管理一揽子资产的交易所交易基金（ETF），还有根据投资组合管理理论在廉价基金之间配置资金的机器人投顾。这些创新得益于计算能力和机器学习技术的进步，自1975年来大概已为投资者节省下不少于一萬亿美元的费用。

在股票市场以外，高额收费和低交易量仍然阻碍着市场的发展，导致交易缓慢，让交易者却步。但是，股市中压低交易成本和增加流动性的那些力量势必将颠覆其他各类资产市场：从公司债到不动产，乃至毕加索作品和老爷车。和股市一样，这最终将增强散户的力量，而牺牲传统中介的利益。

无论放眼何处，技术都已经帮助创造出了新的强流动性市场。“以前，在阁楼上卖点小玩意的那种市场是没什么流动性的，”诺贝尔奖得主、经济学家阿尔文·罗斯（Alvin Roth）说，“互联网的出现让你可以把摆在自家草坪上卖的旧货搬上eBay。”GPS和智能手机催生了创造出广阔出行市场的网约车应用。

金融市场上的例子也比比皆是。在19世纪，在美国收购小麦要逐个走访农场检验小麦，再和其中某个农场主达成交易。后来，铁路的出现使得人们可以用筒仓车厢低成本运输谷物。但用筒仓分别存放农民的谷物也造成了浪费。因此在1848年，芝加哥贸易委员会（Chicago Board of Trade）开始按品质（最好的定为一级，最差的五级）和类型（红皮或白皮、软质或硬质、冬小麦或春小麦）为小麦分类。标准化降低了谷物的运输和购买成本，提高了市场效率。这种做法非常有效，以至于大宗商品这个词现在已经成为标准化的代名词。

但就某项资产建立一个具有流动性的市场并非易事。要了解原因，可以拿债券和房地产市场与股市做比较。它们的规模大致相当（见图表2）。然而，债券和楼房的换手方式不同。这很大程度上是市场碎片化的结果。美

国有4400家上市公司。购买AT&T股份的投资者并不在乎他们持有的到底是哪一股，就好像是从一组相同的弹珠中选一个那样。现在再想象他们要购买一只AT&T债券。这就好像一颗弹珠被砸碎成千百块，每块都不一样。仅AT&T债券就有224种，息票各不相同，到期日也各不相同，因此价值全然不等。而在美国有30万种不同的公司债券。再想象一下投资者想要买不动产。那些弹珠碎块又都被磨成了碎粒。现有数据显示，美国有500万至600万栋商业建筑，超过1.4亿套住宅，每栋每套都各不相同。

碎片化的市场会让交易低迷。股市却非常繁荣。AT&T的股票每天换手4000万次（尽管有些投资者会长年持有，而高频交易者持有的时间可能一秒都不到）。小盘股（不算上最近游戏驿站股票的交易）一般换手率较低。

债券的交易更不频繁，交易成本更高。就算是AT&T流动性最强的债券一天也不过交易几百次。“有些债券就像博物馆里的展品，被保险公司配置到自己的投资组合中之后就再也不会交易了。”交易平台MarketAxess的理查德·希夫曼（Richard Schiffman）说。

换手率最低的是不动产。只有小部分不动产的投资会通过公开的信托产品提供给普通投资者。大部分投资由私募股权公司管理，只向养老基金等机构投资者和高净值个人客户开放。房屋的转手率也很低。买卖双方必须慢慢耐心匹配。美国的卖家要支付高达5%至6%的佣金。每年只有5%的房屋转手。

交易量低，资产定价就难。AT&T的每股价格可以瞬间确定。一些债券也很容易定价，比如新发行的美国国债。以前发行的老券定价就困难些。债券交易员要么努力撮合买卖双方，要么以同类债券近期的交易价格作为参照。给房地产定价是类似的过程，但还要更慢。

市场碎片化似乎一直阻碍了债券市场像股市那样快速交易。想要购买债券的机构投资者会向市场上主导的两三家大型银行或经纪公司询价。但这种情况已经开始改变，很大程度上是因为有了开放式固定收益ETF，即持有

一篮子多元化债券的基金。这些基金以两种方式增强价格发现能力并提升交易量。

首先是基金的设计。资产管理公司贝莱德（BlackRock）提供的一些固定收益ETF中有8000或更多只债券。随着对一只ETF买入需求的增长，它开始以高于其成分债券公允价值的价格（即溢价）进行交易。“当我们的一只ETF溢价交易时，可以想见会出现一些创设活动。”贝莱德的萨玛拉·科恩（Samara Cohen）表示。该公司与几家做市商合作，当一只ETF溢价交易时，这些做市商会很有动力扩大它的规模。其中的一家做市商简街资本（Jane Street Capital）可能会向贝莱德提供一个由400只债券构成的投资组合，加入到现存的ETF中，让价格回归公允价值。它以市场价买入这400只债券，然后以ETF交易时的隐含溢价卖出该债券组合，赚取两者的价差。当ETF价格下跌时，情况则相反。简街赎回ETF单位，也就是以折价买入其成分债券，并以市场价卖出（同样赚取价差）。这些越来越自动化的交易增强了价格发现能力。

第二种影响是通过ETF交易的扩大实现的。每笔ETF的交易都会为其中的成分债券创建一个新的参考价格，这同时也有助于其他债券的定价。而ETF的交易频率远高于其成分债券。2020年3月，市场大幅波动，贝莱德最大的投资级公司债券ETF每天交易九万次。而该ETF持有的前五大债券仅交易了37次。价格准确意味着交易成本更低，这就向无摩擦市场迈进了一步。

交易技术也在进步。MarketAxess创立的初衷就是为了让投资者可以更轻松地同时与所有大型银行的债券交易平台和经纪公司（总共约20家）联系。但此平台后来引入了开放交易，功能几乎相当于一个交易所，所有参与者都可以相互交流。结果是交易不必只依赖银行来获得流动性，希夫曼说。MarketAxess在其平台上促成的交易中约有三分之一是此类“多对多”交易。

下一阶段可能会将债券交易自动化。固定收益分析公司Overbond整合了

交易数据，将其输入一个机器学习算法中。算法查找到相似债券最近的交易，并给出隐含的价格。快速无服务器云计算的出现帮助该算法实时模拟人类交易员的交易，Overbond的伍克·麦哲里尼（Vuk Magdelinic）说。

在私募股权和房地产等流动性较差的资产中，变革的种子刚刚种下。对较小的投资者而言，流动性不足可能是一个诅咒：紧张的监管者会试图限制低流动性资产市场的准入。但对于机构投资者来说，流动性不足是一个福利。私募股权公司在投资推介材料里大谈特谈它们的投资所获得的“非流动性溢价”。结果私募市场吸引了某些愿意并能够锁定其资金的投资者，而让其他投资者却步。大学捐赠基金和主权财富基金分别把四分之一和六分之一的资本投给了私募。相比之下，保险公司和散户投资者只投入了1%的资本。

这最终可能也会改变。一方面，私募股权公司正开始创建一些基金，可视客户的新增或流失情况扩大或收缩规模，这一创新与债券ETF的创新相近。通常情况下，投资者在基金经理募集资金期间买入私募产品，资金会被锁定十年或更久，基金经理会在几年内购买大概20家公司的股份或投资房地产。但是在1月，资产管理公司汉领资本（Hamilton Lane）成立了一个私募股权加私有信贷基金，跳过了募集期，改变了这种情况。

“当（私募股权）基金经理为自己的基金买入一家公司时，可能会邀请我们合作参股相关项目。”汉领资本的德鲁·沙特（Drew Schardt）说。他指出，这是一种更便宜的投资途径，因为直接或共同投资的项目不附带任何隐含费用。此类交易经常出现，让基金可以随着需求而扩大。当然也可以缩小：根据该基金的结构，不同期限的投资会相继到期。每年可以有20%的投资到期，这样基金就可以满足计划中会提供的限制性赎回的需求。它还计划使用第三方估值，来匹配急于退出的投资者和想要买进的投资者。

其他创业公司还想走得更远。监管正在助它们一臂之力。只有合格的投资者才能投资房地产、风投基金或对冲基金。“合格”一词曾指年收入超过20万美元或净资产超过100万美元的富人。但2017年一项监管规定做了修改，现在具有专业经验或知识的人也算合格。

这一变化推动了向大众提供房地产投资的创业公司扩增。成立于2014年的Cadre就是其一。它的联合创始人瑞恩·威廉姆斯（Ryan Williams）曾在另类资产管理公司黑石集团（Blackstone）工作，他想建立一个商业地产交易所，让人们可以交易楼房股权，差不多就像一个“数字证券市场”。

该公司找到一个期限约五到七年的投资机会，并将它挂自己的平台上。投资者可以通过网站购买部分股权。每季度投资者都会收到租金收入，也可以选择通过一个交易系统变现。“我们按季度为他们的投资估值，他们可以选择在一个价格区间内卖出其全部或部分股权。”威廉姆斯说。这个二级市场通常很快就能清算。

较低的费用很可能会是该平台的吸引力之一。Cadre对平台上存入的现金一律收取1%的佣金和1.5%的年管理费。这只是投资者可能向传统另类资产管理公司支付费用的四分之一。Cadre的客户包括传统大机构，比如高盛就为其理财客户投资了2.5亿美元。但个人客户也在加入。

创立于2015年的Yieldstreet提供房地产投资以及各类时髦的另类投资项目，如艺术品、海运融资（例如集装箱船融资）和私人信贷等。2015年，美国证券交易委员会（SEC）更改了有关“迷你”IPO的规定，将融资上限提高至5000万美元。此后，许多公司都将艺术品和老爷车作为投资对象。

即使是在流动性最低和交易费用最高的住宅市场中，企业也在利用技术提高效率。“我们曾思考是哪些因素让市场正常运转，最终发现一切都取决于价格发现和数据。”“房屋直接买卖”公司Zillow的创始人里奇·巴顿（Rich Barton）说。他的公司就好像一个房屋交易的做市商。这家公司在过去十年里收集了美国每套房屋的特征数据，现在可以将这些数据输入机器学习算法中来给房屋定价，就像麦哲里尼输入债券数据一样。Zillow根据算法的估值来购入房屋，将它们计入自己的资产负债表，然后在自己的平台上出售这些房屋。

有证据表明这降低了中介费用。在“房屋直接买卖”公司运营的地区，佣金在迅速下降。科罗拉多大学的迈克·德尔普雷特（Mike DelPrete）的一项

研究显示，“房屋直接买卖”公司付给买家中介的佣金正在下降。在凤凰城、达拉斯和罗利等地，付给中介的佣金在一年多一点的时间内下降了约0.5至1个百分点。在亚特兰大，佣金在短短两年内下降了一半。

纵观不同市场上的这些发展，有一点看来很明显，就是技术正使得流动性、价格透明和竞争出现在各种金融市场中。的确，艺术品、债券和房屋的市场永远不会像股市那样没有摩擦。希夫曼认为特斯拉的债券不太会像它的股票那样令人兴奋。线索就在名字里面。“债券是固定收益投资！”他笑着说。没有人会瞬间做出买卖房屋的决定，因为他们要住在屋子里。

然而，即将涌来的流动性应该会让机构投资者担忧。很多机构帮助客户投资一篮子小公司或商业地产。但这通常是一整套昂贵交易的一部分，客户还必须购买配套的花言巧语的咨询服务。一旦客户有机会自己在股市里购买这些股票，他们中的许多人就把投资机构踢开了。

现在，价格透明和流动性似乎必将在其他资产市场引发激烈的价格战。散户投资者也许有一天可以将其资金投到低收费基金的投资组合上，从股票、债券到艺术品和房地产，应有尽有。正是这一点——而不是游戏驿站股票的剧烈波动——将让散户的影响力压过华尔街。 ■



Making vaccines

Doing the do

Vaccines must now be produced on a scale greater than ever before. That is hard

NINE VACCINES against covid-19 have already been approved in one jurisdiction or another, with many more in various stages of preparation. That this has happened within a year of the illness coming to the world's attention is remarkable. But it is one thing to design and test vaccines. It is another to make them at sufficient scale to generate the billions of doses needed to vaccinate the world's population, and to do so at such speed that the rate of inoculation can outpace the spread and possible mutation of the virus.

Broadly, there are two ways of making antiviral vaccines. One, tried and trusted, involves growing, in tanks called bioreactors, cell cultures that act as hosts for viruses which are then used in one way or another to make the vaccine in question. Cells grown this way can be of many types—*insect, human kidney, monkey kidney, hamster ovary*—as can the resulting vaccines. These may be weakened or killed versions of the virus to be protected against, or live viruses of a different and less-dangerous sort that carry a gene or two abstracted from the target virus, or even just isolated target-viral proteins. The point is that the vaccine should introduce into the body, or induce that body to make, something which the immune system can learn to recognise and attack if the real target virus should ever turn up.

The alternative method, developed recently and employed to make the mRNA vaccines, such as those of Moderna and Pfizer, that the pandemic has stimulated the invention of, requires culturing cells only at the beginning of the process. mRNA is the substance that carries instructions about how to make a protein from a cell's DNA to the molecular factories, known as

ribosomes, which do the actual manufacturing. In the case of covid-19, the instructions in question generate spike, a protein found on the surfaces of particles of SARS-CoV-2, the virus that causes this illness. Suitably packaged and delivered, such mRNA can induce some of the body cells of the inoculee to turn out spike, which the immune system then learns to recognise. To make this type of vaccine you therefore have to generate lots of the relevant mRNA.

That process does indeed start with cells, though they are bacterial cells, rather than those of animals. But it does not end with them. The bacteria used, normally a well-understood species called *E coli*, have spliced into them a DNA version of the part of the SARS-CoV-2 genome which describes spike. (Confusingly, as is true of many viruses, SARS-CoV-2's actual genes are made of RNA.) The bacteria are then allowed to multiply for a few days before being broken open, their DNA filtered out, and the DNA versions of the spike gene extracted as what is known as a DNA template.

Once purified, this template is mixed with a soup of pertinent enzymes and fed molecules called nucleotides, the chemical “letters” of which RNA is composed. Thus supplied, the enzymes use the templates to run off appropriate mRNAs by the zillion. These are extracted and packaged into tiny, fatty bubbles to form the vaccine.

Both the cell-culture and the mRNA approaches have benefits and drawbacks. The former has the advantage of being well established. Versions of it go back to vaccine-making's origins. But keeping cultured animal cells alive and healthy is a tricky business. A whole subfield of bioengineering is dedicated to this task. Vaccine-makers who rely on live cultures constantly struggle with yields. Using this method to make a lot of vaccine, fast, is hard.

It was difficulties of this sort that Pascal Soriot, boss of AstraZeneca, cited

on January 26th in defence of his firm's failure to provide vaccine supplies which the European Union claimed it had been promised. AstraZeneca is an Anglo-Swedish company that, in collaboration with Oxford University, created one of the first vaccines to be approved. As Mr Soriot told *La Repubblica*, an Italian newspaper, "You have glitches, you have scale-up problems. The best site we have produces three times more vaccine out of a batch than the lowest-producing site."

Maximising a bioreactor's yield is as much an art as a science. The underlying health of the cells involved matters. So do environmental conditions at the manufacturing site. That AstraZeneca has not been able to meet its own production targets shows how hard it is to predict when the right balance of biology will be found. The company says it can take six to nine months to start a production site up from scratch, and that even this timetable is possible only by working with experienced partners and at an accelerated pace. At the moment, AstraZeneca is working with 25 manufacturing organisations in 15 countries to make its vaccine.

Producing mRNA vaccines at scale has problems, too. The biggest is how to protect the mRNA molecules both from the environment they must travel through in order to reach the arm of their recipient, and from the recipient's own body, which will attack them as they journey to the ribosomes which will transcribe them.

Protection from the environment is mainly a matter of having a strategically located set of refrigerators, known as a cold chain. Protection from the body, though, is where the fatty bubbles come in.

Production of these bubbles was a cottage industry before the pandemic. A small Austrian firm, Polymun Scientific, is one of just a handful that can make them. Their main previous use was in niche cancer treatments. Scaling up their production, which is happening right now, has never been

done before and adds uncertainty to the continued supply of mRNA vaccine.

There are other bottlenecks, too. In particular, the factories in which vaccines are made must be built to a high standard, known as GMP, for “Good Manufacturing Practice”. There is currently a shortage of GMP facilities. Andrey Zarur, boss of GreenLight Biosciences, a firm in Boston that is developing an mRNA vaccine, says his company has employees whose entire job, at present, is to work the phones trying to find GMP facilities in which to make their vaccine. There is, though, nothing available. He is therefore looking to buy firms whose vaccine candidates have turned out not to work, simply in order to acquire the facilities in question.

Supplies of raw materials such as nucleotides are also tight. According to Dr Zarur, Thermo Fisher, an American chemical-supplies company, has spent \$200m on a new facility in Lithuania to make these molecules, though the firm itself would not confirm this.

On top of all this, the transport and distribution of vaccines once they have been made presents yet further challenges, and concomitant potential for hold ups. Vaccines must be stored in special non-reactive glass vials. Some, such as the current version of Pfizer’s mRNA vaccine, must also be kept at extremely low temperatures, though that problem may go away soon. Drew Weissman, one of the inventors of mRNA-vaccine technology, says producers are now testing shots which are stable for three months when kept at 4°C.

Once supply chains for both cell-culture and mRNA vaccines have been scaled up, and bottlenecks unblocked, the manufacturing processes may face a different test—how quickly they can produce new vaccines to deal with new viral variants as these emerge. The continued efficacy of approved vaccines against such variants is not guaranteed, and it may be necessary to make others.

Here, the mRNA approach may have an advantage. Its production systems will require a simple tweak—the dropping in at the start of a DNA template describing the new variant’s spike protein. Cell-culture systems, by contrast, will have to be rebuilt to some degree for every new variant they aim to vaccinate against.

Producers, such as those in China, who use older-fashioned cell-culture techniques, will have to recalibrate their entire operations. Newer systems, like AstraZeneca’s, which use cells specially designed so as not to be influenced by the new version of the spike gene in the viruses they are carrying, should be able to get on track in the time it takes to start a culture from scratch—about a month. For mRNA systems, Drs Weissman and Zarur say it would take a couple of months to go from new variant to large-scale vaccine production. If variants resistant to the current crop of vaccines do evolve, then that speed and certainty in making new vaccines to combat them will be essential. ■



制造疫苗

使命必达

现在必须把疫苗的产能提高到前所未有的水平。这很难

目前已有九种新冠疫苗在不同的司法辖区获批上市，处在研发的各种阶段的疫苗更是多得很。在新冠肺炎引发全球关注的一年内就取得了如此进展，是件了不起的事情。但是，疫苗的设计和试验是一回事，足够的产能又是另一回事——不仅要生产给全世界人口接种所需的几十亿剂疫苗，接种速度也要超过病毒传播和可能变异的速度才行。

制造抗病毒疫苗的方法大体上有两种。一种是已经经过检验的可靠方法，在被称为生物反应器的容器中进行细胞培养，让这些细胞成为病毒的宿主，然后以各种方法用这些病毒来制造相关疫苗。用这种方式培育的细胞可以有很多种——昆虫、人类肾脏、猴子肾脏、仓鼠卵巢等等。由此制造出的疫苗也多种多样。它们可能是已经减毒或灭活的目标病毒，也可能是携带有从目标病毒中提取的一两个基因的另一种不那么危险的活病毒，甚至可能只是分离出来的目标病毒蛋白。其中的关键在于疫苗要把某种物质引入人体，或诱导人体制造那种物质，这样一旦真正的目标病毒出现，免疫系统已经学会识别并攻击它们。

另一种方法在新近开发和部署，用于制造mRNA疫苗这种新冠疫情刺激下的发明，比如莫德纳（Moderna）和辉瑞（Pfizer）生产的那些。这种方法只需要在开始阶段进行细胞培养。mRNA这种物质把如何用一个细胞的DNA制造出一种蛋白质的指令递送给名为核糖体的分子工厂，核糖体负责蛋白质的实际生产。就新冠病毒而言，所递送的指令是生成刺突蛋白，这是一种在新冠病毒表面发现的蛋白质。这样的mRNA经过恰当的包装和递送，可以诱导受种者的一些体细胞产生刺突蛋白，之后免疫系统学会识别它。因此，要制造这种疫苗，必须生成大量相关的mRNA。

这种方法在开始时确实需要细胞培养，尽管它们是细菌细胞，而不是动物

细胞。但在最后并不用到细胞。它采用的细菌通常是人们熟知的大肠杆菌，将新冠病毒基因组中表达刺突蛋白那部分的DNA拼接到这些细菌上。

（令人困惑的是，和许多病毒一样，新冠病毒的真正基因是由RNA构成。）然后，让细菌繁殖几天，再把它们裂解，过滤出它们的DNA，从中提取刺突基因DNA作为所谓的DNA模板。

经过纯化后，该模板与一种相关的酶溶液混合，并被注入一种叫作核苷酸的分子——构成RNA的化学“字母”。这样，酶就用该模板复制出无数适用的mRNA。它们被提取出来，封装到微小的脂质体内，形成疫苗。

细胞培养法和mRNA法各有利弊。前者的优点是技术成熟。这种方法可以追溯到疫苗制造的起源。但是，让培育的动物细胞保持存活和健康是件棘手的事情。生物工程学有一个分支就完全在研究这项工作。依赖活细胞培养的疫苗制造商一直都苦于如何提高产量。用这种方法快速生产出大量疫苗很难。

在欧盟称阿斯利康（AstraZeneca）未按承诺的数量提供疫苗时，该公司的首席执行官帕斯卡尔·索里奥特（Pascal Soriot）1月26日就拿这类困难为自己辩护。这家英国和瑞典的合资公司与牛津大学合作，研制出了首批获批的疫苗之一。索里奥特对意大利《共和报》（La Repubblica）说：“这里出些小故障，那里又有增产的问题。我们产量最高的工厂一个批次生产的疫苗是产量最低的工厂的三倍。”

让生物反应器的产量最大化是一门科学，也是一门艺术。相关细胞的基本健康至关重要。生产场所的环境状况也一样。阿斯利康未能达到自己的生产目标这一点表明，要预测何时能找到生物作用机制上的平衡点非常难。阿斯利康表示，从零开始建设一个生产场所可能需要六到九个月的时间，就算是这个时间表，也只有与经验丰富的伙伴合作且加班加点才有可能实现。目前，阿斯利康正在与15个国家的25家生产机构合作生产疫苗。

大规模生产mRNA疫苗也存在麻烦。最大的问题是如何在两方面保护好mRNA分子：在给接种者注射之前要避免受运输中环境的影响；在接种后

要避免受接种者自身身体的影响，因为mRNA分子在到达转录它们的核糖体的过程中会受到接种者身体的攻击。

要免受环境影响，主要是要有一套全面战略布局的冷藏系统，也就是冷链。而要免受人体的攻击，就要靠脂质体。

新冠疫情爆发之前，脂质体的生产还处于家庭作坊模式。奥地利的小公司Polymun Scientific是为数不多的几家能够制造它们的公司之一。脂质体之前主要用于罕见癌症的治疗。目前它们的生产规模正在扩大，这是前所未有的操作，也给mRNA疫苗的持续供应增加了不确定性。

此外还有其他瓶颈。特别是疫苗生产工厂的建造必须符合很高的“良好生产规范”（GMP）标准。目前符合GMP标准的生产设施短缺。位于波士顿的GreenLight Biosciences公司正在研发mRNA疫苗。公司老板安德烈·扎鲁尔（Andrey Zarur）说，现在自己公司有些员工的全部工作就是打电话，为疫苗生产寻找符合GMP标准的设施。然而还一无所获。因此，他正在寻求收购那些所生产的候选疫苗已被证明无效的公司，纯粹就是为了获得相关设施。

核苷酸等原材料的供应也很紧张。扎鲁尔表示，美国化学制品公司赛默飞世尔（Thermo Fisher）已经在立陶宛投资了2亿美元，用于建设制造这些分子的设施，尽管该公司自己未证实此事。

除此之外，疫苗生产出来后，在运输和分发上又面对挑战，为此可能造成延迟。疫苗必须储存在不会引起化学反应的特制玻璃小药瓶中。有些疫苗，比如辉瑞目前的mRNA疫苗，还必须在极低的温度下保存，尽管这个问题可能很快就会解决。mRNA疫苗技术的发明者之一德鲁·韦斯曼（Drew Weissman）表示，生产商目前正在测试可在4°C下稳定保存三个月的疫苗。

一旦细胞培养疫苗和mRNA疫苗的供应链都得以扩大，瓶颈被消除，生产过程可能会面临另一个考验——在新的变异病毒出现时，在最短时间内生产出能够对抗它们的新疫苗。目前已批准的疫苗对这类变异病毒的持续有

效性还不能保证，因此可能有必要制造其他疫苗。

在这点上，mRNA可能有优势。它的生产系统只需要稍作调整——在开始的时候插入表达新变异病毒的刺突蛋白的DNA模板。相比之下，细胞培养系统必须针对每一种新变异病毒做某种程度的重建，才能实现免疫。

使用老式细胞培养技术的生产商，比如中国的生产商，将不得不重新调整自己的整个操作。而阿斯利康等公司采用的较新方法使用的是经专门设计的细胞，并不受细胞携带的病毒中新刺突基因的影响，因此能在从零开始培养细胞所需的一个月左右的时间内步入正轨。至于mRNA方法，韦斯曼和扎鲁尔表示，从发现新变异病毒到大规模生产疫苗需要几个月的时间。如果对现有疫苗具有耐药性的变异病毒确实在进化，那么制造能抵御它们的新疫苗的速度和确定性将至关重要。■



Feuding tech giants

Cook v Zuck

Apple's privacy policy kicks Facebook where it hurts

SELDOM HAS a tech giant excoriated another as Apple did Facebook. “What are the consequences of prioritising conspiracy theories and violent incitement simply because of their high rates of engagement?” asked Apple’s boss, Tim Cook, in a speech on January 28th. “A social dilemma”, he thundered, “cannot be allowed to become a social catastrophe.” Facebook was singled out without being named. Last year it complained about its portrayal in “The Social Dilemma”, a hit Netflix documentary.

Mr Cook’s warning came in response to Facebook’s own broadsides against Apple’s forthcoming “app-tracking transparency” measure. Soon a pop-up from Apple will start asking users of the latest version of iOS, its mobile operating system, if they want named apps such as Facebook to track their digital activity across other companies’ apps and websites. Huge numbers are expected to demur. That is likely to damage Facebook, possibly Google and a wide range of other ad-tech businesses.

Mr Cook’s righteous wrath makes it easy to forget how in the early days, Apple enabled ad tracking. In the 2000s app developers and advertisers learned to use its “unique device identifiers” to follow users around the internet. These UDIDs, as they were known for short, were permanently attached to every iPhone or iPad and made it easy to keep tabs on individuals’ online activity. Then in 2010 a privacy furore erupted around Apple and Google. Two years later Apple responded by banning app developers from using UDIDs. For a brief few months advertisers could barely track its customers at all.

The sixth incarnation of iOS introduced a new, less intrusive tool called “identifiers for advertisers”. Unlike UDIDs, these can be blocked, and do not identify users personally; any data collected are aggregated before being used. But they still allow tracking, which is switched on by default on iPhones, and fiddly to turn off. Apple’s aim back then was to help app developers earn revenue in iOS.

Now privacy is more central than ever to Apple’s brand. Four years ago it stopped tracking users on Safari, its web browser. Google, too, has announced plans to eliminate third-party tracking “cookies” from its Chrome browser by 2022. Ad-industry insiders find it odd that identifiers for advertisers are still around; last year some in the mobile-ad industry reckoned Apple was going to kill them off. With app-tracking transparency at least some users will presumably allow cookies to stay.

Facebook has nevertheless fought back hard. In December the social network took out newspaper ads claiming that Apple’s changes would hurt small businesses. Announcing Facebook’s earnings on January 27th Mark Zuckerberg, its boss, explained how his firm gives tiny firms ad-targeting tools that in the past only large companies had the resources to employ. This echoed other ad-tech types’ warnings of a return to a “spray and pay” world where, once again, half of all ads are wasted but no one knows which half. Moreover, Facebook argues, Apple is trying to shift the internet’s business model from one that is chiefly ad-supported to one that is increasingly paid for. In this view, Apple’s stance on privacy is not selfless but self-serving.

Facebook’s campaign against Apple could go beyond public admonishments. Last month rumours swirled that Mr Zuckerberg’s firm might sue the iPhone-maker over alleged preferential treatment given to its own apps in its App Store, while it imposes restrictions on third-party developers like Facebook. Apple’s App Store is already under scrutiny by America’s Department of Justice and the European Union’s competition

watchdog.

Of course, Facebook's own protestations are not exactly disinterested. It may want to divert attention from the antitrust lawsuits it itself faces. And the company will probably take a hit to its top line as a result of Apple's move. In late January it named the latest iOS changes as a headwind for its ad business this year.

Most people will welcome Apple's privacy proposal. But its ability to impose it on a big industry has underlined its power in a way that may not be entirely helpful for it. As for Facebook, its task now is to come up with its own pop-up to reassure people that its ad-tracking is harmless—even for the most talented ad creative, a tough brief. ■



科技巨头缠斗

库克战扎克

苹果的隐私政策击中Facebook要害

很少有哪家科技巨头会斥责另一个巨头，就像苹果对Facebook那样。“仅仅因为阴谋论和暴力煽动的参与率高，就优先传播这类内容，这样做的后果是什么？”1月28日，苹果公司老板蒂姆·库克在一次演讲中质问。“不能让社交困境演变为社会灾难。”他怒吼道。虽然没有点名道姓，但很明显说的就是Facebook。去年Facebook抱怨了奈飞热门纪录片《社交困境》（The Social Dilemma）对自己的刻画。

Facebook之前曾猛烈抨击苹果即将出台的“应用追踪透明度”措施，库克用这番警告做出了回应。很快，苹果会在其最新版移动操作系统iOS中通过弹窗询问用户，是否希望Facebook等被指名的应用跟踪他们在其他公司的应用和网站上的数字活动。预计大批人会选择“否”。这很可能会损害Facebook，可能还有谷歌和一大批其他的广告科技公司。

库克的义愤填膺很容易让人忘记苹果在早期是怎样启用广告追踪的。本世纪头十年，应用开发者和广告商学会了用苹果的“唯一设备标识符”（unique device identifier, UDID）在互联网上跟踪用户。这些UDID永久地对应每一部iPhone或iPad，让个人的线上活动很容易被监控。2010年，苹果和谷歌的隐私问题掀起了一场轩然大波。两年后，苹果做出回应，禁止应用开发商使用UDID。曾有几个月，广告商几乎完全无法追踪客户。

第六版iOS引入了一种侵入性较低的新工具，称为“广告商标识符”（identifiers for advertisers）。与UDID不同，这些标识符可以被屏蔽，而且不会识别用户的个人信息；收集到的所有数据要在聚合后才能使用。但它们仍然能够追踪用户，且在iPhone上是默认开启的，需要繁琐的操作才能关闭。苹果当时的目标是帮助应用开发者在iOS上赚取收入。

现在，隐私对苹果的品牌来说比以往任何时候都更关键。四年前，苹果停止在它的Safari浏览器上追踪用户。谷歌也宣布计划在2022年前从Chrome浏览器中去除第三方追踪cookie。广告业人士对广告商标识符仍然存在感到很奇怪，去年一些移动广告业人士认为苹果会把它们完全清除。有了应用追踪透明度，想来至少有一些用户会允许继续使用cookie。

尽管如此，Facebook还是做出了强力反击。去年12月，这家社交网站在报纸上刊登广告，称苹果的变化会伤害小企业。1月27日，老板扎克伯格在公布Facebook的业绩时，解释了他的公司如何为小公司提供广告定向投放工具，而在过去只有大公司才有资源来部署这样的工具。这呼应了其他广告科技公司发出的警告，说广告投放会重新回到那个“广而告之，盲目投钱”的世界，其中有一半广告根本是白白烧钱，但没人知道是哪一半。此外，Facebook认为，苹果正试图将互联网的商业模式从主要靠广告支持转变为越来越多的付费服务。从这个角度来看，苹果在隐私问题上的立场并非大公无私，而是夹带私心。

Facebook针对苹果的行动可能不只是公开训斥。上个月盛传扎克伯格的公司可能会起诉苹果，指控它在自家的App Store里偏袒自家应用，而对Facebook这样的第三方开发者加以限制。苹果的App Store已经受到美国司法部和欧盟竞争监管机构的审查。

当然，Facebook自己的抗议也并非完全大公无私。它或许想转移人们对它面临反垄断诉讼的注意力。而且它的营收可能会受到苹果此番举措的冲击。1月下旬，它将iOS系统的最新更新列为今年广告业务的一个不利因素。

大多数人都会欢迎苹果的隐私提议。苹果把它强加给一个大行业的能力突显了自身影响力，但这种彰显或许并不完全对它有利。至于Facebook，它现在的任务是推出自己的弹窗，说服人们相信它的广告追踪没有害处——即便是对最有才华的广告创意人士来说，这也是一项艰巨的任务。■



Schumpeter

Alpha pipers

The cult of an Elon Musk or a Jack Ma has its perks—but also perils

“I AM BECOME meme, Destroyer of shorts.” This recent tweet by Elon Musk struck a messianic tone that his disciples lap up. The past month has boosted the cult status of the uber-entrepreneur. The GameStop saga gave him ammunition in his long-running battle with short-sellers, while also positioning him as a champion of the little guy taking on Wall Street. This week fans were spellbound by the announcement that Mr Musk’s electric-car maker, Tesla, had invested \$1.5bn in bitcoin and would start accepting the cryptocurrency as a form of payment. Earlier, a barrage of cheeky tweets from Mr Musk about dogecoin (“the people’s crypto”) had sent serious investors scrambling to learn more about a digital currency that started as a joke.

Impish humour is a Musk hallmark, but the impact of his missives is no joke. They can set herds stampeding. His bitcoin announcement propelled it to new heights. Tesla’s market value briefly climbed above \$830bn, near its peak. The history of business is littered with Pied Pipers but, as Peter Atwater, a social psychologist, points out, none has matched Mr Musk for the number of things he has helped turn red-hot, from cars and crypto to space travel and Clubhouse, a live-podcasting app he appeared on. That invites two questions. What makes the Musk scent so intoxicating to so many? And what are the pros and cons of being a cult CEO?

Larger-than-life business figures enjoy various degrees of celebrity. One category includes chief executives of big firms who, while charismatic, fail to inspire feverish devotion. Jeff Bezos, Amazon’s outgoing boss, commands admiration on Wall Street and envy in other corner offices, but is too

restrained to attract drooling groupies. Similarly, in his 20 years running GE, Jack Welch earned a reputation (since disputed) for red-toothed success, but was too cold-blooded to mesmerise the masses.

The second group comprises tycoons who achieve cultlike status but whose businesses scarcely warrant the adulation. Their trademark is often shameless self-promotion. Richard Branson has spent decades cultivating an image as a corporate hippy-cum-pirate who takes on complacent incumbents in industries from aviation to finance. Donald Trump touted himself as the arch-dealmaker. Both have hordes of wide-eyed fans. Neither has built a business that comes close to \$10bn in value or is built for stability.

The third category is more exclusive: those who build both cults of personality and huge businesses. Joining Mr Musk in this club is Jack Ma, the founder of Alibaba, China's tech titan. Millions of Chinese college students and other wannabe entrepreneurs bought into the image he cultivated, of a humble teacher turned philanthropic tech titan with a splash of cultural cool (he once appeared as a tai chi master in a martial-arts film). Admiration of Mr Ma has often verged on religious fervour. In 2015 a group of online merchants created a shrine to him, to bring them good luck on "singles day", an e-shopping festival.

Messrs Musk and Ma walk a trail blazed by an Indian business legend: Dhirubhai Ambani, who founded Reliance Industries, a petrochemicals-to-telecoms conglomerate. The son of a village schoolteacher who cut his teeth trading polyester yarn, Ambani pioneered the equity cult. His trick, in a country where companies had long relied mostly on banks for funding, was to see the untapped potential lower down the pyramid. He toured India, convincing middle-class savers that they, too, could join the capitalist class. When Reliance went public in 1977 it attracted 58,000 punters. The shareholders he drew in have done well: the share price has gained

275,000% since the flotation. When 30,000 of them turned up to pay homage at one general meeting, it had to be moved to a park. These days only Warren Buffett attracts zealots in such numbers (or did before covid-19).

Cult status confers perks. Equity is cheaper when those buying it are devout retail investors, not hard-headed institutions. Small investors are also more patient, heeding calls to “keep the faith” during profitless investment splurges. Marketing costs are low; Mr Musk can use social media to burnish his (and Tesla’s) brand for nothing. Fans are willing to overlook flaws that more dispassionate consumers won’t. Tesla’s build quality is hardly world-class and regulators, most recently China’s, frequently flag up concerns. Yet it is hard to see that reflected in the firm’s sales or share price. Lastly, mass appeal means political clout. Ambani’s popularity helped him bend India’s trade policy to his advantage. Mr Musk’s helps explain soft treatment by governments and regulators, over rogue tweets or reopening factories in the pandemic.

But combining star power and scale is not risk-free. Mr Musk forged his reputation as a David, fomenting rebellions against Detroit and Wall Street elites. But now he is a Goliath: the world’s richest man who runs its most valuable carmaker. Playing both roles is a dangerous game. This is made more so by being a cultural icon, which leaves him more vulnerable to changing social taste—and taste can change in a trice online.

Sentiment could turn if his devotees start to doubt he has their interests at heart. Ambani was able to bat away repeated allegations of financial manipulation; he beat back short-sellers with help from a group of brokers known as “Friends of Reliance”. Mr Musk may not be so lucky. Acolytes who piled into GameStop stock after his “Gamestonk!!” rallying cry on January 26th were buying near the top. His recent crypto-talk looks self-serving in light of Tesla’s bitcoin move.

Finally, political advantage can turn into a bane. Just ask Mr Ma, who, overestimating his power, publicly chided Chinese regulators last year. Irked, Beijing scuppered the planned listing of Ant, Alibaba's financial affiliate, and is forcing it to restructure. Joining the ranks of cult CEOs may lower your cost of funding. But it raises the cost of miscalculation. ■



熊彼特

阿尔法魔笛手

对马斯克、马云等人的膜拜有好处——也有坏处

“我是散户神股化身，空头毁灭者。”马斯克最近这条推文一派救世主口吻，粉丝们听来甘之如饴。过去一个月，对这位超级企业家的膜拜再次升级。游戏驿站（GameStop）事件为他对抗做空者的持久战提供了弹药，同时也把他塑造成小散户对抗华尔街的领军人物。最近，马斯克的电动汽车公司特斯拉宣布已投资15亿美元买入比特币，并将开始接受比特币付款，令粉丝们心驰神往。此前，马斯克有关狗狗币连串口不择言的推文（说它是“人民的加密货币”）一出，许多严肃投资者忙不迭地研究起这个一开始只是个玩笑的数字货币。

搞怪式幽默是马斯克的标志，但他推文的影响力可不是闹着玩儿的。这些文字足以引发集体狂热。他有关比特币的言论把这一数字货币推至新高度。特斯拉的市值一度攀升至超过8300亿美元，接近其史上峰值。“魔笛手”在商业史上随处可见，但正如社会心理学家彼得·阿特沃特（Peter Atwater）指出的，马斯克“带货”下爆红的事物之多无人能及——汽车、加密货币、太空旅行，还有他现身开讲的直播应用Clubhouse。这就引出了两个问题。马斯克气息何以如此迷倒众生？而做一个被封神的CEO又有何利弊？

商界传奇人物的人气各异。其中一类是虽然魅力十足，却未引发狂热追捧的大公司首席执行官。即将卸任亚马逊CEO的贝索斯在华尔街深受敬佩，也让其他公司的高管羡慕，但他行事谨慎克制，难以吸引粉丝为他神魂颠倒。同样，执掌GE长达20年的韦尔奇以铁腕制胜闻名（之后备受争议），但他太冷血无情，难以让大众着迷。

第二类是那种崇拜者众，但他们的企业根本配不上这般追捧的富豪。他们的标志往往是恬不知耻的自吹自擂。理查德·布兰森（Richard Branson）

几十年来一直为自己打造嬉皮士加海盗企业家的形象，挑战航空、金融等行业内固步自封的传统企业。特朗普把自己吹捧为交易高手。两人都有大批天真的粉丝，但他们企业的价值都不到100亿美元，也并不稳健。

第三类的人数更少：他们既打造了受人膜拜的个人形象，又创建了庞大的企业王国。与马斯克同属这一类的还有中国科技巨头阿里巴巴的创始人马云。千百万中国大学生和其他怀揣创业梦的人景仰他塑造的形象：从一名普通教师变身仁慈的科技大亨，还带一丝文化酷感（他曾是一部武侠电影中扮演太极宗师）。人们对马云的崇拜往往近乎宗教狂热。2015年，一群网络商家建了一座神龛供奉他，祈求在双十一购物节为他们带来好运。

马斯克和马云这一路线的开山鼻祖是一位印度的商界传奇人物：创立了信实工业（Reliance Industries）这家业务覆盖石化以至电信的企业集团的迪鲁巴伊·安巴尼（Dhirubhai Ambani）。安巴尼是一位乡村教师的儿子，一开始做聚酯纱线买卖的他是掀起股票狂热的先驱。在印度，企业向来要依赖银行融资，而安巴尼的本事就是看到了金字塔下层尚未开发的潜力。他在印度四处游说中产阶级储蓄者，让他们相信自己也可以迈入资本家阶级的行列。信实在1977年上市时吸引到58,000人投资。这些股东获得了不俗的回报：股价自上市以来上涨了275,000%。在一次股东大会上，其中三万人来到现场表达敬意，会议不得不转移到一个公园内举行。这些年（或者说，在新冠疫情前）只有巴菲特才能吸引来如此数量的狂热粉丝。

受人膜拜的地位会带来好处。当买家是虔诚的散户而非精明的机构时，股票融资会更便宜些。小投资者也更有耐心，在企业大举烧钱投资而没有盈利时能听从“坚守信念”的呼吁。营销成本也低，马斯克不花一文就能利用社交媒体擦亮自己（还有特斯拉）的招牌。相比冷静客观的消费者，粉丝们更愿意忽略企业的缺陷。特斯拉的汽车质量说不上世界级水准，监管机构也常发出警告——最近一次是中国的监管机构。但这一点却很少反映在特斯拉的销量或股价上。最后，大众热捧意味着政治影响力。安巴尼的人气帮助他游说印度政府向有利于他自己的方向调整贸易政策。而马斯克的人气也解释了为何政府和监管机构只是温和地处理了他任性的推文或在疫

情期间重开工厂的做法。

但把明星影响力与企业规模相结合也非毫无风险。马斯克把自己打造成了勇斗巨人哥利亚的大卫，动员反抗底特律和华尔街的精英。如今他却成了哥利亚：掌管市值最高的汽车公司的全球首富。同时扮演这两种角色是一场危险的游戏。兼为文化偶像就更危险了，因为大众的口味会变，在网络世界里更是瞬息万变。

当信徒们开始怀疑神明是否真的心怀他们的利益时，情绪便可能逆转。安巴尼能多次摆脱操纵金融的指控，又在一群号称“信实之友”的券商的帮助下击退了卖空者。马斯克可能没那么幸运。在他1月26日发出“游戏开炮!!”的战斗口号后，他的信徒大举买入游戏驿站的股票，但当时股价已接近顶点。考虑到特斯拉对比特币的投资，马斯克最近有关加密货币的言论似乎是出于私心。

最后，政治上的优势也可能变成祸根。问问马云就知道。他高估了自己的力量，在去年公开指责中国的监管机构。恼怒之下，政府叫停了阿里巴巴旗下金融服务公司蚂蚁集团的上市计划，并正迫使它重组。加入CEO封神榜或许能降低融资成本，但也会增加误判成本。■



China's capital outflows

Border crossings

Mainland investors' access to foreign assets expands—a bit

THE 55-KILOMETRE Hong Kong-Zhuhai-Macau bridge is a quick drive but a technical challenge. The trip requires motorists to buy insurance in three jurisdictions. Those making the jaunt from Hong Kong to Macau must still buy a Chinese policy, because the waters below the bridge belong to the mainland. Traffic is low.

Such are the barriers to movement in and out of China. For most people, attempting to shift money between China and the territories can be even more frustrating. For many years insurance products sold in Hong Kong created a bustling business whereby rich customers from the mainland bought policies worth hundreds of thousands of dollars using Chinese credit cards, only to later cash them out in Hong Kong dollars. In Macau, plastic watches once sold for \$10,000. Upon swiping their Chinese cards, buyers received the tawdry timepiece along with a stack of dollars.

China's regulators have sought to crush these schemes, wary of outflows of capital from the country. Yet they have also acknowledged the very real demand for overseas investments. A series of reforms have been launched over the past two decades to construct a closely monitored regime for cross-border investments, mostly catering to institutional investors. Stock Connect, which since 2014 has allowed Chinese investors to buy shares in Hong Kong, helped make the territory the world's best-performing major stockmarket in January. Money from the mainland poured into stocks such as SMIC and China Mobile, which have been, or face being, delisted from the New York Stock Exchange, and have been removed from some MSCI indices. Buy trades from Shanghai to Hong Kong hit HK\$423bn (\$55bn) in January,

up by 155% from December. China's retail investors played a significant role in the rally.

In coming weeks regulators in Hong Kong and China will take another step towards opening up, with an investment channel called Wealth Management Connect. This will allow rich individuals to buy unlisted investment products in Hong Kong, opening a new world of assets to those who qualify. But rather like crossing the bridge between the jurisdictions, the technical details of the plan are onerous.

For a start, the scheme will be open only to people living in the Greater Bay Area, a region of about 72m people in Hong Kong, Macau and much of China's Guangdong province. To use the channel, investors must open an account at a bank in China and then travel to Hong Kong to open a separate account in person—a difficult task during the covid-19 pandemic. The investment size, at 1m yuan (\$155,000) a year, will be rather limited for China's wealthy punters. The overall programme is to be restricted to 150bn yuan (\$23bn) a year, a drop in the ocean next to China's \$3.2trn in foreign-exchange reserves.

The design of Wealth Management Connect underlines Beijing's desire for unwavering control over its capital account even as it ever so gradually opens up. Much like Stock Connect, the new scheme will operate in a closed loop that does not allow convertibility beyond the target investments. Cashing out can be done in yuan only. Proceeds must be sent back to the mainland. "Regulators are still very cautious on capital outflows," says a partner at a large accounting firm. Whether such limited exposure to offshore assets replaces the demand for pricey plastic watches in Macau remains to be seen. ■



中国资本外流

跨越边境

大陆人投资海外资产的渠道拓宽了——略微一点点

全长55公里的港珠澳大桥车程虽短，操作细节却颇有挑战性。驾车者需要在三个司法管辖区购买保险。经大桥从香港驾车到澳门也必须购买一份大陆的保险，因为所经过的桥面处于大陆水域之上。大桥的车流量并不大。

这些便是进出中国大陆的障碍。对大多数人来说，要在大陆与港澳地区之间转移资金还要更麻烦。很多年里，在香港销售的保险产品备受追捧，大陆的富裕客户会用大陆信用卡购买价值数十万美元的保单，日后拿到的理赔金却是港币。在澳门，塑料手表曾售价一万美元。买家刷完大陆银行卡，拿到一块华而不实的塑料表和一叠美元找零。

中国的监管机构担心资本外流，一直在想办法打击这些行径。不过它们也承认国人确实存在投资海外的需求。过去20年里中国启动了一系列改革来构建一个严密监控的跨境投资制度，主要是为迎合机构投资者的需求。

2014年以后“港股通”让大陆投资者可以购买在香港上市的股票，这在今年1月助力香港成为全球表现最佳的主要股市。大陆资金大举购入中芯国际和中国移动等已经或面临从纽约证券交易所退市并被一些MSCI指数剔除的股票。1月，沪港通南向资金的买入成交额达到4230亿港元（550亿美元），较去年12月增长155%。大陆散户在这轮反弹中扮演了重要角色。

在未来几周内，香港和大陆的监管机构将朝着开放的目标再迈出一步，建立名为“跨境理财通”的投资渠道。这让富裕个人可以在香港购买非上市投资产品，为符合条件的个人打开了一个资产新世界。但和横跨多个司法管辖区的港珠澳大桥一样，理财通的方案也有着繁琐的操作细节。

首先，该计划只对粤港澳大湾区（包括香港、澳门和广东省大部分地区，共有约7200万人口）的居民开放。要使用该渠道，投资者必须在一家大陆银行开立账户，然后亲身前往香港开立另一个账户——这在疫情期间是一

项艰难的事务。每年100万元的投资额度对大陆富人来说相当有限。整个项目的规模将被限制在每年1500亿元（230亿美元），与中国3.2万亿美元的外汇储备相比只是沧海一粟。

理财通的这种设计突显出中国政府在非常缓慢地逐步开放的同时，仍想要牢牢控制其资本账户。大体上和港股通一样，这一新机制将是闭环运行，在目标投资之外不能兑换资金。兑现只能拿到人民币，而收益必须汇回大陆。“监管部门还是非常警惕资本外流。”一家大型会计师事务所的合伙人说。这么有限的离岸投资机会能否取代对澳门天价塑料手表的需求，还有待观察。 ■



Asian corporate culture

Here's my QR code

Business cards are going online

IN ASIA MEETINGS do not begin until business cards have been swapped. It is no mere formality. Accept the card with two hands and carefully examine it, noting the giver's title and other indicators of rank—essential information in any strongly hierarchical business culture. It is so important to master this ritual in Japan (just how deep does one bow?) that numerous books and courses promise to transform bumbling novices into *meishi-koukan* (card-swapping) virtuosos. If a new acquaintance fails to give a card to Glenn Lim of CEO Asia, a Singaporean business-networking company, “it makes me forget them,” he says.

Yet the pandemic has put the business card on life support. Networking is difficult when white-collar workers have fled to home offices, business lunches have been cancelled and conferences have migrated online. Orders for business cards from Vistaprint, a multinational printing company, plummeted by 70% in late March and early April and have yet to recover fully. Mr Lim normally hands out about 200 cards a month. In the six months following Singapore's lockdown in March, he reckons he dispensed about five. “I've forgotten what business cards look like,” remarks a British banker based in Singapore. “How do you sanitise them?”

But it is still helpful to know who is who at meetings, even when they take place on Zoom. Companies are therefore reimagining the business card for the era of social distancing. Nagaya, a Japanese firm, prints them on face masks (a literal interpretation of a Japanese metaphor that likens business cards to one's face). After the launch of the “Meishi” mask, traffic to Nagaya's website surged by 65,000%.

Sansan, another Japanese firm, allows companies to sort scanned business cards so bosses can see which employees have made new contacts. It also offers “virtual cards”. Users receive QR codes which they display as virtual backgrounds on video-conferencing apps. Scanning the code with a phone camera will summon the user’s digital business card. Some 4,300 companies have begun using Sansan’s virtual cards since they launched in June.

But Mr Lim, who uses Sansan’s virtual cards, does not plan on binning the paper version just yet. People tend to exchange virtual cards after meetings have started or as they end, forcing participants to ask who does what during the meeting itself. “That’s sometimes a little bit rude,” he says. Many others in Singapore are evidently fond of paper cards, too. Sales at ExpressPrint, a printing company, have picked up in the past two months, as more people resume in-person meetings. Stephen Forshaw, head of public affairs at Temasek, Singapore’s sovereign-wealth fund, says that he recently topped up his supply of cards for the “first time in a long time”. Even Edward Senju, the head of Sansan’s operations in South-East Asia, still keeps some in his wallet, “just in case”. ■



亚洲企业文化

这是我的二维码

名片上线

在亚洲，等人们交换完名片后，会议才算正式开始。这不仅仅是一种礼节。双手接过名片，细看一番，留意递上名片者的职衔和其他透露地位的东西——这在任何等级森严的商业文化中都是非常重要的信息。在日本，掌握这一套礼仪（例如需要鞠躬到多深）极为重要，所以会有不计其数的书籍和课程承诺把职场菜鸟变为“名刺交換”（交换名片）的高手。新加坡商业人脉拓展公司CEO Asia的林智雄说，如果一个新认识的人没给他名片，“那我就不会记得他们。”

然而，新冠疫情已经让名片“生命垂危”。白领们纷纷居家办公，商务午餐被取消，会议转到网上，人脉拓展活动难以进行。跨国印刷公司Vistaprint的名片订单在去年3月底至4月初间暴跌了70%，至今未完全恢复。林智雄以往每个月递出200张左右的名片。新加坡去年3月封城后的六个月里，他估计只给出了五张。“我都不记得名片长什么样了，”一位常驻新加坡的英国银行家说，“你怎么给名片消毒啊？”

但是，即使会议搬到了Zoom上，弄清楚谁是谁仍然很有帮助。因此，企业正在为社交疏离时代重塑名片。日本长屋印刷（Nagaya）把名片印在了口罩上（生动演绎了日本人把名片比作脸面的说法）。在推出“名刺”口罩后，长屋印刷的网站访问量激增了65,000%。

另一家日本公司Sansan帮助公司分类管理扫描下来的名片，这样老板就可以看到哪些员工结识了新联系人。Sansan还提供“虚拟名片”。用户会收到二维码，可用作虚拟背景显示在视频会议应用上。用手机镜头扫描二维码就会显示用户的数字名片。自去年6月推出以来，已有约4300家公司开始使用Sansan的虚拟名片。

但正在使用Sansan虚拟名片的林智雄并不打算就此扔掉纸质名片。人们往

往往在会议开始后或结束时才交换虚拟名片，这让与会者不得不在会议期间问及对方具体负责什么。“这有时有点不礼貌。”他说。在新加坡，许多人显然也偏爱纸质名片。过去两个月，随着更多人恢复在线下开会，印刷公司ExpressPrint的销售额有所回升。新加坡主权财富基金淡马锡的公共事务主管斯蒂芬·福肖（Stephen Forshaw）表示，他最近加印了名片，“很久没干这件事了”。就连Sansan的东南亚业务主管千住洋也还会在钱包里放一些纸质名片，“以防万一嘛”。 ■



Glencore

Pit stop

A new boss takes the reins at a good time for commodities

MINING BOSSES often leave under a cloud, ousted after a profit slump, a public-relations disaster or pit-hole calamity. Not so Ivan Glasenberg. For his last set of results on February 16th the boss of Glencore offered shareholders—including himself—a reinstated dividend and an upbeat outlook. Leaving on a high note after 19 years in the top job will not make life easier for his anointed successor, Gary Nagle.

All miners have had a bull run of late as commodity prices have surged. China's appetite for natural resources is unabated. America and Europe are planning infrastructure pushes that will juice demand. The green tinge of such stimulus spending is especially good news for Glencore, a big producer of the cobalt, copper and nickel needed for electric cars and the like.

Investors on the earnings call were as focused on life after Mr Glasenberg. It may not be so different. Those used to seeing the Swiss firm run by a fast-talking South African accountant who has spent much of his career on the coal side of the business might not notice the handover, due to happen in the next few months. Like his predecessor, Mr Nagle is all those things. He will become only the fourth boss to lead the company since its founding in 1974.

Investors expect continuity in the business. Mr Glasenberg has re-engineered a pure commodities trader into a firm that also digs the stuff up. The model has not delivered stellar returns, at least since the firm went public in 2011 (see chart). But trading profits last year were fat and Mr Nagle says the set-up is fit for purpose.

Three thorny dossiers will keep him busy. The first is coal, of which Glencore is the biggest shipper. The banks that fund its trading arm are under pressure to cut ties to polluters. Glencore has some green credentials and says it is running down coal assets gradually. But a more radical move, like a spin-off, may be needed.

Then there is the Democratic Republic of Congo. A big source of copper and cobalt profits, it is also in the sights of America's Department of Justice. Glencore denies any wrongdoing. After the Congolese elected a new president in 2018 some faces that helped Glencore thrive are being replaced. Dan Gertler, who teamed up with Glencore to develop assets in the DRC, recently earned a partial reprieve from American sanctions (he also denies wrongdoing). The copper belt is rife with rumours that Mr Gertler may be looking to cash out.

Perhaps the trickiest dossier is Mr Glasenberg. He will not upgrade himself to chairman, as some CEOs are wont to do. But he intends to keep his 9% stake, making him the second-biggest shareholder. And, potentially, its biggest back-seat driver. ■



嘉能可

开进加油站

新老板在大宗商品的好时机接棒

矿业老板常常在利润大跌、公关危机或矿井灾难后被扫地出门，黯然离场。伊凡·格拉森伯格（Ivan Glasenberg）不是。2月16日，这位嘉能可公司（Glencore）的老板公布了自己任内最后一组业绩，向股东——包括他自己——恢复分红，并对前景做出了乐观的展望。他在这个最高职位工作19年后高调离任，但这并不会让他指定的接班人加里·纳格尔（Gary Nagle）日子更好过些。

随着大宗商品价格飙升，所有的矿商最近都经历了一波牛市。中国对自然资源的胃口有增无减。美国和欧洲正在计划推动基础设施建设，这将为需求注入活力。这一轮刺激支出更注重绿色环保，这对嘉能可而言尤其是个好消息，它是生产电动汽车等同类产品所需的钴、铜和镍的重要生产商。

财报会议上，投资者对格拉森伯格离任后的状况同样关注。可能不会有太大不同。那些习惯看到这位伶牙俐齿、大部分职业生涯都花在煤矿业务上的南非会计掌管这家瑞士公司的人，可能觉察不到这场未来数月即将发生的交接。纳格尔具备他前任的所有这些特质。这家1974年成立的公司到他这里仅迎来第四位掌门人。

投资者期望业务保持连续性。格拉森伯格把一家纯粹的大宗商品交易商重构为一家也开采资源的公司。至少自2011年公司上市以来，该模式尚未带来亮眼的回报（见图表）。但去年的交易利润颇丰，纳格尔说公司架构契合目标。

三份棘手的卷宗会让这位新老板很忙。第一份是煤炭，嘉能可是全球最大的煤炭生产商。为其贸易部门提供资金的银行正面临压力，被要求切断与污染大户的联系。嘉能可拥有一定的环保资质，并表示正在逐步减少煤炭

资产。但它可能还是需要采取更激进的行动，比如分拆。

然后是刚果民主共和国。作为铜钴利润的重要源头，该国也是美国司法部的关注对象。嘉能可否认有任何不法行为。刚果人在2018年选出新总统后，一些曾帮助嘉能可崛起的面孔正在被取代。与嘉能可在刚果（金）合作开发资产的丹·格特勒（Dan Gertler）最近获得了美国制裁的部分暂缓执行（他也否认有不当行为）。在铜矿带，有关格特勒可能会伺机套现的传言不绝于耳。

最难处理的卷宗可能是写着“格拉森伯格”的那一份。他不会效仿一些CEO的惯常做法，把自己晋升为董事长。但他打算保留自己9%的股份，这让他成为公司第二大股东，也可能会成为最大的幕后操控者。 ■



SPACs in Silicon Valley

Rain for the rainmakers

The SPAC craze will change tech investing

SILICON VALLEY has thrived by inventing new ways of doing things, from searching for information to contacting friends. So it may come as no surprise that the Valley is eagerly embracing another sort of disruption: special-purpose acquisition companies (SPACs), as an alternative to the conventional initial public offering (IPO) for startups. “So many things have become cheaper and more efficient. Why are IPOs as expensive and inefficient as ever?” asks Roelof Botha, a partner at Sequoia Capital, a venture-capital firm. He describes the IPO process as “chicanery and grand larceny”.

With Wall Street banks allocating shares to top clients and encouraging companies to price their offerings low to ensure a rise on the first day, many in Silicon Valley feel the IPO “tax” is too great. Last year in America, underpricing led to \$30bn of unrealised gains for newly public companies (and their employees). With SPACs and direct listings, another route to going public, there is no pressure for a price to pop.

Signs of the SPAC craze are now as common as sightings of unicorns in the Valley. A few venture-capital firms, including Khosla Ventures, have announced SPACs, as have hedge funds that invest in tech, and individual venture capitalists. Prominent tech firms, including 23andMe, a genetic-testing firm, and SoFi, a personal-finance platform, are going public through SPACs.

Though their impact will be felt across corporate America, SPACs will have a pronounced effect on the Valley. For one, they might help finance

adolescent tech companies that struggle to attract more private investment, but are too small to do an IPO. Some point to Opendoor, a property-tech firm, as an example of a company that struggled to raise another round of funding but has thrived since going public through a SPAC. Valued at \$4.8bn before its merger in September, it is now worth \$18.1bn.

Blank-cheque firms may also fund technologies in need of long-term investment. “Deep tech” like autonomous vehicles, biotech and quantum computing could benefit. (Software companies, which make easy, quick margins, are less likely to be targets.) “A SPAC allows you to be valued on the hopes and dreams of tomorrow, versus the results of today,” says Nirav Tolia, the founder of Nextdoor, a social network, and an independent director of IPOD, a SPAC.

SPACs are opening up tech investing to retail investors, too. The fact that tech firms tended to delay listing meant that the lion’s share of returns had already been captured by venture capitalists even before startups reached public markets. SPACs that merge with early-stage firms could give more investors a chance to pile in. They “are the closest thing a retail investor can get to a venture investment”, says Mr Tolia. This lucrative but speculative kind of investing will bring punters both risk and reward. ■



硅谷的SPAC

为造雨人造雨

SPAC热潮将改变科技投资

从搜索信息到联系朋友，对各种行为方式的创新让硅谷蓬勃兴盛。所以，或许见怪不怪的是，它目前正在急不可待地拥抱又一类颠覆——以特殊目的收购公司（以下简称SPAC）替代创业公司传统的IPO。“那么多东西都变得更便宜、高效了。为什么IPO还和过去一样昂贵、低效？”风险投资公司红杉资本（Sequoia Capital）的合伙人罗洛夫·博沙（Roelof Botha）问道。他说IPO是“欺诈和重大盗窃”。

由于华尔街银行都把股票配售给自己最重要的客户，并且为确保上市首日股票上涨而鼓励公司将发行价定低，硅谷很多人认为IPO“课税”太重了。去年在美国，发行价过低给新上市的公司（及其员工）造成的未实现收益达300亿美元。有了SPAC和直接上市（上市的另一条途径），就不会有要让股价在首日大涨的压力了。

如今在硅谷，SPAC兴起的迹象就像独角兽公司那样常见。科斯拉风投（Khosla Ventures）等一批风险投资公司已经宣布成立SPAC，一些投资于科技的对冲基金和个人风险投资家也一样。包括基因检测公司23andMe和个人金融平台SoFi在内的著名科技公司正在通过SPAC上市。

尽管SPAC的影响将会波及整个美国企业界，但它对硅谷的影响将尤为显著。首先，它或许可以帮助刚起步的科技公司融资，这些公司难以吸引更多私人投资，又因规模太小而无法走IPO之路。有些人会提到房地产科技公司Opendoor这个例子，这家公司就是难以再获得一轮融资，但通过SPAC上市后风生水起。在去年9月被合并前，它的估值为48亿美元，现在市值已达181亿美元。

“空白支票公司”也可能为需要长期投资的科技公司提供资金。无人驾驶汽车、生物科技和量子计算等“深科技”可能会受益。（能轻松、快速获利的

软件公司就不太可能成为并购目标。）“SPAC让你的公司能以明天的希望和梦想被估价，而不是今天的业绩。”社交网络Nextdoor的创始人、SPAC公司IPOD的独立董事尼拉夫·托利亚（Nirav Tolia）表示。

SPAC也增加了散户投资者投资科技产业的机会。过去，科技公司倾向于推迟上市，这意味着早在创业公司上市之前回报的大头就已被风险投资家拿走。SPAC与处于早期发展阶段的公司合并，让更多投资者有参与的机会。托利亚表示，SPAC“是散户投资者能接触到的最接近风险投资的东西”。这种利润丰厚但投机性强的投资方式将给赌徒们同时带来风险与回报。■



Capital markets

SPAC invasion

Blank-cheque firms are gobbling up capital and companies. How to make sense of the craze for SPACs

WHAT LINKS Martin Luther King III, the son of the civil-rights leader; Shaquille O’Neal, a former basketball player; and Kevin Mayer, the former boss of TikTok? The unlikely trio sponsors a special-purpose acquisition company (SPAC), a listed pot of capital that seeks a firm to take public through a merger. Mr O’Neal is not the only sportsman turned SPACman. Colin Kaepernick, the former quarterback famous for kneeling during America’s national anthem to protest against racism, has teamed up with a private-equity firm to launch a “socially conscious” SPAC. Alex Rodriguez, a former baseball player, plans to raise up to \$575m for a SPAC targeting sports-related firms.

Financiers are in on the action, too. Bill Ackman, the boss of Pershing Square, a hedge fund, launched a SPAC that raised \$4bn in July, making it the biggest to date. Gary Cohn, a former Goldman Sachs banker and adviser to President Donald Trump, has one too. So do a number of private-equity giants, including Apollo, Ares, Bain, KKR and TPG.

Around 250 SPACs were launched last year in America, raising \$83bn. Things have only sped up since: in January an average of five were created each working day, amassing more than \$26bn in capital. Because they tend to raise more cash once they find an acquisition target—around five times that in the initially listed pot—SPACs may be looking to buy firms worth as much as \$500bn, about 1% of the value of all listed American companies. Look beyond the frenetic growth and you find a spectrum of SPACs, ranging from the earnest to the exuberant.

The life of a SPAC tends to last at most two years. It begins with the sponsor taking the blank-cheque firm public. Investors typically pay \$10 a share and also receive warrants, which give them the right to buy more shares at a later date. The sponsor then searches for an acquisition target that is looking to raise capital and go public. Once it is found, shareholders vote on the merger; often new investors are brought in to provide more capital. When the deal is done the sponsor receives a slice of the merged firm's equity and typically a seat on the company's board. The pot of capital is now cash to be used by the newly public firm.

Proponents say SPACs are cheaper than conventional initial public offerings (IPOs), but they still incur underwriting fees, and the sponsor's share of the proceeds dilutes other shareholders. The path to going public can be shorter and less uncertain than an IPO, though. A firm merging with a SPAC knows exactly how much capital it will raise.

Though SPACs have been around as a financing vehicle for almost two decades, they were regarded warily for much of that time—as a route to be used only by firms shunned by sharp-suited investment bankers. The latest mania can be traced to a serendipitous deal struck in 2019 by Chamath Palihapitiya, a venture capitalist turned boss of a SPAC, and Sir Richard Branson, a billionaire businessman.

Mr Palihapitiya's SPAC had raised \$674m, wooing investors with promises of disrupting the IPO scene. Sir Richard had sought funding for Virgin Galactic, a space-venture company, from Saudi Arabia's sovereign-wealth fund. But after Jamal Khashoggi, a journalist, was killed in a Saudi consulate in Turkey, Sir Richard suspended the plan. A year later Virgin Galactic merged with the SPAC. It received the \$674m pot, and another \$100m in investment from Mr Palihapitiya, and went public at a valuation of \$2.2bn. Its market capitalisation is now \$12bn.

That success set off the trend. Today SPACs range from the tiddlers, with less than \$50m in capital, to the titans, such as Mr Ackman's \$4bn SPAC. (The median SPAC raises \$240m at the initial stage.) Some issue vast quantities of warrants and hand sponsors fat slices of firms; others are leaner. Some have target industries in mind; others are ambivalent. High-profile deals tend to spawn mini-trends. After Virgin Galactic went public several space deals took off; when Nikola, an electric-truck maker, merged with a SPAC, interest in electric-vehicle deals picked up; the enthusiasm for sports-SPACs follows the listing of DraftKings, a sports-betting platform, in April.

Their sudden popularity and the sheer variety of their size, scope and structure raise the question of which SPACs are sensible and which show signs of mania. A financier in charge of a big investment bank's SPAC business sees a clear bifurcation. There are plenty of good SPACs with excellent management teams that can help turn mediocre companies into good ones. But the rest, perhaps a third to two-thirds, "don't know the first thing about the businesses they are dealing with".

That seems to be confirmed by a recent study by Michael Klausner and Emily Ruan of Stanford University and Michael Ohlrogge of New York University. The authors look at blank-cheque firms that made acquisitions between January 2019 and June 2020. They find that, in 25% of cases, the sponsor's payout exceeded 12% of post-merger equity, compared with a median stake of 7.7%.

They also conclude that some SPACs deliver far worse returns for investors than others: companies that went public through the SPAC route fell in value by an average of 3% after three months, 12% after six months and by a third after 12 months. They lagged behind the wider market and even further behind an index of firms that listed via IPO.

However, about half the sample is made up of "high-quality" SPACs, defined

as those run by former Fortune 500 bosses or set up by large private-equity firms. These perform much better, outperforming IPOs and the wider market over six months (though not over 12).

How might the craze play out? About three-quarters of SPACs launched last year are yet to do a deal. One scenario worth considering is that bumper issuance leaves many SPACs unable to find suitable targets. Investors can redeem their shares at cost until a target is bought (the proceeds from the SPAC's IPO are kept in an escrow account in the meantime). The burden of failure—the SPAC's set-up and search expenses—would therefore probably fall on sponsors. In order to avoid this, many might take any willing firm public. Voting and redemption mechanisms guard investors against dodgy deals, though they have not prevented investors from losing money so far.

Investors' willingness to accept poor returns may wane as they become more familiar with SPACs. They certainly grasp that those like Mr Ackman's, which will issue him 6.7% of the shares in the merged firm only once investors earn a 20% return, are more sensibly structured, valuing it more handsomely than the rest. (Its share prices are trading at 50% above their IPO level.) But they also still want to take a punt on Nikola and other electric-vehicle copycats, in the hope of finding the next Tesla. Seen this way, the mania around SPACs is simply an expression of wider exuberance. ■



资本市场

SPAC入侵

空白支票公司正在吞噬资本和企业。如何理解SPAC热？

民权领袖马丁·路德·金之子马丁·路德·金三世、前篮球运动员沙奎尔·奥尼尔（Shaquille O'Neal）和TikTok的前老板凯文·迈耶（Kevin Mayer）之间有什么联系？这三个看起来互不相干的人同为一家特殊目的收购公司（SPAC）的发起人。SPAC是一个已上市的资金池，目标是寻找一家公司，通过合并让它上市。奥尼尔并不是从运动员转变为SPAC一族的个例。前橄榄球四分卫、因在奏国歌时单膝跪地抗议种族歧视而闻名的科林·卡佩尼克（Colin Kaepernick）与一家私募股权公司合作，成立了一家“有社会责任感的”SPAC。前棒球运动员亚历克斯·罗德里格斯（Alex Rodriguez）计划为一家SPAC融资多达5.75亿美元，用于收购体育相关企业。

金融家们也参与其中。对冲基金潘兴广场（Pershing Square）的老板比尔·阿克曼（Bill Ackman）成立的SPAC去年7月筹集了40亿美元，成为截至目前规模最大的一家SPAC。高盛前高管、曾任特朗普经济顾问的加里·科恩（Gary Cohn）也有自己的SPAC。包括阿波罗、Ares、贝恩、KKR和TPG在内的一些私募股权巨头也都如此。

去年，美国共成立了大约250家SPAC，共融资830亿美元。此后势头有增无减：今年1月，平均每个工作日就有五家SPAC诞生，积聚的资金超过260亿美元。一旦找到收购目标，它们往往会募集更多资金，大约是最初上市的资金池的五倍，因此SPAC有望收购的公司总价值可能高达5000亿美元，大约是美国上市公司总市值的1%。更深入地观察这种疯狂的增长，你会发现SPAC这个群体从严肃到亢奋，形形色色。

SPAC的寿命往往不超过两年。首先，发起人让这家空白支票公司上市。投资者通常为每股支付10美元，也会拿到认股权证，这让他们有权在日后买

入更多股份。然后，发起人寻找想要融资并上市的收购目标。一旦发现目标，股东们会就这一合并交易发起投票；此时往往会有新的投资者以提供更多资金。交易完成后，发起人获得合并后的公司的一部分股权，通常还会获得公司董事会的一个席位。资金池这时就变成了供新上市公司使用的现金。

SPAC的支持者说这种方式比传统的IPO花费少，但它仍然产生承销费，而且发起人分得的收益稀释了其他股东的股份。不过，与IPO相比，它的上市之路会更短，不确定性也会更少。与SPAC合并的公司能确切知道自己将融到多少资金。

尽管SPAC这种融资工具已经存在近20年，但在此期间的大部分时间里人们都对它心存警惕——认为只有那些被衣冠楚楚的投资银行家回避的公司才会使用SPAC。最近的狂热可以追溯到2019年意外达成的一笔交易，交易双方分别是从风险资本家转型为SPAC老板的查马斯·帕里哈皮蒂亚（Chamath Palihapitiya）和亿万富翁商人理查德·布兰森（Richard Branson）。

帕里哈皮蒂亚的SPAC许诺颠覆传统的IPO，以此招徕投资者，筹集了6.74亿美元。布兰森曾经试图从沙特阿拉伯的主权财富基金那里为太空探险公司维珍银河（Virgin Galactic）融资。但记者贾迈勒·卡舒吉（Jamal Khashoggi）在沙特驻土耳其领事馆遇害后，布兰森暂停了这一计划。一年后，维珍银河与帕里哈皮蒂亚的SPAC合并。它获得了那笔6.74亿美元的资金，又另外从帕里哈皮蒂亚那里获得了1亿美元的投资，并以22亿美元的估值上市。它目前的市值为120亿美元。

这个成功案例开启了SPAC热。如今，SPAC既有资本不足5000万美元的小鱼虾，也有巨无霸，比如阿克曼那家40亿美元的SPAC。（SPAC初始阶段的融资中位数为2.4亿美元。）有些SPAC发行大量认股权证，并把公司的一大块分给发起人，另一些则更精简。有些SPAC有明确的目标行业，有些则含混不明。备受瞩目的交易往往引发小规模跟风。维珍银河上市后，几笔与太空相关的交易相继达成；电动卡车制造商尼古拉（Nikola）与一家

SPAC合并后，人们对电动汽车相关交易兴趣倍增；去年4月，体育博彩平台DraftKings的上市引发了人们对体育类SPAC的热情。

SPAC的快速走红以及它形形色色的规模、范围和结构引发了一个问题：哪些SPAC是合理的，哪些有头脑发热的迹象？在一家大型投资银行负责SPAC业务的一位金融家认为，分化非常明显。有很多优秀的SPAC拥有出色的管理团队，可以帮助平庸的公司转变成优质企业。但其余的SPAC——大概有三分之一到三分之二——“对自己经手的企业一无所知”。

斯坦福大学的迈克尔·克劳斯纳（Michael Klausner）、艾米丽·阮（Emily Ruan）和纽约大学的迈克尔·奥尔罗格（Michael Ohlrogge）最近的一项研究似乎证实了这一点。作者调查了在2019年1月至2020年6月间完成过收购的空白支票公司。他们发现，在25%的案例中，发起人所获合并后公司股份超过12%，而全部案例的中位数为7.7%。

他们还得出结论，有些SPAC给投资者带来的回报远比其他SPAC糟糕：走SPAC路线上市的公司平均在上市三个月后价值下跌3%，六个月后下跌12%，12个月后下跌三分之一。这些糟糕的案例落后于整体市场，甚至落后于一批通过IPO上市的公司。

不过，全部样本中约有一半是“高质量”SPAC。所谓“高质量”，是指它们由财富500强的前老板管理或由大型私募股权公司创立。这些SPAC的表现要好得多，在六个月内（尽管不是12个月内）的表现超过了通过IPO上市的公司和整体市场。

这股热潮可能会如何演变？去年成立的SPAC中约有四分之三尚未达成交易。值得考虑的一种可能性是，巨大的发行量让很多SPAC无法找到合适的目标。在对目标公司达成收购前，投资者都可以按原价赎回自己的股票（与此同时，从SPAC自身的IPO中获得的收益被保存在第三方托管账户中）。因此，收购未果所导致的损失——成立SPAC和寻找目标公司的费用——很可能会落在发起人头上。为避免这种情况，很多SPAC可能会让任何一家有意向的公司上市。投票表决和赎回机制防范投资者陷入欺诈性交

易，尽管迄今为止它们还未能保证投资者不赔钱。

随着投资者对SPAC日渐了解，他们可能越发不愿接受低回报。他们当然明白，像阿克曼的那种SPAC在结构上更合理——只有在投资者获得的回报达到20%时，阿克曼才会获得合并后公司6.7%的股份。他们对它的估值也比其他SPAC高（它目前的股价比IPO发行价高50%。）但投资者也仍然想在尼古拉和其他电动汽车模仿者身上赌一把，希望找到下一个特斯拉。从这个角度看，SPAC狂热不过是普遍亢奋的体现。 ■



The world economy

Inflategate

How higher inflation could disrupt global economic policy

THE DEBATE about whether high inflation will emerge out of the pandemic is becoming more pressing. In January underlying prices in the euro zone rose at their fastest pace for five years. In America some economists fear that President Joe Biden's planned \$1.9trn stimulus, which includes \$1,400 cheques for most Americans, may overheat the economy once vaccines allow service industries to reopen fully. Emerging bottlenecks threaten to raise the price of goods. Space on container ships costs 180% more than a year ago and a shortage of semiconductors caused by this year's boom in demand for tech equipment is disrupting the production of cars, computers and smartphones.

Headline statistics on price rises will soon contribute to the sense that an inflationary dawn is breaking. They will go up automatically as the collapse in commodities prices early in the pandemic falls out of comparisons with a year earlier, and the recent rise in the oil price begins to bite—on February 8th Brent crude rose above \$60 a barrel for the first time in more than a year. In Germany the reversal of a temporary cut in VAT has already helped year-on-year inflation rise from -0.7% to 1.6% in a month.

For most of the past decade the world economy's problem, judged by central banks' targets, has been too little inflation, not too much. As a result it is easy to view the coming acceleration in prices as welcome. In fact, it is worth worrying about, for several reasons.

One is that it weakens the hand of those arguing for more fiscal stimulus in places that need it. There is little prospect of the euro zone sustaining

higher inflation, for example. Its main rate of interest has not been cut during the pandemic and its deficit spending remains inadequate given its economic outlook and lack of monetary firepower. Much as the European Central Bank mistakenly raised rates in response to a temporary burst of inflation in 2011, the danger this time is that a temporary acceleration in prices emboldens fiscal hawks who are complacent about the dangers of a depressed economy. The same danger lurks in Japan, the archetypal low-inflation economy. Its prices started falling during the pandemic. Japan will probably escape deflation this year, but beyond that it looks destined to remain in a low-inflation trap, having seemingly given up on its brief attempt to spring out of it in the mid-2010s.

Higher inflation could also cause gyrations in monetary policy in America, where rising inflation expectations and a faster rebound mean price rises are more likely to prove persistent. Financial markets imply a one-in-five chance that consumer prices will grow by at least 3% per year on average over the next five years. The Federal Reserve has promised to keep interest rates low and to keep buying bonds because it wants inflation to overshoot its 2% target, in order to make up for today's shortfalls. But its new "average inflation targeting" regime does not allow for an enduring or large overshoot. Eventually the central bank will want to raise interest rates to bring inflation back down.

The faster prices rise this year, the sooner that tightening could come. Richard Clarida, the Fed's vice-chairman, has said that the central bank will make up only for inflation shortfalls that have occurred over the preceding year, meaning the point at which catch-up is complete could come surprisingly quickly. On February 7th Janet Yellen, the Treasury secretary, tried to reassure critics of Mr Biden's stimulus by saying that America has the tools to deal with inflation. But higher rates are not without consequence, and if the Fed finds itself pouring cold water on an overheating economy, the risks of another recession will rise.

Higher rates also hold deep implications for markets. Almost everything about today's financial landscape is premised on central banks keeping interest rates low for a long time. Cheap money lies behind the idea that the government can spend however much it likes—including, say, on Mr Biden's planned infrastructure bill—and underpins today's sky-high stockmarket values and abundant credit. An abrupt change in the interest-rate outlook would be painful, as it was in 2013 when the Fed's hawkish comments led to what became known as the "taper tantrum".

On Wall Street higher rates would be a shock. In emerging markets they would be agonising. Many have been experimenting with unconventional monetary policy and bigger budget deficits, following the rich world. But their efforts assume that global financial conditions will stay loose. Higher interest rates in America to see off inflation would mean a stronger dollar and capital outflows from emerging economies, as in 2013. This would imperil their finances and make it harder for them to fight the effects of the pandemic. There is a lot to like about the idea of escaping the low-inflation, low-rate paradigm of the past decade. But higher inflation will expose the world economy and financial markets to a bumpy ride. ■



世界经济

膨胀门

【首文】更高的通胀会如何扰乱全球经济政策

关于疫情是否会引发高通胀的争论越来越紧迫了。1月，欧元区基础价格以五年来最快的速度上涨。在美国，一些经济学家担心，一旦疫苗允许服务业完全重启，拜登总统计划的1.9万亿美元刺激措施（其中包括为大多数美国人发放1400美元支票）可能会使经济过热。新出现的瓶颈预示着商品价格的上涨。集装箱船上的舱位费比一年前上涨了180%，而今年对技术设备的需求激增导致半导体短缺，影响了汽车、计算机和智能手机的生产。

有关物价上涨的总体数据很快就会使人感到通胀已经抬头。由于相比于一年前，疫情初期大宗商品价格暴跌的状况已渐渐消退，而最近石油价格上涨的影响开始显现——2月8日布伦特原油价格一年多来首次突破每桶60美元——物价会自动开始上涨。德国暂时降低增值税率的措施到期，已经帮助通胀率在一个月内从同比-0.7%上升到1.6%。

如果以各国央行的目标来衡量，在过去十年中的大部分时间里，世界经济的问题一直是通胀过低，而不是过高。因此，即将到来的价格上涨很容易视为可喜的现象。实际上，有几个原因令它值得担心。

其一是这让那些主张在有需要的地方施加更多财政刺激的人更为被动。例如，欧元区维持更高通胀的可能性很小。疫情期间其主要利率并未降低，而考虑到它的经济前景和缺乏货币手段，赤字支出仍然不足。就像2011年欧洲央行错误地因短期通胀突增而加息一样，这次的危险是价格的暂时上涨会鼓舞那些对经济萧条的风险满不在乎的财政鹰派。日本作为低通胀经济的典型也面临着同样的危险，物价在疫情期间开始下跌。日本今年可能会摆脱通货紧缩，但除此之外，由于它似乎已经放弃了2010年代中期摆脱通货紧缩的短暂尝试，看起来注定要留在低通胀陷阱中。

更高的通胀也可能导致美国货币政策动荡——不断上升的通胀预期和经济更快反弹意味着价格上涨更有可能持续下去。金融市场的现状暗示着未来五年，消费者价格有五分之一的机会平均每年至少增长3%。美联储已承诺保持低利率并继续购买债券，因为它希望通货膨胀率突破其2%的目标来弥补今天的缺口。但是，其新的“平均通胀目标”制度不允许持久或大幅度的超出。最终，美联储会将希望提高利率来使通胀率回落。

今年价格上涨得越快，货币紧缩就可能到来得越早。美联储副主席理查德·克拉里达（Richard Clarida）已经表示，央行将仅弥补上一年出现的通胀缺口，这意味着补齐通胀所需的时间可能会短得出人意料。2月7日，美国财政部长珍妮特·耶伦（Janet Yellen）试图安抚拜登刺激计划的批评者，说美国拥有应对通胀的工具。但加息并非没有后果，如果美联储给过热的经济泼冷水，再次陷入衰退的风险就会增加。

加息也会对市场产生深远的影响。当下金融局面中的一切几乎都以央行长期保持低利率为前提。廉价资金支撑着政府可以随心所欲地花钱的想法（包括如拜登计划中的基础设施法案），也支撑着当下高企的股价和充沛的信贷。利率前景的突然变化将是痛苦的，就像在2013年美联储的强硬言论导致众所周知的“缩减恐慌”一样。

加息对华尔街来说会是一场冲击，而对新兴市场则是痛苦的折磨。许多国家效仿富裕国家，尝试非常规的货币政策和更大的预算赤字。但这样的做法是假定全球金融状况将保持宽松。美国用加息来抑制通胀意味着美元走强和新兴经济体的资本外流，就像2013年那样。这将危及这些国家的财政，使其更难对抗疫情的影响。摆脱过去十年低通胀、低利率范式的想法有很多可取之处。但更高的通胀将使世界经济和金融市场前路崎岖。■



Oncology

Precisely!

Studying cancer genomes gene by gene could lead to better treatments

PRECISION MEDICINE holds that, because people are unique, so too are their diseases. It aims to prescribe treatments tailored to the genetic and biochemical characteristics of individual patients. Achieving this, in the context of oncology, is the purpose of the Cancer Dependency Map (DepMap), which is being developed jointly by the Wellcome Sanger Institute, near Cambridge, in Britain, and the Broad Institute in the city in Massachusetts of that name. Cancer is a good candidate for the application of precision medicine, because it arises when previously well-behaved cells start reproducing uncontrollably, usually as a result of a mutation in their genetic code. Numerous mutations can have this result, so many tailored treatments may be possible. DepMap seeks to find both mutations and treatments.

The first step, as Jesse Boehm, who runs the Broad's side of the project, explained to last month's AAAS meeting, is to grow cancerous tissue in laboratories, where it can be studied at researchers' convenience. Before DepMap began, around 1,700 lines of lab-grown cancer cells were available. To try to increase this number, the project's scientists turned to social media. Working with American cancer charities they encouraged patients across the country to send in biopsies of their tumours. That has given them more than 2,000 new samples, from which they have been able to create more than 400 extra cell lines. Encouragingly, 30% of these represent cancers that are either rare or occur mostly in children—both groups that researchers need more examples of.

Once the cancerous cells have been persuaded to start growing in DepMap's

Petri dishes, the next step is to examine them for weaknesses. So far, the teams have tested around 6,000 drugs—about half the number ever licensed for any disease—against more than 500 cancers. They have already turned up some promising candidates. Tepoxalin, an arthritis medicine for pets, appears to kill cancers in which a gene called ABCB1 is overactive. Disulfiram, used to treat alcoholism, seems toxic to certain tumours that lack genes involved with the processing of heavy metals.

New technology means it is not only drugs which can be analysed systematically. Matthew Garnett, of the Sanger Institute, discussed using CRISPR-CAS9 to do the same for genes. CRISPR-CAS9 is a set of chemical scissors employed by bacteria to chop up and deactivate DNA introduced by viruses that prey on them. Repurposed as an all-purpose DNA-cutting device, it has become one of biology's most useful tools.

Dr Garnett described how researchers at the Sanger had used CRISPR-CAS9 to disable, one by one, nearly every gene in hundreds of cancer-cell lines. This permitted them to discover which genes are essential for a tumour's survival and might therefore make promising targets for new drugs. He gave the example of WRN, a gene involved in fixing damaged DNA. Cancer cells are often already deficient in DNA-repair mechanisms, and some seem reliant on WRN for survival. Based on those results, Dr Garnett said, drug companies are already developing drugs designed to suppress either WRN itself, or the protein it produces.

Deconstructing cancer cells' genomes has yielded other insights, too. Dr Boehm noted that examining the rate at which genes are expressed—that is, used to make proteins—is often more useful for predicting vulnerabilities than looking for mutations in the genetic code. This, he said, is especially true of some childhood cancers, which often exhibit few mutations.

An encouraging start, then. But there is a long way to go. Dr Boehm

estimated that, despite having analysed all the genes and thousands of drugs for around 1,000 different sorts of cancer, the project remains about 90% unfinished. This may be an underestimate. As Fiona Behan, another of the Sanger's DepMap researchers, pointed out, besides examining individual genes in isolation, disabling several at once may also yield useful insights. In that case, though, the number of possible combinations would be astronomical.

Moreover, not all results in Petri dishes bear fruit in human beings. Andrea Califano of Columbia University observed that cancer cells which have adapted to grow in laboratories often have different patterns of gene expression from those that grow in bodies. Nevertheless, as Dr Garnett told the meeting, the success rate for developing new cancer drugs is, at the moment, depressingly low. If DepMap can uncover plausible targets for developers to aim at, that may start to change. ■



肿瘤学

切中要害

逐个研究癌症基因组中的基因可能启发更好的疗法

精准医学认为，每个人都是独特的，所以他们所患的疾病也是如此。它旨在针对个体患者的遗传和生物化学特征给出治疗方案。在肿瘤学领域，这就是“癌症依赖关系图”（Cancer Dependency Map, DepMap）要实现的目标，该项目由位于英国剑桥附近的惠康桑格研究所（Wellcome Sanger Institute）和美国麻省剑桥市的布罗德研究所（Broad Institute）联合研发。癌症是精准医学的一个上佳应用领域，这是因为癌症发生在先前规矩行事的细胞开始不受控地繁殖之时，通常是由于这些细胞的遗传密码发生了一个突变。大量突变都可能导致这种结果，因此可能有许多针对性的治疗方案。DepMap试图找到突变和对应的疗法。

布罗德研究所负责该项目的杰西·贝姆（Jesse Boehm）在上月的美国科学促进会（AAAS）会议上解释说，第一步是在实验室里培养癌细胞组织，方便研究人员观察分析。在DepMap启动之前已有约1700个实验室培养的癌细胞系。为增加这个数字，该项目的科学家求助于社交媒体。他们和美国的癌症慈善机构合作，鼓励全国各地的患者提交肿瘤活组织切片。这为他们提供了2000多个新样本，从中创建了400多个新细胞系。令人鼓舞的是，其中30%的癌症是罕见的或主要发生在儿童中——都是研究者需要更多样本的癌症种类。

一旦成功引导癌细胞在DepMap的培养皿中生长，下一步就是观察它们的弱点了。截至目前，研究小组已经针对500多种癌症测试了约6000种药物——相当于所有疾病已批准药物数目的一半。从中已经找到了一些有前景的候选药物。用于宠物关节炎的药物替泊沙林（Tepoxalin）似乎可以杀死ABCB1基因在其中过度活跃的癌症。治疗酒瘾的双硫仑（Disulfiram）似乎对某些缺乏与处理重金属相关的基因的肿瘤具有杀伤力。

新技术意味着不仅仅可以对药物做系统性分析。惠康桑格研究所的马修·加尼特（Matthew Garnett）讨论了使用CRISPR-CAS9对基因做同样的事。CRISPR-CAS9是细菌使用的一组化学剪刀，用于切碎和灭活由入侵它们的病毒引入的DNA。它被改造成通用DNA切割设备，已成为生物学最有用的工具之一。

加尼特描述了惠康桑格的研究人员如何用CRISPR-CAS9令成百上千个癌细胞系中的几乎每个基因逐一失效。这使他们能够发现哪些基因对肿瘤的存活至关重要，从而可能成为有前景的新药的标靶。他以参与修复受损DNA的WRN基因为例。癌细胞常常已经缺乏DNA修复机制，有些似乎依赖WRN存活下去。加尼特说，基于这些观测结果，制药公司已经在研发旨在抑制WRN基因本身或其生成的蛋白质的药物。

解构癌细胞的基因组也带来了其他见解。贝姆博士指出，观察基因的表达速度（也就是制造蛋白质的速度）通常比在遗传密码中查找突变更能有效地预测脆弱性。他说，这对于某些儿童癌症尤其如此，这些癌症通常表现出极少的突变。

由此看来，这是一个令人鼓舞的开端。但还有很长的路要走。贝姆估计，尽管已经分析了约1000种不同类型的癌症的所有基因和数千种药物，但该项目尚有约九成未完成。这可能还是低估了。正如惠康桑格研究所的另一位DepMap研究员菲奥娜·贝汉（Fiona Behan）指出的那样，除了单独检测单个基因外，一次让多个基因失效可能也会带来有用的发现。但是，在那种情况下，可能的组合数量将是个天文数字。

而且，并不是所有培养皿中的结果都在人体上有效。哥伦比亚大学的安德里亚·卡利法诺（Andrea Califano）观察到，适应了实验室生长环境的癌细胞的基因表达模式往往与人体内生长的癌细胞不同。不过，正如加尼特在大会上所言，目前研发抗癌新药的成功率之低令人沮丧。如果DepMap能为新药研发人员找到合理的标靶，这可能会开始改变。■



Life, the universe and everything

Alien dreams

The search for ET may soon yield an answer

MOST SCIENTIFIC research has practical ends. But some still pursues goals better described by the field's original name: "natural philosophy". One of its most philosophical questions is, "Is there life elsewhere in the universe?"

It is philosophical for two reasons. One is its grand sweep. If there is life elsewhere, particularly of the intelligent sort, that raises the question of whether humans might ever encounter it, or its products. If there is not—if all the uncountable stars in creation waste their light on sterile, lifeless worlds—then life on Earth must be the result of a stroke of the most astronomically improbable good luck. As Arthur C. Clarke, a science-fiction author, is reputed to have said: "Two possibilities exist. Either we are alone in the cosmos or we are not. Both are equally terrifying."

The other reason the question is philosophical is that there has, historically, been too little evidence to settle it. Arguments about life in the cosmos must extrapolate from a single example that is itself poorly understood. Biologists still lack a bulletproof theory of how earthly life began. Other planets are far away and hard to study. That leaves room for all sorts of theories. Perhaps life is rare. Perhaps it is common, but intelligence is not. Or perhaps even intelligent life is common, but the technology that lifts it up ends by destroying it (a popular line of thinking after the development of nuclear weapons).

This paucity of data will soon change. A variety of telescopes and spacecraft are, or soon will be, looking for signs of life in places ranging from the moons and planets of the solar system to other stars in Earth's corner of the

Milky Way. In particular, this search will employ powerful telescopes to try to find chemical signatures of life in the atmospheres of planets orbiting stars other than the sun. An alien astronomer looking at Earth, for instance, would be struck by the persistence of both oxygen and something that it reacts with in the atmosphere, and might conclude—correctly—that living organisms were responsible for keeping them there.

An unambiguous detection of alien life would count as one of the momentous discoveries in the history of science. Exactly what would happen next would depend on what was found. News of a “biosignature” on a planet dozens of light-years away would shake the world. It would be strong evidence that life is indeed common in the cosmos. That conclusion could upend humanity’s understanding of its place in the universe.

A few adventurous scientists might suggest using a radio telescope to beam a message, in the hope that, if anything intelligent lives there, it will, decades later, send a reply. Still, the sheer distances involved mean that there would be few immediate, practical consequences. By contrast, finding life closer to home—beneath the Martian regolith, say, or in the oceans under the frozen surfaces of the solar system’s icy moons—would lead to a flurry of action. A sample-return mission would give biologists the ability to compare earthly life with the unearthly sort, a process that could shed new light on the workings and origins of both.

And if nothing is found? That too would be a piece of data, albeit of a less dramatic sort. It would not prove that no life exists elsewhere in the cosmos, but it would be evidence that it is, at least, rather uncommon.

Half a century ago, returning from the arid and sterile lunar surface, the Apollo astronauts found a new appreciation for Earth’s joyous blooms of life and colour. If there are no aliens nearby, such sentiments might grow stronger. A jewel is all the more valuable for being rare. ■



生命、宇宙及万物

外星梦

对外星人的搜索可能很快就会有一个答案

大多数科学研究都有实用目标。但还是有一些研究的目标更适合以科研领域最初的名字来描述——“自然哲学”。其中一个最具哲学性的问题是：“宇宙的其他地方是否存在生命？”

这个问题的哲学性体现在两个方面。一是它的命题宏大。如果宇宙的其他地方存在生命，尤其是智慧生命，那么自然会引出一个问题——人类是否会与它们或它们的产物相遇？如果不存在，也就是说宇宙中无数恒星都只是把光热徒然浪费在荒凉死寂的世界，那么地球上的生命必定是一次最不可想象的天文奇迹的结果。正如据传科幻小说家亚瑟·克拉克（Arthur C. Clarke）曾说过的那样：“有两种可能：我们在宇宙中要么是孤独的，要么不是。两者一样可怕。”

另一方面是，一直以来能解开这个谜团的证据太少。关于宇宙存在生命的论点只能从唯一一个例子来推断，而对这个例子本身的了解都还很浅薄。对于地球生命的起源，生物学家仍缺乏一个无懈可击的理论。其他星球远在天边，难以探究。这就给各种理论留下了发展空间。也许生命极为罕有，也许普遍存在，不过不是智慧生命。或者连智慧生命也很普遍，但促进生命发展的科技最终却摧毁了生命（核武器发展起来之后这种思路流行起来）。

数据匮乏的状况很快就会改变。各式各样的天文望远镜和宇宙飞船正在或即将开始搜索生命的迹象，范围包括太阳系里的卫星、行星，还有银河系中靠近地球这一隅的其他天体。特别是，这些搜索将运用强大的望远镜，试图在其他恒星系统的行星大气层中找寻生命的化学信号。举个例子，如果有外星天文学家在观测地球，会惊奇地发现地球大气层中一直有氧气和与之反应的某种东西，他可能就会推断这是因为那里存在生物有机体——

他是对的。

找到外星生命的确凿证据将会是科学史上的一大里程碑式发现。接下来会发生什么将取决于发现的是什么。在几十光年外的星球上发现“生命迹象”的消息将轰动世界。这将是宇宙中确实遍布生命的有力证据。这个结论可能会颠覆人类对自身在宇宙中地位的理解。

一些勇于冒险的科学家或许会建议用射电望远镜来发送信息，期待着如果遥远星球上存在智慧生命，几十年后会得到回音。但这其中的距离太过遥远，难以很快得到实际性的结果。相比之下，如果在离地球较近的地方找到生命，比如在火星风化层下或太阳系冰卫星冰冻表层下的海洋里，可能就会引发一连串行动。天体采样返回任务会让生物学家得以比较地球生命和非地球生命，进一步揭示两者的机制和起源。

如果什么都没找到呢？那也会是一份数据，尽管不那么轰动。这不证明宇宙其他地方没有生命，但能显示生命至少并不普遍。

半个世纪前，阿波罗号宇航员从荒凉贫瘠的月球表面返回，地球上生机勃勃、多姿多彩的景象令他们重新生出感恩之心。如果邻近的星球上没有生命，这种情感可能会变得愈加强烈。宝石因稀有而愈发珍贵。■



Stock exchanges

Advantage Amsterdam

The Dutch financial centre gains an edge over continental rivals

THOUGH MANY exchanges are run by multinational companies, they are still often seen as the financial equivalent of a national football team. When Amsterdam ousted London as the largest share-trading centre in Europe in January, it made headlines in both countries. “The EU wins first battle for stock trading over Britons,” said *Het Financieele Dagblad*. London’s *Financial Times* observed that “Amsterdam punctures the City’s post-Brexit hopes”.

Announcements of high-profile listings in Amsterdam have further bolstered the Dutch side. Jean-Pierre Mustier, the former boss of UniCredit, an Italian bank, and Bernard Arnault, a luxury-goods tycoon, are intending to list a special-purpose acquisition company (SPAC) in Amsterdam aimed at buying fintech and other financial firms. Vivendi, a French media group, plans to list Universal Music, its record label, in the city. Earlier last month Martin Blessing, the former boss of Germany’s Commerzbank, said he planned to raise around €300m (\$362m) for a SPAC listed in Amsterdam that targets the financial industry. That follows an initial public offering (IPO) in January by Poland’s InPost, an e-commerce group, which raised €2.8bn—the biggest continental European listing since 2018.

Ever since Britain voted to leave the European Union, a number of continental cities, including Paris and Frankfurt, have been vying to snatch business from London. Amsterdam seems to have gained a head-start. In January average daily European share trading amounted to €9.2bn on the Amsterdam bourse and the Dutch arms of the Chicago Board Options Exchange (CBOE) and Turquoise, a share-trading platform, much higher

than daily trading of €2.6bn in 2020. By contrast, trading sank to about €8.6bn in London in January, about half its level in 2020.

The shift was foreseeable: after Britain's exit from the single market on January 1st, the EU refused to grant it "equivalence", a regulatory arrangement that would have allowed the City of London to trade relatively unhampered in European markets. That forced trading in European shares to move to the continent. Both the CBOE and Turquoise plumped for the Netherlands as their alternative to Britain.

Why Amsterdam? Euronext, the company that runs exchanges in cities including Amsterdam, Brussels and Paris, has focused on building relationships with big and small tech companies all over Europe, says Michael Werner, a stock analyst at UBS, a Swiss bank. The aim is to become the listing venue of choice for hot tech companies. Several factors make the Dutch exchange more attractive than its continental rivals. Its regulation and governance framework, such as its tolerance of dual-class voting structures, are slightly more favourable to companies. Its first-class internet infrastructure makes it easy to trade fast. And the fact that English is so widely (and well) spoken probably helps attract foreigners.

Nonetheless, in most respects London's crown is still secure. Take the Dutch IPO boom, which starts from a very low base. Last year only two companies went public in Amsterdam, compared with 33 on London's stock exchange; 11 firms have already listed in London this year, to Amsterdam's one. A spokeswoman for Euronext says that it is "too early to draw any conclusions" from the jump in trading volume.

For Marieke Blom of ING, a Dutch bank, the big question is whether the Brexit effect proves temporary or not. The EU is considering whether to grant Britain equivalence. Even if it does, Amsterdam could still benefit from a virtuous circle. Stock exchanges compete so aggressively for the thin-

margin business of share trading because liquidity begets liquidity. The high volume of trading should make it easier for sellers and buyers to find each other, and that should make the exchange more attractive for listings. Some of Amsterdam's gains will probably stick. ■



证券交易所

阿姆斯特丹领先

荷兰这个金融中心比欧洲大陆的竞争对手更具优势

虽然很多交易所由跨国公司运营，但它们还是常常被看作金融界的国家足球队。阿姆斯特丹在1月把伦敦踢下了欧洲第一大股票交易中心的宝座，这在两国都登上了报刊头条。《荷兰财经日报》（Het Financieele Dagblad）称，“欧盟在跟英国人的股票交易大战中取得了首场胜利”。伦敦《金融时报》则评论说，“阿姆斯特丹戳破了金融城在英国脱欧后的希望泡沫”。

多个备受关注的上市项目宣布落户阿姆斯特丹更是让荷兰队意气风发。意大利裕信银行（UniCredit）前老板让-皮埃尔·马斯蒂尔（Jean-Pierre Mustier）和奢侈品大亨伯纳德·阿诺特（Bernard Arnault）打算在阿姆斯特丹上市一家以收购金融科技公司和其他金融企业为目标的特殊目的收购公司（SPAC）。法国媒体集团维旺迪（Vivendi）计划让旗下的唱片公司环球音乐（Universal Music）在阿姆斯特丹上市。上月早些时候，德国商业银行（Commerzbank）前老板马丁·布莱辛（Martin Blessing）表示，他计划为一家在阿姆斯特丹上市、以金融业为目标的SPAC融资3亿欧元（3.62亿美元）。此前波兰的电子商务集团InPost在1月完成IPO，融资28亿欧元，这是自2018年以来欧洲大陆规模最大的IPO。

自英国公投脱欧以来，包括巴黎和法兰克福在内的一些欧洲大陆城市一直在争相从伦敦抢生意。阿姆斯特丹似乎占得先机。1月，阿姆斯特丹证券交易所、芝加哥期权交易所（CBOE）的荷兰子公司，以及股票交易平台Turquoise的欧洲股票总日均交易量达到92亿欧元，远高于2020年26亿欧元的日均水平。相比之下，伦敦1月份的交易量降至86亿欧元左右，约为2020年水平的一半。

这种变化是可预见的：在英国于1月1日退出欧洲单一市场后，欧盟拒绝给

予其“对等”待遇（“对等”的监管安排将让伦敦金融城在欧洲市场上相对不受阻碍地开展交易）。这迫使欧洲股票的交易转移到欧洲大陆。CBOE和Turquoise都选择了荷兰来替代英国。

为何是阿姆斯特丹？瑞银集团（UBS）的股票分析师迈克尔·维尔纳（Michael Werner）说，在阿姆斯特丹、布鲁塞尔和巴黎等城市运营交易所的泛欧证券交易所（Euronext）一直注重与欧洲各地大大小小的科技公司建立关系。其目标是成为热门科技公司的首选上市地点。有几个因素使得荷兰的交易所比欧洲大陆的其他竞争对手更具吸引力。它的监管和治理框架对公司稍微有利一些，比如包容双重投票权结构。它一流的互联网基础设施让它更易展开快速交易。而广泛（且流利）地使用英语可能也有助于吸引外国人。

尽管如此，从大多数方面看，伦敦头上的皇冠仍然稳稳当当。来看看荷兰的IPO热，它的起点非常低。去年只有两家公司在阿姆斯特丹上市，而在伦敦证券交易所有33家；今年以来已有11家公司在伦敦上市，而在阿姆斯特丹仅一家。泛欧交易所的一位发言人说，要从交易量大增中“得出什么结论还为时过早”。

荷兰银行荷兰国际集团（ING）的玛瑞克·布洛姆（Marieke Blom）认为，最大的问题是英国脱欧的影响是否只是暂时的。欧盟还在考虑要不要给予英国对等待遇。但即便给了，阿姆斯特丹仍可以从一种良性循环中受益。交易所之所以激烈争夺利润微薄的股票交易业务，是因为流动性会带来流动性。高交易量应该会让买卖双方更易彼此匹配，从而让交易所更能吸引到公司来上市。阿姆斯特丹的一些收获很可能会留下来。■



Great expectations

Economic forecasters are pencilling in heady growth rates

America is expected to grow at its fastest pace since 1984

ECONOMIC FORECASTERS are pencilling in heady growth rates for the world's big economies this year. GDP in America is expected to expand by close to 6% in 2021, the fastest pace since 1984. Growth is expected to be most rapid in the second and third quarters of the year, as vaccinations boost activity and fiscal stimulus takes effect. By contrast the bounce-back in the euro area and Britain is expected to be more modest this year. That reflects a delayed recovery: with economies still locked down, output is expected to contract in the first quarter. ■



远大前程

经济预测勾画的增长率令人兴奋

预计美国经济将以1984年以来最快的速度增长

经济预测显示，今年全球各大经济体将出现令人兴奋的增长。2021年美国GDP预计将增长近6%，为1984年以来最快。预计今年第二和第三季度的增长最为迅猛，因为疫苗接种将促进经济活动，而财政刺激措施也会实施起效。相比之下，欧元区和英国今年的经济反弹预计要更温和。这反映出复苏的延迟：考虑到多个经济体仍处于封锁状态，预计第一季度产出将出现收缩。■



Television audio

In your face

Generating sound from the screen

ALTHOUGH PICTURE quality has improved greatly with the development of flat-screen televisions, sound has taken a dive. The problem is that TVs with slimmed-down screens have insufficient room for decent speakers to be fitted to them, either at the back or in the frame. Such televisions are therefore usually connected to an external sound system, such as a sound bar or a home-cinema system, to improve their audio quality.

The loudspeakers of early televisions were as big as the screen, but engineers have got good at making speakers smaller and squeezing them into tighter spaces. A conventional speaker produces sound waves using an electromagnet to vibrate a cone-shaped diaphragm, but there are other ways to generate sound, including employing an actuator to vibrate a flexible panel. That raises the question, why not vibrate the TV screen itself? And this is exactly what a couple of television-makers are now doing.

Sony, of Japan, was the first to announce it had developed such a system, which it calls Acoustic Surface. It is now fitting this to some of its upmarket televisions. Acoustic Surface employs a pair of rear-mounted actuators to vibrate a screen made with organic light-emitting diodes (OLEDs). Unlike screens that employ regular inorganic LEDs as a backlight, OLEDs emit their light directly. This means OLED screens have few layers—and that, in turn, means they are easier to make flexible and are thus able to vibrate more easily.

This vibration is invisible to the viewer and, Sony says, does not affect picture quality. One beneficial consequence is that a programme's

soundtrack is broadcast directly at the viewer instead of from the side, as is the case with separate speakers. It is also possible to create stereo effects by moving the sound's point of origin across the screen.

The other version of vibrating-screen technology now on offer is Cinematic Sound, from LG, a South Korean firm. This includes, as one of the screen's layers, a 600-micron-thick film that works as an "exciter" to vibrate the display. It is all very snazzy. Sceptical audiophiles and Luddites will be pleased to note, though, that both sorts of sound screens can still be connected to separate audio systems, if the owner so desires. ■



电视音频

新声扑面

用屏幕发声

随着平板电视的发展，画质显著提升，音质却大幅下滑。原因是屏幕变薄后，无论在电视机的后部还是边框都没有足够的空间安装优质扬声器。因此，这类电视机通常要外接音响系统来提升音质，比如回音壁或家庭影院系统。

早期电视机的扩音器和屏幕一样大，但工程师们如今已能娴熟地制造出更小的扬声器，把它们塞进更狭小的空间。传统的扬声器使用电磁铁振动锥形振膜产生声波，但还有其他产生声音的办法，包括采用致动器振动一块柔性薄板。这就引出了一个问题：为何不振动电视屏幕本身？而这正是几家电视机制造商在做的事。

日本的索尼公司率先宣布研发出了这样的系统，它称之为“银幕声场”（Acoustic Surface）。现在，索尼正在把这种系统安装在一些高档电视机上。“银幕声场”采用一对后置致动器来振动用有机发光二极管（OLED）制成的屏幕。与采用普通无机LED作为背光源的屏幕不同，OLED直接发光。这就使得OLED屏幕的层数很少，而这又意味着更容易打造出柔韧的屏幕，因此也更容易振动。

这种振动对观众不可见，索尼表示画质不会受影响。一个有益的结果是，节目的音轨直接从正面对观众播放，而不是像独立的扬声器那样从侧面播放。还有可能在屏幕上移动声音的原点来打造立体声效果。

目前推出的另一种振动屏技术是韩国公司LG的电影级音效（Cinematic Sound）。它的屏幕层之一是一片600微米厚的薄膜，被用作“激发器”来振动显示器。这一切都很时髦。不过，持怀疑态度的发烧友和卢德派分子会很高兴地注意到，如果电视机的主人愿意，这两种可发声屏幕仍然可以和独立的音频系统相连。 ■



Mobility in China

Trafficking dreams

To glimpse the future of the ride-hailing business, look east

“WE INVEST A lot of money here in China,” proclaimed Travis Kalanick, founder and then boss of Uber, at a confab in Tianjin in June 2016. But, he added with foreboding, “we have a competitor who is investing even more.” Two months later the American ride-hailing giant threw in the towel, selling its Chinese operations to its Beijing-based rival, Didi. Uber lost some \$2bn over two years in China. Its retreat paved the way for Didi to grow into China’s undisputed ride-hailing champion, which today processes over four-fifths of all domestic orders. The Chinese titan is widely expected to go public in the next few months, eight years after its launch. It could fetch a valuation of \$60bn.

That Uber was willing to burn through so much cash, at least for a time, is a testament to the size of the prize. China boasts the world’s biggest ride-hailing market. According to its transport ministry, 21m trips were booked on ride-hailing platforms each day, on average, last October. That is double the figure in pre-pandemic America, when travel was safer. Until it sold its Chinese business, Uber received more orders in China than in any other country, including its home market. The gross transaction value of China’s ride-hailers reached 221bn yuan (\$32bn) last year, up by more than half since 2017, reckons Frost and Sullivan, a consultancy.

America may have invented ride-hailing. But it is in China where the conditions are most fertile for it to flourish. The reasons go deeper than the size of the market. Didi has the most to gain. But its dominance will increasingly be contested.

Ride-hailing firms depend disproportionately on customers in big cities, where population density is highest. Around a quarter of Uber's gross bookings by value in 2019 came from just five metropolises: Chicago, Los Angeles, New York, San Francisco and London. China has 14 metropolitan areas with a population of over 10m (see map), more than any other country.

Most of these cities, keen to reduce rage-inducing congestion, discourage private car ownership by restricting the supply of licence plates. In Beijing's most recent bi-monthly lottery 3.6m applicants competed for 6,370 number plates. Shanghai, China's most populous city, puts a small number of plates up for auction each month. The average winning bid at the auction in January was 91,863 yuan, more than double what it was a decade ago and costlier than many mid-range cars (see chart). The southern boomtowns of Guangzhou and Shenzhen have hybrid models whereby some plates are allocated via lottery and the rest sold to bidders. All that leaves millions of disappointed wannabe motorists for ride-hailing firms to cater to.

Moreover, high urban density and the absence of American-style suburban sprawl turn parking space into a prized (and pricey) commodity. The number of public parking spaces per car in Beijing, China's second-most populous city, is a fifth of that in its American opposite number, Los Angeles. China's extensive high-speed rail network, the world's longest, blunts the benefits of car ownership for long-distance travel. And cheaper labour means rides can be offered at low prices, making them accessible to a wider group of customers. More than 340m Chinese booked a ride-hailing service at least once in the first half of 2020, notes the Ministry of Industry and Information Technology.

In 2019 Didi disclosed that it was losing an average of just 2% of the total fare on each ride. The company now says its "core ride-hailing business

in China is already profitable". It is coy about the details; Uber also insists it makes money from ride-hailing but continues to report vast operating losses, of \$4.9bn last year. Yet most analysts in China take Didi at its word. The question for Didi, they say, is not whether it can break even but rather how well it can sustain profits, maintain its near-monopoly in China and expand abroad.

In recent years the firm has expanded into new business lines, from bike-sharing and food delivery to financial services. The aim is to build up a convenient "ecosystem" to make it costlier for customers to switch to a rival platform. Those rival platforms are not standing still, however. Jack Wei, boss of Shouqi Yueche, Didi's closest domestic competitor, is sanguine about the challengers' prospects. He sees room for "multiple firms", perhaps three or four, to thrive in China in the long term.

One way to carve out a bigger slice of the market is through differentiation, Mr Wei suggests. Shouqi prides itself on premium customer service (as Lyft, Uber's domestic rival, tries to). Its ambition is to become the "leader" in upscale rides while "keeping up" with Didi in the mass market. China is large enough that serving this niche is big business. Shouqi expects to turn a net profit this year on revenues of 8bn yuan.

Another path is to forge strategic alliances. Shouqi has one with Meituan, a rising Chinese e-commerce star that offers, among other things, food-delivery and bike-sharing services. The agreement allows Meituan's 477m annual active users to book Shouqi rides directly in its super-app. In return Shouqi pays Meituan a small commission on each booking. Crucially, Meituan excludes Didi, which it views as a threat, from its platform.

Despite its advantages, the Chinese market presents some obstacles. As in the West, the authorities are concerned about big tech. In December the markets regulator summoned six online giants, including Didi, and lectured

them on how not to abuse their dominant positions. At the local level, more than a hundred municipalities have drafted stricter rules on who can drive for ride-hailing firms over the past four years. The aim appears to be to appease embattled local taxi industries. The rules typically set a high bar, such as requiring existing residency status in the city where a driver wants to work. Yet most drivers are migrant workers who lack the proper papers. In 2016 Didi complained that only 3% of its 410,000 drivers in Shanghai would have passed the test.

The arrival of self-driving cars, which Didi has been developing since 2016, may one day solve this problem, though probably not imminently (last year Uber called it quits and spun off its autonomous-vehicle arm). In the meantime, Didi is hedging its bets by diversifying. In 2017 it set up an international division. A chunk of the \$4.5bn it raised a year later was earmarked for foreign expansion. Today it operates in 13 overseas markets, mainly in Latin America. Three years ago it acquired a controlling stake in 99 Taxi, which competes with Uber in Brazil, in a deal that valued the Brazilian startup at around \$1bn.

But China remains the biggest opportunity, which explains why Shouqi has chosen to lock in on its home market for the time being. It helps that local authorities have, for the most part, turned a blind eye to rule-bending by the ride-hailing firms. Perhaps they calculate that unemployment resulting from tougher enforcement imperils social stability, not least as economic growth slows and good manufacturing jobs are harder to come by. One in eight drivers for Didi in China are military veterans, a group known for staging small-scale protests when their interests are harmed. Given Beijing's harmony-obsessed leaders, it is a good bet that ride-hailing in China has plenty of road left to run. ■



中国的交通出行

运输梦想

要一瞥网约车业务的未来，向东看

“我们在中国投了很多钱。”2016年6月，优步的创始人、时任老板特拉维斯·卡兰尼克（Travis Kalanick）在天津一次非正式会面中宣称。但他语带不安地补充道：“我们有个竞争对手投的更多。”两个月后，这家美国网约车巨头认输，把它的中国业务出售给了总部在北京的竞争对手滴滴。优步在中国的两年里亏损了约20亿美元。它的撤退为滴滴的壮大铺平了道路，后者在中国成为无可争议的网约车霸主，如今处理的出行订单占国内总量的五分之四以上。人们普遍预计，问世八年后，这家中国巨头将在未来几个月内上市。它的估值可能达到600亿美元。

优步愿意烧这么多钱（至少一度如此），足以证明成功的回报巨大。中国拥有世界上最大的网约车市场。据中国交通运输部的数据，去年10月，网约车平台的日均订单量为2100万单。这是美国在新冠疫情前出行较安全时的数字的两倍。在出售中国业务前，优步在中国的订单量比在其他任何国家的都多，包括在它的本土市场。咨询公司弗若斯特沙利文（Frost & Sullivan）估计，去年中国网约车市场交易总额达到2210亿元，自2017年以来增长超过50%。

美国也许创造了网约车行业，但中国为它的繁荣发展提供了最肥沃的土壤。这背后的原因不仅仅在于市场规模。滴滴从中获益最多，但它的霸主地位将面临越来越多的挑战。

网约车公司特别依赖人口密度最高的大城市里的客户。2019年优步订单总额的约四分之一来自五个大都市：芝加哥、洛杉矶、纽约、旧金山和伦敦。中国拥有14个人口超过1000万的大城市（见地图），比其他任何国家都多。

这些城市大多急于缓解让人光火的交通拥堵问题，通过限制发放车牌来控制私家车数量。北京每两个月摇号一次，最近一次有360万申请人竞争6370个车牌。中国人口最多的城市上海每个月都会拿出少量车牌来拍卖。在1月的竞拍中，平均成交价为91,863元，比十年前高出一倍多，比许多中档车还贵（见图表）。新兴的南方城市广州和深圳则采取混合模式，即一部分车牌通过摇号分配，其余通过竞拍供应。这一切让数以百万计想买车的人望牌兴叹，他们成为了网约车公司的服务目标。

此外，中国城市人口密度高，又不像美国那样有大面积的城郊居住区，停车位成了宝贵（且昂贵）的商品。在中国人口第二多的城市北京，平均每辆车的公共停车位数量是美国人口第二多的城市洛杉矶的五分之一。中国的高速铁路网覆盖广阔，里程世界第一，这削减了拥有私家车对于长途旅行的好处。这里的劳动力更廉价，使得网约车服务的价格便宜，让更广泛的客户群体都能负担得起。工业和信息化部指出，2020年上半年，超过3.4亿中国人至少预订了一次网约车服务。

滴滴在2019年披露，平均每笔订单仅亏损车费的2%。该公司现在表示“在中国的核心网约车业务已实现盈利”，但不愿透露细节。优步也坚称自己的网约车业务是盈利的，但继续报告巨额运营亏损，去年亏了49亿美元。不过，中国的分析师大多相信滴滴的说法。他们说，滴滴的问题不在于能否实现收支平衡，而在于能否很好地维持利润、保持它在中国近乎垄断的地位，并向海外扩张。

近年，滴滴已经向新业务进发，包括共享单车、外卖以至金融服务，目的是建立一个便捷的“生态系统”，提高客户转向对手平台的成本。但这些对手平台也不是原地踏步。首汽约车是滴滴的第一大国内竞争者，CEO魏东对挑战者这一方的前景态度乐观。他认为，长远来看，中国有足够的空间让“几家公司”——大概三四家——蓬勃发展。

魏东提出，想在这个市场上分得更大的一杯羹，一个方法是差异化。首汽约车以高端客户服务为荣（像优步在美国的竞争对手Lyft力图做到的那

样）。其抱负是成为高端网约车的“领头羊”，同时在大众市场“跟上”滴滴的步伐。中国那么大，能做好这个利基市场也是笔大生意。首汽约车预计今年将在获得80亿元收入的同时实现净盈利。

另一个办法是打造战略联盟。首汽约车已与提供外卖和共享单车等服务的中国电商新贵美团达成了这样的合作关系。美团的4.77亿名年活跃用户可以在其超级应用中直接预订首汽约车。作为回报，首汽约车就每笔订单向美团支付少量佣金。这里的一个关键是，美团视滴滴为威胁，把它排除在自家平台之外。

中国市场尽管有其优势，但也存在一些障碍。和西方一样，政府也对科技巨头心存忧虑。去年12月，市场监管机构约谈了包括滴滴在内的六家网络巨头，告诫它们不得滥用市场支配地位。在地方层面，过去四年，一百多个城市就网约车司机的从业资格起草了更严格的规定。这似乎是为了安抚陷入困境的地方出租车行业。这些规定通常都设置了很高的门槛，比如要求网约车司机必须有本地户籍，而大多数司机都是没有本地户口的外来打工族。2016年，滴滴抱怨称，它在上海的41万名司机中只有3%可能通过审核。

自2016年以来滴滴一直在开发的无人驾驶技术有朝一日也许能解决上述问题，但这一天大概不会很快到来（去年优步剥离了无人驾驶部门，宣告退出该市场）。与此同时，滴滴正通过多元化来对冲风险。它在2017年成立了国际化事业部，一年后融资的45亿美元中很大一块被划拨用于海外扩张。如今，它在13个海外市场开展业务，主要在拉丁美洲。三年前，它收购了优步在巴西的竞争对手99 Taxi的控股权，这项交易对这家巴西创业公司的估值约为10亿美元。

但最大的机会仍在中国，这也是为什么首汽选择暂时专注发展本土市场。地方政府在大多数情况下都对网约车公司违规经营睁一只眼闭一只眼，这是个有利因素。也许政府估计收紧执法会导致失业，危及社会稳定，尤其是在经济增长放缓、制造业好职位减少的情况下。在中国，每八个滴滴司机中就有一人是退伍军人，这一群体以常常在利益受损时发起小型抗议闻

名。考虑到中国领导人极度重视维稳，押注中国的网约车市场前途广阔还是非常稳妥的。■



Digital currencies

Token gestures

Bitcoin grabs the headlines, but the real action is at central banks

ANYONE WHO bought bitcoin a year ago must feel vindicated—and rich. The price of the cryptocurrency crossed \$50,000 for the first time on February 16th, a five-fold increase over the past year. Wall Street grandes including BlackRock, Bank of New York Mellon and Morgan Stanley are mulling holding some for clients. Last month Tesla, an electric-car maker, said it had bought \$1.5bn-worth of bitcoin and would accept it as payment for its cars.

Investors' interest in bitcoin as an asset may be rising, but the inefficiencies and transaction costs associated with its use make it unlikely ever to be a viable currency. Here the action has been within central banks. As consumers have shifted away from using physical cash, and private companies—such as Facebook—have expressed an interest in launching their own tokens, many central banks have begun planning to issue their own digital currencies. The Bank for International Settlements, a club of central banks, said in January it expects one-fifth of the world's population will have access to a central-bank digital currency (CBDC) by 2024.

China is the clear frontrunner. On February 17th it concluded the third big test of its digital currency, handing out 10m yuan (\$1.5m) to 50,000 shoppers in Beijing. It has announced a joint venture with SWIFT, an interbank-messaging system used for cross-border payments. Sweden, another champion, has extended its pilot project.

The latest big central bank to get serious about a CBDC is the European Central Bank (ECB). Its public consultation, seeking views on the desirable

features of CBDCs, concluded in January, garnering over 8,000 responses. Speaking to *The Economist* on February 10th, Christine Lagarde, its president, said she planned to seek approval from her colleagues to begin preparing for a digital euro. A decision is expected in April. Ms Lagarde hopes the currency will go live by 2025.

Much like other central banks, the ECB wants to offer consumers digital tender that is as safe as physical cash. Unlike bank deposits, a claim on central-bank reserves carries no credit risk. Digital-currency transactions could be settled instantly on the central bank's ledger, rather than using the pipes of card networks and banks. That could provide a back-up system in the event that outages or cyber-attacks cause private payment channels to fail.

The bank also sees a digital currency as a potential tool to bolster the international role of the euro, which makes up just 20% of central-bank reserves globally, versus the dollar's 60%. It could let foreigners settle cross-border transactions directly in central-bank money, which would be faster, cheaper and safer than directing them through a web of "correspondent" banks. That could make the digital euro attractive to businesses and investors.

Its main draw may be to offer a level of privacy that neither America nor China can promise, says Dave Birch, a fintech expert. The former uses its financial system to enforce sanctions; the latter seeks control. But getting the design right will be tricky: the European Union still wants to be able to track cash that is being laundered or hidden to dodge taxes. One fix could be to let users open e-wallets only once they have been vetted by banks, but for the use of the digital currency itself to be unmonitored.

A wildly successful digital euro could siphon deposits away from banks and threaten the availability of credit. Remedies being considered include

capping the amount of currency users can hold or—as Fabio Panetta, a member of the ECB’s executive board, suggested on February 10th—charging penalties on use above a threshold. A digital euro could also involve “huge legal reform”, says Huw van Steenis of UBS, a bank. “Settlement finality”—which governs when a payment completes and cannot be reversed—varies across the euro zone’s 19 countries, and would need to be harmonised. Launching a CBDC will take more than token efforts. ■

For the full interview with Christine Lagarde, go to economist.com/CLpod ■



数字货币

代币行动

比特币常常占据新闻头条，但真正的进展发生在各国央行

一年前买了比特币的人一定都觉得自己扬眉吐气，而且很富有。这种加密货币的价格在2月16日首次突破五万美元，过去一年里涨了五倍。包括贝莱德（Blackrock）、纽约梅隆银行（Bank of New York Mellon）和摩根士丹利在内的华尔街巨头正在考虑为客户持仓。上月，电动汽车制造商特斯拉表示已购买了价值15亿美元的比特币，并将接受用比特币购买它的汽车。

投资者把比特币当作一种资产的兴趣可能日渐浓厚，但比特币使用时的低效和交易成本问题让它不可能成为一种切实可用的流通货币。这方面的行动一直在央行内开展。随着消费者渐渐不再使用现金，加上Facebook之类的私人公司已表示有兴趣推出自己的代币，多国央行已开始计划发行自己的数字货币。央行俱乐部国际清算银行1月表示，预计到2024年，全球五分之一的人口将能用上央行数字货币（CBDC）。

中国显然是领跑者。2月17日，它结束了对其数字货币的第三次大型测试，向北京的五万名购物者发放了1000万元数字人民币。它已宣布与用于跨境支付的银行间报文系统SWIFT成立合资公司。另一个冲在前头的国家瑞典已延长了其试点项目。

最新一个认真考虑CBDC的大型央行是欧洲央行。它对CBDC的重要功能的公开征求意见于1月结束，收到了8000多个回复。2月10日，该行行长克里斯汀·拉加德（Christine Lagarde）在接受本刊采访时说，她计划征得同事们的同意，开始筹备数字欧元。预计将于4月做出决定。拉加德希望这种货币在2025年之前投入使用。

很大程度上与其他央行一样，欧洲央行希望向消费者提供和现金一样安全的数字货币。与银行存款不同，对央行储备的拥有权没有信用风险。数字

货币交易可以通过央行分类帐即时结算，无需使用信用卡网络和银行的渠道。万一发生停电或网络攻击导致私营支付渠道不能正常运行，它可以作为一个后备系统。

欧洲央行还把数字货币视为一种可能增强欧元国际地位的工具。欧元仅占全球央行储备的20%，而美元占60%。数字货币可以让外国人直接用央行货币结算跨境交易，这比通过“代理”银行网络结算更快、更便宜，也更安全。这可能会让企业和投资者对数字欧元感兴趣。

金融科技专家戴夫·伯奇（Dave Birch）表示，数字欧元的主要吸引力可能是提供美国和中国都无法保证的某种程度的隐私保护。美国利用其金融系统制裁别国，中国则是寻求控制。但要把数字欧元设计妥当不容易，因为欧盟仍然希望能够追踪洗钱或为避税而隐藏的现金。一种解决方法是让用户仅在经银行验证后才能打开电子钱包，但他们对数字货币的使用则不受监控。

数字欧元如果大获成功，可能会从银行吸走存款，威胁到信贷的供应。正在考虑的补救措施包括限制用户可以持有的数字欧元的数量，或者如2月10日欧洲央行执行委员会委员法比奥·帕内塔（Fabio Panetta）建议的那样，对超过上限使用数字欧元施以处罚。瑞银（UBS）的休·范斯坦尼斯（Huw van Steenis）表示，推出数字欧元可能还需要“巨大的法律改革”。欧元区19个国家的“结算最终性”（决定付款何时完成且不可撤销）各不相同，需要统一。推出一种CBDC可不是做做样子就行的。

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Online shopping

South Korea's baby Amazon

Coupang hopes to emulate other second-generation e-commerce stars

WANDER AROUND Seoul's residential neighbourhoods at dawn and you will invariably encounter a Coupang delivery van. In the past few years South Korea's mini-Amazon has parked itself in a choice spot amid a crowded e-commerce market by steadily expanding the range of products it offers to deliver in time for breakfast, so long as customers order before midnight. Some items arrive the same day. The strategy looked sensible before the covid-19 pandemic. After 2020 it looks inspired. Coupang's revenue nearly doubled from \$6.3bn in 2019 to \$12bn last year. It employs 50,000 people, twice as many as a year ago, and controls a quarter of South Korean e-commerce, up from 18% in 2019, according to Digieco, a research firm.

The 11-year-old firm has yet to make money—its cumulative \$4.1bn loss so far has been bankrolled by venture capital, notably SoftBank's \$100bn Vision Fund, which owns a 37% stake, according to estimates by Bloomberg. Cashflow has improved, says Kim Myoung-joo of Mirae Asset Daewoo, an investment firm in Seoul. But it needs more capital to grow.

Happily for Coupang, investors' appetite for startups seems insatiable, as the boom in blank-cheque companies created to merge with them shows. So on February 12th it filed the paperwork for an initial public offering (IPO) on the New York Stock Exchange. It may go public as soon as this month, at a market capitalisation that could surpass \$50bn.

Coupang is the latest in a generation of young e-commerce stars nibbling at the heels of Amazon and Alibaba, a Chinese titan. The incumbents are being challenged at home (by Shopify in Amazon's American backyard, and

Meituan and Pinduoduo in Alibaba's), as well as in places like Latin America (by Argentina's MercadoLibre) or South-East Asia (by Sea, a Singaporean group). The upstarts' sales have soared of late (see chart). In the past 12 months they have more than quadrupled their combined stockmarket value, to \$1trn.

With no known plans to expand abroad, Coupang's prospects depend on fending off local rivals. These range from the e-commerce arms of big conglomerates such as Lotte and Shinsegae to internet platforms like Naver and upstarts like Baemin, a food-delivery service backed by Germany's Delivery Hero. To extend its dominance Coupang must thus continue to nurture the customer goodwill it has garnered thanks to those pre-dawn deliveries. The firm prides itself on employing delivery workers directly, and has a newsroom section dedicated to correcting allegations, for instance over working conditions, that it deems false or distorted. But it has not escaped scrutiny of the e-commerce industry. Last month it had to apologise after a government commission classified the death of a young contract worker at one of its logistics centres as an industrial accident.

Even if it manages to keep consumers on its side, as seems likely, long-term growth could require looking beyond fulfilment and logistics, thinks Ms Kim. MercadoLibre and Sea owe significant chunks of their rich valuations to adjacent businesses, from e-payments to gaming. To thrive in South Korea's isolated online ecosystem, Coupang may need to occupy more than one niche. ■



网购

韩国的小亚马逊

Coupang希望赶上其他第二代电商明星

黎明时分走在首尔的居民区，总会遇到Coupang的送货车。过去几年中，这个韩国迷你版亚马逊靠不断扩大“午夜前下单、早餐前送达”的商品种类，在一个拥挤的电商市场中占据了优势地位。有些商品当日送达。这个策略在新冠疫情之前看起来很明智，在2020年之后就堪称绝妙了。

Coupang的营收几乎翻了一番，从2019年的63亿美元增至去年的120亿美元。根据研究公司Digioco的数据，它有五万名员工，是一年前的两倍，控制着四分之一的韩国电商市场，高于2019年的18%。

这家成立11年的公司尚未盈利——据彭博估计，它迄今为止累计亏损的41亿美元一直由风险资本买单，尤其是软银1000亿美元的愿景基金（Vision Fund），该基金持有它37%的股份。首尔的投资公司未来资产大宇（Mirae Asset Daewoo）的金明珠（Kim Myoung-joo，音译）表示Coupang的现金流有所改善。但它需要更多资本来实现增长。

对Coupang来说，幸运的是投资者对创业公司的胃口似乎永不满足。为与创业公司合并而创建的特殊目的收购公司大量涌现就是一个明证。2月12日，Coupang在纽约证券交易所提交了IPO申请文件。它可能最快在本月上市，市值可能超过500亿美元。

Coupang是年轻一代电商明星中最新的一家。这些企业正在蚕食亚马逊和中国巨头阿里巴巴的市场份额。两大霸主在本土和全球市场都遭遇挑战。在各自本土，亚马逊面对Shopify，阿里巴巴面对美团和拼多多；在海外，拉丁美洲有阿根廷的美客多（MercadoLibre），东南亚有新加坡的Sea。电商新贵的销售额近年来增长迅猛（见图表）。在过去12个月中，它们的总市值增加了三倍多，达到一万亿美元。

Coupang未曾披露过海外扩张计划，它的前景取决于能否抵挡住本土竞争者。这些对手包括乐天（Lotte）和新世界（Shinsegae）等大型企业集团的电商部门、Naver等互联网平台，以及由德国的Delivery Hero投资的外卖公司Baemin等电商新贵。要扩大优势，它就必须继续加强靠黎明前送货在客户中积累的声誉。这家公司以直接雇用送货员为傲，并设有新闻部，专门纠正它认为虚假或歪曲的指控，比如有关工作条件的。但它一样躲不过电商行业受到的审视。上个月，政府的一个委员会把它某个物流中心里一名年轻合同工的死亡定性为工伤，它不得不为此道歉。

金明珠认为，即使Coupang能留住消费者（现在看来很有可能），要实现长期增长可能需要寻求在履单和物流以外拓展业务。美客多和Sea的高市值有很一大部分都要归功于电子支付和游戏等周边业务。要在韩国孤立的网络生态系统中蓬勃发展，Coupang可能需要在不止一种利基业务中独领风骚。 ■



Free exchange

Radiant energy

If America's economy runs hot, what happens to the rest of the world?

WHEN AMERICA sneezes, the rest of the world catches a cold. But what happens when it runs a fever? After a trying 2020 in which GDP fell by 3.5%, America is poised to enjoy a robust rebound in 2021 simply by returning to something like normal as vaccination proceeds. Yet it might manage more than just that. If President Joe Biden's covid-19 relief bill is enacted, total stimulus this year may exceed \$2.5trn. That could easily push output above what the Congressional Budget Office estimates to be its “potential” level: that is, the amount the economy can produce without an increase in inflationary pressure. This possibility has some American economists on the lookout for signs of accelerating growth in prices and wages. America does not operate in a vacuum, however; should overheating occur, its effects will not be confined within its borders. Depending on how the recovery plays out, a hot American economy could be a boon for the rest of the world—or yet another source of concern.

In a closed economy that does not trade with the rest of the world, too little spending leads to job losses and downward pressure on prices, whereas too much should push up employment and, eventually, prices. In an open economy, however, some of the effects of the shifts in demand spill over to the rest of the world. A sharp drop in spending, for instance, may be associated with plunging demand for imports, in which case some of the pain of a slump is exported abroad. During the global financial crisis of 2007-09, troubles in financial markets wreaked havoc all over the world, but even countries relatively insulated from those woes felt a chill thanks to trade links with America and Europe. According to one estimate, about a quarter of the drop in American demand and a fifth of the fall in European

demand was borne by other economies, and transmitted through trade.

A boost to demand ought to work in a similar way, but in the other direction. As Americans spend more, some of it leaks abroad: through purchases of foreign goods, for example, or spending on services—including tourism, which should begin to rebound as pandemic restrictions are lifted. An analysis of fiscal-policy spillovers published by the IMF in 2017 found that an American stimulus consisting mostly of spending (as opposed to tax cuts) and worth 1% of GDP raises the output of the average country by 0.33% in the first year. Countries with closer trade ties experience bigger effects; the fillip to Canada's economy is estimated to be almost three times the average, for example. If the combination of reopening and stimulus invigorates the American consumer, the effects could quickly be felt all over the world.

The degree to which it is felt, however, depends crucially on the policy response, both at home and abroad. Fiscal spillovers are more powerful when recipient countries are themselves operating below potential. American spending is thus more likely to spill over to the rest of the world if its recovery is much stronger than those of its trading partners. Ordinarily, spillovers provide a strong incentive for governments to co-ordinate their stimulus efforts—lest some tight-fisted economies (eg, those in Europe) free ride on the largesse leaking from more generous ones. Indeed, on February 12th Janet Yellen, America's treasury secretary, urged her counterparts in the G7 group of countries to “go big” on stimulus, too. Countries that free ride could find themselves in hot water with Ms Yellen: the Biden administration has promised to be stern with countries that run large, persistent trade surpluses.

But if America does come close to overheating, then a reluctance to spend elsewhere may be less irksome than usual, as demand-starved countries serve as a release valve for the pressure building up at home. Growth in

global trade seems to have enhanced its pressure-relieving capabilities, according to work by Jane Ihrig, Steven Kamin, Deborah Lindner and Jaime Marquez of the Federal Reserve. They reckon that the expansion in trade has served to weaken the link between changes in domestic demand and corresponding shifts in total output, with net exports bearing more of the burden of adjustment to changes in domestic spending. In the late 1990s, for instance, measures of domestic demand grew even faster than real GDP (which was itself growing at a rapid clip). Inflation remained relatively subdued, however, in part because America's current account deficit swelled. Similarly, a surge in imports this year might dissipate potential inflationary pressures in America while giving a lift to its weaker trade partners.

The biggest uncertainty about the global effects of a hot American economy is the reaction of the Fed. Recent work by Kristin Forbes of the Massachusetts Institute of Technology suggests that domestic inflation has become more responsive over time to global factors—including the amount of economic slack across the global economy as a whole. Yet wage inflation still seems to respond mostly to domestic conditions. The Fed might therefore shrug off price rises later this year, reckoning that short-run price pressures will not translate into sustained inflation until America's job market, and the world economy, is fully recovered. A doveish Fed should make for a weaker dollar and easier financial conditions worldwide, adding to the boost that comes from Americans buying more goods from abroad.

But a really rip-roaring economy could test the Fed's patience, particularly if a yawning current account deficit and soaring asset prices cause it to worry about a build-up of financial risk. The spectre of American interest-rate hikes could frighten global markets, and force emerging economies to adopt less stimulative fiscal and monetary policies. A bit of demand spilling over from America would seem insignificant in comparison. That the Fed will suddenly turn hawkish still seems unlikely. But if America's temperature

runs high enough, the rest of the world may break out in cold sweats. ■



自由交流

热力四射

如果美国经济过热，世界其他地区会如何？

美国打个喷嚏，全世界都会感冒。但如果美国发烧了，会怎样？美国在2020年GDP下跌了3.5%，经过这艰难的一年后，其经济势将在2021年强劲反弹——只要随着疫苗接种的推进恢复到近似正常的状态就能实现。但是，美国经济可能不止是反弹。如果拜登的新冠疫情救济法案获通过，那么今年的刺激方案总规模可能会超过2.5万亿美元。这可能会轻易推动经济产出超过美国国会预算办公室（Congressional Budget Office）估计的“潜在”水平，也就是不会增加通胀压力的产出上限。这种可能性让一些美国的经济学家开始警惕物价和工资增长提速的迹象。但美国经济不是在真空中运行。如果过热，其影响将不会局限于美国国内。一个火热的美国经济可能是世界其余地区的福音，也可能是又一个麻烦的源头——全看这场复苏如何发展。

在一个不与世界其他地区开展贸易的封闭经济体中，支出太少会导致失业并给物价带来下行压力，支出过多则会增加就业，最终推高物价。但在一个开放的经济体中，需求变动的某些影响会溢出到世界其他地区。例如，支出急剧下降可能引发对进口产品的需求大幅下降，在这种情况下，经济下滑的部分痛苦就会输出到国外。在2007年至2009年全球金融危机期间，金融市场的麻烦震撼全球，但即使是在相对而言隔绝于这些金融风暴之外的国家，由于和美国及欧洲存在贸易联系，也感到了阵阵寒意。一项估计认为，在贸易的传导下，美国需求下降的约四分之一和欧洲需求下降的五分之一都落在了其他经济体头上。

需求提振应该会有类似的效应，只是方向相反。随着美国人支出增加，其中一些会流向国外，比如购买外国商品，或者花在包括旅游在内的服务上——疫情限制措施开始解除后旅游业应该会开始反弹。国际货币基金组织2017年发布的对财政政策溢出效应的分析发现，美国一项刺激政策在第一

年让其他国家的经济产出平均提高了0.33%，该政策主要以支出（而非减税）为主，相当于GDP的1%。与美国贸易联系更紧密的国家受到的影响更大，例如对加拿大经济的利好作用估计为平均水平的近三倍。如果经济重启加上刺激措施能鼓舞美国的消费者，那么全世界可能都会很快感受到这种影响。

但是，感受有多深与国内外采取的响应政策息息相关。当受影响国的经济低于潜在产出水平时，财政溢出的影响会更强。因此，如果美国的复苏远强于其贸易伙伴，那么美国的支出就更有可能溢出到世界其他地区。通常，溢出效应的存在是各国政府想要在彼此间协调刺激力度的强大诱因，以避免被一些财政收紧的国家（例如欧洲某些经济体）搭了更慷慨撒钱的国家的便车。实际上，在2月12日，美国财政部长珍妮特·耶伦（Janet Yellen）敦促七国集团国家的财长也“加大”刺激力度。搭便车的国家可能会被耶伦找麻烦，因为拜登政府已承诺对那些长期对美保持高额贸易顺差的国家采取严厉态度。

但是，如果美国经济确实接近过热，那么把钱花到了其他国家这件事可能就不像往常那么叫人讨厌了，因为需求不足的国家充当了美国国内压力积聚的泄压阀。美联储的简·伊里格（Jane Ihrig）、史蒂文·卡明（Steven Kamin）、黛博拉·林德纳（Deborah Lindner）和海梅·马奎兹（Jaime Marquez）的研究表明，全球贸易的增长似乎增强了它缓解压力的能力。他们认为，贸易增长已经削弱了内需变化与总产出相应变化之间的联系，因为净出口对国内支出的变化起到了更大的调节作用。例如，在上世纪90年代后期，内需指标的增长速度甚至超过了实际GDP（其本身也在快速增长）。但通胀仍然相对较低，一定程度上是因为美国经常账户赤字激增。同样，今年进口的激增可能会消除美国潜在的通胀压力，同时让其经济较疲弱的贸易伙伴获得提振。

关于美国经济过热对全球影响的最大不确定性是美联储的反应。麻省理工学院的克里斯汀·福布斯（Kristin Forbes）近期的研究表明，随着时间的推移，国内通胀已变得对全球因素（包括全球经济的整体低迷程度）更为敏感。不过，工资上涨势头似乎仍然主要与国内状况相关。因此，美联储

可能不会太紧张今年稍后的价格上涨，认为在美国就业市场以及世界经济完全复苏之前，短期价格压力不会转变为持续的通胀。一个鸽派的美联储应该会令美元走弱，让全球金融状况更为宽松，从而在美国人购买更多国外商品带来的增长之上再添一把火。

但如果经济实在太热，特别是如果经常账户赤字激增和资产价格飞涨导致美联储担心金融风险加剧的话，它的耐心可能就会受到考验。对美国大幅加息的预期挥之不去，这可能会令全球市场惧怕，迫使新兴经济体采取刺激性较小的财政和货币政策。相比之下，美国溢出一些需求的好处就会显得无足轻重了。美联储似乎仍然不太可能突然转变成鹰派。但是，如果美国经济发热到一定程度，世界其他地方可能就会冒冷汗了。 ■



Tackling climate change

The race to zero

Governments and business must work together to save the world, says Bill Gates

“HOW MANY planets?” That question was posed by Mahatma Gandhi as he contemplated the environmental implications of India’s following the resource-intensive path of development pioneered by Britain. The inquiry still resonates. As the World Economic Forum, a think-tank, has put it, the global “food-energy-water nexus” is in trouble. Global warming is the most alarming crisis of all. How many planets would be needed if everyone in China lived in McMansions and drove gas-guzzlers, as many Americans do?

For some tycoons, the solution is to find more planets. Fifteen years ago Elon Musk was so worried about climate change making Earth uninhabitable, he earnestly told this reviewer, that he intended to turn humanity into a multi-planetary species. He has since been funnelling the fortune he is making at Tesla, his electric-car company, into building ever-better rockets at SpaceX. Last month Jeff Bezos stepped back from running Amazon, an e-commerce goliath, to spend more time on Blue Origin, his rocket venture, which he calls his most important work. The coming energy crisis, he has declared, means that “we have to go to space to save Earth.”

By contrast, Bill Gates, the co-founder of Microsoft, has his feet firmly planted on the ground. He is just as concerned about global warming as are those trillionaires, but in his view there is only one planet that matters. His new book, “How to Avoid a Climate Disaster”, is devoted to reconciling the legitimate aspirations of billions of people for economic advancement with the environmental harm that results. If humanity is to win the great race between development and degradation, he writes, green innovation must accelerate.

Previous energy transitions—for instance, from coal to oil—took many decades. But given the pressing need to decarbonise the global economy, says Mr Gates, “we have to force an unnaturally speedy transition”. He wants governments to increase funding for climate research fivefold in a decade; disclosing his own investments, he urges them to bet on such promising but risky fields as advanced nuclear power. There should be more green procurement (a path China has followed with solar panels and electric cars) and greener regulation. But the linchpin of his argument is the introduction of a meaningful carbon price, to account for the externalities involved in using dirty energy.

Mr Gates is hardly the first to advance these proposals. Besides his status as one of the world’s richest people and most generous philanthropists, two things make his endorsement of them compelling. First, he is not a reflexive environmentalist. His long-standing commitment to public health and the alleviation of poverty led him to oppose flaky green causes like Europe’s unscientific bans on genetically modified organisms. In a moving chapter, he notes that Africa’s poor have yet to enjoy the benefits of the first “green revolution” in agricultural science, which from the 1960s boosted farming yields and saved a billion people in Asia from starvation; they desperately need more such innovations in crop science and fertilisers. He awakened to the climate crisis as it became clear that the world’s indigent, who have contributed least to the problem, are likely to suffer most from famines, droughts, rising seas and other effects of global warming.

Second, Mr Gates has long been allergic to top-down regulation. “It might seem ironic that I’m calling for more government intervention,” he concedes. “When I was building Microsoft, I kept my distance from policymakers in Washington.” Because he instinctively favours markets over mandarins, his policy recommendations carry more weight than the common calls heard today in America and Europe for blank-cheque spending on Green New Deals. A carefully calibrated push from the top, he

insists, will set off a tsunami of private-sector investment and invention.

Much of his book is devoted to a delightfully wonkish assessment of contenders in the race to solve the climate problem. In Mr Gates's view, decarbonising electricity is the "single most important thing we must do to avoid a climate disaster". This is not only because electricity accounts for over a quarter of the direct greenhouse gas (GHG) emissions caused by human activity today, but because clean power can enable a shift to zero-carbon transport (think electric cars). Greening industry is harder, he acknowledges, but he points to advances even in such unsexy areas as low-carbon cement and steel.

Mr Gates takes on some green shibboleths, which he clearly considers courageous, though others will detect an outmoded mindset. He is an unabashed defender of carbon-free nuclear power, despite the industry's failure to solve serious problems surrounding waste and proliferation. He chastises those who make a fetish out of wind and solar technologies, emphasising the constraints of the intermittent generation they involve.

Many environmentalists are clamouring for cuts in emissions of GHGs by 2030. Mr Gates rejects that: what matters most, he counters, is getting to a "net zero" carbon footing by 2050, which means any man-made GHG emissions are offset by absorption and sequestration. Provocatively, he claims that "making reductions by 2030 the wrong way might actually prevent us from ever getting to zero". For example, a breathless dash from carbon-loaded coal to natural gas sounds climate-friendly, as it would lead to a decline in energy-sector emissions within a decade. However, it would lock gas technology—which is not carbon-free—into the grid for decades, perhaps blocking the adoption of better alternatives. "The things we'd do to get small reductions by 2030 are radically different from the things we'd do to get to zero by 2050," he insists.

The most refreshing aspect of this book is its bracing mix of cold-eyed realism and number-crunched optimism. Mr Gates reveals that when he attended the UN's landmark Paris summit on climate change in 2015, he had serious doubts about mankind's willingness to take on this Herculean task: "Can we really do this?" Even now, after making the case for why the world must do so, and urgently, he wonders if the climate challenge will be harder than putting "a computer on every desk and in every home".

That is a useful analogy, for the techno-Utopian vision of a global internet seemed as impossible to achieve a few decades ago as solving the climate crisis does now. Ken Olsen, founder of Digital Equipment Corporation, a pioneering computer firm, once stated flatly: "There is no reason anyone would want a computer in their home." Yet before long the digital revolution succeeded—because of a happy convergence of top-down forces and disruptions from below.

Mr Gates wants the same combination to take on climate change. He acknowledges the power of the state and a need for intergovernmental co-operation, something not often heard from techno-libertarians; but he also calls for more green ambition and risk-taking by short-termist investors and company bosses. Ultimately his book is a primer on how to reorganise the global economy so that innovation focuses on the world's gravest problems. It is a powerful reminder that if mankind is to get serious about tackling them, it must do more to harness the one natural resource available in infinite quantity—human ingenuity. ■



应对气候变化

零排放竞赛

盖茨说，政府和企业必须携手拯救世界【《如何避免气候灾难》书评】

“需要多少个地球？”圣雄甘地提出这个问题时，他在思考如果印度效仿英国开创的资源密集型发展道路，将给环境带来什么影响。这一发问在今天依然引发共鸣。正如智库世界经济论坛所称，全球的“食物-能源-水的联结”陷入了困境。全球变暖是最令人担忧的危机。如果每个中国人都像许多美国人那样住巨无霸式豪宅、开高油耗大车，需要多少个地球才够呢？

在一些大亨看来，解决办法是找到更多星球。15年前，马斯克非常忧心气候变化会让地球变得不宜居，他恳切地告诉笔者自己打算把人类变成跨行星物种。此后，他不断将自己在电动汽车公司特斯拉上赚到的钱投入到SpaceX，打造越来越好的火箭。上月，电子商务巨头亚马逊的贝索斯退出了公司的日常管理，好将更多时间花在他的火箭企业蓝色起源（Blue Origin）上——他称之为自己最重要的工作。他宣称，即将到来的能源危机意味着“我们必须走向太空来拯救地球”。

相比之下，微软的联合创始人比尔·盖茨更脚踏实地。他和这些亿万富翁一样关注全球变暖，但在他看来，重要的星球只有一颗。他的新书《如何避免气候灾难》（How to Avoid a Climate Disaster）专门论述了如何调和几十亿人追求经济发展的合理愿望和由此造成的环境破坏。他写道，如果人类要在经济发展与环境退化之间的大竞赛中获胜，就必须加快绿色创新。

先前的能源转型历时几十上百年，例如从煤炭转到石油。但考虑到全球经济脱碳的紧迫性，盖茨说，“我们必须推动不同寻常的快速转型”。他希望各国政府在十年内将气候研究的资金提升到目前的五倍；他披露了自己的投资，敦促政府押注于先进核能这种前景广阔但风险较高的领域。政府应该加大绿色采购（中国发展在太阳能电池板和电动汽车上就是这么做

的），施行更环保的监管政策。但他最核心的观点是要引入有意义的碳价，来体现使用污染性能源所产生的外部性。

盖茨并不是第一个提出这些建议的人。他是全球最富有的人之一，也是最慷慨的慈善家之一，除此之外他还有两个特点让他的背书令人信服。首先，他并不是条件反射式的环保主义者。他长期致力于公共卫生和消除贫困，因此反对那些经不起推敲的环保事业，例如欧洲缺乏科学依据的转基因生物禁令。在一个章节中，他笔触感人地写道，第一次农业科学“绿色革命”从上世纪60年代开始提高了农业产量，让亚洲十亿人免遭饥荒，但非洲的穷人至今还没能享受到这场革命的好处；他们迫切需要作物科学和肥料等领域出现更多这样的创新。已经变得清晰的一点是，世界的贫困人口对气候问题所负的责任最小，看起来却要在全球变暖所带来的饥荒、干旱、海平面上升和其他影响中蒙受最深的苦难，这让他醒悟到气候危机的影响。

其次，盖茨向来反感自上而下的监管。“我在呼吁政府做出更多干预，这看起来可能有点讽刺，”他承认，“创建微软时，我和华盛顿的政策制定者保持距离。”由于他本能地倾向市场力量而不是政府官员，因此他提出的政策建议就会比今天在欧美不计成本地投资“绿色新政”的普遍呼声更有分量。他坚持认为，上层精心设计的推动措施将会在私营部门引发投资和发明的大浪潮。

书中大部分篇幅都在细致评估气候问题的各种潜在解决方案，充满学究气却也谈笑风生。在盖茨看来，电力脱碳是“避免气候灾难的第一要务”。这不仅是因为电力占如今人类活动直接温室气体排放的四分之一以上，也是由于清洁电力也可以助力实现向零碳交通运输（例如电动汽车）的转变。他承认工业的绿色转型会更困难，但他也指出，即使在低碳水泥和钢铁这些不那么酷炫的领域也已取得了进展。

盖茨支持一些陈旧的环保理念，他显然认为这些理念充满勇气，但其他人会感受到一些过时的思维。他毫不掩饰地捍卫无碳核能，尽管该行业未能解决核废料与核扩散的严重问题。他谴责对风能和太阳能的过度迷恋，强

调这些技术存在间歇性发电的局限性。

许多环保人士强烈呼吁在2030年前减少温室气体排放。对此盖茨并不认同。他反驳道，最重要的是到2050年达到“净零”碳排放，这意味着任何人为的温室气体排放都可以通过吸收和封存被抵消。他不无挑衅地声称，“以错误的方式在2030年之前减排，实际上可能会阻碍我们实现零排放”。例如，急冲冲将高碳排放的煤炭转为天然气听起来对气候有利，因为这将在十年内减少能源部门的排放，但天然气并非完全无碳，此举会导致电网在几十年里持续使用天然气技术，可能阻碍采用更好的替代能源。他坚称“在2030年之前实现小幅减排，与在2050年之前实现零排放，需要做的事情是截然不同的。”

本书最令人耳目一新的是，它兼具冷酷的现实主义和理性计算的乐观主义，令人振奋。盖茨透露，在2015年参加具里程碑意义的联合国巴黎气候变化峰会时，他曾严重怀疑人类是否愿意承担这项极其艰巨的任务：“我们真能做到吗？”即使是现在，在阐述了世界必须这么做的理由和迫切性之后，他仍然在想，气候挑战会不会比“在每户人家的每张书桌上都放一台电脑”更难。

这是一个有用的类比，因为在几十年前，全球互联网的技术乌托邦愿景看起来还遥不可及，就和现在解决气候危机的前景一样。计算机先驱企业数字设备公司（Digital Equipment Corporation）的创始人肯·奥尔森（Ken Olsen）曾断言：“没理由人人都想在家里放一台电脑。”但没过多久，自上而下的力量与自下而上的颠覆一拍即合，数字革命成功了。

盖茨寄望于同样的组合来对抗气候变化。他承认国家的力量和政府间合作的必要性，这在技术自由主义者中不常听到；但他也呼吁短线投资者和企业老板有更多的绿色追求和冒险精神。归根结底，他的书是一本关于如何重组全球经济以使创新聚焦于世界最严重问题的入门读物。它有力地提醒我们，如果人类要认真应对这些问题，就必须更好地利用一种取之不尽的自然资源——人类才智。 ■



The Economist film

Inflation and covid-19 - trailer

In the past two decades inflation has puzzled economists by remaining low in good times and bad. Could the pandemic cause it to rise?



经济学人视频

通胀与新冠 - 预告短片

过去20年，通胀在不同经济形势下保持低迷，经济学家很难为此找到解释。新冠袭来，情况会变化吗？



The glass-ceiling index

More cracks appear

The lot of female executives is improving—but still too slowly

WALL STREET'S glass ceiling cracked at last on March 1st, as Jane Fraser took charge of Citigroup, becoming the first woman to head a big American bank. That cracking sound has also been echoing across the rest of America Inc. Last year Carol Tomé became boss of UPS, a package-delivery giant. In January Rosalind Brewer became only the third black woman ever to run a *Fortune* 500 company (Walgreens Boots Alliance, a pharmacy chain). A month later Thasunda Brown Duckett was picked to run TIAA, a big pension fund.

America ranks below the average for the OECD club of industrialised countries in *The Economist's* annual glass-ceiling index of female empowerment, owing to poor marks on parental leave and political representation. But it has a high share of women in management (41%) and on company boards (28%). In both cases America outpaces egalitarian Germany, which in January enacted a quota for female board members (and where the shares for management and boardrooms are 29% and 25%, respectively).

Most countries have a long way to go. Just one in three managerial positions across the OECD's 37 members is occupied by a woman. A recent study by SIA Partners, a consultancy, found that in Britain bias against women in senior corporate hiring remains systemic.

At least signs of progress can be seen even in traditional laggards like Japan. Mori Yoshiro had to resign as chief of the Tokyo Olympics in February after he complained that women talked too much in meetings. A woman replaced

him.

Full results can be found at economist.com/glassceiling2021 ■



玻璃天花板指数

更多裂缝出现

女性高管的境况在改善——但还是太慢

三月一日，华尔街的玻璃天花板终于开裂了。简·弗雷泽（Jane Fraser）接管花旗集团，成为第一个执掌美国大型银行的女性。美国企业界其余的角落也回荡着玻璃破裂的声音。去年，卡罗尔·托梅（Carol Tomé）成为包裹递送巨头UPS的老板。今年1月，罗莎琳德·布鲁尔（Rosalind Brewer）接掌药店连锁沃博联（Walgreens Boots Alliance），成为有史以来仅仅第三个掌管财富500强公司的黑人女性。一个月后，塔桑达·布朗·达克特（Thasunda Brown Duckett）被任命管理大型养老基金美国教师退休基金会（TIAA）。

在本刊衡量女性赋权水平的玻璃天花板年度指数中，美国的排名低于工业化国家俱乐部经合组织的平均水平，原因是它在育儿假和政治代表性方面得分不佳。但美国女性在管理层和公司董事会中的比例较高，分别是41%和28%。美国的这两个比例都高于主张平等主义的德国，后者在1月份颁布了女性董事配额制（目前德国女性在管理层和董事会的占比分别为29%和25%）。

大多数国家都还有很长的路要走。在经合组织的37个成员国中，只有三分之一的管理职位由女性担任。咨询公司SIA Partners近期的一项研究发现，在英国，女性在企业高级职位招聘中仍面临系统性的偏见。

不过，即便是在日本等一贯吊车尾的国家也至少能看到一些进步的迹象。森喜朗抱怨女性在会议上话太多，后来不得不在2月辞去了东京奥组委主席一职。一位女士取代了他。

完整结果请见economist.com/glassceiling2021 ■



China's economy

Taper test

As China unwinds stimulus, its exit will offer a preview for others

THE PHRASE “first in, first out” has become shorthand for China’s experience of the covid-19 pandemic: it is both where the virus started spreading and the first large country to control it. Its early failure and subsequent success will be studied by epidemiologists for years to come. But for economists and investors, it is another “first in, first out” that matters more at the moment. China was the first country to open its lending and spending taps in the face of the coronavirus downturn. Now, it is the first to start to close them, giving others a partial preview of what the end of stimulus will look like.

Parallels between countries are, of course, imperfect. China required less stimulus because its workers went back to factories and offices nearly a full year ago. But a few general conclusions can still be drawn about its return to more normal monetary and fiscal policies.

The most notable is its gradualism. On March 5th, after *The Economist* went to press, the government was set to announce its budget for 2021. It was widely expected to target a smaller fiscal deficit this year, probably about 3% of GDP, down from last year’s 3.6%. Factoring in other quasi-fiscal measures such as spending by government-linked companies, China’s true fiscal deficit will be about 12% of GDP, compared with a record high of 15% last year, according to Morgan Stanley, a bank. That is a retrenchment, but still higher than its deficit in 2019, of roughly 10% of GDP.

The central bank has also been cautious. It has withdrawn liquidity to guide up market interest rates and to slow the growth in bank lending. But both

the price and quantity of credit remain more generous than before the pandemic struck. “They are aiming to avoid a sharp turn in the policy orientation,” says Zhu Ning of the Shanghai Advanced Institute of Finance. With 2021 marking the start of a new five-year plan for China, officials will be racing to launch infrastructure projects. The new plan—an important part of the policy process in China—promises big expansions of railways, power lines and more. That, Mr Zhu says, should help offset the end of the coronavirus stimulus.

The tightening, however gradual, is bound to be bumpy. In the past couple of weeks global markets have been roiled by the rise in Treasury yields in America. China went through a similar squeeze in late January when the central bank was far stingier in its open-market operations than expected, leading to a spike in overnight borrowing rates. Stocks fell sharply, though recovered when the central bank eased up. Officials may have wanted to put investors on notice. They have also sounded warnings about asset prices. On March 2nd Guo Shuqing, the top banking regulator, warned of bubbles in the Chinese property market and global financial markets.

As well as China has done in taming covid-19, its policy normalisation still depends on the course of the pandemic globally. Domestic travel remains limited amid lingering concerns about the virus and international travel is largely blocked. A slow roll-out of vaccines in China means there is no chance that it will fling open its doors to the world soon.

Nevertheless, given how rough last year was, China’s rebound is likely to be big—something else that other countries will also enjoy. Many analysts think growth could be 9% in 2021, up from last year’s 2.3%. That puts the government in a slightly awkward position. At the same time as announcing its budget, it typically sets a GDP target. Were the government to aim for 9% growth—realistic but higher than any previous annual target—markets might conclude that it is not so serious about ending stimulus. Were it to

shoot for lower growth, markets might fret that the unwinding would be harsher than expected. As far as dilemmas go, it is a happy one. ■



中国经济

缩减测试

中国逐步退出经济刺激措施，这将为其他国家提供预演

中国的新冠疫情经历可以概括成“先进先出”：中国是新冠病毒最早开始传播的地方，也是首个控制住疫情的大国。它早期的挫败和后来的成功将会在未来多年里成为流行病学家研究的课题。但对经济学者和投资者来说，眼下另一个“先进先出”的议题更重要。面对疫情造成的经济低迷，中国是首个打开贷款和支出水龙头的国家。现在它又率先开始关闭它们，一定程度上为其他国家提供了一个退出刺激措施的预演。

当然，各国情况不尽相同。中国所需的刺激较少，因为它复工复产已经有差不多一整年了。但关于中国重回更正常的货币和财政政策的过程还是可以得出几点普适性结论。

最值得注意的是它循序渐进的做法。3月5日，在本刊最新一期付印后，中国政府将公布2021年预算。外界普遍预计今年的财政赤字规模缩小，很可能在GDP的3%左右，低于去年的3.6%。根据摩根士丹利的数据，算上其他准财政措施，例如有政府背景的企业的支出，中国实际的财政赤字将在GDP的12%左右，而去年是破纪录的15%。这是一种缩减，但仍高于2019年约占GDP10%的水平。

人行的操作同样谨慎。它已经收紧了流动性，以引导市场利率上升，减缓银行放贷增长。但信贷无论在价格还是数量上都还是比疫情前更宽松。

“他们要避免政策方向的急转弯。”上海高级金融学院的朱宁说。2021年是中国新一轮五年规划的第一年，官员们将竞相推出基建项目。五年规划是中国政策进程的重要组成部分，新一轮规划承诺大举扩建铁路和输电线路等。朱宁说，这应该有助于抵消退出刺激措施带来的影响。

尽管是循序渐进，收紧的旅程势必仍会颠簸不平。过去两三周里，全球市场因美国国债收益率上升而动荡。中国在1月底也经历了类似的挤压，当

时人行在公开市场的操作远比预期更吝啬，导致隔夜拆息飙升。股票大幅下跌，虽然在人行稍作放宽后回升。官员们可能是想提醒投资者。他们还对资产价格发出警告。3月2日，中国银保监会主席郭树清警告称，中国楼市和全球金融市场存在泡沫。

虽然中国很好地控制了疫情，它的政策正常化仍要取决于全球疫情的走向。对病毒的担忧挥之不去，国内旅行仍受限制，国际旅行也基本阻断。中国的疫苗接种进展缓慢意味着它不可能很快向世界敞开大门。

尽管如此，鉴于去年的处境之艰难，中国今年的反弹幅度应该会很大——这也是其他国家同样会经历的。许多分析师认为中国2021年的增长可能达到9%，高于去年的2.3%。这就将中国政府置于略为尴尬的境地。在公布预算的同时，中国政府通常会设定GDP增长目标。假如把目标定为9%——这切合实际，但高于以往任何年度目标——市场可能会得出结论，认为政府并非动真格要退出刺激措施。如果把目标定得比这更低，市场则可能担心政策收紧会比预期更严苛。尽管进退两难，但这也算一个幸福的困局。





Cryptocurrencies

UnTethered

A stablecoin is branded anything but, adding to jitters in crypto-markets

A HEALTHY CORRECTION, or the first signs of a crypto-crash? On February 21st bitcoin hit a new high of more than \$58,000, double its price at the start of the year, after several big firms and investors, led by Tesla, signalled that they were starting to take the cryptocurrency seriously. Within two days, though, the price had tumbled by over a fifth (before recovering slightly), jangling the nerves of HODLers, as bitcoin diehards are known. A trigger for the fall was Elon Musk, Tesla's boss and bitcoin's cheerleader-in-chief, musing that its price "seems high". The news that Tether, an integral component of crypto-markets, had fallen foul of American regulators hardly helped calm the faithful.

Tether is a so-called stablecoin. Its issuer, a company of the same name, has long claimed that Tethers—of which more than 34bn are in circulation—are backed one-to-one by dollars. One purported advantage of such pegging is lower volatility; bitcoin's price, by contrast, is notoriously erratic. Another is that stablecoins make it easier to move between cryptocurrencies and the ordinary sort.

Doubts have long swirled around Tether's claim to be a sort of digital dollar. Critics say the one-to-one-backing claim looks flaky. They also suspect that Tether has been used—not least on Bitfinex, a cryptocurrency exchange owned by some of the same people—to manipulate bitcoin; one academic study found that purchases with Tether were "timed following market downturns and result in sizeable increases in bitcoin prices". A related concern is the degree of control that Tether's owners have over supply. Whereas only a fixed number of bitcoin are available to be "mined", Tethers

can be issued at will, giving those behind the stablecoin central-bank-like printing powers.

The growing queasiness spurred investigators on. New York's attorney-general, Letitia James, has spent two years unpicking Tether's opaque operations and its relationship with Bitfinex. On February 23rd she branded the firms "fraudulent", fined them \$18.5m and ordered them to end trading activity with New Yorkers. Bitfinex and Tether said they "admit no wrongdoing".

Ms James's charge-sheet is damning. Tether, she says, lied about its dollar backing. Its "self-proclaimed verification"—after an external audit had been abandoned—was allegedly a sham: the cash ostensibly backing the Tethers had been put there that morning, the probe concluded, and some of it was moved elsewhere soon after. Moreover, Bitfinex was not upfront about hundreds of millions of dollars that went missing through a third-party payments processor reportedly based in Panama. The attorney-general says Bitfinex falsely claimed it knew where all the money was when questioned about it. As part of the settlement, Bitfinex and Tether have agreed to submit to mandatory reporting.

This will ensure a light is shone on a dark but surprisingly large part of the cryptocurrency world. Though Tether is nowhere near as much of a household name as bitcoin, its influence has grown enormously. A recent analysis found that the majority of bitcoin purchases on several crypto-exchanges, including Binance, Bit-Z and HitBTC, are made using Tether. (By contrast, on Coinbase, a smaller but more transparent exchange that is soon to list on the stockmarket, they are mostly paid for with dollars, euros and sterling.)

According to the analysis, more than two-thirds of all bitcoin bought on all crypto-exchanges in one 24-hour period studied were purchased with

Tether. In other words, Tether makes up far more than just a corner of the market. Indeed, its rampant minting—hundreds of millions were reportedly once pumped out in a single day—has led to jokes: in one popular meme, an armoured truck sporting the Tether logo hurtles by, money billowing out of its open rear door.

That is why the outcome of the New York investigation—along with reports of other probes, growing talk of a regulatory crackdown on opaque trading, and the market's latest wobbles—is likely to make many punters in the \$1.4trn cryptocurrency market nervous. Strategists at JPMorgan Chase, a bank, summed up the risk in a recent note: “Were any issues to arise that could affect the willingness or ability of both domestic and foreign investors to use Tether, the most likely result would be a severe liquidity shock to the broader cryptocurrency market.” An unTethered market is a scary prospect for many. ■



加密货币

扯断引线

一款稳定币如今被指名不副实。加密货币市场更添不安

是健康回调，还是加密货币崩盘的迹象开始显现？在以特斯拉为首的多家大公司和投资者表露出自己开始认真看待加密货币之后，2月21日比特币创下超过58,000美元的新高，比年初的价格翻了一倍。但两天内又暴跌超过五分之一（之后略有回升），刺痛了被称为“囤币党”（HODLer）的比特币死忠粉的神经。下跌的一个导火索是特斯拉的老板、比特币“拉拉队长”马斯克认为比特币的价格“显得高了”。作为加密货币市场不可或缺的一部分，泰达币（Tether）被美国监管机构盯上的消息更是无助于安抚这些死忠粉。

泰达币是所谓的“稳定币”。发行它的同名公司一直宣称泰达币（共有超过340亿枚在流通中）受美元1比1支持。据信这种挂钩的一大优势是波动性低；相比之下，比特币的价格是出了名地起伏不定。还有一个好处是，稳定币与普通货币的兑换更加容易。

对于泰达自称是一种数字美元的说法，人们一直心存疑虑。批评者说，所谓受美元1比1支持似乎并不靠谱。他们还怀疑泰达币已被用于操纵比特币，尤其是在加密币交易所Bitfinex里。这个交易所由一些泰达币的持有者拥有。一项学术研究发现，使用泰达币买入比特币都是“在市场走低时发生，并推动比特币价格显著上涨”。一个相关的担忧是泰达币的所有者对供应的控制程度。比特币只有固定数量可供“挖矿”，但泰达币可随意发行，意味着这款稳定币的发行者拥有中央银行那样的印钞权。

越来越多的疑虑促使调查人员介入。纽约州总检察长莱蒂西亚·詹姆斯（Letitia James）花了两年时间揭开泰达公司的不透明操作及其与Bitfinex的关系。2月23日，她指控这两家公司“欺诈”，对它们罚款1850万美元，并责令它们停止在纽约州的所有交易活动。Bitfinex和泰达公司则表示“不承

认存在不当行为”。

詹姆斯的控罪书杀伤力很强。她说，泰达谎报了美元储备。该公司在废止了一项外部审计后开展的“自称的审核”被指弄虚作假。调查认为，表面上用于支持泰达币的现金储备是审核当天的早上才存入的，其中一部分在审核后随即被转移至别处。此外，Bitfinex没有坦白披露数亿美元是怎样从据称位于巴拿马的第三方支付处理机构中消失的。这位总检察长表示，在被问及时，Bitfinex谎称知道这些钱的去向。作为和解条件之一，Bitfinex和泰达公司已同意提交强制性报告。

这将确保加密货币世界里一处大得惊人的“暗角”被照亮。虽然泰达币远不如比特币那样家喻户晓，但它的影响力已经得到了极大扩张。最近一项分析发现，在Binance、Bit-Z和HitBTC等多个加密货币交易所，大部分比特币都是使用泰达币购入的。(相比之下，即将上市的交易所Coinbase规模较小但更透明，这里的比特币交易大多以美元、欧元和英镑支付)。

这项分析称，在它观察的24小时内，通过加密货币交易所买入的所有比特币中，超过三分之二是用泰达币支付的。这也就是说，泰达币所占的份额已远不止市场一角。事实上，泰达币的疯狂发行（据说曾单日发行数亿枚）已引发笑话：在一个流行表情包中，一辆印有泰达币标志的装甲运钞车飞驰而过，大把钱币从敞开的后门倾泻而出。

这就是为什么纽约州调查的结果（加上有关其他调查的报道、监管部门打击不透明交易的传言日盛，以及该市场近期的波动）很可能令许多押注这个价值1.4万亿美元的加密货币市场的人焦灼不安。摩根大通的策略师在最近一份简报中总结了其中的风险：“如果出现任何问题影响到国内外投资者使用泰达币的意愿或能力，最可能的后果就是加密货币市场全面遭受严重的流动性冲击。”对很多人来说，一个扯断了泰达币这根“风筝引线”的市场将是可怕的。 ■



Carmaking

ICEy conditions ahead

Volkswagen's boss wants more electric cars—but won't kill the petrol engine

THE SCRAMBLE to electrify motoring resembles a car race. Tesla and like-minded startups, unencumbered by the legacy of the internal combustion engine (ICE), are surging up the straight. Behind them, jostling for position at the first corner, are the established carmakers, urged on by ever-tightening government deadlines for clean power to supersede fossil fuels. Many are calling time on the ICE. On February 17th Ford's European division said that it would go all-electric by 2030. Days earlier Jaguar Land Rover (JLR), an Indian-owned firm based in Britain, announced that the posh Jaguar brand would become fully electric by 2025. In January General Motors (GM) promised it would make only zero-emissions cars after 2035.

No one is dedicating more resources to electrification than Volkswagen Group, says Herbert Diess, the German giant's boss. The company plans to spend around €73bn (\$88bn) over the next five years on battery power and digitisation, he says. "The competition is now taking the same decisions," Mr Diess notes, alluding to rival firms' pledges.

Among the old guard, VW is indeed firmly in the driving seat. A fifth of the millions of cars it sells will be electric by 2025. Some analysts think that by then VW will churn out more electric cars than Tesla, today's market leader. Mr Diess is more circumspect. A year ago he was confident his firm would lead the world in electric vehicles in ten years' time. Now he is less sure, admitting that Tesla's surging shares give it the resources to grow fast. Although Apple's talks with carmakers such as Hyundai and Nissan did not go anywhere, the tech giant's evident interest in an iCar could yet make it a force to be reckoned with, Mr Diess admits. But he still thinks that the

electric race is Volkswagen's to lose, not least because the cashflow from its traditional business gives him the money to invest in the future.

Indeed, despite all the noise about electrification the old ICE technology has plenty of mileage left in it. Unlike his counterparts at Ford Europe, JLR or GM, Mr Diess is unwilling to set a date for the demise of the fossil-fuel engine. His electric plans for 2025 still leave four-fifths of his firm's cars powered by petrol or diesel. Volkswagen is a global company and, he says, many markets will not be ready for electric cars by 2035. Coal-fired power stations will still provide part of the electricity that might charge batteries, making electric cars a moot proposition. In places such as Latin America ICE-friendly biofuels will be the prevailing green alternative to petrol.

Scratch the surface and the ICE seems to be lurking even at firms which claim to be forsaking it. GM says its target is an aspiration. Citigroup, a bank, notes that the majority of investment by established carmakers is still directed towards conventional power trains. BloombergNEF, an energy-analysis firm, reckons that more than one in three cars sold in 2040 will be powered by petrol and diesel. Some will sport the Volkswagen logo. ■

For the full interview with Herbert Diess go to economist.com/VWpod ■



汽车制造

内燃机不熄

大众的老板想造更多电动汽车——但不会扼杀汽油发动机

汽车制造商争相推进电气化的局面就像一场赛车。特斯拉和理念相近的创业公司不用背负内燃机遗产的包袱，正在直线道上轻快冲刺。在它们后头，老牌企业正在第一个弯道你争我抢——政府以清洁能源取代化石燃料的最后期限不断收紧，驱赶着它们向前。许多公司都宣称要淘汰内燃机。2月17日，福特的欧洲部门表示将于2030年之前实现全电动化。此前几天，总部在英国的印度公司捷豹路虎（JLR）宣布，豪车品牌捷豹将在2025年前完全电动化。1月，通用汽车承诺在2035年后只生产零排放汽车。

德国巨头大众集团的老板赫伯特·迪斯（Herbert Diess）说，大众在电气化方面投入的资源比谁都多。他表示，公司计划未来五年为电池动力和数字化投入约730亿欧元（880亿美元）。“竞争者也在做同样的决定。”迪斯说，暗指对手公司也都做出了类似的承诺。

在传统派中，大众确实稳坐掌舵者之位。到2025年，它销售的千万辆汽车中将有五分之一是电动汽车。一些分析师认为，届时大众的电动汽车产量将超过今天的市场领导者特斯拉。迪斯的态度更谨慎些。一年前他还很有把握大众会在十年内成为电动汽车领域里的全球第一。现在他没那么确定了，承认飙升的股价赋予了特斯拉实现快速增长所需的资源。尽管苹果与现代及日产等汽车制造商的谈判没有任何进展，但迪斯承认，这个科技巨头对iCar显而易见的兴趣仍可能使之成为一股不容小觑的力量。但他还是认为大众将是这场电气化竞赛的赢家，尤其是因为来自传统业务的现金流为他提供了投资未来的资金。

的确，尽管围绕电气化锣鼓喧天，但内燃机这种老旧技术并没有那么快就走向穷途末路。与福特欧洲、捷豹路虎或通用汽车的老板们不同，迪斯还

不愿为化石燃料发动机设定一个大限之日。按照他的2025年电动车计划，大众到那时仍有五分之四的汽车是由汽油或柴油驱动。大众是一家全球性企业，而按迪斯的说法，在2035年之前许多市场都还不能为电动汽车做好准备。为电池充电的电力仍有一部分将来自燃煤发电站，这让电动汽车成了一个无实际意义的主张。在拉丁美洲等地，对内燃机友好的生物燃料将成为汽油的主要绿色替代品。

刮开表面的油漆，会看到内燃机潜藏在那些即便是声称要丢弃它的公司中。通用汽车表示自己设定的目标其实是一种抱负。花旗集团指出，老牌汽车制造商的大部分投资仍导向了传统动力系统。能源分析公司彭博新能源财经（BloombergNEF）估计，2040年售出的汽车中超过三分之一将是汽油车和柴油车。其中有些安着大众的车标。

赫伯特·迪斯的完整采访请见economist.com/VWpod ■



Chaguan

Build it and they will go

China's high-speed trains enable long-distance commuting. Officials are not sure they approve

FEW CHILDREN grow up dreaming of being a commuter. But there is a logic to a life spent between a city job and a home in some quiet, affordable spot. The first modern suburbs sprang up to greet trains puffing out of Victorian London. As countries such as Japan, France and Spain invested in high-speed trains, travelling at 250kph or more, new pairs of cities found themselves an hour or so apart, allowing for previously unthinkable commutes.

Now it is China's turn. Planners did not have commuters in mind when they began building the world's largest high-speed rail system just over a decade ago. They started with national trunk lines and regional spurs, to bind together a vast country and boost growth. Now, with more than 35,000km of lines laid, planners are building more intercity routes, creating conditions for fast, short hops. One study in 2018, using mobile-phone data to track movements, found tens of thousands of people commuting from neighbouring cities into Shanghai, a megalopolis of 24m. Most of them came from Suzhou, a historic city half an hour away by fast train.

Last year the *Journal of Transport & Health*, an international outlet, published a survey of such pioneering riders. The typical respondent was a married man with one or two children, a middling-to-high income and a university degree. Three-quarters became long-distance commuters only after the arrival of high-speed rail. More of them describe intercity travel as a route to a better job than to a higher quality of life. Indeed, many call commuting stressful, and something to do "when they are young", notes

a co-author of the survey, Chia-Lin Chen of the University of Liverpool. China's high-speed railways do not sell season tickets to commuters, who must often scramble to secure daily tickets on trains meant for long-distance travellers. Moreover, to promote newly built districts, high-speed railway stations are often built far from existing city centres, obliging commuters to travel long distances from stations to workplaces. All this exacts a toll on marriages and families, says Ms Chen.

The Xiao Langfang housing complex is a cluster of apartment blocks in the small, nondescript city of Langfang, 60km from central Beijing. It is an excellent base for commuting—a seven-minute walk from a high-speed railway stop that is, in turn, a 21-minute ride from Beijing South station. The one-way fare is 28 yuan (\$4.33). It is a friendly spot. On a mid-week afternoon, its landscaped grounds are thronged with children flying kites, yapping lapdogs and old women playing cards in the winter sun. Above all, here in the northern province of Hebei, just outside Beijing's city limits, property is cheap. Apartments in Xiao Langfang sell for 15,000 yuan a square metre. A comparable flat in Beijing could easily cost six times as much.

Shao Zeyu, a young father playing with his five-year-old son in the compound's gardens, met his wife in Beijing and rented a home with her there for years. They left the capital after their child was born. Mr Shao's legally registered hometown is Langfang, while his wife is from Tianjin, a nearby coastal city. Mr Shao's mother lives in Langfang, so she can offer both love and free child care. But the family faced constraints, too. It is very hard to obtain a new household-registration permit, or *hukou*, from Beijing, a city that Chinese leaders consider full. Without a Beijing *hukou*, the Shao family could not easily gain access to many public services in that city, including school places. So they left.

The train has been a boon. Initially, his wife carpooled from Langfang to her job in northern Beijing. She left at 5:30am and reached her desk before

most colleagues, allowing her to return home early to see her son. In bad traffic the journey could take three hours each way, and left her exhausted. The fast train to Beijing enables her to leave home at seven. That makes the Shao family lucky. Many friends work such brutal hours, until nine or ten each evening, that they come home only at weekends. Mr Shao himself used to work similar hours for a computer-games firm in Beijing, and is now looking for a job he can do locally. Because Tianjin is affordable and offers better schools and an easier route to university, the family expects to move there when their son is older. Mr Shao's wife plans to commute by train from Tianjin.

Such hyper-mobility is new in China. The government is promoting a new form of urban development that embraces multi-city clusters, including one uniting Beijing and Tianjin. But the aim is to make it more appealing to live in a wider range of secondary cities and new towns, not to create alternative routes to work in central Beijing. In 2016 the Communist Party boss of Hebei said that Langfang "absolutely cannot become a dormitory town for those who work in Beijing". Indeed, China's tax system currently punishes commuter towns. Someone who works in Beijing pays taxes and social-security contributions into the capital's coffers, even when sleeping each night in Langfang. Locals murmur that officials in Langfang blocked moves to call a housing development "Shouzhan", meaning "First Stop" on the line from Beijing.

The authorities in Langfang want new residents to live and work in their city. They recently eased restrictions on outsiders buying property there, allowing them to invest if they make six months' worth of social-security payments to Langfang's fund (on top of payments made elsewhere). But Langfang should be realistic, suggests a local property-salesman. He calls his home town a place where newlyweds and those starting families will choose to live until they can afford to move on.

In truth, Langfang's greatest asset is being a convenient stop on the way to bigger places. That is a puzzle for officials rewarded for developing the place under their charge, not for facilitating the restless ambitions of individuals. China's high-speed railways are a spectacular economic achievement. Their impact on society may prove as dramatic, if officials allow it. ■



茶馆

高铁通，人走空

中国的高铁让长途通勤成为可能。官员们拿不准是不是赞同这件事

很少有孩子梦想日后成为一名长途通勤者。但是，在城里工作，在一个宁静的、负担得起开销的地方居住——这样的生活是一种合情理的选择。近代最早的郊区是在维多利亚时代伴随着蒸汽火车从伦敦驶出而出现的。在日本、法国、西班牙等国投资建设时速不下250公里的高铁后，更多城市之间只需一小时左右便可互通，让从前无法想象的通勤成为可能。

现在轮到中国了。十几年前，当规划者开始建设世界上最庞大的高铁网络时，他们并没有把通勤者考虑在内。他们起初是要打造全国性干线铁路和地方性支线铁路，把辽阔的国土联系起来，促进经济增长。如今，随着超过3.5万公里高铁的建成，规划者正在建造更多的城际线路，让短途旅行更加快速、便捷。2018年的一项研究用手机数据追踪人员流动，发现每天有几万人从周边城市去到人口2400万的特大城市上海上班。他们中的大多数来自相距半小时高铁车程的历史名城苏州。

去年，国际刊物《交通与健康杂志》（Journal of Transport & Health）发表了一份对这些城际通勤先行者的调查报告。他们中的典型成员是有一到两个孩子、中高水平收入和大学学历的已婚男性。四分之三的人是在高铁建成后才开始长途通勤的。多数人表示城际通勤是为了获得更好的工作，而不是更高的生活质量。报告的合著者之一、利物浦大学的陈嘉琳指出，事实上很多人都表示通勤压力大，也就是“现在年轻时”还能应付。中国的高铁主要面向长途旅行者，不出售季票，通勤者常常要靠抢票才能买到每天的车票。此外，为了促进新开发区域的建设，高铁站往往建在远离现有城市中心的地方，所以从高铁站去往工作地点还得走很长一段路。陈嘉琳说，这一切给婚姻和家庭带来了不利影响。

离北京市中心60公里的廊坊是个不起眼的小城市，这里的晓廊坊住宅小区

是一个绝佳的通勤据点——步行七分钟便可到达高铁站，然后乘车21分钟到达北京南站。单程票价28元。这里气氛和谐。周中的一个午后，景观带满是放风筝的孩子、汪汪叫的宠物狗，还有冬日阳光下打牌的老太太。最重要的是，河北的这座城市紧邻北京，房价却很便宜。晓廊坊每平米售价1.5万。而在北京，一套类似的房子动辄就是六倍的价格。

年轻的父亲邵泽宇（音译）带着他五岁的儿子在小区花园里玩耍。他和妻子相识于北京，在那里租房子住了几年。孩子出生后，他们搬离了首都。邵先生的户籍在廊坊，妻子来自附近的沿海城市天津。邵先生的母亲住在廊坊，所以她能照顾儿子一家，免费帮他们看孩子。但之前仍有些事比较棘手。中国领导人认为北京的人口已经饱和，所以要在那落户非常困难。没有北京户口，邵先生一家就很难享受到北京的许多公共服务，包括孩子入学。于是他们离开了北京。

高铁是个福音。一开始，他的妻子拼车从廊坊去北京的北边上班。她早上5点30分离家，比大多数同事都到得早，这样她就能早点下班回家看儿子了。交通拥堵的时候，单程就要花费三个小时，这让她筋疲力尽。现在有了到北京的高铁，她可以在7点离家。这对邵先生一家来说很幸运。他的很多朋友工作非常辛苦，每天忙到晚上九十点，所以只在周末回家。邵先生之前在北京一家电脑游戏公司上班，每天差不多也工作那么久，现在他正在找一份本地的工作。因为天津的生活成本比较低，教育资源更好，以后孩子考大学也更容易，他们期待等儿子大一点就搬到天津去。邵先生的妻子打算到时候从天津乘高铁通勤。

这样的超高流动性在中国是新事物。政府正在推动一种新的都市发展形式——创建城市集群。其中就有一个把北京和天津联结起来的城市群。但其目的是吸引人们到更大范围的二线城市和新城镇生活，而不是为到北京市中心工作再添一条路径。2016年，河北省委书记曾表示，廊坊“决不能搞住在河北、回京上班的睡城”。中国目前的税收制度确实会让通勤城镇吃亏。在北京工作的人，即使每晚都住廊坊，也要向首都财库缴纳税款和社保。廊坊的官员们没有批准将一个住宅开发区取名“首站”（意思是高铁开出北京后的“第一站”），对此当地居民颇有微词。

廊坊市政府希望新居民能在本地生活和工作。他们最近放宽了外地人在当地购房的限制，允许他们（在外地缴纳过社保的基础上）在廊坊缴满六个月社保便可买房。但是，一名本地的房地产销售员说，廊坊应该现实一点。他说新婚夫妇和刚有了孩子的家庭会选择在这里暂住，一旦有能力就会搬走。

其实，廊坊最大的优势就是成为人们通往更大城市的道路上一个便利的落脚点。而这一点对于官员们是一个谜题——因为他们的政绩在于发展辖区经济，而不是让人们更不安于现状。中国的高铁是一项了不起的经济成就。它们对社会的影响可能同样巨大，如果官员们让它发生的话。 ■



Commodity-traders

Black-gold rush

The risks and rewards of commodity-traders

THE COMMODITY-TRADERS who feature in “The World for Sale” are not the kind who yell orders at each other in the ring of the London Metal Exchange. Javier Blas and Jack Farchy, journalists at Bloomberg News, are instead interested in the small band of mostly private companies that move bulk commodities from there to here. It is a fascinating and revealing story, largely because of where “there” is: usually a place where many people would prefer not to do business, run by characters they would prefer not to do it with. A handful of swashbucklers became billionaires by overcoming such qualms.

The opportunities to make these riches came in three big waves. During the 1960s and 1970s commodity-traders were pivotal in breaking the established Anglo-American oil cartel known as the “seven sisters” and establishing a new one in OPEC. Fortunes were made in the wake of the free-for-all that followed the collapse of the Soviet Union. And after 2001 these figures were instrumental in the integration of China into the global trading order, supplying vast quantities of raw materials from Africa and elsewhere. Along the way, as the authors describe, some traders helped apartheid-era South Africa sidestep economic sanctions, sold oil for Saddam Hussein’s Iraq and funnelled dollars to Vladimir Putin’s Russia. There are tales in the book of breathtaking trades, such as shipments of rebel oil from war-torn Libya or deals bartered amid the brutal “aluminium wars” in the Russia of the 1990s.

The wonder is that so few firms, owned by a tiny number of people, were able to grab such a hold on global commodity-trading with so little oversight. Vitol, a Dutch trading house, became the largest independent oil-

distributor under Ian Taylor, its British boss, in part by being venturesome in former Soviet republics. Many of the industry's branches sprang from a single tree—Philipp Brothers, a trading outfit based in America but with roots in Hamburg, at which a young Marc Rich made his name as a trader.

Rich saw more clearly than others how emerging Middle Eastern petro-states would reshape the oil market. He set up Marc Rich & Co in 1974, after a breach with the Philipp Brothers' brass over the profits from a bet on Iranian oil. He became the model for a new style of commodity-trader—a bold risk-taker on personal terms with unsavoury leaders. His firm in turn spawned Trafigura and Glencore, a mining giant that listed in London in 2011.

“The World for Sale” has an elegiac air. Rich died in 2013; Taylor in 2020. Ivan Glasenberg, the hard-charging boss of Glencore, will retire this year. Deeper factors are at work, too. The rapid growth in China’s economy in the first decade of this century, which spurred a commodity “super-cycle”, will not be repeated. And public disquiet over the ethics of dealing with shady regimes is growing. Rich spent two decades as a fugitive from American justice because of his business with Iran; other commodity-traders have since had expensive brushes with the law. America has used the dollar’s role as a global currency to enforce economic sanctions more effectively.

Meanwhile the suppliers and customers of the traders have become more astute. The super-profits of the middlemen were in part based on superior private knowledge. It is much harder to make so much money from arbitrage now that information flows so freely.

Still, the instinct to buy low and sell high will endure. Peddling stuff dug up from the ground may always be a mucky business, but if it becomes too unrefined for Western tastes, others are bound to step in. As Messrs Blas and Farchy say, the leading hawker of Iranian crude is now Zhuhai Zhenrong, a Chinese trading house. “The Chinese”, Taylor told the authors in 2019,

"probably are willing to take much more risk than we are." The seeds of a sequel to this gripping book lie somewhere here. ■



大宗商品交易商

黑金热

大宗商品交易商的风险和回报【《待售的世界》书评】

《待售的世界》（The World for Sale）一书中的大宗商品交易商并不是那种在伦敦金属交易所里对着彼此大声喊价的人。彭博新闻的记者哈维尔·布拉斯（Javier Blas）和杰克·法尔奇（Jack Farchy）更感兴趣的倒是一小批大多是私营的公司，它们把大宗商品从那里移到这里。这是一个引人入胜、料很足的故事，主要是因为“那里”的位置：通常是在很多人不会想要去做生意的地方，由他们不愿与之做生意的人物经营。少数狂妄的冒险家克服了这些顾虑，成为了亿万富翁。

发财的机会在三次大浪潮中涌现。上世纪60和70年代，大宗商品交易商在打破被称作“七姐妹”的老牌英美石油卡特尔、建立欧佩克这个新联盟方面起到了关键作用。他们还在苏联解体后的大混战中赚得盆满钵满。而2001年后，这些人物又在中国融入全球贸易秩序的过程中发挥了重要作用，供应了来自非洲及其他地区的大量原材料。这一路上，正如作者所描述的那样，一些供应商帮助种族隔离时期的南非规避了经济制裁，为萨达姆·侯赛因统治的伊拉克销售石油，还向普京治下的俄罗斯输送美元。书中记述了惊心动魄的买卖，比如从饱受战火蹂躏的利比亚出口叛军控制的石油，或在上世纪90年代俄罗斯残酷的“铝战争”期间做交易。

令人惊奇的是，就这么几家由寥寥数人掌管的公司竟能控制全球大宗商品贸易到如此程度，受到的监管又是如此之少。荷兰贸易公司维多公司（Vitol）在英国老板伊恩·泰勒（Ian Taylor）的领导下成为了最大的独立石油分销商，部分得益于在前苏联国家的大胆冒险。该行业的许多分支都来自同一棵树——菲利普兄弟公司（Philipp Brothers），这是一家总部设在美国但诞生于汉堡的贸易公司，年轻的马克·里奇（Marc Rich）在这家公司做交易员时声名鹊起。

里奇比其他人更清楚地看出，新兴的中东石油国家将重塑石油市场。在与菲利普兄弟的高层因为一宗押注伊朗石油的交易所获的利润发生冲突后，他于1974年创立了马克里奇公司（Marc Rich & Co）。他成为了新式大宗商品交易商的典范——一个和不受欢迎的领导人建立私人关系的大胆冒险者。他的公司转而又催生了托克集团（Trafigura）和2011年在伦敦上市的矿业巨头嘉能可（Glencore）。

《待售的世界》带着一丝伤感的氛围。里奇于2013年去世；去年泰勒也走了。嘉能可干劲十足的老板伊凡·格拉森伯格（Ivan Glasenberg）今年会退休。更深层次的因素也在起作用。本世纪头十年中国经济的快速增长刺激了大宗商品的“超级周期”，但它不会再重演。而公众对于和流氓政权做交易的道德忧虑在加重。里奇因与伊朗做生意被美国司法部门通缉达20年之久；此后其他大宗商品交易商也为触法付出了高昂代价。美国利用美元作为全球货币的角色，更有效地实施经济制裁。

与此同时，贸易商的供货商和客户变得更精明了。中间商能赚到超额利润一部分是基于优质私密信息。但现在信息流通已是如此自由，要想从套利中赚这么多钱可难得多了。

不过，低买高卖的本能还会持续下去。兜售从地里挖出的东西可能永远都是一门肮脏的生意，但如果这对西方的品味而言太过粗俗，其他人必定会接手。正如布拉斯和法尔奇所说，现在伊朗原油的主要商贩是中国贸易公司珠海振戎。“中国人，”泰勒在2019年告诉两位作者，“很可能愿意承担比我们大得多的风险。”这本扣人心弦的书在这里的某处埋藏着续作的种子。 ■



The Economist film

The great inflation mystery

In the past two decades inflation has puzzled economists by remaining low in good times and bad. Could the pandemic cause it to rise?



经济学人视频

解读通胀之谜

过去20年里，通胀一直困扰着经济学家：无论经济是好是坏，通胀率总是保持在低位。新冠大流行会改变这一现象吗？



Technology and competition

Collusion and collisions

The new rules of competition in the technology industry

43 Those of Facebook have come down from a lofty 50% in 2017 to less than 40%. The companies mostly keep mum about how their individual businesses are doing. But one possible explanation for slimmer overall margins is greater competition. Another is that entry into new markets eats into profits from core businesses. This could eventually put pressure on rivals also present in those markets.

The presumption that the tech giants are either colluding to divvy up the planet's digital pie or carefully steering clear of each other is no longer right. Many people would of course prefer to see more than a handful of firms slug it out for the modern economy's critical digital markets. Still, so long as they truly are slugging it out, that is good news for everyone else. ■



技术与竞争

合谋与冲突

科技行业的竞争新规则

科技公司的名字稀奇古怪。谷歌和Zoom在英语里是动词。阿里巴巴庞大的电子商城的名字“淘宝”在中文里也是动词。优步和它的中国网约车竞争对手滴滴的名字都已是“出租车”的同义词。Facebook在越南就是互联网的意思，越南人大多通过这个社交平台访问互联网。亚马逊、苹果、微软和奈飞（Netflix）这些名字还不能直接拿来指称在线购物、智能手机、办公软件和视频流，但或许这么用也无妨。

在科技界批评人士看来，这些能界定行业的独特名称暗藏险恶，在一个词里浓缩了每家公司在自己的数字领地占据的统领地位——其中有些可能得之不义。去年12月，美国的反垄断机构起诉Facebook涉嫌反竞争行为，中国的反垄断机构也对阿里巴巴展开了调查。在针对谷歌的三起反垄断诉讼中，其中一起的核心是一项协议，谷歌按该协议每年向苹果支付80至120亿美元（大约相当于苹果全球利润的五分之一），以确保谷歌的搜索引擎在苹果设备上作为默认引擎出现。谷歌还被指与Facebook达成私密协议，不支持由新闻出版商投资的一个竞争广告系统。

试图切断公司名称与产业关联性的行动正愈演愈烈。电子游戏公司Epic Games称苹果在其App Store中敲诈应用开发人员，已在美国和欧洲投诉苹果。2月22日，英国的竞争监管机构警告称，即将对科技巨头展开反垄断调查。欧盟正在制订法规以限制这些公司的势力。澳大利亚刚刚通过一项法律，将要求这些公司为与搜索结果或社交媒体信息流一起显示的新闻向澳大利亚媒体支付更多费用。

所以，在外界看来，科技行业是一个一团和气的俱乐部，成员间互不干涉，或者更糟的是，还帮助彼此巩固各自的垄断地位。而巨头只会变得越来越强大。去年，全球市值最高的十大数字公司大赚了2610亿美元的净利

润，因为在社交隔离的情况下，人们依赖它们来办公、娱乐、购物和社交。它们的总市值猛增了3.9万亿美元，超过了整个英国股市的总值，反映出投资者预期它们的影响力还会进一步扩张。

科技巨头们不这么看。阿里巴巴、苹果、谷歌和Facebook表示，它们的各种做法完全正当。这些美国公司之间确实有合作，但只是为了确保它们的产品之间的互操作性。实际上，所有科技巨头都坚称它们在大多数情况下并没那么亲密，而是激烈竞争。微软的总裁布拉德·史密斯（Brad Smith）认为科技公司之间的关系是竞争占八成，合作占两成。Facebook的首席执行官扎克伯格最近称苹果是“我们最大的竞争对手之一”。“每天醒来，我们都面临无比大的竞争压力。”与苹果的老板库克关系密切的高管菲尔·席勒（Phil Schiller）表示。

最近几周，科技巨头之间的互相攻击确实多过友好合作。Facebook投放的广告攻击苹果新的iPhone隐私设置，该设置会询问用户是否希望禁用其他公司的应用和网站的追踪功能。按Facebook的说法，这将伤害那些需要通过追踪功能向客户投放广告的小企业。库克这边一直在暗示Facebook对待用户数据的态度轻率。

微软在2月22日表示将与欧洲的新闻出版商合作开发一个系统，类似于谷歌和Facebook在澳大利亚反对的那个系统。微软在上个月率先表示支持澳大利亚政府的计划时，谷歌反击说，“（微软）当然巴不得竞争对手被收取不切实际的费用，好增加自己的市场份额。”这里指的是微软的搜索引擎必应。

这些口头上的交锋反映出，在科技行业内部有一种感觉越来越强烈——大企业正受到攻击。尽管占支配地位的公司依然强大，有时彼此还很友好，但在一个又一个数字市场中，挑战者正在攻城略地。传统行业里的领军者终于真正启动了数字化，例如沃尔玛推进线上零售，迪士尼拓展流媒体业务。规模稍逊的科技公司（例如电商Shopify，或云计算和商业软件服务商Salesforce）也启动了入侵模式。大量涌入创业公司的资金很容易转化为更多的竞争。最重要的是，科技界最强大的巨头正越来越起劲地踏入彼

此的地盘。

这么看来，随着科技业步入竞争更为激烈的新阶段，赢家通吃式的抢地盘时代正在走远。果真如此的话，科技业的名称词典可能会变得复杂得多。

这种转变在中国走得最远。中国最大的两个数字集团阿里巴巴和腾讯已经在多个市场上相互竞争，同时还要与新兴对手竞争。券商中信里昂的数据
显示，阿里巴巴在中国电商市场的份额在2013达到62%的顶峰，去年为51%（见图表1）。一度分散的竞争正在集中化。紧随其后的两家公司拼多多和腾讯入股的网上商城京东总共占领了24%的市场。中信里昂估计到2026年该比例会达到33%。腾讯的微信支付和阿里巴巴的支付宝一直在竞争成为中国购物者首选的数字钱包。去年，腾讯宣布将在未来五年内投资5000亿元，一部分将用于在云计算领域追赶阿里巴巴。

美国科技业的格局也开始发生变化。本刊研究了美国11个大型科技市场，它们去年的总收入共计1.6万亿美元。根据我们的计算（不可避免地包含一些估计），在过去的五年中，在应用商店、商业软件、云计算和在线广告领域排名第一的公司的市场份额一直没有增长。2015年以来，在外卖、网约车和视频流媒体领域排名第一的公司的市场份额有两位数的下降。

在大多数市场中，即便第一名的市场份额有小幅增加（比如在电子商务和智能手机市场），紧随其后的两大挑战者的合并市场份额增长更快（见图表2）。11个市场中有六个的二、三名如今占据了三分之一或以上的份额，在2016年仅有两个市场是这样。前三名以外的追赶者则远远落后。

一些挑战者并非来自科技巨头的老家硅谷和西雅图。迪士尼于2019年底推出了新的流媒体服务，如今在全球已有9500万订户，达到这一数字的速度比奈飞快了近十倍。沃尔玛多年来在线上购物上的投资在疫情期间开始获得回报。百思买（Best Buy）、家得宝（Home Depot）和塔吉特（Target）等其他实体零售商也都升级了数字业务投资。成立14年的加拿大公司Shopify目前控制着十分之一的美国电商市场，在2015年是七十分

之一。它的市值在过去两年增长了六倍，达到1500亿美元。

这一竞争新格局中最显著的特征也许就是美国五大巨头间的交叠越来越多。谷歌母公司Alphabet、亚马逊、苹果、Facebook和微软之间也开始像阿里巴巴和腾讯那样相互竞争，规模甚至更大。投资全球科技公司的大型资产管理公司巴美列捷福（Baillie Gifford）的詹姆斯·安德森（James Anderson）尚未在这些公司的竞争中看到中国巨头身上那股“一决雌雄的劲头”。但正如券商盛博的马克·史穆里克（Mark Shmulik）借用现代计算的基础布尔代数的术语所说的那样，科技巨头之间正在从“或”的析取关系转向“和”的合取关系。

诚然，确保彼此的系统能无缝协同对这几家公司都有好处。消费者想要访问谷歌的搜索引擎和Gmail邮箱或Facebook的社交网络的需求促进了对iPhone的需求。亚马逊提供的廉价云计算转化成了苹果App Store里更多的应用。亚马逊是谷歌最大的广告客户之一。微软的Surface Duo智能手机获授权运行安卓操作系统。

五巨头的高层和那些自视绝顶聪明的人也心知肚明，因此尽管它们近来针锋相对，但多数情况下还是彼此尊重的。萨蒂亚·纳德拉（Satya Nadella）在2014年接任微软的首席执行官后，放弃了一个支持保护隐私的广告活动，该活动指称谷歌查看用户的电子邮件以投放定向广告。微软内部人士称，纳德拉与某些谷歌工程师之间的交情可能影响了他的决定。纳德拉还决定停止尝试在搜索引擎领域赶超谷歌。

科技巨头之前的许多相互入侵都惨淡收场。2010年代初，所有大公司都试图进入设备制造领域。还记得亚马逊的Fire Phone吗？微软的Zune音乐播放器没成为另一个iPod，而必应也没流行成一个动词。许多iPhone用户都用谷歌地图导航，而不用不受待见的苹果自带地图。Facebook早期涉足电商领域的尝试Facebook Gifts同样反响平淡。

的确，美国这五大巨头的收入大头仍然来自那些令它们成为了万亿美元或准万亿美元公司的业务，大部分情况下利润也是。去年，在线广告分别为

Alphabet和Facebook带来了80%和98%的销售收入。2020年苹果的收入足有80%来自它那些时尚的设备（主要是iPhone）。微软继续靠商业软件带来一大部分收入，亚马逊靠的还是它的在线商城，尽管它大部分利润（相对微薄）来自云计算部门AWS。

然而，这些比例在过去还要更高。随着首次购买iPhone的人数下降，苹果通过进入支付、金融和娱乐业务减少了对iPhone、iPad和Mac电脑的依赖。服务现在占到苹果总收入的20%，是五年前占比的两倍。其中一些服务如视频或音乐流与亚马逊Prime Video和Prime Music竞争，还与奈飞和迪士尼（视频流）或Spotify（音频流）等专门经营这些业务的公司相竞争。亚马逊的电商收入份额已从2015年的87%下降至72%，现在它十分之一的销售额来自云计算，6%来自数字广告。去年Alphabet的广告收入占比相比2015年降低了十个百分点。

核心业务让出的那些份额正由越来越多的新业务填补。许多新业务需要五大巨头涉足彼此的领域。现在，它们收入的近五分之二来自存在交集的业务，在2015年时为五分之一（见图表3）。根据盛博的说法，如果将科技业划分为20个左右的业务领域，从智能手机、智能音箱，到即时通信和视频会议等，那么每个巨头都会出现在其中大部分领域中。

对新业务的投入有许多还没有赚到多少钱。但这些巨头的超高市值（25到82倍的市盈率）需要宏大的增长计划支撑。随着主营业务逐渐成熟，发展放缓，它们必须在其他领域寻求新的增长源。一位硅谷风险投资家说，在反垄断机构高度警惕之时，要吞并有竞争力的创业公司（或以其他方式消除它们的威胁）变得越来越难。“增长可能要依赖在已知的大市场中凭借内部力量展开竞争。”

随之而来的相互踩踏有几种形式。首先，这些公司越来越多地销售相同的产品或服务。其次，它们以不同的商业模式提供类似的产品和服务，例如免费提供竞争对手要收费的东西（或者反过来，收费提供那些竞争对手免费提供给用户以换取数据卖给广告商的服务）。第三，它们都在盯着人工

智能（AI）或无人驾驶汽车等相同的新生市场。

最激烈的直接竞争发生在云计算领域。这个630亿美元的市场每年增长40%，华尔街预计它在未来一二十年内将成为万亿美元市场。亚马逊的老板贝索斯曾开玩笑说，巴诺书店（Barnes& Noble）几个月之内就明白了必须复制亚马逊的Kindle电子阅读器，但是他那些天才的科技竞争对手花了几几年的时间才明白它们应该模仿AWS。最终它们还是醒过神来。

微软创建11年的云计算部门Azure年收入估计约为200亿美元。盛博预计，到2024年，云计算在谷歌收入的占比将从2020年的7%升至12%。鉴于该部门的重要性，谷歌在1月单独公布了其云计算业务的运营业绩（2020年亏损56亿美元）。

受疫情大力推动的电子商务是另一个被争抢的地盘。Facebook名为Marketplace的二手商品市场已经运营一段时间了。去年5月，Facebook推出了Facebook Shops，更直接地挑战亚马逊，为已经在用Facebook或其姊妹应用Instagram展示产品的约1.6亿家企业提供了一个销售产品的途径。Facebook和谷歌也都在与Shopify合作，让Shopify的商家可以在它们的平台上销售产品。就连微软都在盯着零售，尽管走了条更迂回的路线——它计划把自动收银技术卖给沃尔玛。

社交媒体是Facebook的主要收入来源，它的竞争对手也盯上了这一块。去年，微软希望通过收购中国所有的短视频应用TikTok来增强它包括Surface平板电脑和Xbox游戏机在内的消费者业务。今年，它考虑过收购照片分享网络Pinterest。两笔交易都未达成，但微软的意图已经表露无遗。

亚马逊也一样。它“得是疯了”才会不关注社交媒体，一位与这家公司走得比较近的业内高管这样说道。2013年，亚马逊收购了被称为“图书界的Facebook”的图书点评和推荐平台Goodreads。成百上千万用户在亚马逊的网购平台上给购物打分，他们有可能在未来孕育出一个新的社交网络。“亚马逊进入社交网络比Facebook进入网购要容易。”一位亚马逊前高管很肯定地说，因为亚马逊掌握的物流配送系统比社交网络更难靠一己之力建

成。

然后是搜索引擎。微软受到自己在云计算上取得的成功鼓舞，可能会开始在性能不错但市场份额很低的必应上投入更多。亚马逊已经得出结论，如果自己电商平台上的商家想向网购者展示商品，为什么让谷歌独赚这笔钱呢？亚马逊的搜索广告业务与谷歌相比仍是小巫见大巫。但如今大多数产品搜索都是从亚马逊的应用或网站上开始的。

苹果也怀揣着搜索引擎的抱负。2018年，它挖走了谷歌搜索和AI的负责人约翰·詹南德雷亚（John Giannandrea）。人们已经注意到，网络爬虫Applebot最近越来越活跃，大概是在收集大量用于训练的数据。一位科技业内人士说，苹果的语音助手Siri“基本上就是一个搜索引擎”。他补充说，富有的iPhone用户所提出的问题最有价值，苹果可以通过回答这些问题“捞到油水”。

和亚马逊与谷歌正面竞争广告收入不同，苹果似乎不太会想要直接从搜索广告中获利。它的搜索项目可能是想吸引注重隐私的用户深入它安全的“围墙花园”中，这自然会让扎克伯格十分懊恼。

这也说明了第二种竞争行为。摧毁谷歌或Facebook的商业模式可能不是库克明言的目标。但这还是在逼迫扎克伯格和Alphabet的桑达尔·皮查伊（Sundar Pichai）这两个依赖广告的巨头老板推出能说服用户“同意”在苹果设备上启用追踪功能的服务和产品。

至于皮查伊，他也在通过免费提供各种产品做类似的事情，这些产品包括基于云的文字处理软件、电子表格和视频聊天应用环聊（Hangouts）、Alphabet的机器学习软件TensorFlow，以及云计算项目Kubernetes。一些观察家认为，这些靠谷歌广告收入支撑的免费产品意在创造一个完全竞争性的利润“沙漠”，让竞争对手无意进入其中，从而把整个撒哈拉的数据都留给谷歌。

这些公司并不是自己选择进入新的技术领域，而是被拖入其中——往往是

被用户拖进去的。一位前高管说，亚马逊认为互联网和海量数据意味着如果你进入了一个业务领域，就必须进入相邻那一个。电商和社交媒体就是一个很好的例子。零售商在社交媒体上为买家组织的大型虚拟“社交购物”狂欢风靡中国，可能很快也会在西方流行起来。

拥有几亿乃至几十亿的客户群使得科技平台可以轻松而低成本地多元化发展。例如Facebook会推出Marketplace就是因为它发现有很多人在Facebook群组中买卖各种东西，负责Facebook核心产品的哈维尔·奥利文（Javier Olivan）指出。

随着科技巨头从紧盯彼此转向注目未来，这个过程看起来很可能会加剧。结果它们经常都望向了相同的方向：数据和AI。五大巨头中的四家已经推出了数字助理，希望它们成为消费者接入互联网的主要门户。这些巨头也全都在垂涎支付业务，尤其是想到PayPal近年来取得的成功——它从Visa和万事达手中抢夺了市场影响力。

巨头们正在向雄心勃勃的AI项目注入数以十亿美元计的资金。苹果已与多家汽车制造商洽谈生产一款无人驾驶汽车。迄今为止，在五巨头中，无人驾驶汽车一直都是Alphabet的子公司Waymo的地盘。虽然还没有任何成形的协定，但几乎可以肯定“苹果车”的想法不会是昙花一现。去年，亚马逊收购了无人驾驶创业公司Zoox。阿里巴巴和中文搜索引擎百度也都对汽车感兴趣。

并非方方面面都有改善。手机领域的竞争就仍然不足。谷歌的安卓和苹果的iOS这两大移动操作系统延续双头垄断。它们的应用商店也是如此。在线广告市场总体看来竞争更加激烈，但目前仍不清楚亚马逊在搜索上是否真的和谷歌在同一层级竞争，或者TikTok在社交媒体领域是否构成Facebook的直接对手。

科技巨头还变得擅长扮演反垄断裁判的角色，让潜在竞争者忙于捍卫自己的核心业务不受监管干预，从而无暇入侵其他市场。“大家都急着说不是我们搞垄断，是他们。”一位科技高管说。2000年代末，微软组织了一个

企业联盟来反对谷歌在搜索领域的支配地位，把反垄断的压力转移到了谷歌身上。现在包括本地搜索和点评网站Yelp在内的联盟成员再次跃跃欲试反对谷歌，业内人士笑称微软的“潜伏者”又活跃了起来。

哥伦比亚大学法学院的丽娜·可汗（Lina Khan）为美国国会一个负责调查科技巨头的委员会提供法律咨询。她说这些巨头在云计算和语音助手等领域有些小冲突。但她说它们并未在核心地盘交火，而且，将竞争比作打仗可能会让人们忽视这些公司通过更广泛的方式用它们的集体垄断地位互惠互利。

如果小冲突加剧，可能会导致科技巨头的盈利能力下降。在竞争最显著的云计算领域，利润空间已经在收紧。按巴美列捷福的安德森的说法，谷歌对AWS和Azure的准双寡头垄断的冲击已经压低了价格。腾讯对云的投资应该会更增压力。

过去十年中，Alphabet的营业利润率下降了13个百分点。就连苹果的营业利润率也比2012年的峰值低了10个百分点。Facebook的利润率则从2017年的高达50%跌至不到40%。这些公司大多对自己各项业务的盈利状况闭口不提。但总利润率降低的一个可能的原因是竞争加剧。另一个是进入新市场会消耗核心业务的利润。这最终可能会给同样进入这些市场的竞争对手带来压力。

认为科技巨头不是在合谋瓜分全球数字馅饼就是在小心翼翼地相互避开的假设已不再正确。一定会有许多人愿意看到不止少数几家公司为现代经济中至关重要的数字市场争个你死我活。不过，只要它们真的是一决雌雄，这对其他所有人而言就是个好消息。 ■



Duty-free retail

Continental drift

The pandemic has landed travel shopping in limbo. The industry is finding new ways to grow

HAINAN, A TROPICAL island 450km (280 miles) south-west of Hong Kong, used to be a sleepy backwater populated by budget resorts catering to Chinese tourists unable to afford a trip to Hawaii. Today it draws travellers with considerably fatter wallets. Buying a Gucci gown or a Tiffany trinket in one of its giant, posh malls feels no different from shopping on Fifth Avenue in New York or Avenue Montaigne in Paris—until the tills are rung. Instead of walking out with their bling, visitors from mainland China pick up their items at the airport on their way home, or get them dispatched there directly. Under rules devised a decade ago, which mean that for duty purposes Hainan is treated as a separate zone from mainland China, they are exempt from certain taxes and duties. Savings can reach 30% as a result.

Duty-free shopping conjures up images of crowded airport terminals. As covid-19 has emptied these of passengers around the world, the shops inside have suffered commensurately. After reaching \$86bn in 2019, according to Generation Research, a consultancy, duty-free sales collapsed by two-thirds last year. Mauro Anastasi of Bain, another consultancy, forecasts that travel-retail sales will not reach those levels again in real terms before the second half of the decade. Intercontinental passengers and business travellers, the biggest spenders, are likely to take longest to return to the skies. Chinese tourists, by far the most prized by duty-free operators, are shunning countries with poor records of handling the pandemic.

Shoppers will one day return to airports. Yet when it emerges from the current crisis, duty-free shopping will have been transformed: unabashedly

focused on luxury, less connected to travel and closer to Asian high-rollers. Hainan points the way.

Before covid-19, selling stuff to travellers had been one of the few bright spots in the brick-and-mortar retail world. The practice has been popular ever since cruise ships on the high seas plied their passengers with booze and cigarettes free of government levies. In 1950 Ireland applied the principle to aviation. As mass tourism took hold, airports the world over turned themselves into tax-free shopping malls with departure gates. Annual growth of around 8% in recent pre-pandemic years—twice the figure for other shops—was fuelled by sales of cognac, sunglasses, handbags and other knick-knacks. Sales have grown eight-fold since the late 1980s. Excited marketers referred to duty-free shops as “the sixth continent”.

Covid-19 has deflated that enthusiasm. It has also, as in many other areas, accelerated pre-existing trends that were reshaping the duty-free business. The first has to do with the mix of stuff sold in duty-free. Alcohol and, particularly, cigarettes have dwindled over the years. Posh brands became mainstays of airport concourses as they realised that these were good places to pitch to wealthy people, particularly Asian passengers. Luxury goods, perfumes and cosmetics now dominate travel retail, accounting for two-thirds of sales.

The second development is the shift away from airports. Although the terminal remains its natural habitat, duty-free shopping has in recent years expanded farther afield. Spending per passenger in airports was sagging even before the coronavirus swept the globe.

At the same time, specialised downtown shops in tourist hotspots have lured visitors eligible for tax discounts if they repatriate what they buy. These outlets, particularly popular in Asia, now represent nearly 40% of all sales. Rules vary globally, but some allow shopping even by those with a

tenuous link to travel, for example a ticket booked for several months hence.

Tax-exempt outlets are popping up across mainland China, catering to domestic travellers who have returned from overseas (and, soon, who plan to travel there in future). Chinese shoppers in Hainan, for example, now enjoy a duty-free allowance of 100,000 yuan (\$15,500), thanks to a recent tripling of the tax break.

The final trend, also on display in Hainan, is duty-free's eastward drift. In 2011 Asia-Pacific overtook Europe as the largest regional market. (America, where most flights are domestic, has always been a laggard.) Before the pandemic Seoul's Incheon, a two-hour flight from Beijing, became the biggest airport shop in the world. Revenues for Prada and Hermès in Asia excluding Japan have jumped by over 40% in 2020, owing partly to splurges in Hainan. Industry sales there are reported to have reached \$5bn last year, more than doubling from 2019. Some predict they could grow five-fold within a decade.

Although the Chinese have been the world's biggest luxury buyers for years, accounting for a third of global sales, brands were reluctant to consider places like Hainan as top-tier luxury venues. Two-thirds of Chinese spending on handbags, watches and other fripperies took place overseas.

The Communist Party wants to change that. The ever-more-generous tax breaks for the well-heeled are "the key tenet of a long-term government mission to maximise domestic consumption and repatriate travel-related shopping from abroad", says Martin Moodie of the *Moodie Davitt Report*, a travel-retail newsletter. Daniel Zipser of McKinsey, a consultancy, expects the overseas share of luxury spending to decline. As a consequence of these developments, luxury groups' attitudes towards venues like Hainan "have changed dramatically", says Cherry Leung of Bernstein, a broker.

If the Chinese continue to buy their baubles at home, that will suck more business away from the duty-free operators that have historically dominated non-Chinese airports. These include Dufry of Switzerland and DFS, part of the LVMH luxury empire. Last year China Duty Free, a state-controlled group, overtook Dufry as the world's largest purveyor of tariff-free luxury goods. The market capitalisation of China Duty Free's Shanghai-listed arm has more than tripled over the past year to \$112bn, making it one of the most valuable retailers in the world.

In an acknowledgment of the shifting balance of spending power, some travel retailers from Europe are trying to muscle in on Hainan. Dufry has sold a stake to Alibaba, hoping that China's e-commerce giant can improve its fortunes there. In January Lagardère Travel Retail, part of a French conglomerate, launched a second shop on the island.

Airports will remain good places to find well-off shoppers. Bored people waiting for their flights to be called are perfect marks for luxury brands. Most retailers spend fortunes attracting customers to their shops or websites, points out Julián Díaz González, boss of Dufry. "For us it is just moving them from the corridor to the shops." As the industry continues to evolve, Mr Díaz may increasingly find it is a matter of moving the duty-free shops to the customers. ■



免税零售

大陆漂移

疫情令旅游购物陷入停滞。行业正在探索新的成长路径

海南岛是香港西南向450公里处的一个热带岛屿，曾经是个清冷偏僻之地，到处是经济型度假村，满足那些没钱去夏威夷度假的中国游客的需求。如今，它吸引到的游客阔绰了许多。在里面的其中一个大型豪华购物中心买一件古驰礼服或蒂芙尼首饰，就如同身在纽约的第五大道或巴黎的蒙田大道——直到结账时才回过神来。大陆游客不能把买下的一袋袋华服珠宝拎出店，而要到回家时在机场提货，或者等它们被直接邮寄到家。根据10年前出台的规定，海南从中国的关税体制中划分了出来，这些商品免除了某些税收和关税。省下的金额可多达30%。

一提到免税购物，就不免让人想到人头攒动的机场航站楼。新冠疫情让全球各地的机场门可罗雀，机场免税店也随之受到重创。咨询公司 Generation Research 的数据显示，免税销售额在2019年达到860亿美元，而去年骤减了三分之二。另一家咨询公司贝恩的毛罗·阿纳斯塔西（Mauro Anastasi）预测，按实值计算，旅游零售额在2025年之前都无法回升到之前的水平。洲际旅客和商务旅客是消费力最强的群体，而他们很可能是一批恢复搭飞机出行的人。中国游客最受免税运营商看重，他们对防疫不力的国家可是敬而远之。

总有一天购物者会重返机场。然而，在走出这次危机之后，免税购物会变得大不一样：毫不掩饰地专注于奢侈品，与旅行的关联减少，更加贴近亚洲的豪客。海南就指明了这一方向。

疫情爆发前，向游客销售商品是实体零售业为数不多的亮点之一。自从邮轮开始在公海上向乘客兜售免税烟酒以来，这种操作大行其道。1950年，爱尔兰将它运用到了航空领域。随着大众旅游的兴起，世界各地的机场都变身成为带有登机口的免税购物商场。在疫情前的几年里，这部分的年增

速达到8%左右，是其他类型商店的两倍，主要受到干邑白兰地、太阳镜、手袋和其他小饰物的销售推动。自1980年代末以来销售额已经增长了七倍。兴奋不已的商家直呼免税店已成为“第六大陆”。

疫情给他们当头浇下了一盆冷水。和在其他许多领域一样，一些原本就在发生着的重塑免税业的趋势得以加速。首先是销售的免税品类。酒类，尤其是香烟，多年来日渐萎缩。奢华品牌成为了机场大厅的主流品类，因为它们意识到这里特别适合向富人尤其是亚洲乘客推销。奢侈品、香水和化妆品现在主导了旅游零售，贡献了销售额的三分之二。

第二个趋势是从机场转移。尽管航站楼仍然是天然之选，但免税购物近年已经扩展到更远的地帶。在新冠病毒席卷全球之前，机场乘客的人均花费就已经开始下降。

与此同时，开在热门旅游地市中心的专营店也吸引到了符合退税资格的游客，只要他们把购买的商品带回本国即可。这些免税店在亚洲尤其受欢迎，现在已经占到全部销售额的近四成。全球各地的规定各不相同，但有些店甚至只要你跟旅行搭一点边就可以购买——比如预订了几个月后的机票。

免税店在中国大陆如雨后春笋般涌现，以迎合从海外归来的（以及很快又会有计划去海外旅游的）国内游客。例如，海南的免税额度最近提高了三倍，中国消费者如今在那里可享受到10万元的免税购物额度。

最后一个趋势就是免税零售的“大陆”向东漂移，这一点同样在海南得到体现。2011年，亚太超过欧洲成为最大的区域市场。（美国大部分是国内航班，因此一直都落在后面。）疫情爆发前，距离北京两小时航程的首尔仁川机场成为世界最大的机场商店。2020年普拉达和爱马仕在亚洲（不包括日本）的收入飙升超过40%，原因之一就是在海南的热卖。据报道，去年海南的免税店销售总额达到50亿美元，比2019年翻了一倍多。有预测认为未来十年还可能增长四倍。

尽管多年来中国人一直是全球最大的奢侈品买家，贡献了全球销售额的三分之一，但各大品牌并不愿意将海南等地作为顶级奢侈品销售地。中国人在手袋、腕表和其他奢侈品上的消费有三分之二是在境外发生的。

中国共产党想要改变这一点。旅游零售行业简报《穆迪戴维特报告》（Moodie Davitt Report）的马丁·穆迪（Martin Moodie）表示，不断加大对富裕人口的减税力度是“实现政府一项长期使命的要义，目的是最大程度地扩大国内消费，让旅游购物从境外回流境内”。咨询公司麦肯锡的泽沛达（Daniel Zipser）预计，奢侈品消费的海外份额将会下跌。经纪公司盛博的彻丽·梁（Cherry Leung，音译）表示，由于这些新的进展，奢侈品集团对海南这类地点的态度“发生了巨大变化”。

如果中国人继续在国内购买奢侈品，就会让那些长久以来统霸了海外机场的免税运营商流失更多生意。这些公司包括瑞士杜福睿（Dufry）和奢侈品帝国路威酩轩（LVMH）旗下的DFS。去年，国有控股的中免集团赶超了杜福睿，成为全球最大的免税奢侈品零售商。过去一年，中免集团在上海上市的子公司的市值增长了两倍多，达到1120亿美元，跻身全球市值最高的零售商之列。

一些欧洲的旅游零售商已经意识到消费力格局的转变，正在努力挤进海南市场。杜福睿向阿里巴巴出售了部分股份，希望这家中国电子商务巨头能够帮助它改善在海南的业务。1月，法国一家企业集团旗下的拉加代尔旅行零售（Lagardère Travel Retail）在海南开设了第二家店。

机场仍会是找到富裕购物者的好地方。等待航班时百无聊赖的旅客是奢侈品牌的完美目标。杜福睿的老板朱利安·迪亚兹·冈萨雷斯（Julián Díaz González）指出，多数零售商都花费重金吸引顾客光顾他们的商店或网站，“而我们只需要把他们从机场大厅的走廊请到店里。”随着免税行业不断演变，迪亚兹可能会越来越意识到，他的免税店得跟着顾客跑了。■



Covid-19 mutations

It's a family affair

Convergent evolution may make travel restrictions redundant

THE GENETIC mutations that cause evolution may arise at random. But natural selection often produces creatures that are similar, despite living in different environments. For example birds, bats, pterodactyls and insects all developed wings independently, because they were a nifty way to travel. This process is known as convergent evolution.

Viruses evolve, too. SARS-CoV-2, which causes covid-19, replicates while infecting its host. As it does, the virus's genetic information—a sequence of 30,000 RNA letters—is sometimes corrupted. These mutations can make SARS-CoV-2 more dangerous in several ways. They can increase transmissibility, evade detection by tests, avoid immune responses (including from vaccines) and cause more severe illness.

This makes tracking the evolution of SARS-CoV-2 crucial. Of the 110m covid-19 cases found worldwide, scientists have sequenced and published the genomes of 600,000. By comparing these sequences and other viral characteristics, evolutionary biologists create phylogenetic trees—a set of hypothetical relationships between sequences which show how the virus has evolved over time.

All trees begin with an initial sample from Wuhan sequenced in January 2020, with subsequent samples as descendants. Sequences with similar new features are grouped into “lineages”, using criteria and a nomenclature developed by researchers at the universities of Edinburgh and Oxford. So far 41,000 mutations have been documented, falling into 880 lineages.

Only a handful of these mutations make the virus more dangerous. Most

occur within the 3,800 letters used for the virus's spike protein, which helps it bind to its host. Sometimes they can combine to pose several new threats, as they seem to have done in a Californian lineage that is worrying scientists. New studies suggest that this lineage may be more infectious, evade antibodies and cause more severe illness. Sequencing done in the state shows that this variant could already be responsible for a majority of cases there.

Two common mutations have appeared in many other worrying lineages. As with the wings of birds and bats, these familiar foes have evolved independently in different places. The first mutation, known as N501Y, increases transmissibility. It is present in the "Kent" lineage that has run riot in Britain since December, as well as some lineages elsewhere. The second, known as E484K, enables the virus to partially avoid the host's antibodies. It is prevalent in Brazil and South Africa. E484K has also recently been spotted in new lineages in America and Europe, including Britain.

This convergent evolution could eventually render travel bans from South America and Africa redundant. Yet E484K's sudden appearance in many places, regardless of border controls, may hold a silver lining. Far better that the virus produces a few recurrent threats than many different ones. The hope is that drug companies can tweak vaccines to zap these mutants.

More worrying is the world's lack of genetic surveillance. Though Britain has sequenced only 6% of all its cases, that is still nearly as many as the rest of the world combined. With just £32m (\$45m) of funding it can now analyse 30,000 genomes a week. America, which has sequenced just 0.4% of its covid-19 cases, is trying to speed up. The government recently released \$200m, with perhaps another \$2bn to follow. As the new threat in California shows, the world needs such investment to keep up with natural selection.





新冠病毒变异

家族事务

趋同进化可能使旅行限制变得多余

推动进化过程的基因突变也许是随机产生的。但即使在不同的生存环境下，自然选择往往也会造就出近似的生物。例如，鸟类、蝙蝠、翼手龙和昆虫都各自进化出了翅膀，因为翅膀是绝佳的移动方式。这个过程称为趋同进化。

病毒也会进化。引发新冠肺炎的新冠病毒在感染宿主时会自我复制。过程中病毒的遗传信息——由三万个RNA字母组成的序列——有时会发生损坏。这些突变会在几个方面让新冠病毒变得更加危险。它们会增强传染性、难以被检测到、逃逸免疫应答（包括疫苗的）、导致更多重症。

因此，跟踪新冠病毒的进化至关重要。在全球发现的1.1亿例新冠肺炎病例中，科学家对60万例进行了基因组测序并发表了结果。进化生物学家比较了这些序列和其他病毒特征，编制出了病毒进化树——各种序列之间的一组假设关系，显示了病毒如何不断进化。

所有进化树都始于2020年1月测序的来自武汉的一个初始样本，随后的测序样本均为其后代。根据爱丁堡大学和牛津大学研究人员开发的标准和命名法，具有相似新特征的序列被分成“谱系”。迄今为止已经记录了41,000个基因突变，分为880个谱系。

其中只有少数突变让病毒变得更危险。它们大多发生在构成病毒刺突蛋白（帮助病毒与宿主结合）的3800个字母当中。有时，多个突变会组合起来构成几种新的威胁，一个美国加州的谱系似乎就是如此，它令科学家感到忧虑。新的研究表明，该谱系可能传染性更强，能够逃避抗体，并导致更多重症。在加州完成的测序显示，州内大部分病例或许都是感染了这种变种所致。

其他许多令人担忧的谱系中均存在两种常见突变。正如鸟类和蝙蝠的翅膀一样，这些似曾相识的危险变种在不同地方各自独立进化而成。第一种突变称为N501Y，增加了病毒传染性。自去年12月起在英国泛滥的“肯特”（Kent）谱系中就存在这种突变，其他地方的一些谱系也有。第二种突变称为E484K，它能使病毒部分地逃逸宿主的抗体攻击。E484K在巴西和南非广为存在，在美国和欧洲（包括英国）最近的新谱系中也发现了它。

这种趋同进化最终可能会让对南美和非洲的旅行禁令变得多此一举。不过，即便有边境管制，E484K仍在多地突然出现，这或许也带来了一线希望。相比出现众多不同的威胁，病毒产生少数重复出现的变异要好办得多。我们可以寄望于制药公司调整疫苗来消灭这些突变毒株。

更令人担忧的是全球基因检测的不足。尽管英国只对它全部病例的6%做了测序，但仍然已经接近于世界其余地区测序数量的总和。英国只有3200万英镑（4500万美元）的检测资金，目前每周可以分析三万个基因组。美国只测序了0.4%的病例，现在正设法加快速度。美国政府最近拨款2亿美元，可能还会再追加20亿美元。正如加州的新毒株所显示的，世界需要加大投资来跟上自然选择的步伐。■



Five-year plan

The big target

Flush with confidence, China wants to insulate itself from the world

THE ANNUAL session of China's legislature, the National People's Congress, leaves nothing to chance. Speeches are thoroughly rehearsed, those attending are carefully vetted and even the tea service is immaculately choreographed. Yet there are always a few unscripted remarks—or, perhaps, remarks scripted to sound unscripted—that stick out. During the weeklong event, which ended on March 11th, the most memorable words came from Xi Jinping, the country's leader. "China can now look the world in the eye," he said in a small meeting on the sidelines. "It's not like back in the day, when we were still bumpkins." It was an unvarnished expression of Mr Xi's belief that China has become a great power and now must act like one.

The main business of the congress was ratification of a new five-year plan that aims to make China even more powerful, while guarding it against global rivals. A legacy of the Soviet economic system, such plans remain important. They set targets that officials must fulfil. The new plan—the 14th, running from 2021 to 2025—confirms just how serious the leadership is about trying to insulate the country from the hostile foreign forces that it believes are arrayed against it.

The document does not mention America by name, but it does not need to: every official knows that competition with America looms large in China's strategies. The previous five-year plan described how a peaceful multilateral world would benefit China. This one highlights the danger of "hegemonism". Geopolitical uncertainties help explain what, to many observers, is its most striking element. That is its omission of one target that was a centrepiece of previous plans: average yearly growth. Instead, it states

that growth targets will be set each year, depending on conditions. China is wary of committing itself when it does not know whether America will choke off its supply of high-end semiconductors, among other things. But the plan does pledge that China will be a “mid-tier developed country” by 2035.

It also sets out numerous other goals. These include an increase in spending on research and development of at least 7% annually over the next five years. The plan says 65% of the population should be urban by 2025, up from nearly 61% at the end of 2019. And it vows to reduce the amount of carbon dioxide emitted for each unit of GDP by 18% between 2021 and 2025. These targets, however, are slightly underwhelming. If China were to continue on its trajectory of the past five years, it would handily outperform them all.

More telling in this plan is the kind of growth it describes. It talks of a “dual-circulation strategy”, a mouthful of a concept unveiled by Mr Xi last year. This requires China to remain part of the “international circulation” of global trade—the plan says it must defend its share of export markets. But it emphasises the improvement of “domestic circulation”—ie, the building of a vibrant economy at home while reducing dependence on others.

Some aspects of this strategy are welcome. Officials say that it will require resources at home to be allocated according to market principles, not government diktats. They recognise the need to relax the *hukou* system, a household registry that makes it hard for rural citizens to settle in cities. The plan says *hukou* will be paired with a points-based arrangement that could make migration easier, especially for young, educated workers.

Other aspects may worry the rest of the world. The plan does not mention the “Made in China 2025” programme that has been roundly criticised by American officials as an industrial policy on steroids. But the main elements of it remain. In setting out priorities for manufacturing, the plan

urges investment in the very same sectors, from robotics to electric vehicles.

It also identifies seven frontier technologies that are deemed vital to development and national security. These include quantum computing, semiconductors and artificial intelligence. China is already spending vast sums on these technologies, but results have been patchy. Its years-long drive to catch up with world leaders in the making of semiconductors has so far fallen well short of the government's ambitions.

China wants to prop up less cutting-edge production, too. The country is the world's biggest maker of goods. Its share of global manufacturing is nearly 30%—about the same as the combined shares of America, Japan and Germany. Many foreign firms wonder whether to move some operations away from China, because of climbing costs and political risks arising from tensions with America. The plan calls for China to keep critical parts of supply chains in the country. To foreign executives, that may sound threatening.

More positively, one way that China hopes to maintain its industrial advantage is with its tried-and-tested approach of building top-notch infrastructure. The transport ministry has plans to nearly double the length of China's high-speed rail network to 70,000km within 15 years. That would make it almost five times as long as all other high-speed rail networks in the world combined.

The five-year plan hints there may be economic difficulties ahead. It commits to stabilising or reducing the ratio of China's debt to GDP—implying that it is getting too high (nearly 300% of GDP). But cutting debt will be tricky when pouring cash into infrastructure and sponsoring high-tech.

The environment is another thorny issue. China has vowed that its carbon emissions will peak by 2030, and the country will be carbon neutral by 2060. The plan, however, gives little indication of how to get there, except for boosting nuclear-power generation from 52 gigawatts today to 70 gigawatts by 2025. It vows to promote the “clean use of coal”, but does not promise to phase it out. More details may emerge in the coming months as ministries draw up their own targets.

State media hail five-year plans as evidence that China has far-sighted leaders, who bravely chart new paths for the future. But the documents really summarise where the country is already heading. The pursuit of self-sufficiency is well under way, however costly it may prove. ■



五年规划

大目标

中国信心满满，打算与世界隔离

中国的立法机构全国人民代表大会每年举行的会议都组织得万无一失。发言经过周密排练，与会人员经过细致审查，连茶水服务也都精心安排。然而总归还是会爆出一些引人注目的脱稿发言——也可能是特意把稿子写得好像脱稿一样。今年，为期一周的人大会议在3月11日闭幕，期间最让人印象深刻的言辞来自国家领导人习近平。“中国已经可以平视这个世界了，”他在一场政协联组会议上说道，“也不像我们当年那么‘土’了。”习近平毫不掩饰地表达出一份信念——中国已成为强国，现在必须像强国那样行事。

这次人大会议的主要议题是审议批准新的五年规划，其目标是让中国变得更加强大，同时抵御全球竞争对手。这类规划承袭自苏联经济体制，在中国依然发挥重要功能。它们设定了官员们必须完成的目标。2021年至2025年的新五年规划（第14个，以下简称“十四五”）证实，中国领导层认为外国敌对势力在联合攻击中国，他们是动真格要让中国与之隔离。

该文件没有点名提到美国，但也并不需要，因为所有官员都知道与美国的竞争在中国战略规划中的重要性。上一个五年规划指出中国将得益于和平的多边世界。而“十四五”则强调“霸权主义”的危险。地缘政治的不确定性有助于解释在众多观察家看来这份规划中最异乎寻常的一个要素。作为以往规划中的核心内容，年均GDP增速的目标没有出现在“十四五”中。取而代之的是，“十四五”提出要根据实际情况每年设定增长目标。面对美国可能掐断高端半导体供应等未知数，中国对于承诺增长目标非常谨慎。但“十四五”还是明确承诺到2035年中国人均GDP达到“中等发达国家”水平。

“十四五”还设定了很多其他目标。其中包括未来五年全社会研发经费投入

年均增长7%以上。规划还指出，到2025年，常住人口城镇化率应从2019年底的近61%上升至65%。它还誓言在2021年至2025年间把单位GDP二氧化碳排放降低18%。不过这些目标有些平平无奇。只要中国保持过去五年的前行轨道，这些目标都能轻松超越。

更能说明问题的是规划中对发展模式的描述。“十四五”谈到了“双循环战略”。这是习近平去年提出的一个颇拗口的复杂概念。它要求中国保持参与全球贸易的“国际循环”——“十四五”表示中国必须捍卫出口市场份额。但它强调加快构建“国内大循环”，即建立充满活力的国内经济，减少对其他国家的依赖。

该战略的某些方面是受欢迎的。官员们表示，它将要求国内资源按市场规律而非政府指令分配。他们认识到有必要放宽户口制度，现行制度让农村人口难以落户城市。“十四五”提出户口将与积分落户制度挂钩，让人们移居落户变得更容易，特别是对受过教育的年轻劳动人口。

但有些方面可能令其他国家担心。“十四五”没有提及“中国制造2025”，该计划曾被美国官员斥为打了兴奋剂的产业政策。但它的主要元素仍然在。在确定制造业的优先项目时，“十四五”敦促向从机器人到电动汽车的领域投资，与“中国制造2025”完全一致。

规划还列出了七项被认为对发展和国家安全至关重要的前沿技术。其中包括量子计算、半导体和人工智能。中国已经在这些技术上投入巨资，但成果良莠不齐。多年来中国努力要在半导体制造方面追赶世界领先水平，至今远未达到政府的期望。

中国也希望支撑非尖端制造。中国是全球最大的商品制造国。它占全球制造业的份额接近30%，大约相当于美国、日本和德国的份额总和。由于成本攀升以及中美关系紧张令政治风险加大，许多外国公司都在考虑是否该将部分工厂移出中国。“十四五”提出要把供应链的关键部分留在中国。在外国高管听来这可能带有威胁意味。

而较为正面的是，中国希望保持产业优势的一个做法是建设一流的基础设施

施，这是它的一条屡试不爽的策略。交通部计划在15年内把中国的高速铁路网里程增加近一倍，达到七万公里。这几乎将是全球其余高铁里程总和的五倍。

“十四五”暗示前方可能遭遇经济困境。它承诺稳定或降低中国的债务占GDP比重，意味着当前占比过高（接近GDP的300%）。但是，要在大举投资基建和发展高科技的同时削减债务是有难度的。

环境是另一个棘手的问题。中国之前已经承诺国内碳排放将在2030年达到峰值，到2060年实现碳中和。然而，除了把核电发电量从目前的52GW提高到2025年的70GW之外，“十四五”几乎没有说明将如何实现上述目标。规划誓言促进“煤炭的清洁利用”，但并没有承诺逐步淘汰煤炭。随着各部委制订各自的目标，更多细节可能在未来数月浮现。

中国官方媒体盛赞五年规划体现了中国领导人的远见卓识，他们勇于为未来开拓新道路。但这些计划实际上无非是在总结中国现在的前进方向。追求自给自足的行动早已展开，无论最终代价可能多大。 ■



Schumpeter

The smuggest guys in the room

McKinsey's partners suffer from collective self-delusion

ONE OF THE best explanations for the triumph of a “solution shop” like McKinsey was co-written by the late Clayton Christensen of Harvard Business School in 2013. When hiring a management-consulting firm, he said, clients do not know what they are getting in advance, because they are looking for knowledge that they themselves lack. They cannot measure the results, either, because outside factors, such as the quality of execution, influence the outcome of the consultant’s recommendations.

So they rely on reputation and other squishy factors—the consultants’ “educational pedigrees, eloquence, and demeanour”—as substitutes for tangible results. On that basis, no one would hire Schumpeter to help fix McKinsey’s problems. His diagnosis is as lacking in eloquence as he is in demeanour. In his unschooled view, those of the firm’s 650 senior partners who voted to oust their global managing partner, Kevin Sneader, on February 24th, are in a clueless mess. Worse, they don’t get that they don’t get it.

The Byzantine voting system that has done away with Mr Sneader has not yet determined which of his two potential successors will replace him. Nor is it clear for what precisely the 54-year-old Scot is paying the price. Some see his departure as the firm’s strangled *mea culpa*; the ousting of a boss is typical of a firm engulfed in the sort of scandals Mr Sneader has had to cope with, from dodgy dealings in South Africa and settling conflict-of-interest lawsuits to paying almost \$575m to settle claims that its advice helped exacerbate America’s opioid crisis. Yet the roots of all those crises predate his three-year tenure. He is, at most, the fall guy.

More likely, sticking his nose into his partners' businesses to avoid future calamities could have rubbed enough of them up the wrong way that they voted against him. That would suggest that a majority cannot fathom how serious McKinsey's problems are.

At heart, they stem from a simple delusion. Its partners see themselves as missionaries. Yet they are also mercenaries—"guns for hire", as Duff McDonald, a biographer of the firm, calls them. They have a mantra that puts their clients' interests above their own, and a belief, drawn from the firm's pristine heritage, that no one knows better how to distinguish between right and wrong. Yet in some cases, as in working with Purdue Pharma, maker of the addictive painkiller OxyContin, their moral compasses go haywire. That is most likely because of the lure of lucre.

Numerous notes of dissonance follow from this. For almost 95 years, McKinsey has sought to portray itself as a genteel professional-services company, not a grubby business. Unlike, say, a profit-hungry Goldman Sachs banker, who walks into a room aware she may be hissed at, a McKinsey consultant expects his halo to be noticed. However much its senior partners insist that they are not motivated by outsized profits, they can earn as much each year as that Goldman banker. Revenues have roughly doubled in a decade to over \$10bn. Partners number 2,600. The firm's employees revel in the aura of the old McKinsey—of autonomy, discretion and intellectual prestige—while embracing the growth, profits and power that have come in more recent years. Rarely do they doubt whether they can have it all.

More people and more wealth inevitably make oversight more important. Still, McKinsey continues to think of itself as a partnership built on trust, not one that requires centralised command and control. Its voting system resembles an elite Athenian democracy. The more trouble it is in, the more it needs a Spartan leader, backed by a strong risk-control apparatus, to keep

it on the straight and narrow. McKinsey's 30-person "shareholder council", its board of directors, may be too steeped in the firm's cult-like culture to realise how pressing is the need for change. Mr Sneader started the reforms. His defenestration seems ominous for those hoping they will go much further under his successor.

As scrutiny of it intensifies, McKinsey must learn to balance preserving its discretion on behalf of clients with greater transparency. The more work it does for governments, the more public attention it will receive. Its costly legal encounters are bringing to light details of more client contacts, including with Johnson & Johnson, which last year settled an opioids lawsuit with a group of state attorneys-general. McKinsey's settlements over opioids—in which it did not admit wrongdoing—require it to publish reams of correspondence, which increase the risk of reputational damage.

Within the cryptic world of McKinsey, what signs would indicate that the firm recognises the crisis that it is in? The winner of the run-off to replace Mr Sneader, which will reportedly be between Sven Smit from the Amsterdam practice and Bob Sternfels from San Francisco, should say which aspects of his predecessor's reforms he intends to keep. More risk control is a must. Client payments should be more standardised. Most are flat fees (albeit fat ones) but about 15% are tied to performance; the latter create incentives for abnormally turbocharging results. Bruised by scandal, a truly progressive firm would launch its own version of a truth-and-reconciliation commission to see if anything else is lurking in the closet. It could shunt a generation of partners towards retirement. That would make it less unwieldy and make way for those more accustomed to the glare of publicity.

Above all, when it does open up, the firm should adopt some radical new talking-points. Rather than cloak itself in righteousness and assert its right to complete discretion and total opacity over how it behaves, it should

admit that it exists to make cold, hard cash, and make explicit the ethical lines that it will not cross and the process it has to police them. Well-run companies confront and manage conflicts of interest. McKinsey has tried to blag its way through them with a narcissistic recklessness. Its partners like to think of themselves as the smartest guys in the room. They should have realised the perils of their self-delusion long ago. ■



熊彼特

房间里最自以为是的人

麦肯锡的合伙人集体自欺

关于麦肯锡这样的“解决方案商店”何以能取得巨大的成功，最佳案例分析之一是由哈佛商学院已故教授克莱顿·克里斯滕森（Clayton Christensen）在2013年与他人共同撰写的。他说，在聘请管理咨询公司时，客户事先并不知道自己能得到什么，因为他们是在寻找自己缺乏的专业知识。他们也无法衡量结果，因为执行水平之类的外部因素会影响到推荐方案的成效。

因此，他们依靠声誉和其他软指标作为切实成效的替代物，比如顾问们的“名校背景、口才和风度”。按照这种标准，没有人会请本专栏作者去帮忙解决麦肯锡的问题。因为他在做分析诊断时口才和风度都欠奉。从他未经名校训练的视角来看，麦肯锡650位资深董事合伙人中，那些在2月24日投票赞成撤换掉全球总裁施南德（Kevin Sneader）的人根本没弄清状况。更糟糕的是，他们知道自己不知道。

撤换了施南德的拜占庭式投票制度尚未决定他的两个可能的继任人中哪一个将取代他。目前也还不清楚这个54岁的苏格兰人到底是为了什么而下台。有些人认为把他撤换掉是麦肯锡在被迫认错。罢免老板是一家公司在陷入了施南德被迫应对的那类公司丑闻之后典型的做法，麦肯锡的丑闻包括在南非的问题交易、对利益冲突诉讼的和解，以及在被指控其建议助长了美国的阿片类药物危机后支付近5.75亿美元达成和解。然而，这些危机全都源于他的三年任期之前。他顶多就是个替罪羊。

更有可能的是，他为了避免未来再出大问题而干预合伙人的业务，可能惹恼了他们中的很多人，乃至投票撤换他。如果是这样，那么大多数合伙人没能真正明白麦肯锡问题的严重性。

从本质上讲，这些问题源于一个简单的错觉。麦肯锡的合伙人自视为传教士。然而他们也是雇佣军，就像为该公司写传记的达夫·麦克唐纳（Duff

McDonald) 所说的，是“收钱办事”。他们的座右铭是将客户利益置于自身利益之上，并且从公司历久不变的传承中汲取了一种信念，即没人比他们更清楚如何区分对错。但在某些情况下，例如在和成瘾性止痛药奥施康定（OxyContin）的制造商普渡制药（Purdue Pharma）合作时，他们的道德指南针开始错乱摆动。利益的诱惑是最可能的原因。

许多不和谐的音符随之而来。在将近95年的时间里，麦肯锡一直试图将自己塑造成一家体面的专业服务公司，而不是一门肮脏的生意。麦肯锡的顾问期望别人注意到自己的光环，而不是像一个追逐利润的高盛银行家那样，在走进一个房间时知道自己可能会被人“嘘”。无论麦肯锡的资深合伙人如何坚称他们不受高额利润的驱使，他们每年赚到的可以和这位高盛银行家一样多。十年来，麦肯锡的收入大约翻了一番，超过100亿美元。合伙人达到2600名。公司员工沐浴在历史悠久的麦肯锡自主、审慎和专业威望的光环之中，同时又欣然拥抱了更近些年里取得的增长、利润和影响力。他们很少怀疑是否可以同时拥有这一切。

更多的人员和财富不可避免地让监督变得更为重要。但麦肯锡仍将自己视为建立在信任基础上的合伙企业，不需要集中指挥和控制。它的投票机制类似于雅典的精英民主制。它遇到的麻烦越多，就越需要一个以强大的风险控制机制为后盾的斯巴达式领导人，防止公司行差踏错。麦肯锡由30人组成的“股东委员会”（即它的董事会）可能深陷于公司邪典般的文化中，难以意识到变革的迫切性。施南德启动了改革。对于那些希望改革能在他的继任者领导下走得更远的人来说，他的出局似乎是个不祥之兆。

随着监督日增，麦肯锡必须学会在继续代表客户自主审慎行事和提高透明度之间取得平衡。它为政府提供的服务越多，受到的公众关注也就越多。麦肯锡代价高昂的法律纠纷曝光了更多它与客户沟通的细节，其中包括与强生公司的合作。去年，强生公司与美国多个州的检察长就阿片类药物诉讼达成和解。麦肯锡就阿片类药物问题的和解协议（不承认有不当行为）要求它公布大量信函，增加了它声誉受损的风险。

在麦肯锡的神秘世界中，有哪些迹象会表明它认识到了所处的危机？赢得

竞争接替施南德的人（据说将在阿姆斯特丹办公室的斯文·史密斯[Sven Smit]和旧金山的鲍勃·斯特恩费尔斯[Bob Sternfels]之间产生）应该会明言打算延续前任哪些方面的改革。加强风险控制是必须的。客户付款应更加标准化。付款的大头是固定费用（金额很高），但约有15%与成效挂钩——这一部分会激励追求超常佳绩。饱受丑闻困扰之时，一家真正进步的公司会建立自己的真相与和解委员会，看看公司内部还隐藏着什么见不得光的问题。这可能会促使一代合伙人提前退出。如此会让公司不那么尾大不掉，并给更习惯于公众监督的人让路。

最重要的是，在确实提高透明度后，麦肯锡应该采用一些完全不同以往的新论调。它应该承认自己的存在就是为了赚取冷冰冰的金钱，并划清不能逾越的道德界限，阐明相应的监督机制，而不是躲在正直的外衣下，坚称自己拥有绝对自决权而可以完全不透明。经营良好的公司会直面并管理利益冲突。麦肯锡试图以一种孤芳自赏的轻率妄为来蒙混过关。它的合伙人喜欢自视为房间里最聪明的人。他们早就该意识到这种自我陶醉的危险。





Gene-editing

Tomorrow's world

Two books explore the power and peril of a technology that could transform the human race

WHAT THE transistor once was to electronics, so CRISPR gene-editing is to biotechnology today. It changes the field from something interesting but clunky, and of restricted application, into a game of infinite possibility that almost anyone can play. Transistors led to computer chips and the youthful entrepreneurs of the Homebrew Computer Club in Silicon Valley. Similarly, CRISPR editing has let a new generation of would-be billionaires explore ideas that range from systematising the search for the proteins targeted by drugs, to breeding pigs that might act as organ donors for transplants.

The transistor transformed the world; CRISPR may do that too. But it also offers a potential which transistors never did: that of transforming human beings themselves, by editing their genes. Those genes might be in body cells, in which case the changes would die with the person to whom they were made. Or they might be in germ cells, in which case they could be passed down the generations.

Henry Greely's book is about the first known attempt to perform this more enduring trick, how it spectacularly backfired on the man who did it, and whether, and in what circumstances, anyone should ever try to do it again. Mr Greely is both a bioethicist and a lawyer at Stanford University, qualifications perfectly suited to his subject—the moment when germline editing went from being a topic of philosophical speculation to hard reality. That moment came on November 25th 2018, when He Jiankui, a researcher at the Southern University of Science and Technology, in Shenzhen, China, announced that he had taken it upon himself to edit the genomes of two

embryonic human beings (later born as twin girls), and to do so at a point in their development when those changes would affect their germ cells.

As depicted in “CRISPR People”, Dr He is less the villain portrayed elsewhere than a naive and tragic character who was completely out of his depth. Certainly, he was driven by a yen for fame and fortune. But he seems also to have had a genuine desire to do good. His stated aim was to protect the girls from the threat of AIDS by tweaking their genes for a protein which the responsible virus, HIV, uses to lock onto cells it is about to infect. Almost up to the time that he went public with his experiment, he seems to have expected a hero’s welcome. Instead, he ended up with a three-year prison sentence.

An inauspicious beginning, then, for the idea of human germline editing. But Mr Greely does not dismiss the possibility of future, better-conducted attempts to do it. As forensically as you would expect for an author of his background, he sets out the circumstances in which real need exists and no alternatives are available. Preventing HIV infection is not among them: it is easy to avoid and is treatable if avoidance fails. Mostly, his list consists of couples who carry dangerous mutations in combinations that mean they are bound to be passed on to a child unless its genes are edited. This will not be many couples. But it will be a few.

Attitudes to germline editing may change if it proves safe and effective in these edge cases, and as knowledge increases of how human genomes work. At that point the real debate—about whether to allow the technique to be used to end the genetic lottery of reproduction, and maybe even to enhance human capabilities beyond any now currently found—will become live. How scientific knowledge expands in this way is the ultimate subject of “The Code Breaker”.

Mr Greely’s book is a serious and scholarly work. Walter Isaacson’s, by

contrast, is a page-turner. It weaves history and contemporary events into a narrative propelled by the career of its protagonist, Jennifer Doudna. In 2020 she was the joint winner with Emmanuelle Charpentier of the Nobel chemistry prize for—as the citation by Sweden’s Royal Academy of Sciences laconically puts it—“the development of a method for genome editing”.

Most people agree with the academy in recognising these two as CRISPR editing’s principal inventors—though they were assisted by many others and drew on the work of many more. There are, however, dissenters who want to share the kudos, and particularly the patents. Dr Doudna and Dr Charpentier worked with bacteria. A lot of CRISPR’s applications will be in more complex creatures, such as human beings. And the researcher who first tried the technique on human cells was Feng Zhang of the Broad Institute in Cambridge, Massachusetts. The Broad’s lawyers are thus battling with those of the University of California, Berkeley, where Dr Doudna works, and with Dr Charpentier’s representatives, over whose patent applications give rights to what.

“The Code Breaker” casts light on this dispute, as it does on many other inner workings of American science. For Mr Isaacson, previously editor of *Time* magazine and chairman of CNN, author of acclaimed biographies of Steve Jobs and Leonardo da Vinci and now a history professor at Tulane University, is an insider’s insider. His book glitters with the names of the scientific great and good. Eric Lander, until recently head of the Broad and Joe Biden’s choice for chief scientific adviser, often takes the stage. So does George Church, a brilliant eccentric at Harvard who hopes to revive mammoths and was Dr Zhang’s PhD supervisor.

There are guest appearances by (among many others) Francis Collins, who has astutely survived from one presidential administration to another as head of the National Institutes of Health; David Baltimore, a Nobel laureate who in 1975 helped organise the first scientific meeting to look at the ethics

of genetic engineering; and Anthony Fauci, adviser on infectious diseases to seven presidents. The book offers a sympathetic assessment of a luminary who has fallen from grace—James Watson, co-discoverer of the structure of DNA and founding head of the Human Genome Project, who is no longer received in polite society after making some disgraceful remarks about race and intelligence.

Aside from Dr Doudna, however, the real star of the story is RNA. This is the neglected third member of life's molecular trinity—the other two being DNA and proteins. Indeed, RNA probably predates those other two molecules and, crucially for current events, it forms the genetic material of many of the viruses that afflict human beings, including the one that causes covid-19. It is also the molecule which guides the CRISPR-editing complex to the right part of the genome to edit.

Mr Isaacson traces Dr Doudna's career from its beginnings as a PhD student of Jack Szostak, another pillar of the scientific establishment and one of the proponents of the idea that the origin of RNA and the origin of life are intimately bound up. He follows the byways of her early studies on RNA enzymes, known as ribozymes, and her first introduction to CRISPR in its natural role as a bacterial defence against viruses. Later comes her fortuitous meeting with Dr Charpentier at a scientific conference in Puerto Rico. Fortune favours the prepared mind, and hers was well prepared to profit from what Dr Charpentier told her about her own work on CRISPR. But the meeting itself was serendipity.

In telling her tale, Mr Isaacson captures the scientific process well, including the role of chance. The hard graft at the bench, the flashes of inspiration, the importance of conferences as cauldrons of creativity, the rivalry, sometimes friendly, sometimes less so, and the sense of common purpose are all conveyed in his narrative. “The Code Breaker” describes a dance to the music of time with these things as its steps, which began with

Charles Darwin and Gregor Mendel and shows no sign of ending.

What CRISPR and its successors will mean for humanity over the next few decades is anybody's guess. At minimum, better health and more abundant food. At maximum, perhaps, a world where machines now made of metal and plastic are instead made of flesh and bone, pets and garden plants can be designed to order, mammoths once again thunder over the tundra, and human reproduction itself ceases to be a matter of luck. ■



基因编辑

明日世界

有一种技术可能会改变人类，两本书探讨了它的威力和危险【《CRISPR人类》、《密码破解者》书评】

当年晶体管对电子产业的推动有多大，今天CRISPR基因编辑对生物技术的影响就有多大。它正在将一个有趣但繁琐且应用有限的领域，转变为一个几乎人人都可以玩、具有无限可能性的游戏。晶体管催生了电脑芯片，造就了硅谷家酿计算机俱乐部（Homebrew Computer Club）里的年轻创业家。同样地，CRISPR编辑技术让新一代立志创富的人得以探索各种想法，从系统化地寻找可成为药物靶标的蛋白，到培育可以提供移植器官的猪。

晶体管改变了世界，CRISPR或许也会。但它还具备晶体管从不具备的一种潜力：通过编辑人的基因，改变人类自身。被编辑的基因可能位于体细胞内，那么等到被编辑了基因的人死亡之时，所做的改变也会消失。它们也可能位于生殖细胞内，在这种情况下，改变可以代代相传。

亨利·格里利（Henry Greely）的书讲述的是后一种影响更为持久的改变——关于人类在这方面已知的首次尝试、其始作俑者如何事与愿违地吃了大苦头，以及是否还应该有任何人、在何种情况下再做尝试。格里利是斯坦福大学的一名生物伦理学家和律师，完全有资格讨论这个话题，也就是生殖系基因编辑从一个哲学思辨话题变为了活生生的现实的那一刻。那个时刻发生在2018年11月25日，中国深圳的南方科技大学的研究员贺建奎宣布他已经自行编辑了两个人类胚胎的基因组（后来诞生为一对双胞胎女婴），而他做出这项操作所处的胚胎发育时点将使这些修改影响到她们的生殖细胞。

《CRISPR人类》一书没有像我们在其他地方看到的那样把贺建奎描绘为一名恶人，而更多地是一个不知天高地厚的天真而悲剧的角色。当然，他是受到了渴望名利的驱使。但他似乎也是真诚地想要行善。他宣称自己调

整女孩基因中的一种蛋白质（引发艾滋病的HIV病毒就是通过这种蛋白来感染受体细胞的）是为了保护她们免受艾滋病的威胁。直到他公开自己的实验之前，他似乎一直期待着受到英雄般的欢迎。但结果是，他被判入狱三年。

就这样，人类生殖系基因编辑的想法有了一个不祥的开端。但是格里利并没有排除在未来做出更好尝试的可能性。格里利以符合他专业背景的严谨细致，列出了一些真正需要基因编辑且别无他选的情景。预防艾滋病毒感染并不在此列：避免感染不难，即使预防失败也可以治疗。他的清单主要包括那些基因组合携带危险突变的夫妇，意味着除非编辑基因，否则这些突变注定会遗传给孩子。这样的夫妇并不多，但还是会有一些。

如果在这些极端案例中编辑生殖细胞被证明安全有效，加之对人类基因组运作方式的认知增长，人们对生殖系基因编辑的态度可能会转变。到那时，一场真正的辩论才会启动：是否允许用这项技术来终结繁衍中的遗传运气，甚至用来增强人类能力，全面超越现有水平。科学知识如何以这种方式扩展，正是《密码破解者》（The Code Breaker）一书的终极主题。

格里利的书是一本严肃的学术著作。而沃尔特·艾萨克森（Walter Isaacson）这本书具有引人入胜的情节。书中以主角詹妮弗·杜德纳（Jennifer Doudna）的学术生涯为主线，穿插了各种历史和当代事件。2020年，她与埃玛纽埃勒·沙尔庞捷（Emmanuelle Charpentier）共同获得了诺贝尔化学奖，因为她们“开发了一种基因组编辑方法”——瑞典皇家科学院简洁地介绍说。

大多数人认同瑞典皇家科学院的看法，将这两人视为CRISPR编辑的主要发明者，尽管她们得到了许多人的协助，也吸收了更多人的研究成果。但是也有人持有异议，他们想要分享荣誉，更想分享专利。杜德纳和沙尔庞捷研究的是细菌。CRISPR很多时候会被应用于更加复杂的生物，例如人类。麻省剑桥博德研究所（Broad Institute）的张锋是第一个在人类细胞上尝试这项技术的研究员。因此，博德研究所的律师正与杜德纳所在的加州大学伯克利分校的律师以及沙尔庞捷的法律代表激烈交锋，争论各家专

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《密码破解者》揭示了这一争端，也带出了美国科学界许多不为人知的一面。毕竟，艾萨克森是深谙内幕之人，他曾是《时代》杂志的主编和美国有线电视新闻网（CNN）的董事长，撰写的乔布斯和达芬奇传记备受赞誉，目前是杜兰大学的历史学教授。这本书中闪耀着众多伟大科学家的名字。埃里克·兰德（Eric Lander）的名字反复出现，不久前他还是博德研究所所长，并被拜登选为首席科学顾问。另外还有乔治·丘奇（George Church），一位才华横溢、特立独行的哈佛大学教授，他希望复活猛犸象，也曾是张锋的博士生导师。

还有许多人物在书中客串亮相，包括美国国立卫生研究院（NIH）院长弗兰西斯·柯林斯（Francis Collins），在白宫几次易主中他都机敏地保住了职位；诺贝尔奖得主戴维·巴尔的摩（David Baltimore），他在1975年参与组织了首次探讨基因工程伦理问题的科学会议；安东尼·福奇（Anthony Fauci），曾任七任总统的传染病顾问。作者还带着同情的视角评价了一位跌下神坛的大咖——詹姆斯·沃森（James Watson）。他是DNA结构的共同发现者和人类基因组计划的创始负责人，因为发表了一些有关种族和智力的不光彩言论而遭遇上流社会的冷眼。

然而，除杜德纳外，故事真正的主角是RNA。这是生命三大分子之中不受重视的第三个成员——另外两个是DNA和蛋白质。事实上，RNA的出现可能还早于其他两种分子，而且对当下至关重要的是，许多给人类带来痛苦的病毒的遗传物质都由RNA构成，包括新冠病毒。CRISPR编辑组合物也是由RNA分子引导到基因组的正确位置来实施编辑的。

艾萨克森回顾了杜德纳的学术生涯，从她师从杰克·绍斯塔克（Jack Szostak）攻读博士开始。绍斯塔克是正统科学圈的另一位泰斗，主张RNA起源与生命起源密切相关的观点。接着他介绍了杜德纳早期对RNA酶（称为核酶）的一些冷门研究，以及她如何首次了解到CRISPR在细菌抵御病毒过程中的天然角色。后来，她在波多黎各的一次学术会议上偶遇了沙尔庞捷。幸运总是眷顾那些有准备的人，当沙尔庞捷告诉她自己的

CRISPR研究时，杜德纳已经有了很好的准备来抓住其中的机会。但这次会面本身是一种意外之缘。

在讲述杜德纳的故事的过程中，艾萨克森生动展现了科学的进程，包括运气的作用。实验室里的艰辛、灵感的闪现、学术会议作为创造力熔炉的重要作用、时而友好时而较劲的竞争，以及共同的使命感，都在他的叙述中一一得到体现。在《密码破解者》的描述中，这些元素跟随着时间的节拍激舞飞扬，从达尔文和孟德尔的时代开始，永无止境。

在未来几十年里，CRISPR及其后续技术对人类意味着什么，谁也说不准。至少，它们会让人类更健康，食物更充足。而它潜力的极限或许是造就一个全新的世界——现在用金属和塑料制成的机器将变成血肉之躯，人们可以随心所欲地设计自己的宠物和花园植物，猛犸象将再次在苔原上呼啸，而人类的繁衍将不再听天由命。 ■



The world economy

The \$3trn question

Consumers in the rich world, especially America, are sitting on piles of cash. How much of it will they spend?

THE ECONOMIC controls implemented during the second world war make today's restrictions on restaurants and football stadiums look lax. In America the government rationed everything from coffee to shoes and forbade the production of fridges and bicycles. In 1943 its entire automobile industry sold only 139 cars. Two years later the war ended, and a consumer-led boom ensued. Americans put to use the personal savings they had accumulated in wartime. By 1950 carmakers were producing more than 8m vehicles a year.

Governments today are slowly easing lockdowns, as vaccines reduce hospitalisations and deaths from covid-19. Attention is turning to the likely shape of the economic recovery. The big question is whether or not the rich world can repeat the post-war trick, with pent-up savings powering a rapid bounce-back.

Households have certainly accumulated lots of cash. *The Economist* has gathered data on personal saving—the difference between post-tax income and consumer spending—for 21 rich countries. Had the pandemic not happened, households would probably have stashed away \$3trn in the first nine months of 2020. In fact they saved \$6trn. That implies “excess saving” of about \$3trn—a tenth of annual consumer spending in those countries. Households in some places have built up bigger cash piles than those in others (see chart 1). In America excess savings may soon exceed 10% of GDP, in part because of President Joe Biden’s \$1.9trn stimulus plan, which was due to be signed into law after *The Economist* went to press.

Households do not usually save on such a scale during recessions. For one thing, their incomes usually fall, as their pay is cut or they lose their jobs. But governments in the rich world have spent 5% of their combined GDP on furlough schemes, unemployment benefits and stimulus cheques during the pandemic. As a result, household incomes have actually risen in the past year. At the same time, lockdowns have reduced opportunities to spend.

What will consumers do with the cash? If they were to spend it all in one go, rich-world GDP growth would probably exceed 10% in 2021, a figure so heady it would put the post-war recovery to shame. (It would probably also generate a surge in inflation.) At the other extreme, households could spend none of their savings, perhaps if they anticipated that their tax payments would eventually have to rise in order to pay for the enormous stimulus packages.

The reality will be somewhere in between. Research by JPMorgan Chase, a bank, suggests that in many rich countries consumption will soon rebound to near its pre-pandemic level, powering a strong global recovery. Goldman Sachs, another bank, reckons that in America the spending of excess savings will add two percentage points to GDP growth in the year after full reopening. That points to a fairly rapid recovery in both output and employment. On March 9th the OECD, a rich-country think-tank, upgraded its forecast for GDP growth for the G20 group of countries to 6.2% in 2021, arguing that household savings represented “pent-up demand”.

Such calculations are highly uncertain, however, and not only because there are few precedents apart from the second world war. Two factors matter: how the accumulated pots of cash are distributed across households; and whether people treat those pots as income or as wealth.

Take distribution first. There seems little doubt that in all rich countries wealthier people have accumulated most of the excess savings. They have

been the least likely to lose work. A big share of their spending is discretionary, say on holidays or meals out; and it is many of these services that have been shut down during the pandemic. A large chunk of savings in the hands of the rich limits the potential for a post-lockdown spending bonanza because, the evidence suggests, they have a lower propensity to spend what they earn.

Yet the pro-rich skew in savings varies across countries. In many, low-income folk will not have any excess savings to spend, even once lockdowns end. During the pandemic the poorest quarter of European households have been half as likely to increase their savings as the richest. In Britain the worst-off fifth say they have saved less during the pandemic than before. The poorest Canadians have failed to build any nest-eggs in that time.

America looks different. Its fiscal stimulus has been unusually generous. A third round of cheques, for \$1,400, will soon be sent to most adults. Top-ups to unemployment benefits have ensured that many people who lost work have earned more from the state than they did in their jobs. The result is that low-income Americans may have saved even more than the rich, relative to their incomes. A new study by the JPMorgan Chase Institute found that in late December the poorest Americans' bank balances were some 40% higher than the year before, compared with about 25% higher for the richest (see chart 2). The poorest half have seen their liquid assets rise in value by 11% in the past year, nearly twice the increase for the richest 1%. Low- and moderate-income earners are more likely to spend their savings once the economy reopens, fuelling the recovery.

There is greater uncertainty around the second factor influencing the recovery: whether households perceive their cash piles as income or wealth. This is not merely a semantic distinction. Many studies find that households are more likely to boost spending in response to an increase

in income (say, a pay rise) than they are for an increase in their wealth (say, a rise in the value of their house). Households have built up excess savings in different ways in different countries. Those in Britain and the euro zone have done so by spending less. People are unlikely to treat this as “additional income”, argued Gertjan Vlieghe, a member of the Bank of England’s monetary policy committee, in a recent speech. In America and Japan, by contrast, excess savings are a result of higher income because of stimulus payouts, not spending cutbacks. In that situation, Mr Vlieghe said, excess saving “can more reasonably be interpreted as ‘additional income’”, which consumers may be happier to spend.

And that points to a striking contrast with the post-war boom. America’s recovery was impressive enough, but Europe’s was even more so, with GDP growth running 50% faster throughout the 1950s. This time is different. As the pandemic wanes it is America, where more stimulus is in place and where consumers are likelier to spend it, that seems set to leave the rest of the rich world in its dust. ■



世界经济

三万亿美元问题

以美国为突出代表的富裕国家的消费者攒下了一大笔钱。他们会花掉其中的多少？

比起第二次世界大战期间实施的经济管制，今天政府对餐馆和足球场的管控显得不那么严格。当时的美国政府对从咖啡到鞋子的所有商品实行限量供应，并禁止生产冰箱和自行车。1943年，美国整个汽车行业只卖了139辆车。两年后战争结束，一轮由消费拉动的经济繁荣随之而来。美国人开始花掉他们在战时攒下的钱。到1950年，汽车制造商每年生产的汽车超过800万辆。

随着疫苗接种减少了新冠肺炎导致的住院和死亡人数，各国政府正在慢慢解除封锁。人们开始转而关注经济复苏可能的走势。一个大问题是富裕国家能否重现二战后的戏法，即人们用攒久了没处花的储蓄推动经济快速反弹。

家庭毋庸置疑积累了大量现金。本刊收集了21个国家的个人储蓄（税后收入和消费支出之差）数据。假如没有发生疫情，这些国家的家庭在2020年的前九个月存下的钱可能在三万亿美元。而实际数字为六万亿美元。这意味着有大约三万亿美元的“超额储蓄”——占这些国家年消费支出的十分之一。而其中有些国家的家庭攒下的钱又多于别国（见图表1）。在美国，超额储蓄可能很快会超过GDP的10%，原因之一是拜登启动1.9万亿美元的经济刺激计划——在本刊最新一期付印后该计划预计将签署成为法律。

家庭一般不会在经济衰退期存下这么多钱。一来由于降薪或失业，他们的收入通常会下降。但新冠疫情期间，富裕国家的政府在无薪休假计划、失业救济金和经济刺激支票上投入的资金占到它们GDP总量的5%。结果在过去的一年里，家庭收入实际上有所增加。与此同时，封锁隔离减少了消费机会。

消费者会拿这些钱怎么办？如果他们把它一次性花光，2021年富裕国家的GDP增长可能会超过10%，这个振奋人心的数字足以让二战后的经济复苏相形见绌。（同时还可能导致通胀飙升。）另一种极端情况是，人们或许会预期自己最终还是得缴更多的税来为庞大的经济刺激计划买单，所以他们完全不动这笔钱。

现实将介乎两者之间。银行摩根大通的研究表明，在许多富裕国家，消费将很快反弹到接近新冠疫情前的水平，从而推动全球经济强劲复苏。另一家银行高盛预计，在美国，如果把超额储蓄都花出去，经济完全重启后的一年里GDP将增加两个百分点。这预示着产出和就业都会复苏得相当快。3月9日，富裕国家智库经合组织（OECD）把G20国家2021年的GDP增长预期上调至6.2%，因为它认为家庭储蓄意味着“被抑制的需求”。

然而，这类预测有很大的不确定性，这不仅仅是因为除了二战以外几乎没有其他先例可循。有两个因素很重要：一是积累的这些钱在众多家庭的分布情况；二是人们是把这些钱看作收入还是财富。

先说分配情况。似乎毫无疑问的是，在所有富裕国家，超额储蓄大部分都积聚在富人手中。他们最不可能失业。他们可以自由支配很大一部分开支，比如度假或外出就餐；而提供这些服务的很多企业在疫情期间是关闭的。大量储蓄集中在富人手中降低了封锁解除后出现消费热潮的可能性，因为有证据表明富人把新增收入花出去的倾向更低。

不过这种富人储蓄偏多的情况在各国也不尽相同。在许多国家，即使封锁结束，低收入者也没有任何超额储蓄可花。新冠疫情期间，欧洲最贫穷的四分之一家庭储蓄增加的可能性是最富有家庭的一半。在英国，最贫穷的五分之一家庭表示，自己在疫情期间存下的钱比以往更少。而在此期间，最贫穷的那部分加拿大人没有存下一分钱。

美国看起来与众不同。它的财政刺激措施异常慷慨。大部分成年人将领到第三轮1400美元的经济刺激支票。追加的失业救济金保证了很多失业者从政府领到的钱比之前工作时挣的还多。结果导致低收入的美国人存下的钱

相对于收入来说可能比富人更多。摩根大通研究所（JPMorgan Chase Institute）的一项新调查发现，去年12月底，最穷的美国人的银行存款余额比上一年高出约40%，而最富有的美国人的这一比例约为25%（见图表2）。过去一年里，最穷的一半人口的流动资产额增加了11%，是最富有的1%人群增幅的近两倍。一旦经济重启，中低收入者更有可能把存款花出去，从而推动经济复苏。

影响经济复苏的第二个因素的不确定性更大，即家庭是将这些现金视为收入还是财富。这不仅仅是语义上的区别。许多研究发现，家庭更有可能因为收入增加（如工资上涨）而非财富增加（如房屋升值）加大开销。各国家庭积累超额储蓄的方式各不相同。英国和欧元区的家庭是通过减少开销。人们不太可能将这样来的钱看作“额外收入”，英国央行货币政策委员会委员哥特扬·弗利葛（Gertjan Vlieghe）在最近的一次演讲中表示。相比之下，美国和日本的超额储蓄是刺激计划派钱增加了收入的结果，而不是通过削减开销积累的。在这种情况下，弗利葛表示，超额储蓄“可以被更合理地理解为‘额外收入’”，消费者可能更愿意把它们花掉。

这就与二战后的繁荣形成了一个鲜明对比。美国当时的经济复苏足以令人赞叹，但欧洲有过之而无不及——在整个上世纪50年代它的GDP增速比美国快了50%。这一次不一样了。美国有更多刺激支票在陆续寄出，美国消费者也更有可能花掉这些钱，随着疫情的消退，这回似乎轮到美国让其他富裕国家望尘莫及了。 ■



Chinese law firms

Expansion, your honour!

The Red Circle takes on the Magic Circle

HONG KONG'S Central district has long housed the offices of the world's poshest law firms. Recently a few of them, such as Baker McKenzie, Bryan Cave Leighton Paisner, and Freshfields, have left for parts of the city with cheaper rents. Central still teems with lawyers, except that more now toil for mainland firms like Zhong Lun, JunHe Law Offices and Fangda Partners.

These are members of the so-called Red Circle of elite Chinese practices that increasingly compete with London's venerable Magic Circle (of which Freshfields is one) and New York's white-shoe partnerships. And not just for office space. They are poaching legal eagles from Western rivals, or merging with them to create large groups such as Dentons (*Dacheng* in Mandarin). And they are opening outposts across the globe. The overarching aim, supported by authorities in Beijing, is to offer Chinese lawyering alongside other professional services, such as accounting, consulting and investment banking.

Chinese firms have so far made little headway in the City or on Wall Street. A study last year of 1,400 cross-border deals between 2010 and 2018 that involved at least one Chinese party, by Li Jing of Tilburg University in the Netherlands, showed that only 3% of law firms hired in China by American companies were Chinese. One reason may be cultural. From the West's wood-panelled boardrooms the Red Circle can look like arriviste apparatchiks. James William Freshfield, that firm's eponymous founder, died in 1864. Wei Xiao, who in 1989 launched JunHe, China's first law partnership, only recently stepped down as managing partner. Like Mr Wei, who used to work at the justice ministry, many founding partners came

from Beijing's officialdom. They speak its parlance and view the world through its lens. Their names often reflect traditional virtues.

Culture is not the whole story, however. For Chinese companies, too, have often preferred to retain Western counsel. Ms Li's research found that only one in six law firms hired by Chinese groups to help with foreign transactions were Chinese; nearly two in five were American. Even for inbound investments only about half of firms retained by Chinese companies were local. State-owned enterprises were less likely still to hire home-grown firms.

A bigger reason for the Red Circle's low profile is lack of experience in common law, which underpins much of international commerce. As Western companies globalised in the 1970s they brought their legal advisers with them, spreading the influence of British and American law firms. Many cross-border contracts are still inked in the common-law entrepôts of Hong Kong, London, New York or Singapore.

Part of Chinese law firms' effort to catch up with the Anglo-Saxons involves learning the rules of the old order, says Liu Sida of the University of Toronto. Hence the expansion in Hong Kong. In 1998 just one of Hong Kong's 49 registered foreign law firms came from mainland China. By 2017 about 30% of 84 such firms had their headquarters in Beijing or Shanghai, according to a study by Mr Liu and Anson Au, also of the University of Toronto.

Chinese practices are finding it easier to recruit local lawyers versed in common law, thanks in part to institutions such as Peking University's School of Transnational Law in Shenzhen, which offers degrees in both American and Chinese law. In recent years many more graduates have joined Chinese firms rather than American ones, which they overwhelmingly favoured in the past, observes its dean, Philip McConaughay. Growing size and an ability to compete with global rivals

on pay has “clearly lifted the prestige” of Chinese firms in a relatively short period, he says.

China is not content mastering the niceties of the old order. It is also subtly forging a new one around Chinese law. This begins by luring international students to its law schools, mostly from poor countries along the Belt and Road Initiative (BRI), its globe-spanning programme of infrastructure works. Plenty receive plush bursaries from the government in Beijing. Since only Chinese citizens can practise law in China, many foreign graduates prefer to return home, as paid-up members of China-friendly legal networks.

Some of these networks are formal. The All-China Lawyers Association, equivalent to Western bar associations, established an international group in 2019 to promote legal co-operation and is active in at least 36 countries. Chinese-owned firms like Grandall are setting up BRI practices. King & Wood Mallesons, created by the merger between a Chinese firm called King & Wood and Mallesons, an Australian one, has launched a think-tank-like affiliate to connect Chinese lawyers with local firms, companies and governments across Africa and Asia.

But it is informal webs that are more numerous, and possibly more powerful. Chinese companies seeking to enter new markets hire Chinese firms, which then enlist friendly local lawyers. The locals conduct due diligence, manage compliance with domestic law and appear in court on behalf of Chinese corporate clients, says Matthew Erie of Oxford University, who has studied such arrangements. The Chinese law firms oversee cross-border transactions and dispute resolution. Fees are split accordingly.

These networks attract less attention than new Red Circle digs in Manhattan or tie-ups with white-shoe firms, says Mr Erie. In time, they may nevertheless be as successful at spreading Chinese influence as Anglo-

Saxon law firms were in perpetuating that of the West. ■



中国律所

扩张，法官大人！

“红圈所”挑战“魔圈所”

香港的中环长久以来都是全球最顶尖律师事务所的聚集地。近年来其中的几家，如贝克·麦坚时（Baker McKenzie）、Bryan Cave Leighton Paisner和富而德（Freshfields），已经搬到了城中租金更便宜的地区。但中环仍有大量律师，只不过现在更多人是在为大陆的律所打工，比如中伦、君合和方达。

这几家都属于中国的精英律所，唤作“红圈所”，它们与伦敦久负盛名的“魔圈所”（富而德是其中之一）和纽约的“白鞋所”之间的竞争日趋激烈。当然不仅仅是争夺办公地点。“红圈所”正从西方竞争对手那里挖来律界大咖，或是与对手合并，成立像大成这样的大型集团。它们还在全球各地设立分支机构。它们的首要目标受到中国政府的支持，那就是和会计、咨询和投行等其他专业服务步调一致，提供中国的律师服务。

迄今为止，中国律所在伦敦金融城或华尔街还没有取得什么进展。荷兰蒂尔堡大学（Tilburg University）的李晶去年研究了2010年至2018年间至少涉及一个中方参与方的1400笔跨境交易，结果显示，美国公司在中国聘用的律师事务所中只有3%是中国律所。文化可能是原因之一。坐在西方全实木装潢的董事会议室里看去，红圈所可能像官僚暴发户。富而德的创始人詹姆斯·威廉·富而德（James William Freshfield）于1864年去世。而在1989年创办了中国第一家合伙制律所君合律师事务所的肖微最近才卸任管理合伙人一职。和曾在司法部工作的肖微一样，许多律所的创始合伙人都出自北京的官场。他们说着这个圈子的语言，也从这个圈子的视角看世界。这些律所的名字往往体现了中国的传统美德。

不过文化并不是唯一的原因。中国企业往往也更愿意请西方律所。李晶的研究发现，中国企业集团请来帮助开展海外交易的律所中只有六分之一是

中国的，近五分之二是美国的。即使是对内投资，中国企业请的律所也只有约一半来自本国。国有企业聘请中国律所的可能性还要更低。

“红圈所”不受青睐的一个更大的原因是缺乏英美法系的经验，而英美法系是大部分国际商贸的基石。西方企业在上世纪70年代拥抱全球化之时也带上了自己的法律顾问，扩大了英国和美国律所的影响力。现在许多跨境合同仍在香港、伦敦、纽约或新加坡这些英美法系转口贸易枢纽签署。

多伦多大学的刘思达表示，中国律所追英赶美的努力包括学习旧秩序的规则。因此它们扩张到了香港。根据刘思达和同在多伦多大学的区安森（Anson Au，音译）的一项研究，1998年，在香港注册的49家境外律所中只有一家来自中国大陆。到2017年，84家境外律所中约有30%的总部设在北京或上海。

中国的律所发现招募精通英美法系的本地律师变得容易起来，这一定程度上得益于位于深圳的北京大学国际法学院这样的机构。该学院提供中美法学双学位。院长菲利普·麦康纳黑（Philip McConnaughay）称，近年来越来越多的毕业生加入了中国律所，而不是他们以往极为青睐的美国律所。他表示，规模的扩大加之在薪酬水平上能与全球对手竞争使得中国律所在相对较短的时间里“明显提高了声誉”。

中国不满足于掌握旧秩序的细枝末节。它还微妙地围绕中国法律打造一个新秩序。首先，它吸引国际学生来到中国的法学院，他们大多来自“一带一路”沿线的贫穷国家，“一带一路”倡议是中国在全球推动的基础设施建设项目。很多人获得了中国政府提供的丰厚奖学金。由于只有中国公民才能在中国执业，许多外国毕业生选择回国，成为亲中法律网络的忠实成员。

其中一些网络是正式的。中华全国律师协会（相当于西方的律师协会）于2019年设立了一个国际部门以促进法律合作，目前它至少活跃在36个国家。像国浩所这样的中资律所正在启动服务“一带一路”项目。如今的金杜律师事务所是由同名中国律所与澳大利亚万盛国际律师事务所

(Mallesons) 合并而来，它成立了一个类似智库的下属机构，将中国律师与非洲和亚洲当地的律所、公司和政府连接起来。

但非正式的网络数量更多，可能也更强大。想要打进新市场的中国公司会聘用中国律所，这些律所继而招募乐于配合的当地律师。牛津大学的马修·伊利 (Matthew Erie) 研究过这样的安排方式，他说当地律师会做尽职调查，确保遵守当地法律，并代表中国企业客户出庭。中国的律所则负责跨境交易并解决纠纷。费用也相应地分开结算。

这些网络受到的关注比不上“红圈所”在曼哈顿的新据点或是与“白鞋所”的往来，伊利说。但假以时日，它们在传播中国影响力方面可能会大获成功，就像英美律所在延续西方影响力上所做的一样。 ■



Platform economics

The price of fame

What is a celebrity worth?

“THE WRITER of this piece deserves a big raise,” says Bret “The Hitman” Hart, a professional wrestler from the 1990s. “He is the best there is, the best there was, the best there ever will be,” he adds, echoing his old catchphrase. Your correspondent paid Mr Hart \$150 to sing his praises.

Mr Hart is one of over 10,000 celebrities on Cameo, an online service where anyone can commission famous people to film short messages. Its popularity has surged as celebrities seek new sources of income and confined consumers look for ways to spend money. Last year they paid some \$100m for 1.3m videos, more than in the previous three years combined. Talent on the site ranges from Jack Nicklaus, a golfer (\$1,000 per clip), and Vicente Fox, a former president of Mexico (\$300), to Barkley the Dog, a dog (\$5).

Cameo, like Uber, is a two-sided market. But most Uber users don’t care what car shows up, as long as it is clean, safe and gets them to their destination. On Cameo, the emotional connection between a fan and a star matters. “The price that a market will bear depends on the value being created for a potential customer,” says Jill Avery, a professor at Harvard Business School who has studied how online influencers price themselves. But “value” is hard to measure when it comes down to emotion.

How do celebrities figure out their fees? One way is through a simple opportunity-cost calculation. Steven Galanis, Cameo’s boss, recalls speaking to a basketball player on an annual \$25m contract. For a 40-hour work-week with a fortnight of holiday, that is \$208 per minute. “If he

charged \$100 and did two or three a minute, he could make more money on Cameo,” says Mr Galanis.

Most celebrities are freelance, though. They can try one of two strategies, says Ms Avery. One is “price skimming”—starting high and then lowering the price as demand ebbs. The second is “price penetration”, pricing low to maximise volume. Celebrities often use both, depending on how much time they have.

Another method is to test the market. This is surprisingly underused. Though celebrities can change their prices as often as they like, only about 30% have done so at least once, and less than 10% have done so more than five times.

Less rational reasons are at play, too. Snoop Dogg, a rapper famous for smoking copious amounts of weed, insisted on charging \$420, a number associated with pot culture. He could not keep up with demand and eventually raised his fee to \$1,000. Others charge a premium over perceived rivals or, led by ego, overprice themselves. But reality eventually intervenes. Mr Galanis remembers a TV personality who started at \$60 and found that demand was inelastic all the way up to \$99. But when she raised her price to \$125, demand dropped by half. Value, like fame, is eventually decided by the fans. ■



平台经济

名气的价格

名人身价几何？

“应该给这篇文章的作者大幅加薪，”上世纪90年代人称“杀手”的职业摔跤手布雷特·哈特（Bret Hart）说。“他现在是最强的，过去是最强的，未来也是最强的。”他又补了一句，把自己那句名言改了改。为了让哈特说出这句赞扬，笔者支付给他150美元。

哈特是线上服务Cameo上的一万多位名人之一。在这个平台上，任何人都能付费委托知名人士录制定制的短视频消息。时下名人们正在寻求新的收入来源，而困在家中的消费者寻找新的花钱渠道，推动了Cameo迅速蹿红。去年，消费者为130万条视频付费约一亿美元，超过之前三年的总额。网站上的才艺达人形形色色，有高尔夫球手杰克·尼克劳斯（Jack Nicklaus），每条视频收费1000美元；墨西哥前总统文森特·福克斯（Vincente Fox），每条300美元；狗狗巴克利（Barkley the Dog），每条五美元。

Cameo和优步一样，是个双边市场。但大多数优步用户并不关心召来的是什么车，只要它干净、安全、能把自己送达目的地就行了。而在Cameo上，粉丝和明星之间的情感联结很重要。“市场能够承受多高的价格，要看为潜在客户创造出了多少价值。”哈佛商学院研究网红如何自我定价的教授吉尔·艾弗瑞（Jill Avery）表示。但若这“价值”归结为情感，就难以衡量了。

名人是如何计算出自己的收费呢？一种方法是通过简单的机会成本计算。Cameo的老板史蒂芬·加拉尼斯（Steven Galanis）回忆自己曾和一位篮球运动员交谈。对方年薪2500万美元，按每周工作40小时、一年两周假期计算，相当于每分钟收入208美元。“如果他收费100美元，一分钟做两三个视频，那他在Cameo上能赚更多。”加拉尼斯说。

不过，大多数名人都是自由职业者。艾弗瑞说，他们可以尝试两种策略之一。第一种是“撇脂定价”——起价高，随着市场需求的减少再降下来。第二种是“渗透定价”——收费低，以实现销量最大化。名人通常两种都会用，主要看他们有多少时间。

还有一种方法是试探市场。出人意料的是，这种方法远没有被充分利用。虽然名人们可以随心所欲地更改定价，但只有约30%的人至少改过一次，不到10%的人改过五次以上。

不太理性的原因也在起作用。以吸食大量大麻出名的说唱歌手史努比狗狗（Snoop Dogg）原本坚持收费420美元，因为这个数字与大麻文化相关。但因为市场需求太大，他最终把收费提高到1000美元。其他人或是比心目中的对手收得更高些，或是在自尊心的驱使下给自己定价过高。但现实最终会教他们做人。加拉尼斯想起一位从60美元起步的电视名人，她发现一路提到99美元需求都没有什么变化。但当她涨价到125美元时，需求瞬间跌去一半。看来，所谓的价值，和名气一样，最终还是粉丝说了算。■



Oil prices

High and tight

Oil markets prepare for lofty prices and restrained supply

WHAT A DIFFERENCE a year makes. On March 6th 2020 Saudi Arabia and Russia failed to agree on a deal to restrain production. A price war ensued, with the two giants unleashing millions of barrels of crude just as covid-19 prompted lockdowns and demand dried up. Now Saudi Arabia and other producers are curbing output as demand rises. The price of Brent crude, the international benchmark, briefly climbed above \$70 a barrel on March 8th for the first time since May 2019. It dipped a little thereafter, to \$68 on March 10th.

The surge comes amid a broader boom for commodities from copper to corn, as Chinese imports rise and supply remains constrained. But oil's climb has been particularly vertiginous. In April last year the price of Brent dipped below \$20 a barrel and one American futures contract briefly became less than worthless. Since late October, however, Brent's value has risen by nearly 100%. By the third quarter, analysts at Goldman Sachs, a bank, reckon it could reach \$80.

Three successive events have helped jolt oil prices upwards this month. On March 4th the Organisation of the Petroleum Exporting Countries (OPEC) and its allies surprised the market by agreeing to extend production cuts to April. Then, on March 6th, America's Senate passed a \$1.9trn stimulus bill, which should boost economic activity in the country that remains the world's most voracious consumer of oil. Fears of supply disruption have raised prices further. On March 7th Houthis (Shia rebels fighting the Saudi-backed government in neighbouring Yemen) tried to attack Saudi Arabia's Ras Tanura, home to three giant oil-export terminals and a refinery that

supplies a quarter of the kingdom's fuel.

There was no damage to Ras Tanura, but the attack was the most significant since September 2019, when strikes briefly knocked out half of Saudi production. The latest attempt has rattled markets already anxious about America's recent air strikes in Syria. In addition to the higher risk of disruptions to Saudi output, it looks less likely that America will quickly lift sanctions on Iran, a giant crude producer whose exports have been reduced to a trickle, smuggled out on ships with transponders switched off to evade detection.

After the attacks in 2019 oil prices climbed briefly, note analysts at the Royal Bank of Canada, before subsiding amid confidence in ample supply. The market now looks much tighter. “Drill, baby, drill’ is gone for ever,” Abdulaziz bin Salman, Saudi Arabia’s energy minister, declared this month, referring to America’s shale industry. Texan oilmen may bristle at such a taunt, but investors will continue to rein in their capital spending. America may not reach its pre-pandemic levels of production until late 2023, reckons Rystad Energy, a research firm.

For now, OPEC and its allies look similarly restrained. Prince Abdulaziz remains particularly wary of raising production too soon. In addition to brokering the broader deal with OPEC and its allies, Saudi Arabia said it would extend its additional cut of 1m barrels a day through to April. Russia is slightly less cautious—it will increase output by a modest 130,000 barrels a day—but it has a new reason to keep prices up. Higher social spending means that the country now requires an oil price of \$64 a barrel to balance its budget, up from an average of \$51 in 2018 and 2019, estimates S&P Global Platts, a data firm.

For petrostates, there is a risk in keeping supply too tight. They want prices

to remain high enough to balance their budgets, but not so high that they trip up the recovery in demand. The distribution of vaccines has hardly been smooth (though there are signs of progress: on March 4th more than 2.6m doses were administered in America). India's oil minister, Dharmendra Pradhan, has asked OPEC and its allies to boost supply to lower prices and support the country's economic recovery, a plea that has so far won little sympathy. The oil cartel meets again on April 1st. ■



油价

看涨，吃紧

石油市场准备迎接油价高企和供应受限

一年的光景，竟有如此大的不同。2020年3月6日，沙特阿拉伯和俄罗斯未能就一项限产协议达成一致。一场价格战随后爆发，这两大巨头释放了成百上千万桶原油，而当时新冠肺炎正迫使各地实施封锁，需求也随之枯竭。而现在，需求上升之际，沙特和其他产油国正在抑制产量。3月8日，国际基准布伦特原油价格短暂攀升至每桶70美元以上，为2019年5月以来首次。此后稍有下跌，3月10日降至每桶68美元。

油价飙升之际，从铜到玉米的大宗商品经历了一轮广泛的繁荣，原因是进口增加而供应仍然受限。但是石油价格的攀升尤其令人晕眩。去年4月，布伦特原油价格跌破每桶20美元，一份美国原油期货合约一度变得一文不值。然而自10月下旬以来，布伦特原油价格上涨了近100%。高盛的分析师预计今年第三季度油价可能会达到每桶80美元。

本月，接连发生的三起事件助推油价上行。3月4日，石油输出国组织（欧佩克）及其盟友同意将减产延长至4月，出乎市场意料。之后在3月6日，美国参议院通过了一项1.9万亿美元的刺激法案，应该会促进该国的经济活动，而美国仍旧是世界上胃口最大的石油消费国。对供应中断的担忧进一步推高了价格。3月7日，胡塞武装（沙特的邻国也门的什叶派叛军，与受沙特支持的也门政府作战）试图袭击沙特的拉斯塔努拉（Ras Tanura），那里有三个巨大的石油出口码头，还有一座供应了沙特四分之一燃料的炼油厂。

拉斯塔努拉没有受损，但这次攻击是自2019年9月以来最严重的一次，当时的袭击一度导致沙特产油量减半。市场本就已经在为美国近期对叙利亚发动的空袭而忧虑，最近的这起企图袭击更是令市场紧张不已。除却沙特生产中断的风险增加这一点，看起来美国迅速解除对伊朗制裁的可能性也

降低了。伊朗是原油生产大国，其出口已经减少成涓涓细流，靠关闭了应答器以逃避检测的船只走私出去。

加拿大皇家银行（Royal Bank of Canada）的分析师指出，2019年的袭击发生后，油价短暂攀升，随后在市场对供应充足的信心中回落。现在市场供应看起来要紧张得多。沙特能源部长阿卜杜勒阿齐兹·本·萨尔曼

（Abdulaziz bin Salman）本月在提到美国页岩油产业时称，“钻啊，宝贝，钻吧”的日子一去不复返了。”这样的嘲讽可能会让得州的石油商们火冒三丈，但投资者还是会继续抑制住自己的资本支出。研究公司睿咨得能源（Rystad Energy）认为，美国的石油产量可能要到2023年底才能回到疫情前水平。

就目前而言，欧佩克及其盟友看起来同样克制。阿卜杜勒阿齐兹亲王对过快增产仍旧格外谨慎。除了与欧佩克及其盟友达成更广泛的协议，沙特还表示将把每日额外减产100万桶的措施延长至4月。俄罗斯略微放松些——它将把日产量小幅增加13万桶。但它现在又多了一个保持价格上涨的新理由。数据公司标普全球普氏（S&P Global Platts）估计，由于社会支出的增加，俄罗斯现在需要油价达到每桶64美元才能平衡预算，高于2018年和2019年的平均51美元。

对石油国家来说，保持供应过于紧张有其风险。它们希望价格能保持在足够高的水平以平衡预算，但又不能高到阻碍需求复苏。疫苗的分发难说顺利（不过有改善的迹象：3月4日当天美国注射了逾260万剂疫苗）。印度石油部长达曼德拉·普拉丹（Dharmendra Pradhan）请求欧佩克及其盟友增加供应以降低油价，支持该国的经济复苏，但目前为止这一请求并没赢得多少同情。欧佩克成员将于4月1日再度坐到会议桌前。■



Rupert Murdoch at 90

Next up

As the last great media mogul prepares to hand over his empire, investors and offspring get ready for a battle over its future

BIRTHDAY PARTIES in pandemics are dreary, even for billionaires. But Rupert Murdoch's 90th, which he celebrated on March 11th, should at least have been less stressful than his 80th. Back then British detectives were burrowing into a subsidiary of his firm, News Corporation, then the world's fourth-largest media company, for evidence that its journalists had hacked phones and bribed police. Several convictions later, and after the closure of the 168-year-old *News of the World*, Mr Murdoch was hauled before a British parliamentary inquiry on what he called "the most humble day of my life".

A decade on from the near-collapse of his empire, things are going rather better for the Australian-born tycoon. The phone-hacking scandal has receded. The choicest assets in his collection have been sold to Disney at the top of the market. Fox News is America's most popular (if also its most despised) cable channel. And in a coup last month, Mr Murdoch forced tech giants to pay for linking to his content. "He has the money. He has huge amounts of political power. He has it all," says Claire Enders, a veteran media-watcher.

As he prepares to pass it all on, the outlook is clouding over. Cable television is in hastening decline. A looming legal problem could prove even costlier than the phone-hacking affair. And the succession question—a decades-long saga which HBO, a rival network, cheekily dramatised—lingers on. Mr Murdoch is still the force that holds together a formidable commercial and political project. It may not stay intact without him.

The humbling experience of the phone-hacking affair turned out to be a

blessing. It forced Mr Murdoch to split News Corporation in two, putting the lucrative TV and film assets into 21st Century Fox (which analysts nicknamed “Good Co”). The scandal-hit newspapers were quarantined in News Corp (dubbed “Crap Co”). As the firms were modernised and power devolved to Mr Murdoch’s sons, Lachlan and James, investors returned. In his boldest move, in 2019, the great consolidator of the media business realised that it was time to become prey rather than predator, and sold most of the 21st Century film and TV business to Disney for \$71bn. Ms Enders and colleagues calculate that since 2011 the holdings of the Murdoch family trust, which has nearly 40% of the voting shares in each company, have appreciated more than sixfold.

The next chapter will be trickier. Start with Fox, the larger company, with a market capitalisation of \$24bn. The pandemic has speeded the decade-long decline of American cable TV. Last year cable subscriptions fell by 7.3%, to levels not seen in nearly 30 years. Fox, whose gross operating profit in the last financial year was \$2.8bn, has been insulated from this trend by its focus on news and sport, which streaming companies have yet to snatch. But something has changed. Whereas Fox used to trade at a premium to ViacomCBS and Discovery, two cable rivals, it now trades at a nearly 30% discount (see chart 1).

One reason is that the streamers are coming for sport. Amazon already covers the National Football League and is said to be seeking exclusive rights to some American-football games. Leagues want to reach young fans, and cannot get them on cable TV, where two-thirds of viewers are over 50. So cable companies are moving sport onto their own streaming services. Disney has ESPN+; Comcast announced in January that it would shut down its NBC Sports Network and shift programming to its Peacock service. Michael Nathanson, a media analyst, notes that without a streaming platform for sports, Fox is “the odd man out”.

Fox News, where Fox made about 80% of its money last year, has problems of a different sort. Its close relationship with Donald Trump's White House generated record ratings, but alienated advertisers and some investors. "Any company you hold, you want to see behave ethically," says one large shareholder. Fox is "in that grey area right now. It's defensible, but it's far less defensible than it was." Smartmatic, an election-software company, is suing the company for \$2.7bn for airing ludicrous claims that it rigged the presidential election. (Fox says it will fight the "meritless" lawsuit.) That sum would exceed the phone-hacking payouts.

Fox has reined in its support for Mr Trump, only to see viewers depart for right-wing upstarts like Newsmax and One America News. Fox News remains the most-watched cable channel in primetime. But viewership in February was down by 30%, year on year, even as that of its rivals, CNN and MSNBC, rose by 61% and 23%, respectively. One former Fox executive observes that, like Mr Trump's Republican Party, Fox News was trapped into "super-serving" an ultra-conservative minority of its audience. Now it risks losing it, without attracting less kooky viewers.

Ironically, "Crap Co" is having a better time. Newspapers in America, Britain and Australia provide the largest chunk of its revenue, followed by Australian pay-TV and HarperCollins publishing (see chart 2). But a big new contributor to profits is its majority stake in REA Group and in Move, two online property advertising companies. News Corp's share price has nearly trebled from its trough last April, thanks in large part to a surge in REA's shares.

Like Fox, the newspapers have had to deal with a global shift of advertising online. Ten years ago the Murdoch companies were collectively the world's third-largest seller of ads, says Brian Wieser of GroupM, the biggest media-buyer. Now they are outside the top ten. But the newspapers are further

along the digital transition than Fox is. Online subscriptions account for three-quarters of the total at the *Wall Street Journal*; even the *New York Post*, a perennially loss-making tabloid, reported a modest profit in the last quarter of 2020. A recent deal with Google will see the tech colossus pay News Corp for content as a result of a law passed by the Australian government, which News Corp's papers have backed. "The terms of trade for content are changing fundamentally," Robert Thomson, News Corp's chief executive, said on March 4th.

Still, with a market capitalisation of less than \$15bn, News Corp is worth less than the sum of its eclectic parts. Mr Thomson insists it is on a "course of simplification", having sold assets such as Amplify, an online education business, and Unruly, a video-ad platform. Many analysts think it should go further and separate the news businesses from the real-estate ones. At the moment, investors seeking growth are attracted by the property portfolio but put off by the legacy news brands, whereas investors looking for value like the newspapers but not the real estate.

Some also see a case for breaking up Fox. Mr Nathanson has argued that the firm should sell its broadcast-TV assets and sports channels, which the market seems to undervalue. Perhaps even Fox News could be spun off, if a buyer could be found: the brand is so controversial that it is all but unsellable, Ms Enders believes. A full leveraged buy-out of Fox could generate an annualised return on investment of roughly 25% over five years, calculates Morgan Stanley, an investment bank.

The biggest impediment to restructuring either firm's portfolio may be Mr Murdoch himself. When power is eventually handed down, "a break-up story will gain momentum," believes Brian Han of Morningstar, a broker. Will the next generation be willing to carve the empire up? And which of them will call the shots?

Lachlan is already installed as chief executive of Fox and co-chairman of News Corp. At Fox he has backed Tubi, an ad-supported streaming service, sports-betting ventures and Credible Labs, a credit-scoring agency. None is an obvious fit with the core news business. Insiders think he would be reluctant to trim the legacy assets. Particularly in Australia, “there is a lot of history that [Lachlan] feels very deeply part of”, says a former News Corp executive. “It doesn’t lend itself to clear-headedness.” Lachlan has “stars in his eyes” and wants to build the family empire back up through acquisitions, believes one disapproving shareholder (who also fumes at Lachlan’s recent purchase of the most expensive house in Los Angeles).

Whatever he wants, Lachlan may not get his way. On Rupert’s death, control of the family trust will pass to his four eldest children. James, who resigned from the board of News Corp last year and now has little to do with his father and brother, has made clear his disapproval of the companies’ right-wing editorial line and does not seem attached to the legacy businesses. Elisabeth has warned of the dangers of “profit without purpose” in the media. With their elder half-sister Prudence, who keeps a lower profile, they could alter the course of both businesses.

If the future of the firms is determined not just by commercial logic but by family politics, that would be fitting. The assets in play are political as much as they are economic. The purpose of the Murdoch empire has always been to wield power as well as to make money. “What is Fox News for?” asks a former executive. “Fomenting insurrection.” Both Fox and News Corp may yet face one themselves. ■



默多克九十岁

下一场大戏

当最后的媒体大亨准备移交他的帝国时，投资者和子女已经准备好为帝国的未来而战

疫情期间的生日派对很沉闷，即使是亿万富翁也一样。但鲁珀特·默多克（Rupert Murdoch）在3月11日庆祝90大寿的时候至少应该比他80大寿那天压力要小。当时，英国警方正深入调查他的新闻集团（News Corporation，当时是世界第四大媒体公司）旗下的一家子公司，寻找其新闻记者窃听电话并贿赂警察的证据。多人被定罪，已有168年历史的《世界新闻报》（News of the World）关闭，之后默多克被迫出席英国议会的听证会，他说那是“我一生中最卑微的一天”。

在他的帝国濒临崩溃的十年后，对这位澳大利亚出生的大亨来说，情况正变得越来越好。电话窃听丑闻已经平息。他最珍贵的资产在市场高位时卖给了迪士尼。福克斯新闻频道（Fox News）是美国最受欢迎（也可以说是最受鄙视）的有线电视频道。默多克在上个月取得了一次出其不意的成功，迫使科技巨头为他的新闻链接内容付费。“他有钱。他有巨大的政治影响力。他有一切。”资深媒体观察家克莱尔·恩德斯（Claire Enders）说。

在他准备把这一切交出来时，前方却笼罩着一层阴云。有线电视的衰落正在加速。一宗迫在眉睫的官司可能比电话窃听案付出的代价还要高。而继任问题仍然悬而未决，这延续数十年的传奇故事被竞争对手HBO隔岸观火地演绎成了剧集。默多克仍然是把一个强大的商业和政治工程凝聚起来的力量。离开他，这帝国可能难以保全。

电话窃听事件的丢脸经历最终却因祸得福。默多克被迫将新闻集团一分为二，将利润丰厚的影视资产归入21世纪福克斯（21st Century Fox）这家分析师口中的“好公司”（Good Co）。受丑闻打击的报纸业务被隔离在新闻集团之中——被叫作“烂公司”（Crap Co）。随着公司逐渐现代化，权力逐

步移交给默多克的儿子拉克兰（Lachlan）和詹姆斯（James），投资者又回来了。2019年，默多克跨出了最大胆的一步，这位媒体业大整合家意识到是时候从猎人变为猎物了，他以710亿美元的价格将21世纪福克斯的影视业务的大部分出售给了迪士尼。根据恩德斯和同事的计算，自2011年以来，默多克家族信托的持股已升值了六倍多，该信托在两家公司都拥有近40%的表决权股份。

下一个章节会更加棘手。先来说两家中规模更大的、市值达240亿美元的福克斯公司。疫情加速了美国有线电视已持续十年的衰落。去年有线电视用户减少了7.3%，至近30年未见的低水平。福克斯上一财年的营业利润总额为28亿美元，它还未受到这一趋势的影响，因为它所专注的新闻和体育赛事尚未被流媒体公司争抢。但有些事情已经发生了变化。福克斯之前的股价对ViacomCBS和探索频道（Discovery）这两家有线电视竞争对手存在溢价，而现在却为近30%的折价（见图表1）。

原因之一是流媒体们冲着体育节目来了。亚马逊已经在转播职业橄榄球大联盟（National Football League, NFL）的赛事，据说还在洽谈一些美国橄榄球比赛的独播权。各大体育联盟都希望吸引年轻的体育迷，但依靠有线电视做不到，因为它们三分之二的观众都超过50岁。因此，有线电视公司正在把体育节目转移到自己的流媒体服务上。迪士尼有ESPN+；康卡斯特（Comcast）1月宣布将关闭其NBC体育频道，把节目转到它的孔雀（Peacock）平台上。媒体分析师迈克尔·纳桑森（Michael Nathanson）指出，没有为体育赛事搭建流媒体平台的福克斯成了“异类”。

去年贡献了福克斯总收入约80%的福克斯新闻频道遭遇了另一种问题。它与特朗普任内的白宫关系密切，这让它的收视率创下纪录，但让广告主和一些投资者望而却步。“你投资任何一家公司，都希望它的行为符合道德规范。”一位大股东说。福克斯“现在处于灰色地带。它仍然可以自我辩护，但远不如从前有力了。”选举软件公司Smartmatic正状告福克斯荒唐宣扬它操纵大选，索赔27亿美元。（福克斯表示将把这场“毫无理据”的官司打下去。）这笔赔偿金将超过为电话窃听案支付的金额。

福克斯已经收敛了对特朗普的支持，结果观众却转向了Newsmax和One America News这样的右翼新贵。福克斯新闻仍是黄金时段收视率最高的有线电视频道，但2月的收视率同比下降了30%，而其竞争对手CNN和MSNBC的收视率分别上升了61%和23%。福克斯的一位前高管表示，就像特朗普的共和党一样，福克斯新闻频道也深陷“全力满足”超级保守派的少数观众不能自拔。现在，它有可能失去这一观众群，而又无法吸引到没那么古怪的受众。

有点讽刺的是，“烂公司”目前的财务状况要更好一些。美国、英国和澳大利亚的报纸业务是其收入的大头，其次是澳大利亚的付费电视和哈珀柯林斯出版集团（HarperCollins）（见图表2）。但是，它的一大新利润来源是它在两家线上房地产广告公司REA Group和Move持有的多数股权。新闻集团的股价已较去年4月的低点增加了近两倍，这在很大程度上要归功于REA股价的大涨。

和福克斯一样，这些报纸同样必须应对广告向线上转移的全球趋势。最大的媒体受众购买商群邑（GroupM）的布莱恩·维瑟（Brian Wieser）说，十年前，默多克的各家公司合起来是全球第三大广告销售商。现在，它们已经掉出前十名。但与福克斯相比，报纸在数字化转型方面走得更远。

《华尔街日报》的在线订阅量占总订阅量的四分之三；即使是长期亏损的小报《纽约邮报》（New York Post）在2020年最后一个季度也实现了微弱盈利。根据与谷歌达成的一项最新协议，这个科技巨头将向新闻集团支付内容费用，这缘于澳大利亚政府通过的一项相关法律，新闻集团旗下的报纸对这项立法表示了支持。“内容交易的规则正在发生根本变化。”新闻集团首席执行官罗伯特·汤姆森（Robert Thomson）在3月4日表示。

尽管如此，新闻集团不到150亿美元的市值仍然低于它各式业务价值的总和。汤姆森坚持认为，新闻集团正在经历“简化过程”，它已经出售了在线教育业务Amplify和视频广告平台Unruly等资产。许多分析师认为，它应该进一步将新闻业务与房地产业务分开。目前，寻求增长的投资者被它的房地产资产所吸引，却又因为它传统的新闻品牌却步，而寻求价值的投资

者看重报纸，对房地产不感兴趣。

有些人还认为应该拆解福克斯。纳桑森认为，福克斯应该出售被市场低估的无线电视资产和体育频道。恩德斯认为，甚至可以把福克斯新闻频道也剥离出来，如果能找到买家的话——这个品牌太具争议性，基本上卖不出去。投资银行摩根士丹利估计，充分利用杠杆收购福克斯可能会在五年内获得约25%的年化投资回报。

要调整两家公司中任一的业务组合，最大障碍可能是默多克本人。等到最终交接权力时，“将会很快上演一场分家故事。”券商晨星（Morningstar）的布莱恩·汉（Brian Han）认为。下一代会愿意拆分帝国吗？由谁来做主呢？

拉克兰已被任命为福克斯的首席执行官和新闻集团的联席董事长。他在福克斯收购了依赖广告的流媒体服务Tubi、几家体育博彩公司和信用评分机构Credible Labs。无一明显契合核心新闻业务。内部人士认为，他不会愿意削减既有资产。特别是在澳大利亚，“（拉克兰）深感在那里有很多难以割舍的历史渊源”，一位新闻集团前高管表示。“它难以叫人头脑清醒。”一位颇有微词的股东认为，满脑子幻想的拉克兰希望通过收购来建立家族帝国。他对拉克兰一两年前在洛杉矶以创下该市纪录的高价购置豪宅也大为不满。

无论拉克兰有什么目标，可能都无法如愿以偿。默多克去世后，家族信托的控制权将转移给他四个最大的孩子。詹姆斯去年辞去了新闻集团的董事职务，现在与父亲和拉克兰割席，他已明确表态不支持公司的右翼编辑方针，而且似乎并不留恋家族生意。伊丽莎白在媒体上警告了“无使命盈利”的危险。再加上较为低调的同父异母的姐姐普鲁登斯（Prudence），他们可以让两家公司都改弦易辙。

如果这些公司的未来不仅由商业逻辑决定，也由家庭政治决定，那倒恰恰呼应了它们自身的特性。因为它们运营的资产所具有的政治功能不亚于经济功能。默多克帝国的目标一直都是赚钱兼发挥影响力。“福克斯新闻频

道有何用？”一位前高管问到，“煽动叛乱。”福克斯和新闻集团自己倒可能要面对一场叛乱了。 ■



Spies and technology

Machine intelligence

Intelligence agencies are grappling with the promise—and pitfalls—of AI

WHEN IT comes to using artificial intelligence (AI), intelligence agencies have been at it longer than most. In the cold war America's National Security Agency (NSA) and Britain's Government Communications Headquarters (GCHQ) explored early AI to help transcribe and translate the enormous volumes of Soviet phone-intercepts they began hoovering up in the 1960s and 1970s.

Yet the technology was immature. One former European intelligence officer says his service did not use automatic transcription or translation in Afghanistan in the 2000s, relying on native speakers instead. Now the spooks are hoping to do better. The trends that have made AI attractive for business in recent years—more data, better algorithms, and more processing power to make it all hum—are giving spy agencies big ideas, too.

On February 24th GCHQ published a paper on how AI might change its work. “Machine-assisted fact-checking” could help spot faked images, check disinformation against trusted sources and identify social-media bots that spread it. AI might block cyber-attacks by “analysing patterns of activity on networks and devices”, and fight organised crime by spotting suspicious chains of financial transactions.

Other, less well-resourced organisations have already shown what is possible. The Nuclear Threat Initiative, an American NGO, recently showed that applying machine learning to publicly available trade data could spot previously unknown companies and organisations suspected of involvement in the illicit trade in materials for nuclear weapons. But spy

agencies are not restricted to publicly available data.

Some hope that, aided by their ability to snoop on private information, such modest applications could pave the way to an AI-fuelled juggernaut. “AI will revolutionise the practice of intelligence,” gushed a report published on March 1st by America’s National Security Commission on Artificial Intelligence, a high-powered study group co-chaired by Eric Schmidt, a former executive chairman of Alphabet, Google’s parent company, and Bob Work, a former deputy defence secretary.

The report does not lack ambition. It says that by 2030 America’s 17 or so spy agencies ought to have built a “federated architecture of continually learning analytic engines” capable of crunching everything from human intelligence to satellite imagery in order to foresee looming threats. The commission points approvingly to the Pentagon’s response to covid-19, which integrated dozens of data sets to identify covid-19 hotspots and manage demand for supplies.

Yet what is possible in public health is not always so easy in national security. Western intelligence agencies must contend with laws governing how private data may be gathered and used. In its paper, GCHQ says that it will be mindful of systemic bias, such as whether voice-recognition software is more effective with some groups than others, and transparent about margins of error and uncertainty in its algorithms. American spies say, more vaguely, that they will respect “human dignity, rights, and freedoms”. These differences may need to be ironed out. One suggestion made by a recent task-force of former American spooks in a report published by the Centre for Strategic and International Studies (CSIS) in Washington was that the “Five Eyes” intelligence alliance—America, Australia, Britain, Canada and New Zealand—create a shared cloud server on which to store data.

In any case, the constraints facing AI in intelligence are as much practical as ethical. Machine learning is good at spotting patterns—such as distinctive patterns of mobile-phone use—but poor at predicting individual behaviour. That is especially true when data are scarce, as in counter-terrorism. Predictive-policing models can crunch data from thousands of burglaries each year. Terrorist attacks are much rarer, and therefore harder to learn from.

That rarity creates another problem, familiar to medics pondering mass-screening programmes for rare diseases. Any predictive model will generate false positives, in which innocent people are flagged for investigation. Careful design can drive the false-positive rate down. But because the "base rate" is lower still—there are, mercifully, very few terrorists—even a well-designed system risks sending large numbers of spies off on wild-goose chases.

And those data that do exist may not be suitable. Data from drone cameras, reconnaissance satellite and intercepted phone calls, for instance, are not currently formatted or labelled in ways that are useful for machine learning. Fixing that is a “tedious, time-consuming, and still primarily human task exacerbated by differing labelling standards across and even within agencies”, notes the CSIS report. That may not be quite the sort of work that would-be spies signed up for. ■



间谍与技术

机器情报

情报机构正在与AI的希望和陷阱搏斗

就使用人工智能（AI）而言，情报机构探索它的历史比大多数人都长。在冷战时，美国国家安全局（NSA）和英国政府通讯总部（GCHQ）就摸索了早期的AI，以帮助转录和翻译他们在六七十年代开始拦截到的海量苏联电话。

但那会儿技术还不成熟。一位前欧洲情报官员说，他所在的机构在2000年代并未在阿富汗使用自动转录或翻译，而是依靠母语者。如今特工们希望做得更好。近年来让商业界对AI大感兴趣的那些趋势——更多的数据、更好的算法以及更高的处理能力推动了它的繁荣——也给间谍机构带来了宏大的构想。

GCHQ在2月24日发布了一篇有关AI如何可能改变其工作的论文。“机器辅助的事实检查”可以帮助发现伪造的图像，对比受信赖的来源查找虚假信息，并识别传播该图像的社交媒体机器人。人工智能或许可以通过“分析网络和设备上的活动模式”来阻止网络攻击，并通过发现可疑的金融交易链来打击有组织的犯罪。

其他资源不那么丰富的组织已经展示了AI的潜力。美国非政府组织“核威胁倡议”（Nuclear Threat Initiative）最近展示，把机器学习应用于公开可用的贸易数据，可能会发现以前未被察觉的公司和组织涉嫌参与核武器材料非法贸易。但是，间谍机构可使用的并不限于公开数据。

一些人希望，借助其窥探私密信息的能力，这类不起眼的应用可以为成为AI驱动的巨头铺平道路。美国人工智能国家安全委员会（National Security Commission on AI）于3月1日发布的一份报告热情洋溢地展望“人工智能将彻底改变情报实践”。这个位高权重的研究团队由谷歌母公司Alphabet的前执行主席埃里克·施密特和前国防部副部长鲍勃·沃克（Bob

Work) 担任联席主席。

这份报告不乏雄心壮志。它说，到2030年，美国的大约17个间谍机构应该会建成一个“持续学习分析引擎的联合架构”，能够处理从人类情报到卫星图像的一切事务，以预见潜在的威胁。委员会对五角大楼应对新冠疫情的方式表示赞赏——它整合了数十个数据集以识别疫情热点并管理供应需求。

然而，可以用在公共卫生里的方法要用在国家安全上并不总是那么容易。西方情报机构必须应付有关如何收集和使用私人数据的法律。GCHQ在其论文中表示，它将注意系统性偏差，例如语音识别软件是否对某些群体比其他群体更有效，并且在其算法的误差限和不确定性方面保持透明。美国间谍的说法更含混，说他们将尊重“人的尊严、权利和自由”。这些差异可能需要消除。在位于华盛顿的战略与国际研究中心（CSIS）发表的一份报告中，前美国特工近期成立的一个工作组提出的一个建议是“五眼”情报联盟（美国、澳大利亚、英国、加拿大和新西兰）创建一个共享云服务器来存储数据。

无论如何，情报领域的人工智能所面临的实践上的限制不亚于道德约束。机器学习擅长发现模式（例如独特的手机使用模式），但并不擅长预测个人行为。在数据稀缺的情况下尤其如此，例如在反恐行动中。预测性警用模型可以处理每年成千上万个盗窃案的数据。恐怖袭击事件要罕见得多，因此也更难分析学习。

这种稀缺带来了另一个问题——一个对于那些考虑大规模筛查罕见病的医护人员来说非常熟悉的问题。任何预测模型都会产生误报，把无辜者标记为调查对象。精心的设计可以降低误报率。但是，由于“基本比率”还要更低（谢天谢地，恐怖分子很少），即使是设计合理的系统也可能会派遣大量间谍去白费力气。

而且那些确实存在的数据可能并不适用。例如，人们还没有把来自无人机摄像头、侦察卫星和截获的电话中的数据做成对机器学习有用的形式或加

标注。CSIS报告指出，解决这个问题“繁琐、耗时且仍然主要是人工任务，而机构之间乃至内部不同的标注标准更是令它雪上加霜”。那可能并不是有志做间谍的人想要做的工作。 ■



China's financial opening

Over the great wall

Chinese markets shake off their casino reputation. Can foreigners actually win?

IN A WORLD where internet memes can explain market swings, China is second to none. Early in March, with mainland equities down by 15% in two weeks—their steepest fall in years—a video circulated on Weibo, a microblogging site, of a sheep stuck in a fence on a hill and a hiker climbing up to free it. The description of the video, in its meme incarnation, was “the national team comes to rescue me”. The national team is shorthand for big state firms that are believed to stabilise the market by buying shares when they plunge.

This video, though, had a twist. The hiker frees the sheep, only for it to lose its footing and tumble down the hill. Talk of the national team’s rescue mission had spread for a few days, but equities continued to tumble, wiping out all gains made since late last year.

At last, on March 9th, the national team really did arrive. State media reported that large state-owned insurers had bought stocks. Coincidentally or not, that heralded the market bottom. For casual observers of Chinese finance it all fit a familiar pattern: stocks careening from boom to bust, propelled by day traders and rumours, and the government eventually restoring calm.

But to those inside the market, the story was in fact more novel. The decline in Chinese shares neatly paralleled the decline in the NASDAQ, America’s tech-heavy stock index. Guan Qingshuo, a prominent Chinese economist, argued that the underlying trigger was nervousness about inflation in America. A resulting jump in American bond yields had sparked risk

aversion globally and hit China hard. Foreign investors, who had helped fuel China's equity rally last year, retreated. Reacting to the same signals, big domestic fund managers also rushed to pare their holdings.

The sell-off, in other words, furnished evidence about two important areas of progress in China's capital markets: they are both more professional and more interwoven with global finance than before. At the same time, incessant talk about the national team was a reminder of the idiosyncrasies of finance in a state-dominated economy—idiosyncrasies that matter ever more to the rest of the world.

Just five years ago no analysis of finance in China was complete without a detailed look at shadow banking. Formal banks were too strictly controlled to satisfy borrowing needs in the fast-growing economy. Stock and bond markets were underdeveloped. So between the cracks, lightly regulated institutions cropped up, willing to lend to anyone with collateral—especially property developers and miners.

Banks, despite their conservative exterior, had a big hand in shadow financing. They got around caps on deposit rates by funnelling savings into opaque “wealth-management products”, a chunk of which flowed through the shadow firms. Some of these products offered yields of over 10%. Yet they enjoyed informal guarantees from the state-owned banks, making investors think that they were as safe as deposits. The shadow-banking industry grew to 28.5% of banks' total assets in 2016.

Around that time a series of messy defaults alerted regulators to the dangers. They began a campaign to unwind the shadow financing. They forced trust companies to hold more capital. They stopped banks from offering guarantees on wealth products. And they opened the door to a new professional fund industry, pressing banks to launch formal wealth-

management subsidiaries, rather like asset-management groups in developed markets.

Banks are barred from investing in equities but the new divisions face no such rules. They cannot, however, offer guarantees. Contracts specify that in a downturn investors will face losses. Some banks' wealth units manage their own funds; others team up with outside managers. Much of the money flows into the stockmarket.

The ubiquity of mobile payments has given ordinary people another route to funds. With a few taps users of Alipay or WeChat Pay can choose from hundreds of products. China's 100m or so retail punters have long believed that they can beat professional investors. But that sentiment has shifted over the past two years and many are now buying into mutual funds at record pace, says Desiree Wang of JPMorgan Asset Management. Much as retail investors have been vocal on social media about the performance of individual stocks, they now debate, laud and criticise the performance of the country's top fund managers.

Funds are also becoming more sophisticated. Since the global financial crisis a stream of Chinese nationals has returned to Hong Kong and Shanghai from London and New York, bringing a new set of skills, says Louis Luo of Aberdeen Standard Investments, an asset manager. Funds once limited to plain-vanilla active management have brought in specialists to launch quantitative and absolute-return funds.

These trends have been magnified at China's big mutual funds. Three of the largest mutual-fund companies—China Asset Management, E-Fund and Southern Asset Management—have each surpassed 1trn yuan in assets under management. The rate of growth at mutual funds and at the banks' wealth-management arms is projected to take professionally managed assets in China from around 96trn yuan (\$14.7trn) in 2020 to 244trn yuan in

2029, or near the current size of the asset-management industry in America.

Part of that is a hedge-fund industry with Chinese characteristics. Regulators forbid the short-selling of individual stocks. But scores of big investment managers have emerged, with portfolios that encompass global and domestic assets as well as private and public markets. Operations at China's hedge funds are increasingly similar to those in global financial centres, says Gokul Laroia of Morgan Stanley, a bank. The biggest is Hillhouse Capital Management, run by Zhang Lei, with about \$70bn under management. Some are based offshore with a focus on China like Himalaya Capital, run in Seattle by Li Lu, once seen as a potential successor to Warren Buffett. Investors in China pay close attention to their decisions. When it was revealed last year that Mr Li had upped his stake in Postal Savings Bank of China, scores followed his lead. Shares in the bank, long derided as a stodgy state lender, have doubled in price since October.

Professional fund management is now approaching a tipping point. Retail investors still make up about 80% of average daily trading volume in the stockmarket; in America, even with the much ballyhooed rise in day trading, they account for just about a quarter. Yet institutional investors' holdings as a share of China's market capitalisation have increased from 30% in 2012 to about 50%. At this pace, says an executive at a Chinese asset manager, institutions' share of daily trading volume could hit 50% in the next five years. For foreign firms, the professionalisation of the markets could present an opening. Nothing in China comes easily, though.

For years many officials in China feared that wily Western "wolves" would gobble up the banking market. But Xu Zhong, a senior banking official, observed in 2019 that the problem was in fact the opposite. "We are not open enough," he said. This hindered development; competition was needed to help local firms improve. He added a rhetorical flourish of the kind that

wins debates in Beijing: the lack of opening goes against President Xi Jinping's doctrine that China must be confident in its system. China, he concluded, should be bolder.

Mr Xu's line of reasoning has so far prevailed. There are two separate but related openings that are now drawing Chinese and global finance more closely together. The first is the opening of China's capital markets to foreign investors. Funds allocated to China have risen rapidly since 2018. The inclusion of many onshore stocks into global indices, such as MSCI's flagship emerging-markets index, has led to tens of billions of dollars in passive fund allocation a year. There has also been a rush into the country's sovereign and policy-bank bonds, a tempting alternative to ultra-low-yielding bonds elsewhere.

There is still tremendous scope for growth. In the onshore stockmarket foreigners hold nearly 5% of Chinese shares; by comparison, foreigners own about 25% of American shares. Foreigners own just 3% of Chinese bonds, versus about 30% of the American market, and are overwhelmingly concentrated in government bonds. Corporate debt is still seen as too murky.

One obvious concern for foreign investors is whether they can get their money into and, crucially, out of, China. Doing so is now easier. Hong Kong's stock-connect programme, which allows trading in Chinese stocks, has fuelled a 40-fold increase in daily cross-border trading volumes in China since 2015. Repatriating profits through a qualified institutional-investor scheme used to take up to six months. Now it takes a few days. The real test will come if markets crash, as they did in 2015. Then, the government made it hard for foreigners to take funds out of the country.

The second dimension of China's opening is to foreign institutions.

Investment banks long touted China's potential yet were granted only glacial increases in their onshore presence. Things are speeding up, thanks in no small part to the deterioration in relations between America and China. Wall Street banks, the thinking in Beijing goes, are powerful lobbyists in Washington. Goldman Sachs, which set up its joint venture in China in 2004, is applying to take over 100% of its onshore investment bank. A number of other foreign banks, including Morgan Stanley and UBS, are expanding their domestic businesses.

The optimistic case is that these investments will, in time, pay dividends. The oft-repeated line from foreign financiers is that China is a long-term, strategic project. When SMIC, a semiconductor group, listed in Shanghai in July, it raised \$6.6bn, the largest offering in China since 2010. "That really got people wanting to do more work on initial public offerings (IPOs) and look beyond just secondary trading," says Christina Ma, head of greater China equities at Goldman Sachs. To be a full-service investment bank, a patchwork of licences is needed: for wealth management, underwriting and trading, to name a few. Some firms are putting them together. The disadvantages of being a foreign operator in the Chinese market are disappearing, says Eugene Qian, the chairman of UBS Securities.

The pessimistic view is that China is, and always will be, the market of the future. The head of a foreign bank in Shanghai describes China's regulatory demands as a "purity test". To obtain licences to operate, banks must have teams of underwriters and risk officers in place, all with the right qualifications. That drives up staffing costs before any revenue is earned. Vanguard, an American asset manager, recently halted plans to launch its own mutual-fund unit in China, citing the time it would take to build up a big presence.

Firms that do make inroads in China may face other headaches. HSBC was long the most successful foreign commercial bank in China. Now it is

caught between Beijing and America after being entangled in a dispute over Huawei, a Chinese telecoms giant. Banks will need to be skilful at managing both their relations with China's government and their portfolios to stand any chance of success.

The giant IPO of Ant, a fintech group, would have been a monument to the power of China's capital markets. Instead, it became a monument to the power of its government. Officials halted it in November, less than 48 hours before trading was due to begin in Shanghai and Hong Kong. Heavy-handed regulatory actions are the most obvious way in which the state exercises control over markets. But there are also two more subtle points of influence.

First, even as the government has pulled back from day-to-day economic management, state-run firms cast a shadow over everyday business. State-owned investment banks may be less capable than foreign upstarts. But most big firms that turn to the capital markets know to give most of their business to state players.

The state is also an investment force to be reckoned with. Government-guided funds, which channel cash to companies in priority sectors such as chipmaking, have amassed about 9trn yuan in capital, and are growing quickly, according to China Venture, a research firm. "If they choose to compete in a certain area, you know you can't outbid them," says the head of a big private Chinese investment company.

Second, the state sets rigid parameters around its markets. This is felt most acutely in foreign-exchange trading because of China's careful management of the yuan. Though it is now easier for investors to move money across borders, they still face a host of rules once in China. If foreign firms, for example, do well trading equities, they typically must take their profits out of the country before reallocating money to bonds. Moreover, there are few

currency-hedging tools in the onshore market, a hindrance for big investors. Offshore hedging is possible but expensive.

Over the past few months, the strength of currency inflows into China—via both its trade surplus and inbound financial investments—implied that the yuan should have appreciated strongly. The head of a currency desk at a foreign bank in Shanghai says the central bank, acting through proxies, appeared to restrain it. “Whenever the yuan rose to 6.45 [against the dollar], big Chinese banks came in to stop it,” he says. Without an open capital account, all prices in China’s markets end up skewed. Stocks in Shanghai and Shenzhen trade at a premium of roughly 30% over stocks in the same companies listed in Hong Kong.

Few dare to go against the state. The China head of a global hedge fund reports that one unusual aspect of the mainland is that securities regulators conduct random inspections, turning up without warning and demanding answers to probing questions. “They would only do that in New York if you’re under arrest,” he says.

Yet the controls around China’s markets can exert a pull of their own. Whereas China trails America in the size of its stock and bond markets, it is, by one measure, ahead in commodity futures. The number of contracts traded last year on its main exchanges (in Dalian, Shanghai and Zhengzhou) was six times higher than on America’s CME Group’s exchanges. In terms of value they were roughly equivalent.

It is not just that China has the biggest appetite for commodities, from copper to iron ore. It is also home to some of the world’s most liquid commodity exchanges. Smaller contract sizes make it easier for small companies to get involved in trading. And the very limits that Chinese investors face on investing offshore make commodity exchanges attractive.

“There may be more contracts on foreign exchanges but not many have truly excellent liquidity. In China most contracts are liquid, giving investors lots of opportunities,” says Sunny Fang of Orient Futures, one of China’s biggest futures brokerages.

Commodity futures also show how China’s markets shape global markets. Last April the price of oil futures in America collapsed below zero as demand evaporated and storage filled up. In China, though, futures stayed at around \$30 a barrel, with investors lapping them up. That attracted shipments to China and helped restore global oil prices to a more normal level.

“The information from Chinese futures is very clear. This is what the world’s biggest consumers are paying for commodities,” says John Browning of Bands Financial, a Shanghai-based futures brokerage. Whether in China or Texas, oil is oil, and prices should converge.

The information from China’s stock and bond markets is more abstract. It tells you about the health and direction of the economy—no small thing given China’s weight in the world. Yet interpreting it is not simple. Portfolio managers at Chinese investment groups have learned Western-style stock analysis but they also understand the Chinese regulatory environment, which can be crucial to performance, says Xu Yicheng of China International Capital Corporation, an investment bank. It is a divide that global firms and investors increasingly think they can, and need to, straddle.





中国的金融开放

跨越长城

中国市场摆脱“赌场”之名。外国人真能赢吗？

说到用网络热梗来呈现市场波动，中国的本领真是无出其右。3月初，中国大陆股市在两周内下跌了15%，创下近年最大跌幅，这时一段视频开始在微博上流传——山坡上，一只羊卡在了围栏上，一个登山者爬上去解救它。视频的标题“国家队来救我了”套用了一个热梗。“国家队”指的是人们认为会在股市暴跌时买入股票以稳定市场的大型国企。

然而这段视频还有反转。登山者把卡住的羊拉出后，它却失足滚下了山。有关国家队出手救市的消息传了好几天，但股市继续暴跌，抹掉了自去年年底以来的所有涨幅。

终于，3月9日这天国家队真的进场了。官媒报道称国有大型保险公司已经入市。不知是不是巧合，市场似乎开始触底反弹。在对中国的金融市场多少有些了解的人看来，一切都还是同一个套路：在日内交易者和谣言的推动下，股市先飙升，再暴跌，最终政府出手稳定市场。

但对于身处其中的人来说，这次波动实则有更多新鲜之处。中国股市的这波跌势紧随美国科技股指数纳斯达克的下跌。中国著名经济学家管清友认为，深层触发因素是对美国通胀的忧虑。美债收益率因此攀升，点燃了全球的避险情绪，给中国股市带来沉重打击。去年曾助推中国股市上涨的外国投资者纷纷撤退。国内大型基金经理也对同样的信号做出反应，竞相减仓。

换句话说，这波抛售证明了中国资本市场有两个重大进步：相比以往，它们变得更专业，与全球金融市场也更紧密地交织在一起。同时，人们对“国家队”的心心念念也显示出这个国家主导型经济里的金融市场有其特异性——这些特性对世界其他地区变得越来越重要。

仅仅在五年前，全面分析中国金融市场还少不了要仔细考察影子银行。正规银行受到严格管控，无法满足快速增长的经济对借贷的需求。股票和债券市场也不发达。于是，从夹缝中滋生出一些受到较少监管的金融机构，它们愿意向任何有抵押品的人放贷，尤其是房地产开发商和矿业公司。

银行尽管表面上保守，其实深度参与了影子融资。它们绕过存款利率上限这一障碍，把储户存款注入不透明的“理财产品”，其中的大头流入了影子金融公司。其中一些产品的收益率超过10%。但它们还享有国有银行的非正式担保，让投资者认为它们和存款一样安全。2016年，影子银行业务规模增至占银行业总资产的28.5%。

大约就在那时，一系列的违约乱象让监管部门意识到其中的风险。它们开始展开了一场去影子运动。它们要求信托公司提高资本金，禁止银行为理财产品提供担保，为一个新的专业化的基金行业打开大门，要求银行成立正式的理财子公司，就像发达市场的那些资产管理集团那样。

银行被禁止投资股市，而新设的理财子公司不受这些限制。不过理财子公司不能提供担保。合同写明，市场下跌时，投资者将面临损失。有一些银行的理财子公司管理自己的基金，也有一些与外部财富管理公司合作。这些资金有很大一部分流入了股市。

移动支付的普及给老百姓提供了又一条投资基金的途径。只消点击几下手机屏幕，支付宝或微信支付的用户就可以在成百上千种产品里做选择。中国约有一亿散户投资者，他们一直自以为能打败专业投资者。但过去两年，这种观念发生了转变，许多人现在正以破纪录的速度买入共同基金，摩根资产管理公司的王琼慧表示。散户投资者过去在社交媒体上大谈个股表现，同样，他们现在也会辩论和褒贬国内顶级基金经理的业绩。

基金也变得更为复杂。安本标准投资管理（Aberdeen Standard Investments）的罗勋表示，自全球金融危机以来，大批中国人从伦敦和纽约回流香港和上海，带来一系列新技能。以往只做简单的主动管理的基金公司现在聘雇专家来推出量化绝对收益基金。

这些趋势在中国大型共同基金公司中更加突显。华夏基金、易方达基金和南方基金是中国三大共同基金公司，管理的资产规模均超过了一万亿元。按照共同基金和银行理财子公司的增长速度，预计到2029年，中国由专业机构管理的资产将从2020年的约96万亿元增长到244万亿元，接近美国的资产管理行业目前的规模。

具有中国特色的对冲基金行业是其中的一部分。监管机构禁止做空个股。但中国已出现几十家大型投资管理公司，投资组合覆盖全球和国内资产、私人和公开市场。摩根士丹利的高浩灝（Gokul Laroia）表示，中国对冲基金的运作越来越接近于那些在全球金融中心里的基金。其中规模最大的是张磊管理的高瓴资本，所管理资产约为700亿美元。还有一些总部设在海外但专注中国市场，比如由曾被视为巴菲特接班人的李录在西雅图运营的喜马拉雅资本。中国的投资者密切关注他们的投资决策。去年，李录增持中国邮政储蓄银行股份的消息披露后，很多人随之而动。自去年10月以来，这家一直被嘲讽为古板的国有银行的股价已经翻了一番。

专业基金管理就要来到一个转捩点。在中国股市，散户仍占日均交易量的80%左右；在美国，即使出现了被大肆渲染的日内交易增长，散户也只占四分之一左右。但机构投资者的持股占中国股市总市值的比例已经从2012年的30%升至50%左右。一家中国资产管理公司的高管表示，按这个速度，机构在日交易量中的占比可能在未来五年内达到50%。对于外国公司来说，市场的专业化可能会带来机遇。不过，在中国，任何事情都不会那么简单。

多年来，中国许多官员担心狡黠的西方“狼”会吞噬掉国内的银行业市场。但银行业高级官员徐忠在2019年观察到，问题恰恰相反。“我们还不够开放。”他说。这阻碍了发展，需要引入竞争来推动本土公司升级。他还加上一句在北京无往不利的那种套话：开放不足违背了习近平的理论，即中国必须对自己的制度充满信心。中国应该再大胆一些，他最后总结说。

徐忠的想法到现在仍是主流。目前两个独立而又相关的开放行动使中国金

融和全球金融更紧密地联系起来。首先是对外国投资者开放中国的资本市场。自2018年以来，配置到中国的资金快速增加。许多大陆股票被纳入全球指数，如MSCI的旗舰新兴市场指数，每年因此有数百亿美元通过被动基金配置到中国市场。此外，人们也纷纷购入中国的主权债券和政策性银行债券，相比其他地区超低收益的债券，它们是诱人的替代选择。

这里面仍有巨大的发展空间。在大陆股市，外资持股近5%，相比之下美股的外资持股比例约为25%。外资持债约占美国债市的30%，而在中国仅为3%，而且绝大多数是政府债券。公司债仍被视为一池浑水。

外国投资者明显担忧的一点是，他们的资金能否自由进入和撤出中国大陆，后者尤为关键。这在现在变容易了。沪港通和深港通机制让境外资金可以交易大陆股票，自2015年推出以来已令中国股市每日的跨境交易量增长了40倍。通过合资格的机构投资者机制，现在只要几天就可以把收益收回，而过去要长达六个月。真正的考验将在市场崩溃时出现，就像2015年那样。当时政府设置的障碍让外国人很难把资金撤出中国。

中国开放的第二个层面是向外资金融机构开放。投资银行早就在大谈中国市场的潜力，但它们的在华业务却仅获准以龟速增长。现在开始提速了，这在很大程度上得益于中美关系的恶化。北京的想法是，华尔街投行在华盛顿有很强的游说能力。2004年在中国设立合资公司的高盛正在申请收购其大陆合资公司100%的股权。摩根士丹利和瑞银等一批外资银行也在拓展中国大陆业务。

情况乐观的话，这些投资将在日后带来红利。外国金融家总说中国是一个长期战略项目。半导体集团中芯国际去年7月在上海上市，融资66亿美元，是自2010年以来中国最大规模的IPO。“这确实让人们想在IPO上多下功夫，而不只是盯着二级交易。”高盛大中华区股票部主管马智萍说。在大陆开设全业务投资银行需要申请各种牌照，理财、承销和交易牌照只是其中几个。一些公司正把它们一一拿到手。外资机构在中国市场上的劣势正在消失，瑞银证券的董事长钱于军表示。

悲观的看法是，中国现在是，以后也一直会是一个“未来市场”。上海一家外资银行的负责人形容中国的监管要求是“纯度测试”。为拿到经营牌照，银行必须已经拥有全部具备相应资质的信贷审批和风险人员团队。这就使得它们在还没有赚得任何收入之时就要付出很高的员工成本。美国资产管理公司先锋领航（Vanguard）最近暂停了在大陆设立自己的共同基金的计划，理由是建立大规模业务会很费时间。

已经进入中国的公司可能会面对其他叫人头痛的问题。长期以来，汇丰银行一直是在中国最成功的外资商业银行。但自从卷入中国电信巨头华为的纠纷后，它就夹在中美之间左右为难。银行既要管理好投资组合，还要处理好与中国政府的关系，才有机会成功。

金融科技集团蚂蚁集团的巨额IPO本将成为见证中国资本市场力量的一座丰碑，最后却成了见证政府力量的丰碑。去年11月，距离在上海和香港启动交易仅剩不到48小时之际，这次IPO被官方叫停。铁腕监管行动是政府控制市场的最明显手段。但还有两个更微妙的影响点。

首先，即使政府已经从日常经济管理中抽离，国有企业仍给日常经营蒙上了一层阴影。国有投资银行的能力可能比不上新登场的外资投行，但求助资本市场的大公司多数都知道要把业务大头交给国有企业。

政府也是一股不可忽视的投资力量。据研究公司投中的数据，把资金导向芯片制造等重点行业企业的政府引导基金已经积累了约九万亿元的资金，而且增长迅速。“只要它们决定进入某个领域竞争，你就知道赢不了它们。”中国一家大型民营投资公司的负责人表示。

其次，政府给各个市场领域设置了严格的界限。这一点在外汇交易中感受最强烈，因为政府对人民币的管控尤其细致。虽然现在投资者跨境转移资金比以往容易，但只要是在中国境内，就仍需面对一系列规则。例如，如果外国公司在股票交易中获利，通常必须将收益先转出境外才能把资金重新分配到债市。而且，大陆市场的货币对冲工具不多，这对大投资者来说是个阻碍。虽然也可以离岸对冲，但成本高昂。

在过去几个月，按照资本流入（通过贸易顺差和对内金融投资）的势头，人民币本应强劲升值。上海一家外资银行的货币交易台负责人表示，央行似乎要抑制升值，它通过代理机构来干预。“每当人民币（兑美元）升到6.45时，大型中资银行就会入场阻止。”他说。没有开放的资本账户，中国市场的所有价格最终都会被扭曲。同一家公司的股票在上海和深圳股市要比在香港股市溢价约30%。

少有人敢和政府作对。一家全球对冲基金的中国区负责人表示，中国大陆非同寻常的做法之一是证券监管机构会随机检查，毫无预警地到访，刨根问底。“换了在纽约，被逮捕了才会有这种事。”他说。

不过，对中国市场的管控也可能产生一种独有的吸引力。虽然中国的股市和债市规模落后美国，但在一项统计上，它的大宗商品期货市场领先美国。去年大连、上海和郑州这三个主要交易所的交易合约数量是美国芝加哥交易所集团（CME Group）下属交易所的六倍。若按价值计算则大致相当。

中国不仅对从铜到铁矿石的大宗商品需求最大，还拥有世界上流动性最强的一些大宗商品交易所。较小的合约规模使小公司更容易参与交易。而中国投资者在对境外投资上所受的限制也让大宗商品交易变得有吸引力。“国外交易所的合约量可能更大，但真正流动性好的不多。在中国，大多数合约的流动性都很好，给投资者带来大量机会。”中国最大的期货经纪公司之一东证期货的方慧玲说。

大宗商品期货也显示了中国市场对全球市场的影响力。去年4月，随着需求蒸发和存储爆满，美国的原油期货价格跌破零。但在中国，随着投资者大量涌入，价格保持在每桶30美元左右。这使得更多原油发运中国，帮助全球油价恢复到较正常的水平。

“中国期货市场发出的信息非常清晰。这就是全球最大的消费国为大宗商品支付的价格。”上海的期货经纪公司磐石金融（Bands Financial）的约翰·勃朗宁（John Browning）表示。不管是在中国还是在美国得州，石油

还是石油，价格应该会趋于一致。

来自中国股市和债市的信息就更抽象了。它透露出中国经济的健康状况和走向——鉴于中国在全球经济中的比重这非同小可。但要解读这些信息却不容易。投行中国国际金融公司的徐翌成表示，中国投资机构的投资组合经理已经掌握了西方那一套股市分析法，但他们同时还了解中国的监管环境，而这一点对投资表现可能至关重要。全球企业和投资者越来越觉得自己能够、也需要跨越这道鸿沟。 ■



The sperm and egg business

Swimming freestyle

America's love of free markets extends to its fertility clinics

EVERY TIME one of America's genetic-testing companies advertises a deal on DNA kits, Michael (not his real name) braces himself for what may follow: a message from one of his hitherto unknown offspring. Three decades ago, as a student at the University of Houston, Michael became a sperm donor; the clinic would "pull me out of retirement", he says, every time a customer wanted to expand their family. So far, the 55-year-old knows of around 60 children (and a dozen grandchildren) he has sired in addition to the four teenagers he shares with his wife; he suspects the true number is closer to 100.

"I could write a book," he says, about the lifelong consequences of what had seemed, at the time, like an easy buck and an incentive to live healthily (he steered clear of heavy drinking and drugs to preserve his sperm's motility). Several children contact him regularly. He has been surprised by how many had been led to believe the father who brought them up was their biological parent: "Sometimes they're very angry they've been lied to all their lives". He is aware of some offspring who know his identity but have not made contact, and of a Facebook group he is not part of "so they can compare notes". He gets a lot of cards on Father's Day.

An ever-increasing number of men (and women who donate eggs) will have similar experiences. Because America's sperm- and egg-donor industry is largely unregulated, no one knows how many children have been conceived this way. But social changes mean the industry is going through a period of extraordinary and unprecedented growth. Most of the children Michael fathered were born within heterosexual marriages. Today such couples

constitute a minority of clinics' customers, in part because advances in reproductive medicine mean more couples with fertility problems are able to conceive. But there are two bigger reasons for the change: the legalisation of gay marriage and the rising number of single women who are choosing to become mothers. The majority of sperm banks' customers today are gay couples and women without partners.

Rosanna Hertz of Wellesley College, the author of "Random Families", says the market is booming as gay Americans reach marrying age and elective single motherhood becomes more widespread. Partly because conceiving using donor sperm is a lot more straightforward and affordable than doing so using donor eggs, children born through sperm donors are likely to outnumber those from egg donors.

Surging demand and an absence of government regulation have created a field that has developed "more like a business than medicine", says Dov Fox of the University of San Diego, the author of "Birth Rights and Wrongs". The line is often blurred. Regulating baby-making can raise difficult ethical questions about who should be parents and who should be born. But some elementary regulations are overdue, not least because clinics are already making such decisions: requiring, for example, that sperm donors should be a certain height and educated to college level.

The most obvious gap is a legal limit on the number of children a sperm-clinic donor, however tall and brilliant he may be, can help create. America is one of the few countries to have no such cap (Britain, by comparison, has a limit of ten donor-created families per donor). Many clinics have their own limits. Jaime Shamonki of Generate Life Sciences, which operates California Cryobank, America's biggest sperm bank, says although people worry that large groups of half-siblings could lead to incest, a bigger concern is that a donor with an undiagnosed hereditary health condition may spread

it widely.

But without a law, even self-imposed limits are routinely flouted. Alan (not his real name) reckons he fathered “hundreds” of children as a result of the four years he donated sperm to a clinic three times a week. Because he had a high sperm count, most of his donations were divided into 15 to 20 vials (one is used per insemination effort) and they tended to sell out. The clinic, he says, never mentioned a limit on the number of children he would beget, though he is not complaining; in his most lucrative year he made \$50,000.

Beside health concerns, there is another important reason for limiting a donor's fecundity. The children of sperm and egg donors, like those who are adopted, often want to trace their blood relations. But it is difficult to forge strong relationships when vast numbers of children are involved. Wendy Kramer of the Donor Sibling Registry, which helps connect members of donor families, says this is an example of how the contract between clinics and would-be parents has ignored the interests of the children it produces. She established the group in 2000 after her then ten-year-old son, conceived using donor sperm, had become curious about his wider family. Last month he learned of the existence of two new half-siblings, bringing the tally to 22. Ms Kramer had been told her sperm donor would father no more than ten children, a limit she considers sensible.

Related to this is the issue of anonymity. Most sperm clinics in America offer donors the option of remaining anonymous until a child is 18, or for ever. But because donor-conceived children, like adopted ones, fare better psychologically when told of their origins from babyhood and allowed to trace their relatives if they wish to, there is a push to prohibit anonymity. It is, in any case, a false promise, thanks to DNA testing. There would be a cost: when anonymity is banned the number of donors falls. Other countries have decided that is a price worth paying for children's well-being. Anonymity (and the fact that donors can be paid) is one of the reasons

America has become an exporter of sperm.

Many observers would also like a law requiring clinics to do more comprehensive screening for health conditions. In 2014 a once-popular donor who had fathered innumerable children in several states and at least two other countries was found to have lied about being a polyglot neuroscientist with an IQ of 160 and perfect health. He was, rather, a university drop-out with a criminal record and several health disorders. The case has sparked multiple lawsuits against the clinic in Georgia that had marketed and sold his sperm without checking his medical records or conducting a criminal check. Several were dismissed on the ground that the clinic was not breaking the law. ■



精卵生意

自由泳

美国对自由市场的热爱延伸到生育诊所

每一次有哪家美国的基因检测公司促销DNA试剂盒，迈克尔（化名）都会为接下来可能发生的事做好心理准备：某个他尚未相认的子女将发来消息。30年前，还在休斯敦大学就读的迈克尔捐过精子。他说，每当有顾客想要家里添人进口，这家诊所就会“把我请出山”。据现年55岁的他所知，除了与妻子生育的四个十来岁的孩子外，他还有约60名子女（以及十几个孙子女），他怀疑真实数字接近100。

关于这延续终生的后果，“我可以写一本书了。”他说。当时他捐精只想着能轻松赚点钱，还可以激励自己坚持健康的生活方式（为保持精子的活力，他不酗酒也不吸毒）。有几名子女一直与他保持联系。他惊讶地发现，他们当中有很多人都受了误导，以为养父就是生父，“有时他们非常愤怒自己竟被骗到现在。”他知道有些子女虽知道他的身份，但至今没联系过。他也知道有一个Facebook群组（他没进群），“他们可以在那里交流想法”。每年父亲节他都会收到很多贺卡。

越来越多男性（以及捐卵的女性）将会有类似的经历。由于美国的精子卵子捐献行业很大程度上不受监管，没人知道有多少孩子是通过这种方式受孕出生的。但社会变迁意味着这个行业正经历一段前所未有的非凡增长期。迈克尔捐精所生的大多数子女都是在异性夫妇家庭里出生的。今天，这样的夫妇在生育诊所的客户中只是少数，原因之一是生殖医学的进步使得更多不孕不育夫妇最终能够怀孕生产了。但还有两个更大的原因：同性婚姻合法化和越来越多单身女性选择成为母亲。如今精子库的大部分客户是同性夫妇和单身女性。

《随机家庭》（Random Families）一书的作者、韦尔斯利学院（Wellesley College）的罗珊娜·赫兹（Rosanna Hertz）表示，随着美国同

性恋者达到适婚年龄，加上女性自愿成为单亲母亲的情况变得更普遍，辅助生育市场蒸蒸日上。一定程度上因为捐精受孕要比捐卵受孕简单和便宜得多，捐精出生的孩子数量很可能会超过捐卵出生的。

《出生的是与非》（*Birth Rights and Wrongs*）的作者、圣地亚哥大学的多夫·福克斯（Dov Fox）说，需求激增和政府监管缺位让这个领域的发展“更像一门生意，而非医学”。其中的界限往往模糊。对辅助生殖的监管会引发棘手的伦理问题，即谁有资格成为父母以及谁有资格出生。但一些基本监管是早就该做了，尤其是因为诊所已经在自行做出相关决定：比如要求精子捐赠者应达到一定的身高，具备大学以上学历。

最突出的监管缺口是对一个捐精者的造人数量设定法律上限，无论他多高大多聪明。美国是少数几个没有这类上限的国家之一（相比之下，在英国，每位捐精者最多能向十个家庭捐献）。许多诊所都自设了上限。美国最大的精子库是加州精子银行（California Cryobank），其运营公司制造生命科学（Generate Life Sciences）的海梅·沙蒙基（Jaime Shamonki）说，虽然人们担心大量同父异母的兄弟姐妹会导致近亲通婚，但更大的风险是捐精者未被诊断出的遗传性健康问题可能会广泛传播。

但在没有法律的情况下，就算诊所自行设定了限制，也常形同虚设。艾伦（化名）曾在四年里每周三次向一家诊所捐献精子，据他估计，自己是“几百个”孩子的生父。因为他的精子量多，大多数捐赠都被分装至15到20个小瓶内（每次授精用一瓶），而且它们一般全都能卖出去。他说，诊所从没提过有造人数量的限制，不过他也没什么怨言——收成最好的那一年他赚了五万美元。

除了健康问题，对捐精捐卵的使用设限还有一个重要原因。和被收养的孩子一样，捐精捐卵生子女往往也想追溯自己的血缘关系。但如果牵涉的孩子数量庞大，就不容易结成紧密关系。捐赠者子女登记系统（Donor Sibling Registry）帮助捐赠者家庭成员建立联系，该组织的温迪·克雷默（Wendy Kramer）说，这是诊所和想受孕的父母之间的合同忽视了孩子

利益的一个例子。她在2000年创建了该系统，因为她当时十岁的儿子（通过捐精受孕出生）开始对自己背后的大家庭感到好奇。上个月，他得知自己又多了两个同父异母的手足，现在已有22个兄弟姐妹。诊所曾告诉克雷默说她的精子捐赠者造人数量不会超过十个，她认为这个上限是合理的。

与之相关的问题是匿名。美国大多数精子诊所都允许捐精者选择在孩子18岁之前保持匿名或永久匿名。但是，和被领养的孩子一样，通过捐精孕育的孩子如果从小就了解自己的出身并可以按自己的意愿追溯亲缘关系，他们的心理会更健康，所以有人呼吁禁止匿名捐赠。不论如何，有了DNA测试，匿名捐赠不过是个空头承诺。而禁止匿名是有代价的：捐赠者人数会下降。已有一些国家决定，为了儿童的福祉，这样的代价值得。美国已成为一个精子出口国，匿名（以及有偿捐精）是原因之一。

许多观察人士也希望政府制定法律要求诊所做更全面的健康筛查。2014年，一个曾在美国多个州和至少两个其他国家捐精孕育了众多子女的男子的谎言被识破，他自称神经科学家、通晓多国语言、智商160且非常健康。而实际上他大学辍学，有犯罪前科，患有多种疾病。这引发了对他向之捐精的佐治亚州的生育诊所的多起诉讼，这家诊所在没有事先查核他的病历和犯罪记录的情况下就兜售了他的精子。其中几起诉讼被驳回，理由是该诊所并没有违法。■



Vaccine-making

Racing ahead

One firm. One year. One billion shots or more. Can India's Serum Institute do it?

ON MARCH 5TH 2020 Mumbai's horseracing season culminated with the Poonawalla Breeders' Multimillion, a day-long extravaganza dominated by India's first family of the sport, the Poonawallas. Triumphs at the track were accompanied by news reports on the Bollywood lifestyles of Adar Poonawalla and his wife, Natasha, whom *Elle* magazine described as "India's first lady of fabulousness". Only cursory attention spilled over to the couple's day job running Serum Institute of India, the press-shy vaccine-maker at the root of the family fortune.

A year on it is the company, not its flamboyant owners, that is making headlines. As the covid-19 vaccination drive encounters production glitches in Europe, hits distribution snags in America and faces a geopolitical scramble for supply everywhere, Serum Institute has emerged as the one firm apparently able to ramp up production fast and export the doses without courting controversy. By the end of the year, Mr Poonawalla says, it will add 1.5bn covid-19 shots to 1.3bn-1.5bn doses against diseases from measles to tuberculosis that it already produces annually. On February 23rd it dispatched the first mass shipment, of 70m shots of the Oxford-AstraZeneca vaccine, to India and two dozen other poor countries in the COVAX vaccine-sharing programme. On March 1st Canada said it will procure 500,000 doses from the company. The relatively small family concern, which entered last year with annual revenues of \$735m and a workforce of 6,000, is becoming mission-critical to the global fight against the coronavirus.

Mr Poonawalla's plans are ambitious, to put it mildly. He wants to raise

monthly production of the Oxford vaccine from the current 60m-70m to 100m by April. That month the company will start churning out 40m-50m of a shot developed by Novavax, an American biotechnology firm, to build up a “large stock” as it undergoes accelerated review by a number of global regulators. By late summer Serum Institute expects to be making another vaccine, by SpyBiotech, a British startup. In early 2022 it hopes to be producing a one-dose nasal vaccine being developed by Codagenix, another American biotech firm.

Mr Poonawalla estimates that until rivals’ new capacity comes online in the autumn, his company’s output will account for perhaps 40-50% of the world’s supply. Unlike Pfizer, an American drug giant which recently upped its production goal from 1.3bn to 2bn doses this year, Serum Institute’s shots are cheap and do not need to be stored at ultra-low temperatures. They will inoculate swathes of the poor world.

Some of the factors behind the company’s rise to prominence, like the pandemic and scientists’ rapid response to it, have been beyond its control. But Serum Institute has also placed bold bets that run counter to the traditional process of making vaccines, in which investments in capacity and distribution follow years of research, then more years of clinical trials for safety and efficacy. A brief conversation last April, between Mr Poonawalla and his father Cyrus, Serum Institute’s founder, resulted in a decision to start producing the Oxford vaccine before any clinical trials had begun.

It is the latest daring coup by the Poonawallas. In the 1960s Cyrus turned his horse-breeding business into one that used retired steeds as living vessels to create antibody serum for treatment of snake bites, tetanus and other scourges. Forty years later his son, who has been chief executive since 2011, has added 165 countries as customers (often while courting Natasha on holidays). International sales now account for 70% of the firm’s total. In

December Serum Institute released the first vaccine to be fully developed in India, against a variant of pneumonia which kills 68,000 Indian children a year.

The company's initial investment of \$80m in capacity to produce the untested Oxford shot came from its billionaire owners' own pocket—a tidy sum next to the previous year's \$46m in capital expenditure. Since then Serum Institute has received a further \$800m: \$270m from the Poonawallas, \$300m from the Bill & Melinda Gates Foundation, the world's biggest charity, and the rest from prepayments by governments, including those of Bangladesh and Morocco.

The privately held firm will not say how much of that money has already been deployed. But Mr Poonawalla says it has doubled production capacity. It could do this quickly, he adds, thanks to a strategy of installing "excess capacity ahead of demand". For decades it had been adding a new building each year; one that was ready to go shortly before the fateful chat between father and son was immediately repurposed for the covid-19 effort.

A long-standing collaboration with Oxford and Novavax as part of an effort to create a malaria vaccine allowed Serum Institute to secure their recipes early. Deep relationships with suppliers of everything from glass vials to expensive "bioreactors" for the production of biological substances have helped smooth procurement. Serum Institute has hired 1,000 new employees, increasing its workforce by a sixth. Another 500 construction workers are putting up new buildings with higher production capacity to add to the 30 or so that the company has erected over the years.

At the current pace, Mr Poonawalla thinks, it will take at least two years for the global supply of covid-19 jabs to meet demand. It could take less if the world's regulators co-ordinated more closely for the duration of the crisis, he ventures. Until then Serum Institute expects to be selling the jabs

more or less at cost, which means about \$3-5 a dose for the Oxford vaccine. After that, margins will eventually rise. "This situation will last for a long time and there will be future demand," Mr Poonawalla predicts. Covid-19 looks certain to become endemic in many parts of the world, with annual vaccination drives akin to those for influenza becoming the norm. His firm's output will peak at 600m-700m doses a year for each of the four vaccines it is currently eyeing, he says.

The pandemic will leave vaccine-making more prominent than ever before, Mr Poonawalla believes—and much more crowded. This will inject competition into what most drugmakers consider a thankless volume business with considerable capital outlays. A fire earlier this year at one new building sent a shudder down the spines of the world's covid-responders until the company assured them that the accident, which affected a production line for a tuberculosis jab, will not hurt the pandemic effort. Although the bet on the Oxford vaccine has paid off, and the one on Novavax looks likely to, Codagenix and SpyBiotech are not yet shoo-ins. And vaccine nationalism could stymie exports from India or imports of ingredients and kit.

Mr Poonawalla nevertheless remains confident that his firm will maintain its leading position. In contrast to big pharma, which spends billions on marketing costly medicines, it sells its vaccines chiefly to national health authorities, which prize low prices and reliable supply above all. Those have always been Serum Institute's strong suits. And the Indian company's remarkable response to covid-19 has bought it more global goodwill than any advertising campaign could hope to. ■

For an interview with Adar Poonawalla visit economist.com/serumpod ■



疫苗制造

一马当先

一家公司，一年时间，生产10亿剂甚至更多——印度血清研究所能做到吗？

去年3月5日，普纳瓦拉百万奖金赛马会（Poonawalla Breeders' Multimillion）将孟买的赛马季推向高潮。在一整天的盛会上，印度赛马第一家族——普纳瓦拉家族——是绝对的主角。他们不仅仅是赛场上的王者。媒体还争相报道阿达尔·普纳瓦拉（Adar Poonawalla）和妻子娜塔莎（Natasha）宝莱坞明星式的生活方式——《Elle》杂志曾将娜塔莎誉为“印度最美女性”。这对夫妇的正职——经营印度血清研究所（Serum Institute of India）——只被媒体一笔带过。而这家向来很少见诸报端的疫苗制造商正是这个家族的财富根基。

一年过去了，如今登上各大媒体头条的是这家公司，而不是它招摇的主人。随着新冠疫苗接种行动在欧洲遭遇生产问题，在美国遭遇分配问题，并且在世界各地都面对一场地缘政治上的供应争夺战，血清研究所脱颖而出——这看起来是一家有能力快速提高产量，并在不引发争议的情况下出口疫苗的公司。普纳瓦拉表示，到今年年底，公司将在现在年产13亿至15亿剂麻疹和结核病等疾病疫苗的基础上，再生产15亿剂新冠疫苗。2月23日，它向印度和其他20多个加入了新冠疫苗实施计划（COVAX）的贫穷国家派发了第一批7000万剂牛津-阿斯利康疫苗。3月1日，加拿大表示将从该公司采购50万剂疫苗。这家规模不算大的家族企业去年初还只有7.35亿美元年收入以及6000名员工，现在正成为全球抗击新冠病毒的中坚力量。

雄心勃勃不足以形容普纳瓦拉的计划。他希望到4月份将牛津疫苗的月产能从目前的6000万到7000万剂提高到1亿剂。4月，该公司将开始量产4000万到5000万剂由美国生物技术公司Novavax研发的疫苗，从而在全球一批监管机构加速审批其疫苗之时建立起“大量储备”。血清研究所期望能在夏末之前生产由英国创业公司SpyBiotech研制的另一种疫苗。它还希望

自2022年初生产由另一家美国生物技术公司Codagenix研发的单剂鼻腔疫苗。

普纳瓦拉预计，在今年秋季竞争对手提高产能之前，自己公司的产量可能会占到全球供应量的40%至50%。美国制药巨头辉瑞最近将今年的生产目标从13亿剂提高到20亿剂。而与辉瑞不同的是，血清研究所的疫苗价格低，且不需要在超低温下储存。它们将被贫困国家的大批人群接种。

该公司之所以能崭露头角，有些因素不由它掌控，比如这场疫情以及科学家对疫情的快速应对。但是血清研究所本身也大胆下注，没有遵循传统的疫苗制造流程。过去，在对疫苗的产能和分配做出投资之前，需等待多年的实验室研究，再等待几年的安全性和有效性临床试验。去年4月，普纳瓦拉和他父亲、血清研究所的创始人塞勒斯（Cyrus）在一次简短的交谈后，决定在还没有任何临床试验启动之前就开始生产牛津疫苗。

这是普纳瓦拉家族最近一次成功的冒险。上世纪60年代，塞勒斯把自己的养马业变成了另一门生意——将退役的赛马用作活容器，用于制造治疗蛇咬伤、破伤风和其他疾病的抗体血清。40年后，他儿子（自2011年开始担任公司CEO）把疫苗卖到了165个国家（常常是在假期追求娜塔莎的时候把生意谈成的）。目前，国际业务占到公司总销售额的70%。去年12月，血清研究所投放了首个完全在印度研发的疫苗，用于治疗一种每年导致6.8万名印度儿童死亡的肺炎变体。

该公司一开始为生产未经试验的牛津疫苗投入了8000万美元，这笔钱来自身为亿万富翁的普纳瓦拉的私人腰包——与上一年4600万美元的资本支出相比，这是相当大一笔钱。此后，血清研究所又收到了8亿美元：其中2.7亿来自普纳瓦拉家族，3亿来自全球最大的慈善机构比尔和梅琳达·盖茨基金会，其余则是孟加拉国和摩洛哥等国政府的预付款。

这家私人控股的公司不愿透露这笔资金已经动用了多少。但普纳瓦拉表示，公司已经将产能翻了一番。它之所以能快速做到这一点，是因为采用了“产能走在需求之前”的策略，他补充道。几十年来，公司每年都要新建

一座厂房。在父子间发生那次决定性谈话的前不久建成的那一座立即为新冠肺炎改变了用途。

得益于与牛津大学以及Novavax在制造一种疟疾疫苗上的长期合作，血清研究所能够提早获得它们的配方。与供应商的深厚关系帮助它顺利采购到所有需要的设备，从玻璃小瓶到昂贵的用于生产生物物质的“生物反应器”。血清研究所新雇用了1000名员工，员工总数增加了六分之一。除了历年修建的30多座厂房，500名建筑工人正在建造产能更高的新厂房。

普纳瓦拉认为，按照目前的速度，全球新冠疫苗的供应至少需要两年时间才能满足需求。他谨慎地表示，如果全球监管机构能在新冠危机期间更紧密地协调一致，这个时间可能会缩短。在那之前，血清研究所预计会差不多以成本价出售新冠疫苗，也就是每剂牛津疫苗3至5美元。在那以后，利润率最终会上升。“眼下的状况将会持续很长一段时间，未来还会有需求。”普纳瓦拉预计。新冠肺炎看来肯定会在世界很多地方扎根，新冠疫苗也会像流感疫苗那样，需要每年接种。他表示，对于目前瞄准的四种疫苗，公司的最高年产量都将达到6亿至7亿剂。

普纳瓦拉认为，新冠疫情会让疫苗制造受到前所未有的关注，入局者也会大幅增加。这会给这个行业注入竞争——在大多数制药商看来，这个批量生意吃力不讨好，资本投入又很大。今年早些时候，公司的一座新厂房发生火灾，这让全球新冠应急人员的脊背发凉，直到公司向大家确认发生事故的是一条肺结核疫苗生产线，不会影响到新冠疫苗的生产。尽管对牛津疫苗的赌注已经赢了，对Novavax的赌注看来可能也下对了，但对Codagenix和SpyBiotech的还没有稳操胜券。疫苗民族主义者可能会阻挠印度的疫苗出口以及原料和设备的进口。

尽管如此，普纳瓦拉很有信心他的公司会保持领先地位。有别于砸巨资营销昂贵药品的大药厂，血清研究所的疫苗主要卖给各国卫生部门，它们最看重的是低廉的价格和可靠的供应。而这些一直都是血清研究所的强项。这家印度公司对新冠肺炎的出色反应为自己在全球赢得了很高的声誉，效果胜过任何广告宣传。

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Carbon abatement

Giving up carbs

What are cheap ways to cut carbon? Bill Gates is the latest to ask the question

IN THE TRENDIER parts of Berlin, cargo bikes are the rage. Locals use the bicycles, which have a wheelbarrow-sized box at the front, to do the weekly shop or ferry children around. Because they cut carbon-dioxide emissions, local authorities are subsidising the craze. But the well-intentioned schemes look pricey when you consider how much carbon is abated. One such scheme costs the city €370,000 (\$450,000), but is expected to reduce emissions by only seven tonnes a year. That works out at over €50,000 per tonne abated. The equivalent figure for schemes that support the sale of low-carbon heating systems, by contrast, is €200 per tonne.

More than 100 countries and 400 cities (including Berlin) have promised to get to net-zero emissions by 2050 or before. Investors and regulators are encouraging companies to do the same. To meet these goals policymakers and bosses will have to pick from a menu of policies, from building wind farms to subsidising low-carbon jet fuel. That raises an important question: what is the cheapest way to cut carbon?

One way to discern the answer is to impose a price on carbon, either as a tax or a cap-and-trade scheme. This would encourage firms and consumers to find the cheapest ways to abate. But setting a price is difficult politically. Only a fifth of the world's emissions are covered by an explicit price. Even in Europe, the world's biggest liquid carbon market, free credits still allow many industries to maintain emissions.

So other tools are needed, too. In his new book, "How to Avoid a Climate Disaster", Bill Gates suggests using a "green premium", or the gap between

the price of clean activities and dirty ones, as a guide. Where the premium is low, zero-carbon alternatives exist, and consumers have no reason not to use them. Where the premium is high, more innovation is needed.

A similar approach, popular in climate circles for the past decade or so, is to consider the marginal costs of abatement. Like green premiums, these compute the costs of a climate intervention (including operating costs and upfront spending). But it compares them with the emissions that the policy is expected to abate. Plotting the costs and emissions abated on a curve shows the policies that provide the most bang for the buck (see chart 1).

Such curves have been computed by a number of forecasters over the years, including McKinsey and the Boston Consulting Group, two consultancies; Goldman Sachs, a bank; and Britain's Climate Change Commission, which advises Parliament. As a rule, most show that the biggest bang comes from making buildings more energy-efficient, say by installing insulation or smart cooling and heating systems. Often these have negative costs: analysts think they will eventually save consumers money through cheaper bills.

The next-best bang for the buck tends to be replacing power plants that burn natural gas or coal with renewable-powered ones. There is less agreement about what the next-best option is after that. But the most expensive areas of the economy to decarbonise tend to be transport (planes and ships), heavy industry (steel and cement) and agriculture (cows belching methane). In these cases clean, cheap, scalable alternatives do not yet exist.

Just as abatement-cost curves provide a rough guide for policymakers, they also show how difficult the maths is. Estimates of costs vary widely, for instance (see chart 2). A paper by Kenneth Gillingham of Yale University and James Stock of Harvard University compares the marginal costs of policies

across 50-odd studies. The cost of wind-energy subsidies can range from more than \$260 per tonne of carbon dioxide avoided, to next to nothing.

This is partly because a technology's abatement potential can vary from place to place. Some countries, such as Britain, are blessed with high winds and shallow seas that are ideal for offshore wind farms. In other places, wind energy will provide scant abatement.

Working out costs is tricky, too. The International Energy Agency (IEA), for instance, has routinely underestimated the pace of deployment of renewables (see chart 3). And because economies of scale drive down prices, that means it has overestimated the costs of switching, too. In 2010 the lowest the IEA expected solar prices to drop to over the next decade was about \$195 per megawatt hour. Today the price in America and Europe is \$30-60.

Nor do abatement-cost curves show how technologies interact. Hydrogen is rarely produced without emissions. But if it were, the Hydrogen Council reckons, it could be used in 35 different green applications, from storing energy to heating buildings. Ignoring this could lead to underinvestment in hydrogen power today.

Interactions also affect how much interventions reduce emissions. Consider two things needed to decarbonise the economy: converting the grid to low-carbon power, and electrifying transport. The order in which you do these matters. According to a model developed by the Massachusetts Institute of Technology and others, if transport were electrified, there would be less demand for oil to fill tanks with petrol. Yet, as the demand for dirty power for electricity would surge, overall emissions would drop by only 2% by 2050 (compared with a business-as-usual baseline). If the grid were cleaned up first, though, then emissions would fall by about 30%.

Faced with all these difficulties, forecasters are taking a more sophisticated approach, rather than simply working their way along the marginal-cost curve. Goldman Sachs is incorporating different scenarios and a wider range of costs into its analysis. Others are turning to “energy-systems” modelling, which estimates models over and over again with different assumptions. That lets technologies interact, and means that forecasts rely less on one set of assumptions for, say, prices.

This type of analysis lets you sort climate actions into three categories, says Jesse Jenkins of Princeton University, all of which require funding. The first are what he calls “robust” interventions, such as improving energy efficiency, which are valuable across lots of scenarios. Next come “shaping” interventions, such as investing in hydrogen and batteries, which improve the likelihood of arriving at a low-carbon future. Then come “hedging” strategies: long-shot options to develop, just in case, such as direct-air-capture, which sucks carbon dioxide from the atmosphere. The result is a more complex framework better suited to deal with the complex, ever more urgent task of decarbonisation. ■



碳减排

弃碳

有哪些廉价的减碳方式？提问的人又多了个比尔·盖茨

在柏林比较时尚的地方，载货自行车十分流行。它前面有一个手推车大小的车斗，当地人骑它做每周的采购或接送孩子。这些单车减少了二氧化碳排放，所以地方政府正提供补贴来支持这股热潮。但是，如果细究具体减排了多少，这些意图很好的计划看起来就很昂贵了。柏林为其中一项计划花费了37万英镑（45万美元），但预计每年仅减排七吨，相当于每吨成本超过五万欧元。相比之下，那些支持销售低碳供暖系统的计划每吨成本200欧元。

已有100多个国家和400个城市（包括柏林）承诺在2050年或之前实现净零排放。投资者和监管机构正在鼓励企业也这样做。要实现这样的目标，政策制定者和老板们将必须在从建设风力发电场到补贴低碳飞机燃料的一系列政策中做选择。这就引出了一个重要的问题：最便宜的减排方式是什么？

要找出答案，一种方法是给碳定价，或者通过征税，或者通过限额交易计划。这会鼓励企业和消费者寻找最便宜的减排方法。但是给碳定价在政治上是个难题。世界总排放量中只有五分之一被一个明确的价格覆盖。即使在欧洲这个世界上最大的高流动性碳市场，仍有许多行业凭借免费碳信用额度继续排放。

因此还需要其他手段。盖茨在他的新书《如何避免气候灾难》（How to Avoid a Climate Disaster）中建议使用“绿色溢价”，也就是清洁活动和污染活动之间的价差作指引。绿色溢价低的地方有零碳替代品，消费者没有理由不用。而溢价高的地方就需要更多创新。

过去十年左右的时间里，气候学界流行一种类似的方法：考虑减排的边际成本。和绿色溢价一样，这种方法计算某项气候干预措施的成本（包括运

营成本和前期支出）。但它会将这些成本与该政策预计能达到的减排量相比较。将成本和减排量绘制在一条曲线上，就可以看出哪些政策最划算（见图表1）

这类曲线由一些预测机构历经数年计算得出，它们包括咨询公司麦肯锡和波士顿咨询集团、高盛银行，还有向议会提供建议的英国气候变化委员会。一般说来，这些曲线大多数都表明最划得来的做法是提高建筑的能效，比如安装隔热材料或智能制冷和供热系统。这些方法的成本通常为负：分析师认为它们最终会通过让消费者少交费来帮他们省钱。

第二划算的方法通常是用可再生能源发电厂取代燃烧天然气或煤的发电厂。至于哪种方法排在第三位，意见就没那么统一了。但是脱碳成本最高的经济部门一般是运输（飞机和轮船）、重工业（钢铁和水泥）和农业（排放甲烷的奶牛）。在这些领域内，清洁、廉价且可扩展的替代品尚不存在。

减排成本曲线为政策制定者提供了一个粗略的指南，同时也显示了要算清这笔账有多难。例如，不同的研究对成本的估算相差很大（见图表2）。耶鲁大学的肯尼斯·吉林厄姆（Kenneth Gillingham）和哈佛大学的詹姆斯·斯托克（James Stock）的一篇论文比较了50多项研究中探讨的政策的边际成本。风能补贴减排成本高则超过每吨260美元，低则几乎为零。

这在一定程度上是因为一项技术的减排潜力可能因地而异。一些国家如英国拥有强风和浅海，非常适合建设海上风电场。而在其他地方，风能带来的减排量很少。

成本的计算也很棘手。例如，国际能源署（IEA）一再地低估可再生能源的部署速度（见图3）。而由于规模经济压低了价格，IEA也就高估了转换成本。它曾在2010年预计，之后十年太阳能的价格最低将降至每兆瓦时195美元左右。而如今，这个价格在美国和欧洲是30到60美元。

减排成本曲线也未能体现不同技术之间的相互作用。氢能的生产很少不产生碳排放。但国际氢能委员会（Hydrogen Council）认为，就算造成了排放，氢能也可被用在从储存能量到为建筑供暖的35种不同的绿色应用中。忽视这一点可能导致在当下对氢能投资不足。

技术的相互作用也会影响干预措施的减排程度。来看让经济脱碳需要做的两件事：改造电网向低碳电力转型，以及交通电气化。做这两件事的先后顺序很重要。麻省理工学院和其他机构开发的一个模型显示，如果先让交通实现电气化，车辆对汽油的需求会减少。然而，由于对污染电力的需求会激增，到2050年总排放量将仅下降2%（与一切照旧的基线相比）。但如果是先清洁电网，那么排放量将下降30%左右。

面对上述种种难题，预测机构正采取一种更复杂精密的方法，而不仅是简单地在边际成本曲线上做文章。高盛正在将不同的情景和更广泛的成本纳入自己的分析中。其他机构则转向“能源系统”建模，用不同的假设一遍又一遍地评估模型。如此便可将不同技术的相互作用考虑进来，在预测时也就能减少对单一组假设（如价格）的依赖。

普林斯顿大学的杰西·詹金斯（Jesse Jenkins）说，借由这种类型的分析，可以将气候行动整理为三类，每一类都需要资金。第一类是他所谓的“稳健型”干预，如提高能源效率，这类干预在许多情景下都是有价值的。然后是“塑造型”干预，如投资于氢能和电池，可提高实现低碳未来的可能性。接着是“对冲”策略，即风险很高的方案，例如研发从大气中吸收二氧化碳的直接空气捕捉技术，以备不时之需。由此便得出了一个更复杂的框架，更适合于应对复杂且日趋紧迫的脱碳重任。■



The merchants

Rise of the rebels

For brands, turning their back on Amazon is hard but not impossible

TYPE THE brand Allbirds into Amazon and any number of woolly shoes are displayed. None, though, belongs to the San Francisco-based shoemaker whose Merino-wool sneakers began the trend. Joey Zwillinger, Allbirds' co-founder, grumbles about what he calls the “knock-off” shoes he sees on Amazon. But he says that, since the company first started selling online in 2016, it has avoided the online giant, as well as physical wholesalers like Foot Locker. That strategy is revolutionary in the global shoe industry, with revenues of \$80bn in America alone. The rationale is that by avoiding middlemen, whether online or offline, Allbirds can invest in more sustainable materials that go down well with its rich, techie clientele. It also helps it keep tabs on its customers.

Rather than selling on Amazon, it uses Shopify, an Ottawa-based platform operating in 175 countries that allows it to sell through its own online channels, as well as its physical stores. Yet despite Allbirds’ thirst for independence, Mr Zwillinger is not starry-eyed about the ability of direct-to-consumer (DTC) retailers to resist the gravitational pull of Amazon and other tech platforms. He notes that more than half of all product searches start on Amazon, making it easy to be overlooked (or imitated). Digital advertising needed to start a brand and maintain its popularity is mostly in the hands of a powerful triumvirate of Google, Facebook and Amazon, and its costs are rising. “It’s probably the easiest time in the history of the world to build a business of reasonable size,” he says. Keeping it there is a different matter. “Will a bunch of [DTC] companies be able to overcome the headwinds? The answer is likely to be no,” he says grimly.

For physical retailers, the Amazon effect has been brutal. Many have collapsed, leaving malls and high streets abandoned. In America and Britain, the closure of stores has far exceeded openings in recent years. During the pandemic in 2020, the big ones were particularly hard hit. Goldman Sachs, a bank, says that in Britain, which has a high share of online retail, existing stores have been cannibalised by e-commerce, driving down profit margins.

Not everyone is suffering equally. Big global brands such as Nike or Zara, owned by Inditex, a Spanish retailer, have reputations that encourage customers to find them without their having to fork out a fortune to win loyalty. They can preserve profit margins by keeping supply chains lean, adding RFID identifier tags to ensure clothes can be switched for in-store or online shopping, depending where the demand is, and using their stores as sales points, distribution centres or places to return items. Yet Inditex said last year it would close up to 1,200 stores around the world.

Discount stores, such as Dollar General in America, are thriving. Many continue to open shops. Primark, a low-cost European fashion chain that has eschewed online, is convinced that low prices are such a powerful draw that shoppers will flock back to its shops when lockdowns are lifted. As long as they have a strong brand, “the shop is a much more efficient, lower-cost, lower-carbon method of fulfilment than the little van driving up and down our streets during lockdown,” insists George Weston, boss of Associated British Foods (ABF), Primark’s owner.

Some online-fashion retailers are creating portfolios of brands out of failed physical retailers, on the assumption that, if brands are well-known, it is easy to attract customers. In America Authentic Brands, a New-York based firm, has acquired Brooks Brothers and Barneys. In Britain Boohoo has bought the Dorothy Perkins, Burton and Wallis brands from the failed chain Arcadia.

For digitally native retailers such as Allbirds, one way to expand the business is to open shops as well as selling online. Mr Zwillinger sees the irony that, although people lament the “retail apocalypse” caused by e-commerce, Allbirds is opening not closing shops. Other digital insurgents doing the same include Warby Parker, a firm of eyewear specialists, and Casper, a mattress-maker. Three Squirrels, a snack company that started as a digital darling in China, now has 300 shops.

The trick is to make the shops not just sales nodes but ways for shoppers to interact with the product. Allbirds fineses what Mr Zwillinger calls the “try-on experience”. It stacks artfully presented shoeboxes in the store, not in a backroom, so fittings are available within seconds, not minutes. Casper offers “nap appointments” on its mattresses. Other swanky retailers talk of curating stores like art galleries. This approach may not work for all income brackets. “Bond Street is lovely, but that’s not how most people shop,” quips ABF’s Mr Weston. Nonetheless, the more impersonally goods are sold online, the more urgent it is that shops stand out for customer service.

One drawback in avoiding Amazon is that it is tiresome for shoppers to toggle between apps belonging to different marques. Mr Zwillinger hopes Shopify may provide an answer by building a virtual storefront where brands can display their wares, as Alibaba’s TMall does in China. Not everyone believes independent brands are fighting an uphill battle against the tech giants. Harley Finkelstein, Shopify’s boss, disputes the idea. “I vehemently disagree that it’s only the big folks that are going to get bigger and I have proof of that,” he insists. He points to brands from Beyond Yoga, a clothing company, to Beyond Meat, a vegan one, that have grown rapidly via Shopify. He says their desire to keep close to their customers, to champion sustainability, and to offer inspiring examples of entrepreneurship all support them.

That view is shared by Sebastian Siemiatkowski, founder of Klarna, an online-payments platform that works with many DTC brands. He disdains what he calls the “scrolling” nature of much online shopping. He thinks the infrastructure of e-commerce, including online marketplaces, delivery and payments, will become commoditised. But as digitalisation removes friction between buyers and sellers it will create “a more perfect economy” with almost limitless scope for growth. “People totally underestimate how large the internet economy is,” he says. Even Netflix movies could be a sales channel for shoppers keen to buy what they see on screen. Customer-centric innovations (he includes Klarna’s buy-now, pay-later schemes) will be essential for survival.

Strangely, the pandemic has given part of the retail industry least known for innovation, grocery selling, a crash course in reinvention. As one of the fastest-growing online categories around the world in 2020, it has become the next frontier of e-commerce. But do not get your hopes up. The weekly trip to the supermarket will not become a thing of the past. ■



商家

叛军崛起

对于品牌来说，拒绝亚马逊很难，但并非不可能【专题报道《购物的未来》系列之三】

在亚马逊网站上输入品牌名Allbirds，会看到一页又一页羊毛材质的鞋子。但没有一双出自这家总部位于旧金山的制鞋公司，它的美利奴羊毛运动鞋掀起了这一潮流。Allbirds的联合创始人乔伊·茨维林格（Joey Zwillinger）抱怨亚马逊上的这些鞋是“山寨货”。但他说，自公司2016年开始在网上卖鞋以来，它避开了这家网络巨头和Foot Locker等实体批发商。这一战略在全球鞋业中是革命性的，仅仅在美国就创下800亿美元的营收。其理念是避开中间商——无论线上还是线下——让Allbirds可以投资于更可持续的制鞋材料，这种材料受到富有的科技业客户群的欢迎。这种做法也有助于保持与顾客的联系。

它不在亚马逊上售货，而是通过用Shopify（一个总部位于渥太华的平台，在175个国家和地区运营）自行建立的线上渠道加之实体店来销售。但是，尽管Allbirds渴望独立，但茨维林格并不天真地认为“直接面向消费者”（DTC）的零售商能够抵御亚马逊和其他科技平台的巨大引力。他指出，所有商品搜索有超过一半始于亚马逊网站，使得DTC商家很容易被忽视（或被模仿）。创建一个品牌并维持知名度所需的数字广告主要掌握在谷歌、Facebook和亚马逊这三巨头的手中，且成本在上涨。“这可能是世界历史上最容易成立一家规模尚可的公司的时刻。”他严肃地说。活下去却是另一回事。“一批[DTC]公司是否能逆流而上？答案很可能是否定的。”

对实体零售商而言，这种“亚马逊效应”是残酷的。许多店铺关门大吉，购物中心和商业大街盛景不再。在美国和英国，近几年来商店关门的速度远超过新开店的速度。2020年疫情期间，大型实体店遭受的打击尤其沉重。银行高盛表示，在网络零售占比很高的英国，现有门店被自家电子商务蚕

食，拉低了利润率。

惨况各有不同。国际大品牌——比如耐克或西班牙零售商Inditex旗下的Zara——本身名气够大，不必花大钱来赢得忠诚度，顾客自己就会找上门。它们可以通过多种方式来保持利润率，比如维持精简的供应链；为服装等产品添加射频识别标签（RFID），这样就可以视需求而把货品在实体店和网店间来回转移；把门店用作销售点、分销中心或退货地点。不过，Inditex去年表示它将在全球关闭多达1200家门店。

折扣店，比如美国的达乐（Dollar General），眼下生意红火。许多还在开张新店面。低成本欧洲时装连锁店Primark从来只做线下，它坚信价格便宜的吸引力足够大，封锁解除后购物者又会涌回自己的店里。Primark的母公司英国联合食品（ABF）的老板乔治·韦斯顿（George Weston）坚信，只要拥有一个强大的品牌，“相比封锁期间在街区来来回回的小货车，门店这种履单方式在效率、成本和碳排放上都远远胜出。”

一些线上时尚零售商正从败下阵来的实体零售商当中创建出品牌组合，它们假定如果品牌很有知名度，就容易吸引到顾客。总部位于纽约的“美国正宗品牌”公司（America Authentic Brands）收购了布克兄弟（Brooks Brothers）和巴尼斯（Barneys）。在英国，Boohoo从破产的连锁店阿卡迪亚集团（Arcadia）那里购买了Dorothy Perkins、Burton和Wallis等品牌。

对于像Allbirds这样的数字原生零售商来说，扩展业务的一种方法是在线上销售的同时也开门店。茨维林格明白有件事颇具讽刺意味：尽管人们为电子商务带来的“零售末日”哀叹，但Allbirds却是在开张而不是关闭门店。其他也在走这种模式的数字“叛乱分子”包括处方眼镜公司Warby Parker和床垫制造商Casper。中国的零食公司三只松鼠最初是线上明星，现在已有300家门店。

其中的诀窍是门店不只是销售点，也是顾客和产品交互的途径。Allbirds就巧妙运用了茨维林格口中的“试穿体验”。它把设计精巧的鞋盒直接堆放

在店堂里，而不是后方储藏室，这样顾客只需等个十几秒而不是几分钟就能拿到合适的尺码试穿。Casper的床垫提供“小憩预约”服务。其他走时髦豪华路线的零售商也在谈论像布置画廊那样布置门店。这种方法可能并不适用于所有收入阶层。ABF的韦斯顿打趣道：“庞德街很迷人，但这不是大多数人购物的方式。”不过，线上销售越是去个性化，门店提供亮眼的客户服务就越紧迫。

绕过亚马逊有一个不利因素：对于买家来说，要在不同品牌的应用间来回切换很烦人。茨维林格希望Shopify可以创建一个虚拟橱窗来让各个品牌展示自家产品（就像阿里巴巴的淘宝在中国所做的那样）来解决这个问题。并非所有人都认为独立品牌在艰难地抗击科技巨头。Shopify的老板哈利·芬克尔斯坦（Harley Finkelstein）就不同意这种看法。“我完全不认为只有大店会变得更大，我有实证。”他坚称。他列举了通过Shopify迅速发展的品牌，从服装公司Beyond Yoga到素食公司Beyond Meat。他说，它们渴望与客户保持亲近，倡导可持续发展，成为鼓舞人心的创业案例，这些都支撑它们变强。

与许多DTC品牌合作的在线支付平台Klarna的创始人塞巴斯蒂安·西米亚特科夫斯基（Sebastian Siemiatkowski）赞同这种观点。他不认同大多数网购的那种他称之为“刷手机”的特性。他认为电子商务的基础设施——包括网络市场、送货和支付——将变得大众化。但随着数字化消除买卖双方之间的摩擦，它将创造出“一种更完美的经济”，具有近乎无限的增长空间。“人们完全低估了互联网经济的规模。”他说。甚至奈飞（Netflix）电影也可能成为一种销售渠道，让急切的观众快速买到在屏幕上看到的东西。以客户为中心的创新（他说Klarna的“先买后付”模式就是一种）将攸关生死。

颇不可思议的是，疫情给零售业中最不以创新闻名的那部分——食品杂货——上了一堂改造速成课。这个去年在世界各地增长最快的网络零售类目之一已成为电子商务的下一个前沿阵地。但也别太高骛远。每周去一趟超市不会成为过去。 ■



Mass craftsmanship

Made to measure

Personalised products are reshaping manufacturing

TO SEE HOW consumers have turned the shopping experience on its head, look not to humans but to pets, who hold the world to the highest standards of customer care. If any group has thrived during covid-19, it is the fur-coated crowd. According to Bernard Meunier of Purina PetCare, a brand with \$15.4bn annual sales owned by Nestlé, the world's largest food company, pet ownership has soared during the pandemic. So has the coddling of pets with expensive treats and all manner of pet-related googling, ranging from how to buy the perfect puppy to how to find CBD oil for arthritic retrievers (this correspondent's fruitless quest in Britain).

Purina exemplifies three ways in which the selling and manufacturing of products for pets is being transformed by digital engagement. The first is wholesale e-commerce; it sells pet food through sites such as Amazon or Chewy. In China more than half of pet food is sold online, compared with about a tenth elsewhere, Mr Meunier says. The second is selling direct to the consumer (or at least its owner), via subscriptions and other services. In 2018 Purina acquired a majority stake in Tails.com, a British firm that sells tailor-made dog food online. The close relationship between company and pet owner allows it to "personalise" the brand, as Mr Meunier puts it. And third, as its engagement with pet owners increases, Purina is exploring "the blurring of lines" between products and services. It has bought control of Wamiz, a pet-lovers' website, and in 2019 took a minority stake in IVC Group, a European firm of vets.

Don't expect Nestlé to personalise everything. Grocery shoppers remain mass consumers. The bulk of its products will fill supermarket shelves or

online baskets for the foreseeable future, says Jordi Bosch, global head of sales at Nestlé. But the more options consumers have for where to shop, and the more information they have at their fingertips about what to buy, the more manufacturers need to adapt their products, whether they are Nespresso coffee pods or varied pack sizes of Nescafé.

Bacardi, a global spirits giant, shows how deeper connection with customers can bring new razzle-dazzle to brands, according to Mike Birch, its head of digital commerce. During lockdown, it hosted live-streamed whisky-tasting on Amazon, introduced espresso martini cocktail kits for at-home “mixologists”, and sought to tickle single-malt whisky influencers with an Aberfeldy Scotch dubbed “The Loch Down”.

As yet, few manufacturers in the West are milking their customer data for more than clever sales and marketing campaigns. But in China a new approach to production is emerging: “consumer-to-manufacturer (C2M).” There are several versions, but in essence, C2M makes use of big data and artificial intelligence (AI) gathered by tech platforms to identify the latest shopping trends. Influenced by this, manufacturers then make specialised products directly for consumers, cutting out intermediaries. With more direct insights about customer demands, there is less need to create excess-inventory buffers, improving margins and reducing waste.

Pinduoduo (PDD) is one of the platforms that has pioneered the trend. David Liu, its vice-president of strategy, says that since it began C2M in 2018, it has worked with 1,500 manufacturers, making about 4,000 types of product and generating 460m accumulated orders from its 730m customers. One example is robot vacuum-cleaners. High-end versions sell for 3,000 yuan (about \$500) making them affordable for many in China’s richest cities, but less so in poorer ones. So PDD worked with a manufacturer to produce a much cheaper version, proving via its data that demand existed, and allowing the manufacturer to use after-sales data to improve the product.

Anecdotally, it reckons some fast-fashion firms and factories can shorten the time from conception to market to a few weeks.

PDD is also using agritech to help 12m farmers in its network cultivate products that customers want. For instance, it has launched what Mr Liu calls an “AI versus human strawberry-planting competition,” pitting teams of veteran strawberry farmers against teams backed by digital technology. The former produced slightly sweeter strawberries, but the latter did it more efficiently, Mr Liu says. A fringe benefit is that regulators look kindly on the digitalisation of agriculture, he adds.

Alibaba, China’s biggest e-commerce platform, also has a thriving C2M unit. Early in the pandemic, it noticed a sharp rise in demand for alcohol-based car-cleaning supplies to stop the spread of infections. It approached Odis, a company making car-cleaning products whose sales were cratering, and suggested it bring out portable sanitising sprays instead. It did so within three days, not the three months normally needed to create a new product. Customers were able to pre-order the spray even before manufacturing started. More than 200,000 were sold within 24 hours. ■



批量精工

量身定做

个性化产品正在重塑制造业【专题报道《购物的未来》系列之六】

要知道消费者如何颠覆了购物体验，不要看人，看看宠物吧。它们让世界履行它最高标准的客户服务。如果说有哪个群体在疫情期间春风得意，那就是这些毛孩子了。根据全球最大的食品公司雀巢旗下年销售额154亿美元的品牌普瑞纳（Purina PetCare）的伯纳德·穆尼尔（Bernard Meunier）的说法，宠物拥有量在疫情期间猛增。款待宠物的昂贵口粮的销量同样飙升，各种与宠物相关的谷歌搜索也大增，从如何购买完美的小狗到如何为患上关节炎的寻回犬找到大麻二酚油（笔者在英国苦苦寻求，一无所获）。

普瑞纳举例说明了数字化正以三种方式改变宠物产品的销售和制造。首先是批发电子商务，即通过亚马逊或Chewy等网站出售宠物食品。穆尼尔说，在中国，宠物食品有一半以上是通过网络销售的，而在其他地方这一比例约为十分之一。其次是通过订阅和其他服务直销给消费者（或至少是其主人）。2018年，普瑞纳收购了Tails.com的多数股权，这是一家在线销售定制狗粮的英国公司。公司和宠物主人之间的密切关系使它能够像穆尼尔所说的那样把品牌“个性化”。第三，随着与宠物主人的互动增加，普瑞纳正尝试让产品和服务之间的“界限模糊”。它已经收购了宠物爱好者网站Wamiz的控制权，并在2019年收购了欧洲兽医公司IVC集团的少数股权。

不要指望雀巢能够定制一切。食品杂货的买家仍然是大众消费者。雀巢的全球销售负责人乔迪·博世（Jordi Bosch）说，在可预见的未来，公司大部分的产品将填充超市货架或在线购物车。但是，消费者去哪买的选择越多、在购买时能轻松获得的商品信息越多，制造商就越需要调整其产品，无论是雀巢的咖啡胶囊还是包装大小不一的咖啡粉。

全球烈酒巨头百加得（Bacardi）的数字商务主管麦克·博奇（Mike Birch）

表示，与客户更深层次的联系会给品牌带来更多令人眼花缭乱的东西。在封锁期间，这家公司在亚马逊上直播了威士忌品尝活动，为居家“调酒师”介绍意式马提尼鸡尾酒套装，并试图把一款阿伯费尔迪苏格兰威士忌戏称为“The Loch Down”来引起单麦芽威士忌网红品酒师们的兴趣。

不过，迄今为止，除了巧妙的销售和营销活动之外，没有几家西方制造商进一步利用了客户数据。但是在中国，一种新的生产方法正在出现：“消费者到制造商（C2M）”。这有几种不同形式，但从本质上讲，C2M利用技术平台收集的大数据和人工智能（AI）来识别最新的购物趋势。受此影响，制造商随后直接为消费者生产专门的产品，去掉了中间商。一旦能够更直接地了解客户的需求，就无需创建过多的库存缓冲，从而提高了利润，减少了浪费。

拼多多是引领这一趋势的平台之一。其战略副总裁九鼎表示，自2018年启动C2M以来，它已与1500个制造商合作，生产了约4000种产品，并从7.3亿客户中产生了累计4.6亿个订单。一个例子是扫地机器人。高端版本售价3000元人民币，中国最富裕城市里的许多人都买得起，而在不那么富裕的城市就不是这样了。因此，拼多多与制造商合作生产了一个便宜得多的版本，通过数据证明了需求的存在，并让制造商能够使用售后数据来改进产品。据说它认为一些快时尚公司和工厂能将从构思到上市的时间缩短到几周。

拼多多还利用农业技术帮助其网络中的1200万农民种植客户想要的产品。例如，它发起了九鼎所说的“人工智能vs顶尖农人”的草莓种植竞赛，让资深草莓种植农户团队与数字技术支持的团队一决高下。九鼎说，前者生产的草莓略微更甜一些，但后者的生产效率更高。他补充说，一个附带的好处是，监管机构对农业数字化的态度友好。

中国最大的电子商务平台阿里巴巴也拥有蓬勃发展的C2M部门。在疫情初期，它注意到为阻止病毒传播，对基于酒精的汽车清洁用品的需求急升。它与销售骤降的汽车清洁产品公司好顺欧迪斯接触，建议它推出便携式喷雾消毒剂。这一切在三天内完成，而不是推出新产品通常需要的三个月。

客户甚至可以在制造开始之前就预定喷雾剂。24小时之内就售出了20多件。 ■



The future of shopping

One-to-one commerce

Not since the Industrial Revolution has shopping been in such upheaval, writes Henry Tricks

IN 1966 JEFF JOHNSON, Nike's first-ever full-time employee, created the company's first store in Santa Monica, California. As Phil Knight, Nike's co-founder, recounts in his memoir, "Shoe Dog", it became a "holy of holies" for runners. Mr Johnson was a bookworm, so the shop had shelves of books that he felt runners should read. Pinned to the walls were photos of runners and of Nike's sneakers, then called Tigers. Mr Johnson kept card files of each customer, including their shoe sizes. He sent them Christmas cards and congratulatory notes if they won a big race. Many wrote back seeking Mr Johnson's support and advice, which he gave, especially when it came to injuries.

When your correspondent told this story to Heidi O'Neill, now head of Nike's consumer and marketplace division, she got "goosebumps". It recalled a time, she said, when Mr Knight and his colleagues, struggling to get the business off the ground, put shoes on the feet of one runner at a time. For decades afterwards, she says, Nike was unable to replicate the intimacy of this one-to-one customer relationship, as it relied on rapid expansion of its wholesale business. Yet since 2017 the firm has been cutting the cord with many of its wholesalers, including Amazon, the world's biggest online retailer, to focus on becoming a "direct-to-consumer" (DTC) company. DTC now accounts for 40% of Nike's revenues. Its shoppers' use of digital technology has enabled Nike to recreate that hallowed "one-to-one world", says Ms O'Neill.

One-to-one is shorthand for today's upheaval in the world of shopping. The

consumer has never had so many things to buy, or ways to buy them. New forms of communication via social media, messaging services and apps have brought producers and consumers closer together. Using trillions of gigabytes of data, manufacturers know better than ever what customers want. Their products can be delivered direct to the doorstep. The traditional middleman, who for centuries piled hidden cost on hidden cost, is being squeezed out.

This has been especially visible during the covid-19 pandemic, as e-commerce penetration has in just a few months reached levels that had been expected to take years. Amid lockdowns and social-distancing measures, bricks-and-mortar retailers went bust in droves last year in America and Europe, continuing a long trend. Yet online platforms have thrived. Amazon exceeded \$100bn in quarterly revenues for the first time in the fourth quarter of 2020. The share prices of some Chinese e-commerce giants doubled and even tripled.

DTC businesses have flourished. Early on in lockdown, Nike hit a target, which was originally set for 2023, of selling 30% of its goods online. Over the past year 70m people have become “members”, bringing the total to 250m. It connects to these loyal customers via apps offering everything from free running guidance to access to sneaker vending-machines.

Supermarkets, which had earlier hoped that a mass stampede online was still five years away, suddenly found that even grandparents were mastering the dark arts of ordering groceries and booking slots. Such was the surge in demand in the early days of lockdown that Ocado, a British online grocer, thought for a while that it was under cyber-attack.

The e-commerce explosion does not herald the death of the physical store, however. When lockdowns have been lifted, shoppers have flocked back

to high streets and shopping malls. Even a digital evangelist like Nike inaugurated a flagship “interactive” store on Paris’s Champs-Elysées last year, one of several new stores it has recently opened. After covid-19 is tamed, the pace of e-commerce growth will moderate. As Mark Shmulik of Bernstein, an investment firm, puts it, generations of shoppers’ “muscle memories” will not vanish overnight.

Yet the data-driven shopping upheaval is unstoppable. It will change the nature of stores, so that physical and digital shopping seamlessly interact. It will disrupt marketing, because online ads target shoppers more accurately than any broadcast jingle or billboard. And it will lead to new forms of production. Nike offers an example. Thanks to its apps and interactive shops, it acquires reams of real-time data from its pavement-pounding customers. When it noticed that traffic on its apps was showing more people doing yoga, it swiftly produced new yoga gear, Ms O’Neill notes. Mr Johnson would have been delighted.

To understand the historic importance of such a shift, start in 16th-century England. As Dorothy Davis, a former *Economist* writer, explained in her book from the 1960s, “A History of Shopping”, the first retail revolution occurred in the Elizabethan era when craftsmen, who until then had traded one-to-one with customers, set up the first shops to peddle other people’s wares, earning mark-ups on what they sold.

Centuries later came the Industrial Revolution, which led to the second big retail transformation. This was a new system of factory-produced goods that a growing number of working-class shoppers could afford. Supported by a blitz of advertising, these goods were distributed by shops that grew in size to benefit from economies of scale. The set-up is familiar to many today: mass production supports mass consumption.

The third retail revolution, today’s digital age, turns that model on its head,

creating, in retailers' jargon, a consumers'"pull" system rather than a producers'"push" one. As Mark Cohen, director of retail studies at Columbia University Graduate School of Business in New York, says: "At the turn of the 20th century, the commander-in-chief of commerce was the retailer, with the manufacturer as equal partner. Today it's the customer who's in charge."

In the West, this upheaval causes trepidation. That is because the retail infrastructure was not built for the digital age. America has 24 square feet of retail space per person, according to Bernstein, three times as much as Britain and six times as much as China. In America more than 8,700 stores closed last year, says Coresight Research, a data firm. In Britain 16,000 stores shut and 183,000 retail jobs were lost, estimates the Centre for Retail Research. *Pace Nike*, one of the worst-hit sectors has been clothing and footwear. Those opening stores are mostly discounters.

In parts of Asia, however, this is a time of exuberance. China's embrace of e-commerce reflects the ubiquity of smartphones, the shortage of attractive shopping centres beyond the big cities, and high urban density, which cuts the cost of delivery. Yet China also stands out for a level of innovation, such as live-streaming by celebrity lipstick-sellers, that few saw coming. Like Nike, some Chinese tech firms are taking advantage of people's digital trail to change the way goods are produced—and even to produce high-tech ways to improve fruit and vegetable yields on farms.

Yet even in China, the ultimate goal is not to leapfrog the store. Alibaba, China's biggest e-commerce firm, has brought the latest digital razzmatazz, such as cashier-free shops and video promotions, to its supermarkets in the biggest cities. Along with JD.com and Pinduoduo, its closest rivals, it is working with grocery shops in the farthest-flung villages to make distribution of goods cheaper and more efficient. Daniel Zipser of McKinsey, a consultancy, says 374 large malls were opened in China last year. Prices for retail property in city centres have shown no meaningful fall.

In both East and West, such an amalgamation of the offline and online worlds is widely referred to as “omnichannel”. This is perhaps the most tangible trend affecting the future of shopping. The future will be both online and offline.

For consumers the benefits are obvious. They will gain greater convenience from being able to shop either physically or virtually, depending on their mood and circumstances. But for retailers, the challenges are immense. They have to pay not only for the costs of their stores but also for a form of digital “rent” to display their goods high up on online search channels such as Facebook. They must not only pay for delivery but also allow customers to pick goods up in their shops. And they face a growing nightmare of processing returns that now cost retailers more than \$1trn globally every year, says Shopify, a big online platform. The struggle will be to find ways to make omnichannel more profitable.

It may yet become more lucrative simply because of the sheer size of the market left to conquer. According to Benedict Evans, who writes a tech newsletter, e-commerce sales globally in 2019 amounted to some \$4trn. That was less than a fifth of total retail sales, and a smaller fraction of overall consumer spending, which the World Bank estimates at \$65trn. There are tens of trillions of dollars of extra spending left to battle over.

Yet concerns are already growing that a few behemoths, such as Amazon in America, Europe and parts of Asia, and Alibaba in China, will hog the bulk of that. Regulators in America, the European Union and China are keeping the industry leaders under scrutiny. To keep the future a renaissance not a digital autocracy, this report assesses how entrepreneurs can stand up to and even overcome the supremacy of the digital incumbents.

In the midst of the covid-19 pandemic, with shops shut and doorsteps under siege from the latest Amazon delivery, the world may seem to be on the edge

of a digital dystopia, with shops losing their age-old role as a place of social interaction, banter and succour for the lonely. But that is too pessimistic. Even a time traveller from Elizabethan England would find a lot to recognise in the commerce of the future. As this report will argue, the itinerant peddlers, merchants, food stalls, crafts, salespeople and shoppers will all continue to exist—albeit in new forms. The biggest difference will be the marketplace, the digital architecture dominated by the tech giants that in future will underpin our urge to splurge. ■



购物的未来

一对一商务

本专栏作者亨利·特里克斯（Henry Tricks）观察认为，自工业革命以来购物从未发生过如此剧变【专题报道《购物的未来》系列之一】

一九六六年，耐克有史以来第一位全职员工杰夫·约翰逊（Jeff Johnson）在加州圣塔莫尼卡创建了公司的第一家门店。根据耐克的联合创始人菲尔·奈特（Phil Knight）在其回忆录《鞋狗》（Shoe Dog）中的记述，这家店成了跑步者的“至圣之地”。约翰逊是个书痴，店铺里摆放着几架子他认为跑步者应该看的书。墙上贴着跑步者和耐克的运动鞋（当时还是它代理销售的“鬼塚虎”）的照片。约翰逊为每位客户创建了卡片档案，记录下他们的鞋子尺码等。他会给他们寄圣诞贺卡，在他们赢得了大赛时寄去贺信。许多人回信寻求约翰逊的支持和建议，他会一一回复，尤其是涉及运动损伤的话题。

当笔者向现任耐克公司消费者和市场部负责人海蒂·奥尼尔（Heidi O'Neill）讲述这个故事时，她“起了一身鸡皮疙瘩”。她说，这让她回想起很多年前奈特和他的同事们奋力让公司起步时的艰苦岁月，那会儿鞋是一次一双地卖出去的。她说，几十年后，耐克的生意依赖迅速扩张的批发业务，已经无法复制这种亲密的一对一客户关系了。然而，自2017年以来，公司开始与包括全球最大的在线零售商亚马逊在内的许多批发商切断联系，以专注于成为一家“直接面向消费者”（direct-to-consumer，简称DTC）的公司。DTC业务现在占到耐克收入的40%。奥尼尔说，自家顾客对数字技术的使用让耐克得以重塑了这个神圣的“一对一世界”。

“一对一”就概括了当下购物世界发生的剧变。消费者从来没有像今天这样，有那么多的东西可以买，又有那么多的途径可以买。利用社交媒体、即时消息和手机应用的新型交流拉近了生产者和消费者之间的距离。运用海量数据的制造商比以往任何时候都更了解客户的需求。他们的产品可以被直接递送到家门口。几个世纪以来不断添加隐性成本的传统中介商正在

被排挤出局。

这一点在新冠疫情期间尤为明显，因为电子商务的渗透率在短短几个月内就达到了原本预计还需要几年才会达到的水平。在封锁和社交隔离措施的限制下，美国和欧洲的实体零售商去年延续长期趋势成批关门，但线上平台却异常红火。亚马逊在2020年第四季度的营收首次突破1000亿美元。一些中国电商巨头的股价飙升了一倍甚至两倍。

DTC业务蓬勃发展。封锁初期，耐克实现了它最初为2023年设定的目标，有三成产品在网上卖出。过去一年中，这家公司的“会员”增加了7000万人，总数达到2.5亿。它通过应用与这些忠实客户连接，提供从免费跑步指导到使用跑鞋自动贩售机的各种福利。

超市此前曾祈祷距大规模转移线上尚有五年之遥，却猛然发现爷爷奶奶们也都学会了在网上买菜和预定送货时间等黑魔法。封锁初期需求的飙升甚至让英国在线杂货商Ocado一度以为自己被黑客攻击了。

但是，电子商务的爆炸式增长并不预示着实体商店的死亡。封锁解除后，购物者又纷纷涌回商业街和大型购物中心。甚至像耐克这样的数字布道者去年都在巴黎香榭丽舍大道上开出了一家“交互式”旗舰店，这是它近年开设的零星几家新店之一。疫情控制住后，电子商务的增速将放缓。正如投资公司盛博的马克·谢穆里克（Mark Shmulik）所说，几代购物者的“肌肉记忆”不会在一夜间消失。

但数据驱动的购物剧变势不可挡。它将改变商店的性质——使实体和数字购物无缝交互。这将颠覆营销，因为在线广告比任何广播广告或广告牌都能更精准地定向投放。这也催生新的生产形式。耐克就是一个例子。得益于其应用和交互式门店，它可以从那些在路边慢跑的客户那里获取大量实时数据。奥尼尔指出，当公司注意到它应用上的流量显示越来越多人在做瑜伽时，它迅速生产出了新的瑜伽装备。约翰逊若知道这些应该会很高兴的。

要了解这样一种转变的历史重要性，让我们从16世纪的英格兰说起。正如曾为本刊撰稿的多萝西·戴维斯（Dorothy Davis）在写于1960年代的《购物史》（A History of Shopping）一书中解释的那样，第一次零售革命发生在伊丽莎白时代，此前与顾客一对一交易的工匠开设了第一批商店来兜售其他人制作的手工艺品，赚取中介费用。

几个世纪后发生的工业革命带来了第二次零售业大转型。这是一个由工厂生产商品的新体系，越来越多的工人阶级购物者能够买得起这些东西。在大量广告的支持下，这些商品由店铺分销，而店铺扩大规模以受益于规模经济。今天的许多人都很熟悉这种模式：批量生产满足群体消费。

第三次零售革命，亦即今天的数字时代，颠覆了这种模式。用零售商的行话来说，它创建了一个消费者“拉取”，而非生产者“推动”的体系。纽约哥伦比亚大学商学院的零售学系主任马克·科恩（Mark Cohen）说：“在20世纪初，商业的总指挥是零售商，制造商是它平等的合作伙伴。今天，总指挥是顾客。”

在西方，这种剧变引发了恐惧。那是因为零售基础设施并不是为数字时代而建的。据盛博统计，美国的人均零售面积为24平方英尺，是英国的三倍，中国的六倍。数据公司Coresight Research表示，去年美国有8700多家门店关闭。据英国零售研究中心（Centre for Retail Research）估计，在英国有1.6万家店铺关门，18.3万个零售职位流失。耐克，不好意思，但受灾最严重的部门之一就是服饰鞋类。那些新开的店多是折扣店。

然而在亚洲部分地区，这却是一个繁荣期。中国热情拥抱电子商务是一些因素的综合结果：智能手机普及、在大城市以外的地区有吸引力的购物中心不多，以及城市人口密度高降低了送货成本。但是，中国也在某种没人曾预料到的创新上脱颖而出，例如网红直播卖口红。和耐克一样，一些中国的科技公司正在利用人们的数字化足迹来改变产品的生产方式，甚至以高科技方式提高农场的果蔬产量。

但即使在中国，最终的目标也不是跨过门店。中国最大的电子商务公司阿

里巴巴已在它开设在最大城市的超市中推出了最新的数字技术，例如无人商店和视频促销。和紧随其后的竞争对手京东和拼多多一样，它在最偏远的村庄与食品杂货店合作，把商品分销变得更便宜和高效。咨询公司麦肯锡的丹尼尔·齐普瑟（Daniel Zipser）表示，去年在中国新开张了374座大型购物中心。城市中心区域零售物业的价格没有显现出有统计意义的跌幅。

在东西方，这种线下和线上世界的融合都被广泛称为“全渠道”。这也许是影响购物的未来的最明显趋势。这一未来将是线上和线下并行的。

对消费者而言，好处是显而易见的。他们可以视心情和实际情形来选择去商店或网购，这给他们提供了更大的便利。但对零售商来说，挑战是巨大的。它们不仅要负担门店成本，还要支付数字“租金”来在Facebook等网络搜索渠道上突出显示自家商品；不仅要承担送货成本，还要提供让顾客到门店自提的选择。大型在线平台Shopify表示，它们还面对处理堆积如山的退货这个日益扩大的噩梦，这个部分如今给全球零售商造成的损失每年超过一万亿美元。寻找到让全渠道模式更有利可图的方法是一大挑战。

这种模式可能会变得更赚钱，完全是考虑到可供征服的市场还很庞大。据科技业简报作者贝内迪克特·埃文斯（Benedict Evans）称，2019年全球电子商务销售额约为4万亿美元。这还不到零售总额的五分之一，在整个消费者支出中的占比更小——世界银行估计消费者支出总额达65万亿美元。尚有几十万亿美元的支出可供争抢。

不过，人们已经越来越担心少数巨头会抢占其中的大头，比如在美洲、欧洲和亚洲部分地区运营的亚马逊以及中国的阿里巴巴。美国、欧盟和中国的监管机构正在审查行业领头羊。为使未来的复兴不会成为某种数字专制，本专题报道将评估创业者如何能够挑战甚至战胜数字在位者的霸权。

在疫情中，商店纷纷关门歇业，亚马逊源源不断的包裹淹没了家门口的台阶。看起来，世界似乎行走在某种数字废托邦的边缘——商店逐渐丧失了社交、玩乐和救济慰藉孤独者的古老功能。但这种视角太过悲观了。即使

是从伊丽莎白时代的英国穿越而来的人，也能在未来的商业中认出很多东西。正如本报道将论证的那样，行贩、商贾、食摊、手工艺品、推销员和主顾都将继续存在——尽管是以新的形式。最大的不同将在于市场，这个由技术巨头主导的数字架构将在从今往后支撑我们挥霍的欲望。 ■



The marketplace

Deplatforming

The Amazons and Alibabas are not as impregnable as trustbusters think

THE E-COMMERCE company that retailers talk about most these days is neither Amazon, the American juggernaut, nor Alibaba, China's biggest. It is Pinduoduo (PDD), a Chinese firm that started in 2015 as an online food supplier, but whose success has driven its market value above \$200bn. Last year it was China's fastest-growing internet stock, rising by 330%.

PDD attracts attention for two reasons. One is its business model. David Liu, vice-president of strategy, explains that it has ridden the rise of smartphone penetration in China to create an e-commerce experience in which people club together to buy products from robot vacuum-cleaners to bananas. During the pandemic this has expanded into a fast-growing business across thousands of towns and villages, in which PDD's users gather to bid for shipments of local farm produce at bargain prices. Some term this "community group-buy". Mr Liu calls it "interactive commerce". It is one of the hottest parts of the Chinese internet.

The second is the way PDD has shattered the myth of an impregnable fortress surrounding the titans of online shopping. Until a few years ago, China's e-commerce market seemed a two-way contest between Alibaba and JD.com, a rival platform. No longer. Elinor Leung of CLSA, a brokerage, expects PDD's share of online retail in China to overtake that of JD in 2021. She expects the number of users to surpass Alibaba. And although PDD shells out huge subsidies to entice customers from poorer parts of China to its app, she thinks it may turn profitable this year.

Remarkably, it has done this less by displacing its bigger rivals than by

tapping parts of the market they have been unable to reach. Although online sales of groceries have rocketed during the pandemic, less than a tenth of the 8.1trn yuan (\$1.25trn) farm-produce market is bought and sold digitally. “We are continuing to grow the pie,” says Mr Liu. That lesson applies elsewhere too. However sewn up a market looks, there is opportunity for upstarts because e-commerce is at an early stage of development.

The issue of competition in China has convulsed share prices because of the actions of antitrust authorities. In November 2020 the State Administration for Market Regulation published draft guidelines for platform companies aimed at maintaining orderly competition. In December enforcement of the 2008 antitrust law was strengthened, leading to new investigations and fines. These have included scrutiny of mergers and acquisitions, community group-buy schemes, price-discounting and discrimination against competitors. Ms Leung wrote in January that the chance of a forced break-up of Chinese internet platforms is remote, because of its impact on industry, the economy and consumers. But she expects more regulation, especially over customer data.

Robin Zhu of Bernstein says the crackdown means tech platforms may have to restrain aggressive sales practices such as selling goods at huge discounts. That may reduce growth, but jobs and innovation plus their support for consumer spending argue in their favour. Alibaba seems the biggest target, but PDD has also drawn fire. Alibaba is flying “closest to the sun”, Mr Zhu suggests, partly because of heat on its sister company, Ant Group. But he says up to a fifth of China’s retail sales flow through its doors. Chinese regulators stress their support for the platform economy, he notes, so a crackdown is unlikely to be devastating.

The rampant competition in China’s retail market suggests no platform, however large, can expect fully to dominate it. Alongside PDD, Alibaba, JD

and Meituan, a food-delivery firm, all target China's lower-tier cities with community group-buy and other schemes. Alibaba's Taobao Live platform has led the growth of live-streaming and video, in which influencers sell branded goods at huge discounts. But the explosive live-streaming market has attracted vigorous competitors, such as Douyin, sister to TikTok, a global social-media app. WeChat, part of a super-app owned by Alibaba's rival Tencent, allows brands to sell on its site, and gives customers instant access to digital payments. Everyone is jostling for a share of online advertising. This is especially true in live-streaming, where it is easy to measure the bang for an advertiser's buck through real-time data, says Michael Jais of Launchmetrics, a fashion-and-beauty analytics company.

In Europe and America, by contrast, the view is that the game has been won by Amazon. The gap between Amazon's e-commerce market share in America and that of Walmart, the next in line, is far bigger than Alibaba's lead over the number two in China. Though Bernstein's Mark Shmulik reckons Amazon earns little profit on its core retail business, its fast-growing cloud and online-advertising arms generate huge margins that it can plough back into retail expansion. It had \$42bn of cash on its balance-sheet at the end of 2020. Marc-André Kamel of Bain, a consultancy, says Amazon may spend \$100bn more on information technology over the next five years than each of the world's top ten traditional retailers. It will also continue to invest heavily in logistics, putting more pressure on the likes of UPS and FedEx.

Like Alibaba in China, Amazon has drawn regulatory heat. In October 2020 a congressional committee in America said it was looking at overhauling antitrust laws to counter the power of the big tech platforms. It drew attention to the dominance that Amazon has over third-party sellers on its marketplace, and its practice of selling its own goods in competition with them. In November the European Commission accused Amazon of violating competition laws by using non-public data from third-party sellers to

benefit its own retail business.

Amazon says none of this is true. Although it stands tall online in America, by total sales Walmart is larger. Amazon dominates categories like books, but in groceries it is one of many. Trustbusters may have their eye on how it sells products on its website to compete with those sold by third parties, but this is little different from big retailers selling own-label products. Amazon also has political capital. Brian Nowak of Morgan Stanley says the jobs it provides, its support for small and medium-sized firms, and its technological prowess may all work in its favour.

The recent decision by Jeff Bezos, Amazon's founder, to hand the chief executive job to Andy Jassy will not end the regulatory fire. But if the pressure rises, it could spin out Amazon Web Services, the world's biggest cloud-computing company. As in China, as long as the pie is growing, new challengers may emerge. Some will come from big tech. Many online retailers pay Facebook and Google for their products to be found via search. Online advertising remains the strongest part of their businesses, but Facebook and Google are adding sales channels. Facebook has 160m small firms on its site. In 2020 it let them set up a single online store on its app and on Instagram, its sister platform. Last year Google scrapped commissions for retailers selling directly from its site.

Another source of competition will come from changes in online shopping. Smartphones may overtake personal computers in America and Europe for e-commerce. That will boost the popularity of "social commerce", or commerce via social media and video. TikTok, a medium for promoting brand awareness, may let its most popular celebrities market products on its site, according to the *Financial Times*. The battle will extend to logistics and payment services. In America Amazon delivers more of its own parcels than the US Postal Service. But rivals like Walmart are developing subscription

services like Amazon Prime that offer free delivery and other perks.

Tax is another threat. In both East and West, tax authorities have their eye on the digital giants. In 2020 Amazon saw a big increase in its tax liability, yet the administration of Joe Biden is considering imposing higher taxes on America's most profitable companies. European governments are levying digital-services taxes on tech firms in an effort to force them to pay more where their consumers are located. Some have drawn attention to the low business rates that e-commerce platforms pay on out-of-town warehouses, compared with those of retailers on the high street. Even China plans to raise taxes on its biggest tech firms.

Ultimately, higher taxes, greater regulatory scrutiny and rising competition may make profits in e-commerce harder to come by. But even if they end up regulated like utilities, few will shed a tear. The e-commerce giants have had a fabulous run so far. ■



市场

去平台化

亚马逊们和阿里巴巴们并不像反垄断官员们认为的那样坚不可摧【专题报道《购物的未来》系列之二】

这些日子里零售商聊得最多的电子商务公司不是美国巨头亚马逊，也不是中国老大阿里巴巴，而是拼多多——一家2015年创建的中国公司，起初是一家线上食品供应商，后来大获成功，目前市值已突破2000亿美元。去年它股价大涨了330%，是上涨最快的中国互联网公司。

拼多多吸睛的原因有两个。一是商业模式。公司战略副总裁九鼎解释说，它搭上了智能手机在中国加速普及的列车，创造出了一种新型电子商务体验：人们聚集到一起，拼单购买从扫地机器人到香蕉的各种商品。疫情期间，它扩展出了一项增长迅速的业务，覆盖成千上万个城镇和乡村：那里的拼多多用户凑在一起以便宜的价格购买地方农产品送货到社区。有人称之为“社区团购”。九鼎则称之为“互动商务”。它是目前中国互联网最红火的部分之一。

其二是拼多多如何粉碎了网购巨头的堡垒坚不可摧的错误认知。仅仅几年前，中国的电子商务市场似乎还是阿里巴巴及其竞争平台京东的两方较量。时过境迁。经纪公司里昂证券（CLSA）的梁向奕预计，2021年拼多多在中国线上零售中的份额将超越京东。她预计它的用户数会赶超阿里巴巴。尽管拼多多投入了巨额补贴来把中国较贫困地区的顾客吸引到自己的应用上，但她认为它今年有可能实现盈利。

值得注意的是，它能做到这些，更多是因为撬开了规模更大的竞争对手尚未能覆盖的市场，而不是抢夺它们既有的市场。尽管疫情期间食品杂货在线销量猛增，但8.1万亿元的农产品市场以数字途径买卖的尚不足一成。“我们正在继续把饼做大。”九鼎表示。这个经验也适用于其他领域。无论一个市场看起来如何胜负已定，都仍有新贵崛起的机会，因为电子商务仍处于发展的早期。

由于反垄断部门所采取的行动，中国的竞争议题导致股价大幅波动。2020年11月，国家市场监督管理总局发布了旨在维持有序竞争的平台经济反垄断指南草案。12月，当局加强了对2008年反垄断法的执法，这导向了新的调查和罚款。相关措施包括审查并购、社区团购模式、价格折扣，以及歧视竞争对手。梁向奕在1月写道，鉴于互联网平台对行业、经济和消费者的冲击力，它们被迫分拆的可能性非常小。但她预期会出台更多监管法规，尤其是在客户数据方面。

盛博的分析师朱镇表示，这轮打击行动意味着科技平台可能必须收敛激进的销售手法，比如以超高折扣出售商品。这可能会降低它们的增长速度，但它们带来的工作岗位、创新，以及对消费者支出的支撑都在为它们辩护。阿里巴巴看来是最大的目标，但拼多多也已招来不少批评。朱镇认为，阿里巴巴处境最为危险，部分原因是其姊妹公司蚂蚁集团受到的压力。但他说，中国零售销售的多达五分之一流经它的大门。他指出，中国监管部门强调对平台经济的支持，因此压制行动不大可能是摧毁性的。

中国零售市场的激烈竞争表明，没有哪个平台——无论它规模多大——可以期望完全主导这个市场。除拼多多外，阿里巴巴、京东和外卖公司美团也都在通过社区团购和其他方式瞄准中国的中低端城市。阿里巴巴的淘宝直播平台带动了实时流媒体和视频的增长，名人和网红们在其中叫卖大打折扣的品牌商品。但是，呈爆炸增长的直播市场已经吸引来强劲的竞争者，例如社交媒体应用抖音。阿里巴巴的竞争对手腾讯拥有的超级应用微信允许品牌在其平台上销售，并为顾客提供即时数字支付权限。每个人都想在线上广告中分一杯羹。在直播中尤其如此，时尚美容分析公司Launchmetrics的迈克尔·杰伊（Michael Jais）说，因为在直播中很容易通过实时数据来衡量支付的广告费是否值得。

相比之下，在欧洲和美国，人们认为亚马逊已经赢得了这场比赛。亚马逊在美国电商市场的份额与第二名沃尔玛之间的差距远远大于阿里巴巴在中国领先第二名的差距。尽管盛博的马克·谢穆里克（Mark Shmulik）认为亚马逊的核心零售业务几乎还没有赚到什么利润，但它快速增长的云和在

线广告业务产生了巨大的利润，可拿来投入到零售业的扩张中。2020年底，它的资产负债表上有420亿美元现金。咨询公司贝恩（Bain）的马克-安德烈·卡梅尔（Marc-André Kamel）说，亚马逊未来五年在信息技术上的支出，可能比全球前十大传统零售商中的任何一家都要多1000亿美元。它还将继续在物流上大举砸钱，给UPS和联邦快递（FedEx）等公司带来更大的压力。

和中国的阿里巴巴一样，亚马逊也招致了监管压力。2020年10月，美国国会的一个委员会表示，它正考虑全面改革反垄断法规以对抗大型科技平台的影响力。这引来人们关注亚马逊在其市场上对第三方卖家的支配地位，以及推出与第三方卖家竞争自家商品的做法。11月，欧盟委员会指控亚马逊使用来自第三方卖家的非公开数据助力自己的零售业务，违反了竞争法。

亚马逊说这些都是无稽之谈。尽管它笑傲美国的线上市场，但以总销售额计沃尔玛的规模更大。亚马逊在书籍等品类中称霸，在食品杂货这一块却并不起眼。反垄断官员可能会关注它如何在自家网站上销售产品与第三方产品竞争，但这与大型零售商销售自家品牌并没有什么不同。亚马逊也有政治资本。摩根士丹利的布莱恩·诺瓦克（Brian Nowak）表示，它提供的工作岗位、对中小企业的支持以及它的技术实力都可能对它有利。

亚马逊的创始人贝索斯最近决定把CEO一职转交安迪·雅西（Andy Jassy），这不会终结监管的火力。但如果压力增大，它可能会剥离全球最大的云计算公司亚马逊网络服务（AWS）。和中国的情况一样，只要饼还在变大，就可能出现新的挑战者。有些将来自科技巨头。许多在线零售商向Facebook和谷歌付费，让自家产品能通过搜索被找到。在线广告仍然是这两家巨头最强大的业务，但它们正在增加销售渠道。Facebook网站上已有1.6亿家小企业，去年它让这些企业可以在Facebook和姊妹平台Instagram上开设同一家店面。去年，谷歌不再向从它的网站直接销售产品的零售商收取佣金。

另一个竞争源头是网上购物的变化。在欧美，电子商务可能更多将通过智能手机而非个人电脑发生。这将促进“社交商务”（也就是通过社交媒体和视频做商务）的普及。据《金融时报》报道，作为一个提升品牌知名度的媒介，抖音国际版TikTok可能会让它最受欢迎的红人们在它的平台上营销产品。这场战争将扩大到物流和支付服务部门。在美国，亚马逊自己递送的自家包裹超过了UPS为它递送的量。但像沃尔玛这样的竞争对手正在开发类似亚马逊金牌会员（Amazon Prime）的订户服务，将提供免费送货和其他福利。

税收是另一个威胁。无论东方西方，税务部门都已盯上了数字巨头。2020年亚马逊的应纳税额大幅增加，但拜登政府还在考虑对美国最赚钱的一批公司征收更高的税。欧洲各国政府对科技公司征收数字服务税，以迫使它们在自己消费者所在的地区缴纳更多。一些政府已经提请大家注意，与商业大街上的零售商相比，电子商务平台为城外仓库支付的营业税较低。甚至中国也计划对其最大的科技公司提高税收。

最终，更高的税收、更严格的监管审查，以及日益激烈的竞争可能会让巨头们更难在电子商务中赚到利润。但是，即使它们最终受到如公用事业般的监管，也没什么人会为它们掬一把同情泪。到目前为止，电商巨头们都取得了骄人的成绩。 ■



Carbon capture and storage

Supergrass

Plants in the ocean are better at storing carbon than those on land

OFF THE coast of Formentera, an island in the Spanish Mediterranean, lives an organism that stretches 15km from one end to the other. *Posidonia oceanica*, more prosaically known as seagrass, spreads by sending shoots out beneath the sediment. Entire meadows, covering several hectares, can thus be made up of a single organism. The grasses are long-lived, too. The vast meadow in Formentera is thought to have been spreading for tens or hundreds of thousands of years.

But the seagrass is more than just a biological curiosity. Along with two other kinds of coastal ecosystem—mangrove swamps and tidal marshes—seagrass meadows are particularly good at taking carbon dioxide from the air and converting it into plant matter. That makes all three ecosystems important for efforts to control climate change.

This role was highlighted in a report published on March 2nd by UNESCO, an arm of the United Nations, on “blue carbon”—the sort captured by Earth’s oceanic and coastal ecosystems. In total around 33bn tonnes of carbon dioxide (about three-quarters of the world’s emissions in 2019) are locked away in the planet’s blue-carbon sinks. Research by Carlos Duarte, the report’s author and a marine ecologist at King Abdullah University in Saudi Arabia, has shown that one hectare of seagrass can soak up as much carbon dioxide each year as 15 hectares of rainforest.

All this is attracting interest in blue carbon from those keen to use natural processes, rather than human technologies such as direct-air capture, to suck greenhouse gases from the atmosphere. In 2018 Apple partnered with

Conservation International, a charity, to protect 11,000 hectares of mangroves on the Colombian coast. The firm estimates the project could lock away around 1m tonnes of carbon.

One reason that blue-carbon ecosystems make such effective sinks is that submerged forests are denser than their land-based equivalents. They can also trap floating debris and organic matter, which settles on the sea floor and can double the amount of carbon stored away.

They possess another advantage, too. Unlike forests on land, blue-carbon ecosystems do not burn. Climate change is intensifying wildfires around the world. As forests burn, their carbon stocks are released back into the atmosphere. And fires can impede a forest's ability to capture carbon even after they have burned out. In a study published on February 25th in *Nature Ecology and Evolution*, researchers at the University of Stanford found that repeated fires favour slow-growing tree species. These are better able to survive blazes, but they are also less effective at soaking up carbon than faster-growing species.

Submerged forests may be impervious to fires, but they remain vulnerable to other sorts of disasters. In May 2020 cyclone Amphan destroyed 1,200 square kilometres of mangrove forest on the border between Bangladesh and the Indian state of West Bengal. A marine heatwave in Australian waters in 2010 and 2011 damaged around one third of the world's largest seagrass meadow, in Shark Bay. Over the next three years field studies showed that uprooted plants were releasing their carbon back into the atmosphere.

Fortunately, an older, man-made ecological disaster suggests that restoring damaged blue-carbon ecosystems is possible. During the Vietnam war, napalm and a cocktail of weaponised herbicides destroyed more than half of the mangroves in the Mekong delta. A report published in 2014 by the International Society for Mangrove Ecosystems showed that an intense

post-war replanting programme was able to restore it within two decades.

And there is more to such ecosystems than simply acting as sponges for greenhouse gasses. They also serve as buffers for vulnerable shorelines, shielding them from storms that barrel in from the high seas. One study of 59 subtropical countries estimated that by dampening waves and providing natural barriers to storm surges, mangrove forests prevent more than \$65bn in property damage each year, and help shelter more than 15 million people. Protecting and expanding them, then, appears to be a no-brainer. ■



碳捕存

超级草

海洋植物比陆地植物更能储存碳

在西班牙位于地中海的福门特拉岛的海岸附近，生长着一种绵延15公里长的生物。大洋海神草——俗称海草——在海洋沉积物的下方伸出嫩芽而不断蔓延。这样一来，几公顷大的整个草甸可能都是同一个生物体。这些草的寿命也极长。人们认为福门特拉岛的这片广阔草场已经生长了几万年乃至几十万年了。

但这些海草不仅仅是一种生物学上的奇观。与其他两种沿海生态系统——红树林沼泽和潮汐沼泽——一样，海草草甸特别擅长从空气中吸收二氧化碳并将其转化为植物质。这使得这三个生态系统对于控制气候变化的努力都很重要。

在联合国分支机构教科文组织3月2日发布的一份有关“蓝碳”的报告中，就强调了海草的这种角色。“蓝碳”指的是由地球上的海洋和沿海生态系统所捕获的二氧化碳。总计约330亿吨二氧化碳（约占2019年全球排放量的四分之三）被封存在地球的蓝碳汇中。该报告的作者、沙特阿卜杜拉国王科技大学的海洋生态学家卡洛斯·杜阿尔特（Carlos Duarte）的研究表明，一公顷海草每年吸收的二氧化碳可比拟15公顷雨林。

所有这些都引发了一些人对蓝碳的兴趣，他们热衷于利用天然过程而非像“直接空气捕获”这类人为技术来从大气中吸收温室气体。2018年，苹果与慈善机构“保护国际”（Conservation International）达成合作，共同保护哥伦比亚海岸面积1.1万公顷的红树林。苹果估计该项目可以封存约100万吨二氧化碳。

蓝碳生态系统之所以能成为如此有效的碳汇，原因之一是海底森林比陆上同类森林更为茂密。它们还可以捕获海水中的垃圾碎屑和有机物等悬浮物，它们最终沉降于海床上，可令被封存的碳量增加一倍。

它们还有另一个优势。与陆地上的森林不同，蓝碳生态系统不会起火燃烧。气候变化正在加剧世界各地的森林野火。森林燃烧时，它们储存的碳被重新释放到大气中。而且即便在林火熄灭后，森林捕获碳的能力也可能折损。在2月25日发表于《自然生态与进化》（*Nature Ecology and Evolution*）的一项研究中，斯坦福大学的研究人员发现，反复发生的林火会倾向延续那些生长缓慢的树种。它们更能在烈焰中存活下来，但其吸收碳的能力也比生长更快的树种低。

水下森林可能不会起火，但仍会遭受其他类型的灾难。去年5月，安攀飓风（Amphan）摧毁了孟加拉国和印度西孟加拉邦边界上绵延1200平方公里的红树林。2010年和2011年，澳大利亚海域的海洋热浪毁坏了位于鲨鱼湾的世界最大海草草甸的约三分之一。接下来的三年中，田野研究表明，被连根拔起的植物将它们储存的二氧化碳重新释放回了大气中。

幸运的是，过去的一场人为生态灾难表明，被破坏的蓝碳生态系统是有可能恢复的。越战期间，凝固汽油弹和被用作武器的除草剂混合物摧毁了湄公河三角洲超过一半的红树林。国际红树林生态系统协会2014年发布的一份报告显示，战争结束后的一个大规模再植项目在20年内修复了它们。

而且，这类生态系统不只是吸收温室气体的海绵。它们也是脆弱海岸线的缓冲垫，使这些海岸线免受公海暴风雨的侵袭。对59个亚热带国家的一项研究估计，通过抑制海浪并为风暴潮提供天然屏障，红树林每年防止了超过650亿美元的财产损失，帮助庇护了1500多万人。这么看来，保护和扩展它们是显而易见的选择。■



Clean energy

Toothpaste in your tank

Hydrogen goop could be more convenient than hydrogen gas

ON PAPER, HYDROGEN looks like a dream fuel. Coal, oil and natural gas generate planet-warming carbon dioxide when burned. Hydrogen produces pure water. Hydrogen crams more energy into less space than batteries do (though, admittedly, less than petrol or diesel do). And an empty tank can be refilled with hydrogen much faster than an empty battery can be refilled with electricity.

In practice, things are trickier. Storing meaningful quantities of hydrogen gas requires compressing it several hundred-fold. Liquefying it is another option, but one that requires cooling the stuff to -253°C. Either process requires rugged tanks. Over time, hydrogen gas can infiltrate metals, weakening them and potentially causing cracks. Tanks must be built from special materials designed to resist this breakdown.

There may be a better way. Researchers at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials in Germany, led by Marcus Vogt, think that supplying hydrogen as goop rather than gas offers a way around some of its limitations. They have been experimenting with a chemical compound that can be pumped into a cartridge and then persuaded to give up its hydrogen on demand.

Their invention, which they dub “Powerpaste”, bears a passing resemblance to toothpaste. Its main ingredient is magnesium hydride, a compound that, when introduced to water, reacts with it to form hydrogen and magnesium hydroxide (a substance more familiar as milk of magnesia, a stomach-settling antacid). The escaped hydrogen can then be diverted into a fuel

cell, where it reacts with oxygen from the air to generate electric power. The magnesium hydroxide waste is emptied from the reactor automatically.

Dr Vogt's scheme offers several advantages over batteries, petrol and more conventional ways of handling hydrogen. One is the storage of more energy per litre, and per kilogram, than either batteries or petrol can manage. A second is ease of refilling, which is simply a matter of swapping an empty cartridge of paste for a full one, and topping up the water, which is stored in a separate tank. A third advantage is that, unlike a battery, the paste does not gradually lose its stored energy if it is left on the shelf.

Moreover, the paste itself is non-toxic, as are the reaction's by-products. But there are plenty of subtleties to work through. Left to its own devices, magnesium hydride reacts only slowly with water because the reaction forms a barrier on the material's surface that inhibits further chemistry. To overcome this, Dr Vogt and his team have found a chemical additive that greatly accelerates the reaction. They have also found a way to ensure that the reaction can be controlled precisely enough to supply only as much hydrogen as is needed at any given moment.

The paste is unlikely to up-end the clean-car industry, where battery-powered vehicles have already established themselves as the dominant technology. But Dr Vogt nonetheless hopes that his invention may find niches. One early use could be in small vehicles such as scooters, or in flying drones where weight is at a premium. It is hard to scale down the sorts of heavy-duty tanks needed to store elemental hydrogen, he says. Powerpaste could thus enable longer ranges for scooters, and flight times for drones measured in hours rather than minutes. Miniature stoves aimed at campers are another idea.

A pilot plant in Brunswick, a city in Lower Saxony, will be able to produce four tonnes of the stuff per year when it is finished later this year. And

heavier-duty uses are certainly possible, if that is what customers would like. Dr Vogt has already built a small demonstration unit for the German army. ■



清洁能源

油箱里的牙膏

氢糊可能比氢气更方便

理论上看，氢似乎是一种理想的燃料。煤、石油和天然气在燃烧时会产生让地球变暖的二氧化碳。氢只会产生水。与电池相比，氢能以更小的体积储存更多的能量（当然，还是比汽油或柴油要少）。而且，把一只空储罐重新充满氢气也要远快过把空电池充满电。

但实际情况要更复杂些。储存足量的氢气需要把它加压数百倍。另一个选择是把它液化，但要冷却到零下 253°C 。这两种方法都需要坚固的储罐。年深日久，氢气会渗透进金属，使之脆化，并且可能造成裂纹。储罐必须用特殊材料制成，以抵御这种损坏。

也许有更好的办法。在德国的弗劳恩霍夫制造技术与先进材料研究所（Fraunhofer Institute for Manufacturing Technology and Advanced Materials），由马库斯·沃格特（Marcus Vogt）领导的研究人员认为，以糊状而不是气态形式供应氢可以绕过它的一些缺点。他们一直在试验一种化合物，可以把它注入储藏盒，然后在需要时让它释放其中的氢气。

他们给自己的发明取名“动力膏”（Powerpaste），看上去有点像牙膏。它的主要成分是氢化镁，这种化合物遇水时会反应，生成氢和氢氧化镁（这种物质更为人熟知的形态是镁乳这种缓解胃部不适的抗酸剂）。由此释放出的氢气可以被输送到燃料电池中，与空气中的氧气反应产生电力。氢氧化镁废料会自动从反应器中排空。

和电池、汽油以及传统的氢气处理方法相比，沃格特的方案有几个优势。首先是单位体积和重量所能储存的能量比电池或汽油都要多。第二是方便补充，只要用满装的储藏盒换掉空盒，再把一个独立储水罐里的水加满即可。第三个优点是，与电池不同，这种膏体即便放置不用也不会逐渐流失储存的能量。

而且，这种膏本身及反应的副产品都是无毒的。不过还有很多细节需要解决。如果不加干预，氢化镁与水的反应速度会很慢，因为这一反应会在这种材料的表面形成屏障，抑制进一步的化学反应。为解决这个问题，沃格特和他的团队发现了一种可以大大加快反应速度的化学添加剂。他们还找到了一种方法，保证能足够精确地控制反应，从而随时按需提供氢气。

这种膏不太可能颠覆清洁能源汽车产业，因为电动汽车已经发展为该行业的主导技术。但沃格特仍然希望他的发明能够找到利基市场。早期的应用之一可以是滑板车、电瓶车之类的小型交通工具，或者重量控制至关重要的无人机。他说，存储纯氢气所需的那类结实的储罐很难再缩小尺寸。因此，用“动力膏”可以让滑板车和电瓶车跑得更远，让无人机的飞行时间以小时而不是分钟计。另一个想法是用于露营用小型炉灶。

下萨克森州布伦瑞克市（Brunswick）的一家试点工厂将在今年晚些时候建成，每年可生产四吨这种材料。如果客户希望的话，它当然也可能被用于更重要的场合。沃格特已经为德国军队建造了一个小型示范装置。 ■



Non-fungible tokens

What's wrong with this picture?

Non-fungible tokens are useful, innovative—and frothy

“EQUIVALENT VIII” by Carl Andre was a minimalist sculpture bought by Britain’s Tate Gallery in 1972. The Tate described the work as “a rectangular arrangement of 120 firebricks...altering the viewer’s relationship to the surrounding space”. The public called it a pile of bricks. A few years later newspapers execrated the gallery for having wasted brick-shaped wads of cash on the avant-garde work.

Once again, a famous institution is embracing a controversial new genre. On March 11th Christie’s sold a digital collage of images called “Everydays—The First 5,000 Days” for a cool \$69.3m. The sale elevated the work’s creator, Mike Winkelmann, aka Beeple, to the august company of David Hockney and Jeff Koons, the only two living painters to sell at such prices.

Christie’s sold the artwork as a “non-fungible token” (NFT), a craze for which has gripped Silicon Valley’s elite. An NFT is a secure, blockchain-based record that represents pieces of digital media. Invented a few years ago, it can link not only to digital art but also to text, videos or bits of code.

The pile-of-bricks criticism of digital artworks is that, in contrast to physical collectibles, they can be copied with perfect fidelity and consumed infinitely online. They thus have limited inherent value. A token brings bragging rights to a unique, authenticated version of a digital artwork, song or cute image of a cat (which first earned NFTs their popularity). Another attraction for the creative world is that NFTs make it easy to build in payments to artists when their works are sold on.

Since almost anything can be tokenised and sold if punters are willing, the

craze stretches beyond pictures. Kings of Leon, a rock band, is selling a new album as an NFT and the National Basketball Association is selling clips of famous dunks. Creators can turn to a growing collection of marketplaces, such as OpenSea and Nifty Gateway. Even individual tweets are going for big sums (leading some to wonder if the former tweeter-in-chief, Donald Trump, could flog bits of his oeuvre).

The bumper Beeple sale, plus the arrival of ever more creators, means a mania that has been largely confined to crypto and techie circles could move mainstream. The global NFT market grew from a few tens of millions of dollars in annual sales a few years ago to over \$300m in the past month alone, according to Andreessen Horowitz, a venture-capital firm. NFTs mesh with the massive network effects of social media and meme culture, notes Sam Hart of the Interchain Foundation, a Swiss backer of blockchain infrastructure. There has been little time to educate buyers, he says.

The pitfalls are being called out by a few crypto experts. One worry is that broad crypto-enthusiasm may be what is really behind soaring NFT values. It has not gone unnoticed that the buyer of Beeple's "Everydays" is Metakovan, a professional crypto investor. Christie's got its \$69.3m in Ether, a cryptocurrency.

Some compare the NFT craze to the boom in initial coin offerings, a form of crowdfunding in which firms issue digital "coins" in return for a payment, in 2017-18, which turned to bust soon after. The soaring prices of many NFTs, reliant on ephemeral buzziness in places like Clubhouse, a hot new audio app, could quickly collapse. Celebrities including Lindsay Lohan jumping on a trend that was meant to be about helping penniless artists is, some reckon, another ominous sign. The upfront costs of "minting" NFTs are low, meanwhile, meaning potentially unlimited supply. (For now NFTs' huge carbon footprint, owing to energy-intensive blockchain transactions, is not transparently recorded.)

A final uncertainty around NFTs' value is that they can in practice be separated from the digital good to which they are tied, undermining their worth. A creator can change the image even after sale. One crypto artist recently "pulled the rug" on some NFTs to highlight the flaw. A series of colourful digital portraits suddenly metamorphosed into pictures of antique carpets. But the art market has always been prone to dodgy dealing. Picking NFTs looks akin to sorting real Rembrandts from those daubed by mere followers. ■



非同质化代币

看图找错

NFT有用，有创意——也有泡沫

卡尔·安德烈（Carl Andre）的《平衡8号》（Equivalent VIII）是个极简主义雕塑，英国泰特美术馆于1972年买下了它。该馆描述这件作品“由120块耐火砖呈矩形排列.....改变了观者与周围空间的关系”。公众称它是一堆砖头。几年后，报刊纷纷指责该馆在这个前卫作品上浪费了一摞砖那么多的钞票。

这回又有著名机构积极拥抱有争议的新流派了。3月11日，佳士得拍卖行以6930万美元的天价卖出了一幅名为《日常——最初的5000天》（Everydays—The First 5000 Days）的数字图像拼贴画。这笔交易把创作者Beeple（本名迈克·温克尔曼[Mike Winkelmann]）送上了比肩大卫·霍克尼（David Hockney）和杰弗·昆斯（Jeff Koons）的崇高地位，在世画家中只有这两位卖出过这样的价格。

佳士得是以“非同质化代币”（non-fungible token，简称NFT）的形式拍卖这件作品的。硅谷的精英们对NFT非常狂热。一个NFT是一个安全的、基于区块链的记录，承载单个数字媒体作品。这个诞生于几年前的发明不仅可以与数字艺术相连接，还可以关联文本、视频或代码片段。

给数字艺术品“拍砖”的声音指出，与实体收藏品相比，它们可以被分毫不差地复制，人们也能在网上无限次地消费它们，因此它们的内在价值有限。一个NFT让人们得以拥有一版独一无二且经过鉴定的数字艺术品、歌曲或可爱猫咪图片（NFT最早就是因为猫走红的），带来了吹牛的资本。对创意世界来说，NFT还有一个吸引力，就是让艺术家更容易从作品中获得报酬。

如果投资者愿意，几乎任何东西都可以代币化出售，因此对NFT的狂热不仅限于图片。摇滚乐队莱昂国王（Kings of Leon）正以NFT的形式发售新

专辑，NBA也在以这种形式出售著名扣篮的短视频。供创作者出售作品的市场越来越多，如OpenSea和Nifty Gateway。就连单条推文也指望着赚一大笔钱（这让一些人琢磨着前首席推特用户特朗普是否能从自己的全部作品中拿出一些来卖）。

此次Beeples作品拍出天价，加上越来越多的创作者加入，意味着原本主要局限于加密圈和技术圈的狂潮可能会涌进主流。据风投公司安德森-霍洛维茨（Andreessen Horowitz）称，几年前全球NFT市场的年销售额还只有几千万美元，仅过去一个月就突破三亿美元。位于瑞士的区块链基础设施资助方跨链基金会（Interchain Foundation）的萨姆·哈特（Sam Hart）指出，NFT融合了社交媒体和“梗”文化巨大的网络效应。他说，几乎没有教育买家的时间。

一些加密专家指出了其中隐藏的风险。一个担忧是推动NFT价值飙升的真正原因可能是对加密的广泛热情。Beeples的《日常》的买家Metakovan是专业的加密投资人，这一点没躲过人们的注意。他付给佳士得的6930万美元是用加密货币以太币支付的。

有人觉得NFT热就像2017到2018年的首次代币发行（ICO）热潮，这是一种众筹形式，企业通过发行数字“币”换取资金，但这股热潮很快就退去了。许多NFT的价格飙升倚赖大热新音频应用Clubhouse这些角落一时的热闹，说不定很快会暴跌。这股潮流原本是想帮助困窘的艺术家，但包括林赛·罗韩（Lindsay Lohan）在内的一众名人也横插一脚，一些人认为这是另一个不祥的征兆。另外，NFT“挖矿”的前期成本很低，这意味着它的供应可能会是无限的。（鉴于区块链交易是能源密集型的，NFT的碳足迹巨大，但这在目前并没有被透明地记录下来。）

关于NFT价值的最后一个不确定性是，它们实际上可以与自身关联的数字产品分离，致使价值受损。一张图片即便已售出，其创作者也可以对它做出更改。为了突显这一缺陷，近期一名加密艺术家对一些NFT动了手脚来故意“拆台”，一张张色彩缤纷的数码肖像画突然就变成了古董地毯的图片。但艺术品市场本就容易出现可疑的交易。看起来，要在NFT中披沙拣

金，就跟把伦勃朗的真迹从其追随者拙劣的模仿中挑出来差不多。 ■



The travelling salesmen

Arming the rebels

Alternatives to big tech are flourishing around the world

THOUGH AMERICAN and Chinese tech platforms started the e-commerce gold rush, one Canadian company realised early on what money was to be made from selling shovels. That was Shopify, which supplies tools such as software, logistics and payments to allow firms to set up their own online stores rather than selling via giant platforms like Amazon. Its value, at \$175bn, is only about a tenth that of Amazon. But in the past five years its share-price rise has outstripped that of “The Everything Store” more than tenfold.

Harley Finkelstein, president of Shopify, is an evangelist for small retailers. Shopify’s more-than-1m merchants range from \$1bn-plus brands like Allbirds to tiny startups that make their first sale on its platform every 52 seconds. Yet he believes that consumers will be the big winners from the transformation of retail, giving them more influence over how and what they buy. Not since John Wanamaker set up one of America’s earliest department stores in 1876, he says, has there been such a shift in favour of the customer.

Shopify may be the biggest e-commerce firm that most people have never heard of. Mr Finkelstein says it is “arming the rebels” by enabling independent retailers to survive and thrive via multiple sales channels, from Amazon to social media to bricks-and-mortar stores. Yet it is not the only fifth columnist. Across the world, regional platforms are competing fiercely to avoid American and Chinese dominance.

In Japan Amazon and Rakuten, a local e-commerce veteran, are in a battle

for market leadership, but Softbank also plans to merge Yahoo Japan, an online shopping site in which it has a big stake, with Line, a messaging app, to make it a three-horse race. Amazon also has designs on South Korea via a partnership with 11street, owned by a local telecoms giant. But the market, led by Coupang, an online platform, is highly competitive. The South Korean affiliate of eBay, a big American platform, may be up for sale soon, making the contest fiercer still.

The Chinese tech giants Alibaba and Tencent have e-commerce stakes in South-East Asia via holdings in Lazada and Tokopedia, and Sea, respectively. In India, though the bulk of retailing still takes place in corner shops called *kirana*, e-commerce is a battle between Amazon, Flipkart (owned by Walmart) and JioMart, owned by Reliance, a conglomerate, with backing from Facebook, the American social-media giant. The Western firms are not just vying for a share of India's vast retail market. They also want to learn how best to entice new smartphone users in emerging markets to shop online. That means more voice search, because of the plethora of local languages, as well as more video, says Leigh Hopkins, Walmart's head of international strategy.

In Europe Amazon dominates, but marketplaces selling other people's goods such as Berlin-based Zalando and Manchester-based Boohoo are mounting challenges. In Latin America Alibaba is the model, not Amazon. Buenos Aires-based Mercado Libre, the market leader in the region, does not sell its own products, unlike Amazon. Like Alibaba, it has a strong digital-payments arm. Yet Amazon is strong in Mexico, where it goes head to head with Mercado Libre, and competition between the two is growing in Brazil. Amazon is named after the country's longest river. So far its business in Brazil does not live up to the name. But that is a rare exception. ■



旅行推销员

武装叛军

技术巨头的替代品正在世界各地蓬勃发展【《购物的未来》专题系列之四】

虽然美国和中国的技术平台掀起了电子商务淘金热，但一家加拿大公司很早就意识到了卖铲子能赚到多少钱。那就是Shopify——它提供软件、物流和支付等工具，让公司能够建立自己的网店，而不是通过亚马逊等大型平台来销售。该公司市值1750亿美元，仅为亚马逊的十分之一。但在过去五年中，其股价涨幅超过了“万物商店”十倍以上。

Shopify的总裁哈利·芬克尔斯坦（Harley Finkelstein）是小型零售商的布道者。Shopify上的商家数量超过100万，从Allbirds等价值10亿美元以上的品牌，到每52秒就有一个加入平台启动首次销售的微型创业公司。但他认为，消费者将成为零售业转型的最大赢家，在购买的方式和内容上都获得更大的影响力。他说，自从约翰·瓦纳梅克（John Wanamaker）于1876年成立美国首批百货商店之一以来，就没有发生过这样有利消费者的转变。

Shopify可能是大多数人闻所未闻的电子商务公司中最大的一家。芬克尔斯坦表示，它正在“武装叛军”——让独立零售商通过多种销售渠道（从亚马逊到社交媒体再到实体店）生存和发展。不过“第五纵队”并不止这一家。在世界各地，区域性平台都在激烈竞争，以避开美国和中国的支配。

在日本，亚马逊和经营多年的本地电子商务平台乐天（Rakuten）争夺市场领导地位，但软银还计划将其拥有重大股份的在线购物网站雅虎日本与消息应用Line合并，使之成为三方竞争。亚马逊还通过与一家本地电信巨头旗下的11street合作布局韩国。但是，以在线平台Coupang为首的韩国电商市场竞争非常激烈。美国大型平台eBay的韩国分支可能很快就要出售，这将令竞赛更加激烈。

中国科技巨头持有东南亚的电子商务股权，阿里巴巴持股来赞达

(Lazada) 和Tokopedia，腾讯持股Sea。在印度，尽管大部分零售仍在称为“吉拉纳”的街角商店进行，但电子商务的竞争在亚马逊、Flipkart（沃尔玛旗下）和JioMart（企业集团信实旗下，得到了美国社交网站巨头Facebook的支持）之间展开。西方公司不仅在争夺印度庞大零售市场的份额，他们还想了解如何最有效地吸引到新兴市场的新智能手机用户到线上购物。沃尔玛国际战略负责人李·霍普金斯(Leigh Hopkins)表示，这意味着要进行更多的语音搜索，因为当地语言非常庞杂，也会用到更多的视频。

在欧洲，亚马逊占据主导地位，但诸如总部位于柏林的Zalando和曼彻斯特的Boohoo等第三方卖家平台正带来越来越大的挑战。在拉丁美洲，榜样是阿里巴巴，而不是亚马逊。该地区的市场领导者、总部位于布宜诺斯艾利斯的美卡多(Mercado Libre)并不像亚马逊那样出售自己的产品。和阿里巴巴一样，它也拥有强大的数字支付部门。不过，亚马逊在墨西哥的实力很强，与美卡多并驾齐驱，而两者在巴西的竞争日趋激烈。亚马逊以该国最长的河流得名。到目前为止，它在巴西的业务还配不上这个名字。但这是一个罕见的例外。 ■



Carbon trading

Cleaning up

Can China's carbon market take off?

CHINA IS THE world's biggest polluter. Its cars and factories release almost twice as many lung-harming carbon particles each year as in those in America. The country's leadership has certainly been sending strong messages on cutting emissions. But its plan to reduce the carbon intensity of GDP by 65% by 2030 (compared to 2005 levels) and to hit net-zero emissions by 2060 has done little to comfort environmentalists. China is still building hundreds of coal-fired plants. The Climate Action Tracker, which is compiled by a consortium of experts, rates its efforts to lower emissions as "highly insufficient".

On February 1st China's carbon-trading market went live, a decade after it was first mooted, offering a glimpse of hope that the severe pollution the country generates might be curbed. The general principles of the emissions-trading system (ETS) reflect global standards, and slow implementation has been par for the course in other places. But there are two reasons to worry that Beijing may not get carbon trading right.

The first is the ETS's scope. The expectation was that the market would cover at least 70% of the country's carbon-emitting industries, including power generation, aviation and petrochemicals. It may eventually do that. But its first phase covers just 2,225 power generators, representing a small fraction of emissions (the generation sector as a whole produces about 30% of China's emissions). Instead of employing an absolute emissions cap, as Europe does, it will rate polluters by four benchmarks, including size, fuel type and carbon intensity, to determine caps on emissions. Gas-powered plants, for example, will get a larger allowance than dirtier coal-burners.

Companies need pay for only 20% of the emissions that exceed their cap. Maximum fines for breaches are a paltry 30,000 yuan (\$4,644), according to Fitch, a rating agency.

Benchmarks based on the type of fuel burned will influence efficiency within existing technologies, but it will not encourage a shift to greener ones. Such a system, says Mervyn Tang of Fitch, accommodates the energy needs of China's high rate of economic growth. But policymakers have yet to say when they will move to an absolute emissions cap—a step considered necessary to clear China's smoggiest cities. Nor have they indicated when the ETS will bring in the entire power sector and other polluting industries. Construction and transport may never be included.

Second, the programme faces legal ambiguity. The ETS has been set up by the ministry of ecology. But the framework for enforcing a carbon-trading market is untested. Many of the worst polluters will look for loopholes. To gain acceptance from companies and local enforcers, and to set out guidelines for participation from third-party investors, the State Council (the country's cabinet) itself must issue rules, says Chen Zhibin of Sinocarbon, a think-tank.

The council has already consulted the country's powerful manufacturing and energy lobby, but there is no word on when a final set of rules will be produced. Until then, full backing for the carbon market will remain elusive. ■



碳交易

清理

中国的碳市场能否起航？

中国是全球最大的排放国。中国的汽车和工厂每年排放的有害肺部健康的碳颗粒之多，几乎是美国的两倍。中国领导层无疑一直在发出强烈的讯息要推进减排。尽管中国计划在2030年前将GDP碳排放强度降低65%（相比2005年的水平），并在2060年实现净零排放，却还是难让环保主义者安心。中国仍有数百座燃煤电厂在建。由多个机构的专家联合编撰的“气候行动追踪分析”（Climate Action Tracker）把中国的减排努力评级为“非常不足”。

在提出十年后，中国的碳交易市场在2月1日正式上线，让人看到了该国的严重污染将被遏制的曙光。中国的碳排放权交易体系的总体原则体现了全球标准，而从世界其他地方的操作来看，缓慢推进也是意料中事。但有两个原因让人担心中国可能做不对这件事。

首先是这个交易体系的范围。人们期望该市场至少覆盖国内70%的碳排放行业，包括电力、航空和石化。这最终也许可以实现，但第一阶段只覆盖了2225家发电企业，只占排放量的一小部分（整个发电行业约占中国排放总量的30%）。中国不像欧洲那样设定绝对排放上限，而是将根据规模、燃料类型和碳强度在内的四个基准对排放企业评级，以确定排放上限。举例来说，天然气发电厂会比污染更严重的燃煤发电厂获得更多免费配额。在企业排放量高出免费配额的情况下，缴付上限为排放量的20%。评级机构惠誉称，违规的最高罚款仅为三万元。

根据燃料类型确定基准将促使现有技术提升效率，但不会鼓励转向更环保的技术。惠誉的邓铠俊表示，这样的体系能适应中国高速增长的能源需求。但政策制定者尚未表示何时会转向绝对排放上限，而要让中国那些最雾蒙蒙的城市澄净起来，这一步被认为是必需的。他们也没透露何时会

把整个电力行业及其他污染行业纳入碳排放权交易体系。建筑业和运输业可能永远都不会被纳入进来。

其次，这个体系在法律上含糊不清。它由生态环境部建立。但碳交易市场的执行框架尚未经过考验。许多排放最严重的企业会寻找其中的漏洞。智库中创碳投的陈志斌表示，国务院必须颁布相关法规，让该体系获得企业和地方执法机构的认可，并为第三方投资者的参与提供指引。

国务院已经向国内强大的制造及能源游说团体征询意见，但没有消息表明何时会推出最终的法规。在那之前，对碳市场的全面支持将始终难以落实。 ■



Free exchange

For goodness' sake

Why two former central bankers are talking about trust

AFTER THE global financial crisis, people asked whether economists had not misunderstood something important about markets. The trying experience of recent years has some figures broadening the question, to ask whether economists have not failed to grasp something crucial about people. In a new book, “Value(s)”, Mark Carney, governor of the Bank of England from 2013 to 2020, argues that within profit-obsessed market economies self-interest crowds out other motivations, making the world a more selfish place—and potentially a less resilient and prosperous one, too. The notion is disconcerting, not least because the dominance of orthodox economic thinking leaves leaders poorly equipped to assess and respond to such claims.

Parts of Mr Carney’s argument are echoed in another new book, by Minouche Shafik, director of the London School of Economics, who served as one of Mr Carney’s deputies at the Bank of England. Lady Shafik’s book, “What We Owe Each Other”, examines the role of the social contract and considers how changes in the global economy have undermined the function of the institutions societies rely on to keep the world a reasonably just place. Fixing up and modernising the social contract is necessary, she writes, “if we are not to witness a destructive fracturing of the mutual trust on which citizenship and society is based.” People have become too disinterested in their obligations to other people and to society as a whole, Lady Shafik says; they owe each other more.

Such notions would not have been out of place in the work of the classical economists. Indeed, both Mr Carney and Lady Shafik cite Adam Smith’s

work, “The Theory of Moral Sentiments”, which investigated how people come by their values, beliefs and preferences. They do so, Smith argued, through “mutual sympathy”—by imagining how others feel, essentially. This informs the public’s sense of right and wrong and establishes a social foundation for other institutions, including markets. Smith saw markets as “living institutions, embedded in the culture, practice, traditions and trust of their day”, writes Mr Carney. Modern economists rarely write about markets in such terms. The innovations of the neoclassical economists of the late 19th century shaped the profession into one in which utility, value and market prices are all treated as more or less the same thing. In an effort to become more rigorous or scientific, economists stripped from their analysis the difficult moral questions that interested Smith. Economics “simply doesn’t traffic in morality”, writes Mr Carney, quoting “Freakonomics”, a popular economics book.

But if economists have lost interest in questions of morality, and prefer instead to model worlds in which people act strictly in their own self-interest, moral forces still matter for economics. Lady Shafik reckons that the solidarity that underpins social stability has a moral rationale—that it is wrong to deny people the ability to meet their basic needs—as well as political and economic ones. If the social contract breaks down, and people do not adequately look after each other, then crises (of finance, public health or the environment, for example) will threaten prosperity.

Mr Carney, for his part, worries that market activity and market incentives crowd out important social norms. Private vices like greed or ambition, which can help raise social welfare when exercised within a perfectly competitive market, are often socially destructive in other, less ideal circumstances. As money becomes the primary or sole measure of value, society loses the ability to distinguish between acts of wealth creation that deserve to be heralded and those that do not. People who pass up the opportunity to make money for other more selfless activities come to look

more like suckers than model citizens. The loss of interest in doing good for its own sake leaves society less able to meet serious crises like climate change. (Mr Carney himself worked at Goldman Sachs, a bank, early in his career, and recently drew criticism for using dodgy methods to claim that the portfolio of the asset manager for which he now works emits net-zero carbon.)

Mr Carney provides some support for his argument. Studies show that monetary incentives can crowd out pro-social motivations in ways that prove counterproductive. (In experiments, for instance, student groups paid to do charitable work contribute less to the community than those given only a motivational talk about serving a good cause.) But the events of the past year provide lots of corroborating detail, in the struggles governments have faced persuading citizens to wear masks or be vaccinated, and the human and economic costs that have followed.

It may seem strange that central bankers—who can be a dispassionate and humourless bunch, even for economists—should be among those to raise the alarm about the fraying of the social fabric. But it makes a certain kind of sense. As Mr Carney writes, trust is central to maintaining the stability of a currency or a financial system. Humourlessness itself can be a signal to the public, a mark of seriousness meant to provide assurance that the money and the bank accounts in which people hold their savings can be relied upon. Few public officials will be more aware of the risks from a breakdown in mutual trust and regard for others than those charged with fending off runs on the financial system.

Yet their writing illustrates just how difficult change will be. Their solutions—to make capitalism more inclusive and shore up safety-nets—are built around technocratic tweaks to policy, not a moral awakening, and understandably so. The analytical tools relied upon by top economic policymakers do not include mechanisms for quantifying the

importance of social norms or cultivating ethical behaviour across the population. Indeed, Mr Carney's argument poses a fundamental dilemma: today's powerful figures are those that thrived within the current system. If society needs new moral leadership, it may need to look somewhere else. ■



自由交流

劝善

为何两位前央行官员大谈信任

全球金融危机之后，人们开始质疑经济学家是否误解了市场的某些重要特质。经过了近几年的艰难时日，一些人士把这种质疑扩大到经济学家是否误解了人性的某些关键面相。在新书《价值》（Value(s)）中，曾在2013年至2020年任英国央行行长的马克·卡尼（Mark Carney）论述道，在一心逐利的市场经济中，自利排挤了其他动机，让世界变得更自私——恐怕还会损害韧性和繁荣。这种看法令人不安，尤其是正统经济学思想的支配地位使得领导者几乎无从去评估和回应这类主张。

在另一本新书中，伦敦政治经济学院院长夏菲克（Minouche Shafik）呼应了卡尼的部分观点。夏菲克曾是卡尼在英国央行任职时的副手之一。她的书名为《我们彼此负有的义务》（What We Owe Each Other），探讨了社会契约的作用，并思考全球经济的变化如何削弱了各种制度的功能，而这些制度正是让社会保持适度公正的基础。她写道，“如果我们不想目睹公民和社会所依赖的相互信任出现毁灭性的破裂”，就必须修复社会契约，并使之与时俱进。人们对自己应承担的对他人和整个社会的义务已经变得过于冷漠，夏菲克说，他们理应对彼此承担更多义务。

这些观点若是放在古典经济学家的著作中并不会显得突兀。事实上，卡尼和夏菲克都引用了亚当·斯密的《道德情操论》，这本书研究了人们的价值观、信仰和偏好是如何形成的。斯密认为，它们的形成是通过“相互同情”——本质上就是去想象他人的感受。这支持起了公众的是非观念，并为市场及其他制度奠定了社会基础。斯密将市场视为“活生生的机制，根植于当时的文化、实践、传统和信任之中”，卡尼写道。现代的经济学家极少用这些词汇来描述市场。在19世纪晚期新古典主义经济学家的创新下，经济学被重新塑造，效用、价值和市场价格被看作差不多一样的东西。为求更加严谨或科学，经济学家把斯密感兴趣的道德难题从自己的分

析中剔除了出去。经济学“就是和道德无关”，卡尼引用畅销书《魔鬼经济学》中的话说道。

但是，就算经济学家已经对道德问题失去了兴趣，而更倾向于建立世间所有人都只追求自身利益的模型，道德的力量对经济学依然重要。夏菲克认为，团结是社会稳定的基础，而除了政治和经济理由外，团结还有道德上的理由：剥夺人们满足基本需求的能力是错误的。如果社会契约破裂，人们不去充分地守望相助，那么危机（例如金融、公共卫生或环境危机）将会威胁社会繁荣。

卡尼则担心市场活动和市场激励会排挤掉重要的社会规范。像贪婪或野心这类私恶在完全竞争的市场中可以帮助提高社会福祉，但在其他不太理想的情况下往往会对社会造成破坏。随着金钱成为衡量价值的主要或唯一标准，社会无法区分哪些创造财富的行为值得提倡，哪些不值得。那些放弃赚钱的机会而去从事其他更无私的活动的人看起来更像傻瓜，而不是模范公民。人们对纯粹的行善丧失兴趣，这让社会更难应对气候变化等重大危机。（卡尼本人在职业生涯早期曾在高盛工作，目前任职于一家资产管理公司，最近他使用不可靠的计算方法声称该公司的投资组合达到了净零碳排放，招致批评。）

卡尼为自己的观点提供了一些依据。研究表明，货币激励可能会挤掉为社会做贡献的动机，导致结果适得其反。（例如在学生公益活动的实验中，对一些学生只做鼓励善行的动员，对另一些给予金钱报酬，结果后者对社区的贡献更小。）而过去一年发生的事件提供了大量可作为佐证的细节，包括政府在说服公民戴口罩或接种疫苗时举步维艰，以及之后为此付出的人道和经济代价。

连央行官员也开始警告社会肌理破损的风险，这似乎有些奇怪，毕竟他们是放在经济学家的圈子里都会显得尤其理性冷静、不苟言笑的一群人。但这是有道理的。正如卡尼写道，信任是维持货币或金融体系稳定的核心。不苟言笑的态度本身就是对公众发出的信号，是一种严肃的标志，用来向人们保证，他们用以保存积蓄的货币和银行账户是可靠的。央行官员负责

防范金融系统挤兑，他们比任何政府官员都更清楚不再相互信任和体谅他人会有怎样的风险。

然而，他们的论述也显示出要改变何其困难。他们提出的解决方案是使资本主义更具包容性以及加强安全网，这都是围绕技术官僚对政策做微调展开，而非道德觉醒。这是可以想见的。最高经济政策制定者所依赖的分析工具当中，并不包括对社会规范的重要性做量化或者在全体民众中培养道德行为的机制。事实上，卡尼的观点呈现了一个根本性的两难境地：如今的权贵人物恰恰是在现有体系中崛起的。如果社会需要新的道德领导力，恐怕只能另寻他途。 ■



The Economist Film

Can flying go green? - Trailer

It's an industry that has changed the world and it's now in crisis, but is this aviation's moment for a green reset?



经济学人视频

飞行会变得更环保吗？ - 预告片

一个改变了世界的行业正处在危机之中，这会成为它“绿色重启”的契机吗？



Bright side of the moonshots

Science after the pandemic

Covid-19 has brought together medical technologies that will transform human health

THE FIRST virus to have its genome read was an obscure little creature called MS2; the 3,569 RNA letters it contained were published in 1976, the hard-won product of some ten years' work in a well-staffed Belgian laboratory. The SARS-CoV-2 genome, almost nine times longer, was published just weeks after doctors in Wuhan first became concerned about a new pneumonia. That feat has since been repeated with getting on for 1m different samples of SARS-CoV-2 in the hunt for fearsome variants like the one ravaging Brazil. Within weeks of its publication, the original genome sequence became the basis for the vaccines that today are stymieing the virus wherever supplies, politics and public confidence allow.

It is hardly remarkable that medical science has moved on since 1976. But the covid-19 pandemic has brought the sharp joy of seeing decades of cumulative scientific progress in sudden, concerted action. The spate of data, experiments and insights has had profound effects on the pandemic—and, indeed, on the future of medicine. It is also an inspiration. Around the world, scientists have put aside their own work in order to do their bit against a common foe. Jealously guarded lab space has been devoted to the grunt work of processing tests. Covid-19 has led to some 350,000 bits of research, many of them on preprint servers that make findings available almost instantaneously.

The basis of all this is the application of genetics to medicine in a systematic and transformative way—not just in understanding the pathology of diseases but in tracking their spread and curing and preventing them. This approach could underpin what is becoming known as “natural

security”—the task of making societies resilient in the face of risks stemming from their connection to the living world, whether because of disease, food insecurity, biological warfare or environmental degradation.

The application of genetics to medicine partly reflects huge, rapid gains in efficiency. Reading the DNA in a human genome cost \$10m in 2007, today it takes less than \$1,000 and a fraction of the time. Coupled with ever-better ways of synthesising and editing genes, this has enabled cleverness little short of the miraculous. Before the pandemic, these trailblazing techniques were not much talked about beyond the laboratory. Having shown their mettle against a brand new disease, they have burst out into the open.

Take the vaccination technology rapidly developed by Moderna of America and BioNTech of Germany, building on years of patient and often unsung work on RNA, a store of genetic information. It is remarkable that you can simply instruct the body's cells to make the viral protein you have designed to prime the immune system. The RNA vaccines are testament to the insight of Eddie Cantor, a comedian, that it takes 20 years to become an overnight success.

With this proof of concept, the investments of companies that have worked hard on RNA may now pay off. To some extent, RNA medicine divorces form from function. An RNA vaccine against any disease is a message written in genetic code: a vaccine against malaria, or some form of cancer, can be made in the same way and with the same equipment as a SARS-CoV-2 vaccine. If this provides a platform for getting cells to do all sorts of specific things and to desist from others, as it promises to, medicine will become both more powerful and more personal. Therapies tailored to rare, even one-off, genetic abnormalities should become routine.

The pandemic has also demonstrated the value of gene-sequencing technologies. Observing SARS-CoV-2 as it mutates is essential if the world is

to understand and defend itself against dangerous variants. Should covid-19 become endemic, as is likely, sequencing will become the basis for developing regular booster shots. More broadly, routine sequencing is one of the best ways of knowing what is out there. Companies have done brilliantly in producing powerful sequencing systems for trained technicians. Now the world needs cheap, ubiquitous and reliable systems that can be used in the prison sick bay or the rural health centre, on the farm or at the town sewage works, to act as early-warning systems for the spread of pathogens.

Another area of work is where the pandemic has revealed a gap. Even today's progress has yet to produce small-molecule antivirals to combat SARS-CoV-2. A focus for natural security should be drugs aimed at the viral families most likely to cause trouble in the future. This is not something that the market will support on its own. New mechanisms that involve governments will be needed, such as funds for R&D and trials and to buy stockpiles of medicine. Similar approaches should also be used for the looming threat of antibiotic-resistant bacteria.

These innovations will have big consequences. General-purpose RNA medicine asks new things of firms and regulators—as do other platforms, including some forms of gene therapy. Regulators will need to take advantage of the fact that, say, a malaria vaccine and a SARS-CoV-2 vaccine are both made on the same platform by streamlining approval for them, while continuing to ensure safety.

Drugs firms will have to adapt, as some chronic conditions may, in effect, be cured. Many are used to concentrating on the long-lasting afflictions that most trouble the rich world: heart disease, cancer, metabolic disorders, neurodegenerative conditions and the like. If drug development is more targeted on instructing cells what to do, rather than finding novel molecules against specific proteins, some of the know-how on which old-style pharma

is based will be less relevant. Firms will need new pricing models and a new focus to their research.

Technology will not, in itself, thwart pandemics. That goal also requires systems and institutions which use technology broadly and wisely. Without good systems, great technology will often provide only mediocre results, as it has in many covid-19 test-and-trace programmes. But the pandemic has shown that biomedical science has the tools and the enthusiasm to improve the world. The world must now build on both. ■



【首文】疯狂创意的光明面

疫情后科学

新冠疫情把各种将改变人类健康的医疗技术连结在一起

全球第一个被基因测序的病毒叫MS₂，名气不大。1976年，经过约十年的艰辛研究，比利时一个人才济济的实验室发表了它包含的3569个RNA字母序列。新冠病毒的基因组长度几乎是MS₂的九倍，在武汉的医生开始关注一种新的肺炎仅几周后便被发布。在此后在对一百万个不同的新冠病毒样本筛查可怕变种（像在巴西肆虐的那种）的过程中，这样的壮举不断上演。武汉的原始基因组序列在发布后几周内成为疫苗研发的基础，如今，在供应充足、政治支持、公众有信心的地方，新冠疫苗正在阻止病毒的传播。

自1976年至今，医学取得的进展平平无奇。但新冠疫情让人们惊喜地看到，近几十年积累的科学进步突然协力迸发。大量数据、实验和见解对疫情——以及对医学的未来发展——产生了深远影响。这也是鼓舞人心的一幕。世界各地的科学家纷纷放下手头的工作，为抗击共同的敌人贡献一份力量。原本防范严密的实验室被用于处理繁重乏味的检测分析。新冠疫情已经引发了约35万个研究，其中许多通过预印本服务平台发表，让研究成果几乎可以在第一时间公之于众。

这一切的基础是把遗传学以系统且颠覆性的方式应用于医学，不仅用于探究病理，还用于追踪疾病的传播，以及治疗及预防疾病。这种方式或许可以支撑起所谓的“自然安全”任务，也就是让社会在面对它们与生物世界的连结所导致的风险时拥有复原力，无论这风险是疾病、粮食不足、生物战，还是环境恶化。

遗传学在医学上的应用一定程度上反映了效率的迅速提升。2007年，读取人类基因组的DNA需要花费1000万美元，现在只需不到1000美元，耗时也大大缩短。再加上日益进步的基因合成和编辑方法，人类的聪明才智已

能缔造近乎奇迹的成果。疫情前，这些前沿技术在实验室之外并没有多少人谈论。在一种全新的疾病上一展能耐后，它们突然在大众面前大放异彩。

以美国莫德纳（Moderna）和德国BioNTech研发的疫苗技术为例，它基于多年耐心且往往是默默无闻地研究RNA这种遗传信息储存物质之上。现在你可以简单地指示体内细胞制造出你设计用以激发免疫系统的病毒蛋白，令人惊叹。这种RNA疫苗印证了喜剧演员埃迪·康托尔（Eddie Cantor）的说法：一夜成名的背后是20年的苦功。

在这一概念得到验证后，那些努力钻研RNA的公司之前的投资或许开始有回报了。在某种程度上，RNA医学实现了形式与功能的分离。针对任何一种疾病的RNA疫苗都是以遗传密码写成的一段信息：疟疾疫苗或某种癌症的疫苗可以使用与新冠疫苗相同的方式和设备制造。假如这项技术真的向它承诺的那样，提供了一个平台来让细胞执行各种特定任务，同时停止某些其他进程，那么医学将变得更强大也更个性化。针对罕见甚至极个别基因异常病例提供定制治疗方案应该会成为常规操作。

这场疫情也显现出基因测序技术的价值。世界要了解并抵御新冠病毒的危险变种，就必须细察其变异过程。假如新冠肺炎成为持续存在的地方性流行病——这很有可能，那么测序将成为开发常规疫苗加强针的基础。更广泛地来说，常规测序是了解病毒演变的最佳途径之一。已有不少公司成功推出强大的测序系统，供训练有素的技术人员使用。而现在，世界需要开发廉价、普及且可靠的系统，作为病原体传播的预警系统，应用于监狱医务室、农村卫生所、农场或城镇污水处理厂。

另一个需要付诸努力的领域是在新冠疫情中暴露的缺口。尽管医学在抗疫上取得了重大进展，但能对抗新冠病毒的小分子抗病毒药物尚未问世。“自然安全”的一个焦点应该是针对最可能在未来制造问题的病毒家族研发药物。这不是单凭市场能够支撑的，需要有政府参与其中的新机制，例如为研发、试验、购买储备药品提供资金。面对抗生素耐药性细菌的潜在威胁，也应该采用类似手段。

这些创新将产生巨大的效应。通用型RNA医学对企业和监管机构提出了新要求；其他平台也一样，包括某些类型的基因疗法。在继续确保安全的同时，监管机构将需要简化审批程序，充分利用诸如在同一平台上制造疟疾疫苗和新冠疫苗的新进展。

一些慢性病可能会被基本治愈，制药公司将不得不做出调整。许多制药公司一直都专注于那些最困扰富裕世界的慢性病：心脏病、癌症、代谢紊乱、神经退行性疾病等。如果药物开发更多转向指示细胞行动，而不是寻找对抗特定蛋白质的新型分子，那么传统制药所依赖的一些专有技术将变得不那么重要了。药厂将需要摸索新的定价模式和研究重点。

技术本身不会遏制大流行病。要实现这一目标，还需要系统和体制来广泛而明智地运用技术。如果没有好的系统，伟大的技术往往只能带来平庸的结果，正如不少新冠测试和追踪系统所表现的那样。但这场疫情表明，生物医学拥有改善世界的工具和热情。现在，世界必须依赖这两者。■



Espionage

Round the bend

How to see what is hidden from view

IN A LOCKED room in a busy city, some terrorists are holding a hostage. The curtains are mostly drawn, cutting off any direct line of sight for those outside. In a building across the street, a team of engineers are set a task: they can have whatever equipment they need, but they must paint as clear a picture as possible of what is happening inside the room.

This was the challenge given in 2015 to Daniele Faccio, then at Heriot-Watt University, in Edinburgh, by Dstl, a British government defence laboratory. He and his team eventually found a way to see around corners from a distance of 50 metres—which was reckoned impressive at the time, even though the system they devised could detect only the motion and position of hidden objects, rather than taking pictures of them. Now, however, Xu Feihu and Pan Jianwei of the University of Science and Technology of China, in Hefei, have blown that record out of the water. As they describe in the *Proceedings of the National Academy of Sciences*, they have managed to look around corners from a distance of well over a kilometre.

Non-line-of-sight imaging of this sort relies on two principles. One is that objects are visible to an observer if light bouncing off them makes its way to that observer's eyes or instruments. The other is that at least some light reflects off all but the blackest, most absorbing surfaces. The upshot is that something hidden from an observer's line of sight might nevertheless be visible if it is sufficiently near a wall which can serve as a reflecting surface. In this case, the observer can illuminate the wall with a tightly focused beam of light (in practice, probably a laser), knowing that some of the beam's light will bounce off the wall to illuminate the concealed object, and that some

of this illumination will, in turn, be reflected back whence it came via the wall. The fraction of the original beam returned by this trilogy of reflections may be minuscule, and the information it contains may appear hopelessly jumbled. But sufficiently smart mathematics can turn it into an image of the thing it bounced off.

Dr Xu and Dr Pan conducted their trial at night, to minimise the amount of background light that might have interfered with the results. Their targets, a dummy of a human being on one experimental run and a giant “H” on another, were concealed behind a barrier in an apartment in a block of flats in Shanghai. Their laser and receiving apparatus were in a second apartment block 1.43km away. The receiving apparatus, an instrument called a single-photon avalanche diode (SPAD), was, as its name suggests, so sensitive that it could detect and count individual photons, the particles of which light beams are composed. This was just as well, for, of every seven million billion photons fired across the gap by the laser, only a single one returned.

Because each firing of the laser yielded so little information, the researchers had to take many shots to build up an image. To that end, they imagined a grid on the target wall, 64 dots wide and 64 deep. They fired the laser at each dot in turn, and then fed the data from the SPAD into an algorithm capable of reconstructing, albeit fuzzily, an image of the hidden object (see picture).

The military applications of this technology suggest themselves. They were, after all, why Dstl sponsored Dr Faccio in the first place. But others are also interested. America’s space agency, NASA, has paid for such work in the past in the hope of putting a laser on a satellite orbiting a distant world. This would permit the photographing of the otherwise-invisible interiors of caverns on the surfaces of moons and planets. And, in a more practical vein, engineers in the autonomous-vehicle industry would be keen on a technology that let their cars spot other motorists blithely speeding around blind corners.

For now, such applications remain far in the future. Capturing the experimental data in Shanghai took several hours, which is of little use either on the road or in fast-moving situations like hostage-taking. The amount of light lost between bounces also puts a limit on how far away an object can be from the reflecting wall before the technique stops being useful. The dummy used by Dr Xu and Dr Pan was 75cm from the wall, which is probably near that limit. These caveats aside, however, performing the trick over a distance of almost 1½km is a staggering advance on previous efforts. It would not be surprising, says Dr Faccio, now that it is known what is possible, if that record, too, were broken. ■



间谍活动

视线转弯

如何看见视线外的隐藏物

在一个繁忙的城市中一间上了锁的房间里，一帮恐怖分子劫持了一名人质。窗帘的大部分被拉上，从外面无法直视其中。街对面的一栋楼里，一队工程师接到一项任务：他们可以拿到任何他们需要的设备，但必须尽可能清晰地描绘出房间里正在发生的事。

这是2015年英国政府的国防科技实验室Dstl给丹尼尔·法乔（Daniele Faccio）的任务。当时供职于爱丁堡的赫瑞-瓦特大学（Heriot-Watt University）的法乔和他的团队最终找到了从50米开外隔墙观物的方法——这在当时被认为非常了不起，尽管他们设计的系统只能检测到隐藏物体的动作和位置，而不能给它们拍照。然而现在，位于合肥的中国科学技术大学的徐飞虎和潘建伟已彻底击败了这项纪录。正如他们在《美国国家科学院院刊》中描述的那样，他们已经能从一公里多外隔墙透视。

这种非视域成像技术（Non-line-of-sight imaging）依赖两个原理。一是如果从物体上反射的光线进入观察者眼中或被仪器捕捉到，那么该物体便对观察者可见。二是除了最黑暗、吸收力最强的表面外，至少有部分光会反射出去。其结果是，隐藏在观察者视线之外的某物如果足够靠近可作为反射面的墙体，那它还是有可能被看见。在这种情况下，观察者可以用高度聚焦的光束（在现实中很可能是用激光）照亮这面墙，墙面会反射部分光束而照亮隐藏的物体，从该物体上又会反射一部分光通过墙面原路返回。经过这三重漫反射后，原始光束只返回了一小部分，可能非常微弱，所包含的信息也可能显得极度混乱。但只要经过足够智能的运算，就能将它变成该物体的成像。

徐飞虎和潘建伟在夜间做试验，为的是将可能干扰试验结果的背景光降至最弱。他们在一次实验中试图看到的目标是个假人，在另一次是一个巨大

的字母H，它们都被隐藏在上海一幢公寓楼中某间房屋里的障碍物后面。他们的激光及接收设备位于1.43公里外的第二栋公寓楼内。接收设备是一台叫作单光子雪崩二极管（SPAD）的仪器，从名字就可以知道它的灵敏度非常高，可以探测和计数单个光子，即组成光束的粒子。这再好不过了，因为在他们的激光射出的每七千万亿个光子中，只有一个光子返回。

由于每次激光发射得出的信息太少，研究人员不得不大量拍摄以建构一幅图像。为此，他们在目标墙上想象出一个64个点宽、64个点深的网格。他们依次向每个点发射激光，然后把来自SPAD的数据输入能够重建隐藏物体（尽管是模糊的）影像的算法（见图片）。

这项技术的军事应用不言而喻。毕竟这正是Dstl当初资助法乔做这个项目的原因。但感兴趣的人群还有很多。美国国家航空航天局（NASA）在过去就曾为这类研究买单，希望能把激光安装在绕遥远天体运行的卫星上，这样就可以拍摄到卫星和行星表面那些原本不可见的洞穴内部。而且，更实用的是，无人驾驶汽车行业的工程师会热衷于这种技术，因为这能让他们的汽车“看到”在盲区弯道飞驰的其他车辆。

目前，这类应用还遥不可及。在上海捕捉的实验数据耗时几个小时，这要放到道路上或是像劫持人质这样快速变动的场景下都没什么用处。来回反射间损失的光量也限制了这项技术要起作用物体可以距离反射墙面多远。徐飞虎和潘建伟使用的假人离墙75厘米，可能已经接近极限。然而，撇开这些限制不谈，在近1.5公里的距离上演这个戏法，相比之前的成果可谓进步惊人。法乔说，既然现在已经知道了什么是可能的，那么哪天这项记录也被打破就不足为奇了。 ■



Inflation expectations

A different kind of fluke

Just how anchored are America's inflation expectations?

SINCE DEMOCRATS proposed a \$1.9trn fiscal stimulus in January, hawks have warned that America's economy might overheat. With cheques for \$1,400 now landing in bank accounts, President Joe Biden reportedly considering spending another \$3trn on infrastructure and the Federal Reserve showing no sign of putting the brakes on the rebound from the pandemic, the predictions of impending doom are getting louder. The latest was delivered by Larry Summers, a former treasury secretary, on March 20th. Mr Summers sees it as more likely than not that the economy will suffer either from an inflation surge or from the crushing effects of higher interest rates. America, he says, has the least responsible economic policy in 40 years.

The worst-case scenario painted by inflation hawks can be broken into stages. First, inflation will soon rise mechanically as numbers from the spring of 2020, when the economy and commodity prices slumped, fall out of comparisons with a year earlier. On that everyone agrees.

The next phase is a second wave of inflation as spending by newly vaccinated consumers rebounds from the pandemic faster than production can keep up. Even stimulus advocates typically admit that overheating is a risk, and it would be more likely should more deficit spending pass. Mr Biden may unveil the spending side of his infrastructure bill alongside his preliminary annual budget proposals for government departments, which are due next week. Whereas some of any Biden infrastructure bill may be paid for by raising taxes, it seems unlikely that Congress would raise \$3trn this way, rather than relying on at least some extra borrowing.

It is the last stage of the doomsday timeline that is most controversial, in which temporary inflation turns permanent as the public's inflation expectations rise and become self-fulfilling. Workers, anticipating a higher cost of living, demand higher pay; forward-thinking firms raise prices. The result would be a return to the 5% plus inflation of the late 1960s, or perhaps even the 10%-plus rates of the 1970s.

In recent decades the grip of the Fed on inflation expectations seemed ironclad. Even when in 2019 unemployment plumbed depths not seen since the 1960s, inflation expectations did not stir very much. In theory that makes all inflation surprises temporary. "Having [inflation expectations] anchored at 2% is what gives us the ability to push hard when the economy's really weak," said Jerome Powell, the Fed's chairman, on March 17th.

But how strong is the anchor? There are at least three types of inflation expectations: those priced into financial markets; those that appear in surveys of households and businesses; and those of professional forecasters. Market expectations have been spooking hawks. The ten-year bond yield has risen to about 1.7%, up from 0.5% in early August. However, the inflation expectations incorporated in these yields remain broadly consistent with the Fed's target. The bigger problem is tail risk. William Marshall of Goldman Sachs, a bank, calculates that the implied inflation risk premium—in effect, the price of insuring against very high inflation—has risen. The market-implied probability of average consumer-price inflation exceeding 3% per year for the next five years is over 30%, according to the Minneapolis Fed. That does not imply 1970s-style inflation, but would be uncomfortable for the Fed.

The evidence suggests that survey expectations are more important than market prices. Households' inflation expectations have not budged much, though consumers, like investors, have become less certain about the future (see chart). The danger is that the public is poorly informed, and its

expectations are therefore fickle. Even firms do not seem to pay much attention to inflation nowadays. When Olivier Coibion of the University of Texas and three co-authors surveyed top executives in April 2018, 55% said that they did not know what inflation would be over the next year. When they do have a view, both firms and households chronically overestimate price rises. Consumers seem unduly swayed by the price of petrol. The authors concluded that the public's expectations looked "anything but anchored".

Professional forecasters can give Mr Powell most comfort. They are nearly unanimous and unwavering in believing what the Fed says about the long term. Yet their historical record as an early warning signal is not encouraging. As the economy overheated in the late 1960s prognosticators were behind the curve, according to the Livingston survey, the best available record of their views.

Part of the explanation is that forecasting inflation is hard. Even with today's vastly improved methods, after two years the consensus inflation forecast is on average off by 0.4 percentage points in one direction or another, calculates Goldman Sachs. Someone who forecasts that a central bank's target will lose credibility before it happens can look unhinged. Even Mr Summers—who does not suffer from excessive humility—couches his predictions in probabilities which make it nearly impossible for him to be proved wrong.

Joseph Gagnon of the Peterson Institute, a think-tank, says the Fed should promise "dramatically" higher interest rates if inflation rises and does not fall back. Saying this too soon would knock confidence. Arguably, however, the Fed is undermining the implicit understanding that it will tackle overheating by emphasising its duty to ensure a thriving jobs market that reduces inequality. That makes it harder to imagine the central bank

crushing inflation by engineering a recession, as happened in the 1980s. Should enough people doubt its hypothetical resolve, the door to persistently higher inflation—or to a painful credibility test—would be ajar.





通胀预期

另一种锚

美国的通胀预期有多稳固？

自民主党在1月提出1.9万亿美元的财政刺激方案以来，鹰派就警告美国经济可能过热。现在每人1400美元的支票陆续到账，据称总统拜登正在考虑再推出三万亿美元的基建计划，而美联储也没有释放出要对疫情后的经济反弹踩刹车的信号，预测末日即将降临的声音越来越响亮。最近发声的是前财政部长拉里·萨默斯，他在3月20日预测经济有过半概率要承受通胀飙升，或利率上升带来的破坏效应。他说，美国现在施行的是40年来最不负责任的经济政策。

通胀鹰派所描绘的最坏情况可以分为几个阶段。首先，通胀自然很快会上升，因为2020年春季经济下滑、大宗商品价格暴跌，导致经济数据同比大幅下降。对于这一点各方并无异议。

第二阶段，接种了疫苗的消费者的支出在疫情后迅速反弹，而生产无法跟上，就会出现第二波通胀。就连刺激措施的拥护者一般也都承认过热是一种风险，而如果国会通过更多赤字支出提案，过热的几率就更大。拜登将于下周宣布政府部门的初步财年预算案，届时可能会公布他的基建刺激提案的支出安排。尽管这项基建提案中的一部分资金可能会通过提高税收来筹措，但国会似乎不太可能完全以这种方式筹集全部三万亿美元，而至少会依靠一些额外借债。

最具争议的是末日时间表的第三阶段：随着公众的通胀预期上升并开始自我应验，暂时的通胀将成为长期现象。预期生活成本升高的工人将要求加工资；有前瞻的公司会提高产品价格。结果是通胀可能将恢复到上世纪60年代后期5%以上的水平，或者甚至是70年代10%以上的水平。

近几十年来，美联储似乎一直紧紧控制着通胀预期。即使在2019年失业率下降到60年代以来的最低水平时，通胀预期也没有太大波动。从理论上

讲，这使得通胀的所有意外变化都只是暂时的。美联储主席杰罗姆·鲍威尔（Jerome Powell）3月17日说：“把（通胀预期）锚定在2%，那么到了经济真正疲软的时候我们才有空间使力。”

但这个锚有多强固呢？至少存在三类通胀预期：反映在金融市场定价上的预期；在对家庭和企业的调查中表现出的预期；以及专业预测机构的预期。市场预期一直让鹰派紧张。十年期债券收益率已从去年8月初的0.5%升至约1.7%。但是，这个收益率水平中已隐含的通胀预期仍然与美联储的目标大体上一致。更大的问题是尾部风险。高盛的威廉·马歇尔（William Marshall）计算得出，隐含的通胀风险溢价（也就是对抗极高通胀的价格）已经上升。根据明尼阿波利斯联储的数据，市场隐含的未来五年平均消费者物价通胀每年在3%以上的概率超过30%。这并非意味着会出现70年代那样的通胀，但会让美联储不安。

有证据表明，调查中表现的预期比市场价格更为重要。尽管消费者和投资者一样对未来的不确定性有所提高，但家庭的通胀预期并没有太大变化（见图表）。危险在于公众掌握的信息匮乏，因此他们的预期也会变幻无常。如今即使是企业似乎也不太重视通胀。得克萨斯大学的奥利维尔·科比恩（Olivier Coibion）和三位报告合著者在2018年4月调查了企业高层管理人员，结果有55%的人表示他们不知道明年的通胀会是多少。当他们有一定的判断时，企业和家庭都会习惯性地高估价格上涨的程度。消费者的预期受油价的影响似乎过大。这几位作者得出的结论是，公众的期望看起来“完全没有锚定”。

可以给鲍威尔最多安慰的是专业预测机构。它们几乎完全一致并且毫不动摇地相信美联储对长期的看法。然而，这些机构在提前预警方面的历史表现并不鼓舞人心。利文斯顿专业预测调查（Livingston Survey）是迄今可得的对这些机构预测的最翔实记录，它显示在上世纪60年代后期经济过热时，它们的预警就滞后了。

部分原因是通胀很难预测。即使今天所采用的方法已大为改进，但据高盛

估算，对两年后通胀的预测共识平均而言仍偏高或偏低0.4个百分点。预测央行的目标会失去可信度的人可能会让人觉得满嘴呓语。就连萨默斯这样绝非谦虚过头的人也会用概率来表达他的预测，让人日后几乎没法说他是错的。

智库彼得森研究所（Peterson Institute）的约瑟夫·加农（Joseph Gagnon）表示，美联储应承诺若通胀上升后不回落就会“大幅”加息。过早这样表态会打击信心。然而，美联储强调它有职责确保就业市场繁荣以减少不平等，这也可说是在动摇市场默认它会解决经济过热问题。这让人更难想象美联储会像上世纪80年代那样，通过制造衰退来抑制通胀。如果有足够多的人怀疑美联储意愿的坚定，那就将推开一扇大门，它通向通胀的持续上升——或一次痛苦的可信度测试。 ■



The food stall

Omnivores

Widespread reports of the death of the supermarket have been exaggerated

EARLY THIS year Marc Lore, an entrepreneur who led Walmart's digital counter-attack against Amazon, announced that he was stepping down from the world's biggest physical retailer. Many of his responsibilities have been picked up by Casey Carl, recently appointed Chief Omni Strategy Officer at Walmart. It's an unusual title. "They ran out of characters," Mr Carl quips. Omni stands for omnichannel, and though not a pretty word, it signifies a lot.

Walmart bought Mr Lore's company, Jet.com, in 2016, the year before Amazon acquired Whole Foods, a chain of grocery stores, putting the wind up the entire industry. Mr Lore was asked to lead the Walmart counter-attack. Under his stewardship, Walmart.com overtook eBay to become America's second-biggest online retailer. Yet five years on it is well behind Amazon. The digital push bled red ink, and money was also splurged on trendy dotcom darlings like Bonobos, a menswear firm, that did not fit with "The Beast of Bentonville". Reportedly, there were rumblings of discontent among executives overseeing physical stores. The new focus on "omni", joining physical and digital strategies together, suggests that Walmart has no plan to prioritise e-commerce over its 4,000-store network in America. Instead it sees both as part of the same customer-focused "ecosystem," Mr Carl says.

Walmart is far more than a grocery chain, but its omnichannel strategy shows how purveyors of food and other essentials are being transformed by the pandemic, which in a few months has pushed online grocery shopping from low-single-digit penetration rates to near double digits. Walmart

swiftly expanded services to help facilitate the online and offline experience, such as pick-up in store, kerbside delivery and delivery from its shops—in some cases direct to the customer's fridge. It also introduced Walmart +, a subscription service similar to Amazon Prime that gives members express delivery, discounted petrol and other perks.

Amazon has also gone omni. In America, besides Whole Foods, it is experimenting with a full-sized cashierless supermarket, with Amazon Fresh stores offering same-day pick-up and delivery, and with apps that enable shoppers to jump the checkout queue. So, remarkably, have China's biggest tech platforms, such as Alibaba and JD.com. Both are building vast supermarket chains. "In China offline assets are becoming hot again," says Leigh Hopkins, head of Walmart's international strategy.

The biggest question is whether these omnichannel ventures can make money. Globally the supermarket and superstore sector has had a profitable pandemic, benefiting both from the fact that grocery stores remained open during lockdowns, and from the biggest surge in online activity of any retail category—rising by almost 50% in America in 2020, according to Forrester, a data firm. Its "share of stomach" has increased, as homebound consumers switched from restaurants to their own kitchens. And from Asia to America, online grocery shopping has continued to grow even when lockdowns have eased, suggesting that the trend will outlast the pandemic.

Nonetheless it is widely assumed that few retailers, even Amazon, can make money from selling groceries online, because of the high cost of delivering bulky fruit and vegetables rather than having customers pick them, pack them and take them home, as is common in supermarkets. In a business such as food retailing that already had margins as low as 2-4% before going online, only the best capitalised and most efficient are guaranteed to survive the online onslaught.

Even before the pandemic, several structural factors weighed on supermarkets' bottom lines. In Europe and America, pressure from low-cost operators such as Aldi and Lidl was increasing. So were labour costs, as some big retailers felt compelled to increase minimum wages. Moreover, food delivery and convenience stores were leaching customers away from bigger supermarket aisles. The industry's only consolation was that online penetration was glacial, and it thought it had time to spare before making the necessary jump in digital investment.

That has quickly changed during the pandemic, as shoppers have been given a crash course in online grocery. Now that they have overcome their phobia of delivery slots and repeat orders, demand for faster and better service is only likely to increase, putting further pressure on retailers' profits. Unless grocers start charging more for online services, say analysts at Bain, operating losses from sending goods out from stores or warehouses could range from 5-15%. Even click-and-collect, or kerbside pick-up, barely breaks even in the best of cases. Supermarkets must invest in better technology and up their online game to stop margins continuing to erode over the next decade, says Bain. And even then, grocers are likely to be outgunned by tech giants such as Amazon and Alibaba. To compete, many will have to consolidate or find other sources of revenue such as in-app advertising. In all cases, using physical stores to complement their digital efforts may be vital.

Even in East Asia, where virtual grocery shopping took off earlier than in the West, the blend of online and offline worlds is increasingly the norm. Walmart's Mr Hopkins describes several ways in which omnichannel is flourishing in China. Online grocers, such as JD, are focusing on rapid pick-up of products from stores and inner-city warehouses, known as "dark stores", for express delivery, sometimes within 30 minutes. He says shops are increasingly seen as "nodes" close to the customer that add to the

convenience of online shopping.

Given China's urban density, it can even be profitable. Elinor Leung of CLSA says Alibaba and JD.com are best placed to make money online, and PDD is advancing fast via team purchases and community group-buy. They are pouring money into upgrading supermarkets. Alibaba owns a state-of-the-art supermarket chain called Freshippo (Hema in Chinese) with more than 200 stores that enable shoppers to use apps to learn what they are buying, to eat in store, and to have their groceries carried home. Smaller players are expected to join forces or be acquired to compete. Suning, a Chinese online retailer, recently bought the hypermarket operations in China of Carrefour, a French retailer. Alibaba has taken control of China's largest big-box retailer, Sun Art Retail Group, a big rival to Walmart's hyperstores in China.

Consolidation is also expected in North America and Europe, as supermarkets strive for scale to confront the likes of Amazon and Walmart, as well as fighting off the discounters. The transatlantic merger in 2016 that created Ahold Delhaize, a supermarket giant, is thought to have helped it develop an omnichannel business that served its customers well during the pandemic. Tesco, Britain's largest retailer, and Carrefour, one of the biggest in continental Europe, have forged a strategic partnership.

Yet smaller supermarket chains can also find digital white knights—for a fee. In America and Canada, one of the biggest hopes lies with Instacart, a fast-growing grocery platform that may launch an initial public offering this year valuing it at \$30bn. It offers shoppers a delivery or pick-up service, provided by 500,000 gig-economy workers serving about 45,000 stores. It also supplies technology for supermarkets to offer an omnichannel service themselves. Nilam Ganenthiran, president of Instacart, expects online grocery sales in the region almost to double over the next few years to above 20% of the total. He says that the bigger Instacart gets, the more easily it can scale up its technology (what he calls the digital “plumbing”) to more

supermarkets, providing input from its own engineers to help reduce costs and drive further growth for its retail clients.

In selling technology to retailers, Instacart aspires to be like Shopify. Just as the Canadian firm talks of “arming the rebels”, Mr Ganenthiran claims that he wants to “arm the grocers”. But he does not think the future will be digital only. Customers will want choice, he believes. Sometimes they will want their groceries to be delivered. Sometimes they will want to drive to the supermarket to pick them up themselves. And sometimes they will simply want to do their own shopping. Yet even this level of choice is groundbreaking. “The last big innovation in groceries was the advent of supermarkets,” he says. “That was a full generation ago.” ■



食品摊

杂食动物

关于超市死亡的广泛报道是夸大其词【专题报道《购物的未来》系列之五】

今年早些时候，企业家马克·洛尔（Marc Lore）宣布将辞去在沃尔玛的职务，此前他领导了这家全球最大的实体零售商对亚马逊发起数字反攻。他的许多职责已由最近被任命为沃尔玛首席“全”战略官（Chief Omni Strategy Officer）的凯西·卡尔（Casey Carl）接手。这个头衔不同寻常——“字母用光了。”卡尔打趣道。其中的“omni”代表了“全渠道”（omnichannel），尽管这个词不怎么漂亮，但意味深长。

沃尔玛于2016年收购了洛尔的公司Jet.com，一年后亚马逊收购了食品杂货连锁店全食超市（Whole Foods），令整个行业风起云涌。洛尔受命领导沃尔玛的反击。在他的带领下，沃尔玛网站Walmart.com取代了eBay，成为美国第二大在线零售商。然而五年后它还是远远落后于亚马逊。公司推动数字化带来了大量赤字，还在与这头“本顿维尔巨兽”不合拍的网红公司（如男装公司Bonobos）上一掷千金。据报道，负责实体店的高管们对此颇有微词。沃尔玛新近对“全”的关注将实体和数字战略结合在一起，透露出它并不计划把电子商务置于其遍布美国的4000家超市网络之上。卡尔说，相反，它把两者都视为同一个以客户为中心的“生态系统”的一部分。

沃尔玛远不止一家食品杂货连锁店，但其全渠道战略表明，疫情极大改变了食品和其他必需品的销售商，在几个月之内就使在线买菜的渗透率从低个位数提高到接近两位数。沃尔玛迅速扩展了服务来提升线上和线下体验，例如到店取货、路边收货和商店递送（在某些情况下直达客户的冰箱）。它还推出了Walmart +，一项类似于亚马逊金牌会员（Amazon Prime）的订阅服务，可为会员提供快速送货、汽油折扣和其他优惠。

亚马逊也是四面出击。在美国，除全食超市之外，它还在尝试运营一家大

型无人超市，而“亚马逊新鲜”（Amazon Fresh）商店提供当日取货和送货服务，手机应用还能够让购物者不用排长队结帐。中国最大的技术平台，如阿里巴巴和京东，同样引人注目。两者都在建立庞大的连锁超市。沃尔玛的国际战略负责人李·霍普金斯（Leigh Hopkins）说：“在中国，线下资产再次变得炙手可热。”

最大的问题是这些全渠道策略能否赚钱。全球超市行业都因疫情受益，这是因为食品杂货店在封锁期间继续营业，以及任何零售品类的线上活动都经历了有史以来最大的激增——根据数据公司Forrester的报告，2020年美国的这一数字上升了近50%。随着困守家中的消费者从餐馆转向自己的厨房，其“胃口消费份额”增加了。从亚洲到美国，即使封锁措施有所缓解，在线买菜仍在继续增长，这表明这种趋势将比疫情更为持久。

尽管如此，人们普遍认为，没有几家零售商可以通过在线卖菜赚钱，哪怕是亚马逊。这是因为相比在超市中常见的那样让顾客自己挑选、打包并带回家，把笨重的水果和蔬菜送货上门的成本很高。食品零售业务在上线之前的利润率已经低至2%到4%，只有最有资本和最有效率的商家才可以保证在网络的冲击中幸存下来。

甚至在疫情之前，一些结构性因素就已经影响了超市的利润。在欧美，来自奥乐齐（Aldi）和利多（Lidl）等低成本运营商的压力越来越大。还有劳动力成本的压力，因为一些大型零售商被迫提高最低工资。此外，食品配送和便利店正把顾客从更大的超市中吸走。超市行业唯一的安慰是线上的渗透极其缓慢，它们认为自己还有足够的时间来开展必要的数字投资。

这一切在疫情期间迅速改变，因为购物者上了一堂网上买菜的速成班。现在他们已经克服对送货档期和重复订购的恐惧症，对更快更好的服务的需求只会上升，这给零售商的利润带来了进一步的压力。贝恩（Bain）的分析师表示，除非食品杂货店开始对在线服务收取更多费用，否则从商店或仓库发货的经营亏损可能在5%到15%之间。即使在最好的情况下，哪怕是到店或路边取货也就是刚刚能打平。贝恩说，超市必须投资于更好的技术

并提升线上服务，以防止在未来十年内利润继续被侵蚀。即便如此，食品杂货店也可能被亚马逊和阿里巴巴这样的科技巨头击败。为了竞争，许多公司将不得不合并或寻找其他收入来源，例如应用内广告。无论如何，使用实体店来作为数字尝试的补充可能至关重要。

甚至在虚拟买菜起步比西方更早的东亚地区，线上和线下世界的融合也越来越成为一种常态。沃尔玛的霍普金斯描述了全渠道在中国蓬勃发展的几种方式。京东等在线食品杂货商专注于从商店和市中心仓库（称为“前置仓”）快速取货来快速送货，有时30分钟内就能送达。他说，商店越来越被视为靠近客户的“节点”，这增加了在线购物的便利性。

考虑到中国的城市密度，这甚至可以盈利。里昂证券的梁向奕表示，阿里巴巴和京东最具在网上赚到钱的优势，而拼多多正在通过拼团购买和社区团购快速发展。它们正投入巨资升级超市。阿里巴巴旗下的一家最先进的连锁超市“盒马鲜生”有200多家门店，购物者可以在手机应用上了解自己购买的商品，在店内用餐，并让人把食品杂货送回家。预期较小的参与者会联合起来或是被收购才能参与竞争。中国在线零售商苏宁最近收购了法国零售商家乐福在中国的大卖场业务。阿里巴巴已经控制了中国最大的仓储式零售商高鑫零售集团，后者是沃尔玛在中国的大型超市的主要竞争对手。

随着超市努力扩大规模以对抗亚马逊和沃尔玛等巨头并击退折扣店，北美和欧洲也应该会出现整合。2016年一场跨大西洋的合并打造了超市巨头皇家阿霍德德尔海兹集团（Ahold Delhaize），据信这帮助该公司发展了全渠道业务，在疫情期间为客户提供了良好的服务。英国最大的零售商特易购（Tesco）和欧洲大陆最大的零售商之一家乐福建立了战略合作伙伴关系。

不过，较小的连锁超市也可以找到数字救星——不过需要付费。在美国和加拿大，被寄予最大希望的公司之一是快速发展的食品杂货平台Instacart，该平台可能会在今年首次公开募股，估值预计在300亿美元。它雇用了50万名零工工人，服务于约45,000家商店，为购物者提供送货上

门或到店取货服务。它还为超市提供技术，让它们能自营全渠道服务。

Instacart的总裁尼拉姆·加南特里安（Nilam Ganenthiran）预计该地区的在线食品杂货销售规模在未来几年内将几乎翻一番，达到总销售额的20%以上。他说，Instacart的规模越大，就越容易将其技术（他称之为数字“管道”）扩展到更多超市，公司工程师将向它们提供意见，帮助它们降低成本并推动零售客户进一步增长。

在向零售商销售技术时，Instacart渴望成为Shopify。正如这家加拿大公司谈论“武装叛乱分子”一样，加南特里安声称他想“武装食品杂货商”。但他不认为未来将是纯数字化的。他相信顾客会想要保留选择。有时他们会想要杂货被送上门，有时会想要开车自己去超市提货，有时他们就是想自己去店里买。然而，即使是这种层次的选择也是开创性的。“食品杂货的上一次重大创新是超市的出现，”他说，“那是整整一代人之前的事情了。”■



Schumpeter

Herbie goes electric

Volkswagen will catch up with Tesla. Then comes the hard part

THERE IS SOMETHING of the “Herbie” about Herbert Diess, boss of Volkswagen Group. Like his four-wheeled namesake, the star of several Disney films, he has a mind of his own and a flair for grabbing attention. He is in a high-stakes race in which he is seen as the underdog. And his main rival, Tesla’s Elon Musk, is a “frenemy” with whom occasionally he banters. Investors are salivating: during the past month the German giant’s share price has surged by 60% while Tesla’s has slipped. That is mainly because of a change of heart about which of the two will win the electric-vehicle (EV) contest. Investors have, it seems, caught “The LoEV Bug”.

It is a spectacular turnaround. For most of last year the EV ambitions of one of the world’s biggest carmakers looked like a smokescreen to hide the lingering fallout of the five-year-old Dieselgate-emissions scandal, bloated costs and fractious relations between Mr Diess and organised labour. But then Volkswagen’s boss pulled off two coups. First, he won the full backing of the supervisory board, ending the showdown with unions. This may enable him to improve lacklustre profit margins. Second, he sought to out-meme Mr Musk. He used shareable videos, Twitter and a virtual “Power Day” to wow the underdog-loving retail investors that helped drive Tesla’s market value to \$800bn last year.

It isn’t all fumes. Based on the company’s updates, some car-industry analysts say that within two years or so its marques, including VW, Audi and Porsche, could produce 1.5m EVs, up from 230,000 in 2020. The group may catch up with Tesla, which made 500,000 cars last year—or even overtake it. Only then would the fun really start, however. For alongside electrification,

revolutions in automation and e-mobility are fast approaching. Besides Tesla, new competitors such as Apple, keen to affix wheels to an iGadget, and Baidu, a Chinese tech giant, are entering the race. For laggards, it could quickly turn into a demolition derby.

Start with electrification. Volkswagen has little experience of making batteries, whereas Tesla has already been through Mr Musk's "production hell". Catching up with the American firm will not be easy. Tesla's stockmarket value, currently nearly four times Volkswagen's €135bn (\$160bn), gives it huge capacity to raise funds. Mr Diess has excited investors by promising to halve battery costs, partly by producing long-range and fast-charging solid-state batteries from 2024. But he has not put a date on those cost cuts, whereas Tesla is introducing a more powerful battery this year that could lower costs immediately. By 2030, when Volkswagen vows to have built six "gigafactories" capable of churning out 240 gigawatt-hours' worth of batteries a year, Mr Musk says, with signature ballyhoo, that Tesla's factories will be producing an order of magnitude more, or around 3,000 gigawatt-hours.

In software, the distance between the two looks yet more daunting. Tesla has set the pace by designing a car as a software product that can be regularly upgraded, like the iPhone. Volkswagen has recently started to do the same with its new ID.3 EV, and has set out to become the biggest computing company in Germany after SAP, a maker of business software. But whereas Tesla has tech in its DNA, Volkswagen's most notable software achievement was to facilitate the ignominious emissions-cheating. Autonomous driving will add a whole new realm of complexity. Volkswagen is pursuing two types of software development, one for self-driving passenger cars, the other for fleets of autonomous vehicles offering "mobility as a service" (which includes ride-sharing and other alternatives to traditional car ownership). In both cases, tech giants from America and China, as well as Tesla, will be formidable foes. Mr Diess himself

acknowledges that as software increasingly turns the car into a computer on wheels, it will transform the industry even more than electrification does.

Yet for a legacy manufacturer, Volkswagen has already made bold moves. The company counts on its vast combustion-engine business to fund a planned €15bn a year in electric and digital investments until 2025. It is already creating a modular platform on which its EVs can be built, rather than jerry-rigging its existing production lines, which adds flexibility. Sensibly, it is designing the car around the battery, rather than the other way around. In order to secure access to batteries as demand for EVs grows, it is, like Tesla, vertically integrating its supply chain. Most EV production, from batteries and chassis to software, will be done in-house.

Other firms under assault from cleaner technologies, like those in the oil business, will study Volkswagen's efforts closely. As Mark Newman of Nyobolt, a car-battery startup, notes, in industries such as computers and mobile phones that have faced disruption in the past, the usual pattern is for an innovator to build a new product from scratch, as Tesla has done (and as Apple once did). Once the products are on the market, they can be copied, and outsourced by incumbents. Volkswagen's vertical integration shows that it is not following the same playbook. Mr Diess argues that the long life cycle of a car gives his company more time to catch up than makers of PCs and feature phones had. Whether he is right or not, that makes Volkswagen a fascinating case study.

Legacy firms should observe not just Volkswagen but Mr Diess himself. The changes he has set in motion demonstrate that he is ready to overhaul the old petrol-headed mindset. And just as the firm is copying Tesla, so he is copying Mr Musk—albeit with German characteristics. The buzz he has created around his firm bolsters his position within the group, even among previously restive workers. The more clout he has, the more freedom he may enjoy to reform an unwieldy corporate structure, including spinning

off Porsche, a sports-car brand that is fast-becoming an EV gem and could be valued above €75bn. And if one day he builds an affordable, electric, self-driving, Beetle-like icon—a real-life e-Herbie, in other words—then Tesla better call it quits. ■



熊彼特

金龟车电动版

大众将会赶上特斯拉。然而难题还在后面

大众集团的老板赫伯特·迪斯（Herbert Diess）和迪士尼一个系列电影的主角“金龟车赫比”（Herbie）有些相似之处。与这个同名汽车角色一样，他有自己的想法，也有吸引眼球的天赋。他同样是作为一支弱旅参加一场赌注巨大的竞赛。另外，他和主要对手——特斯拉的马斯克——亦敌亦友，偶尔也开开玩笑。投资者开始对它倾注期望，过去一个月这家德国巨头的股价飙升了60%，而特斯拉的股价在下滑。这主要是因为观众对于谁能赢得这场电动车赛车改变了看法。投资者似乎已情迷“万能金龟电动车”。

这是一个惊人的转向。作为全球最大的汽车制造商之一，在去年大部分时间里，大众的电动汽车宏图看起来都更像是一个烟幕弹，只不过是为了掩盖五年前的柴油门排放丑闻的遗留影响、成本过高，以及迪斯与工会之间的紧张关系。但随后，这位掌门人取得了两项出人意料的成就。首先，他赢得了监事会的全力支持，一举终结了与工会的对决。这或许有助于他提振公司不温不火的利润率。其次，他试着在玩梗上压过马斯克。他利用各种便于传播的视频、推文和虚拟的“电池日”活动（Power Day），成功赢得了一向支持弱队的散户投资者的青睐。去年，正是散户助力将特斯拉的市值推高至8000亿美元。

这不全是烟幕。了解了该公司的最新数据后，一些汽车行业分析师认为，公司旗下包括大众、奥迪和保时捷等品牌将能在两年左右的时间里合计生产150万辆电动汽车，高于2020年的23万辆。大众集团可能会赶上甚至超越去年产量为50万辆的特斯拉。然而，到那时游戏才真正开始，因为除了电气化，自动化和电动出行的革命也在迅速降临。不光是特斯拉，新的竞争对手也竞相加入这场比赛，比如一心想为电子产品装上轮子的苹果公司，还有中国科技巨头百度。对那些落在后头的公司来说，这可能很快会变成一场撞车大赛。

先看电气化。大众在生产电池方面几乎毫无经验，而特斯拉已经走出了马斯克所说的“量产地狱”。要追赶上这家美国公司绝非易事。大众的市值为1350亿欧元（1600亿美元），而特斯拉目前的市值四倍于此，这让后者拥有强大的融资能力。迪斯承诺要将电池成本减半，部分举措是从2024年开始生产续航长、充电快的固态电池，令投资者兴奋不已。但他并没有给出削减成本的具体时间表，而特斯拉则将于今年推出一款更强劲的电池，可以立竿见影地降低成本。大众誓言到2030年将建成六家“电池超级工厂”，年产240吉瓦时的电池。而到那时，马斯克用他标志性的豪言壮语谈到，特斯拉的产量将高出一个数量级，达到约3000吉瓦时。

在软件方面，两者的差距看起来更让人气馁。特斯拉率先像设计软件一样设计汽车，让它可以像iPhone一样定期升级。大众最近开始在它的新款ID.3电动汽车上尝试这件事，并立志成为德国仅次于商业软件制造商SAP的计算公司。然而相比DNA里刻着科技的特斯拉，大众在软件上最突出的成就却是为可耻的排放作弊提供便利。自动驾驶又会让复杂程度上升到一个全新的维度。大众正在开发两类软件，一类针对无人驾驶轿车，另一类针对提供“出行即服务”（包括拼车和其他替代传统私家车的方案）的自动驾驶车队。在这两方面，美国和中国的科技巨头以及特斯拉都将是可怕的对手。迪斯本人也承认，软件把汽车变得越来越像是带轮子的计算机，这一点对汽车工业的改造将比电气化更加深远。

不过，作为一家老牌汽车制造商，大众的行动已经算大胆了。它计划2025年前每年在电气化和数字化方面投入150亿欧元，这要依靠其庞大的内燃机汽车业务来提供资金。大众已经在打造一个模块化平台用于生产电动汽车，而不是对现有生产线拼拼补补，这会增加灵活度。大众十分明智地决定围绕电池来设计汽车，而不是反过来。随着电动汽车需求增长，为了保证电池供应，它也和特斯拉一样开始垂直整合供应链。从电池、底盘到软件，电动汽车的大部分生产都将在公司内部完成。

其他受到清洁技术冲击的企业，例如石油公司，将密切关注大众的努力。汽车电池创业公司Nyobolt的马克·纽曼（Mark Newman）指出，在经受过颠覆的电脑和手机等行业，通常的模式是一家创新企业从零开始打造一个

新产品，就像特斯拉那样（苹果也曾如此）。一旦其产品上市，老企业就会复制它们并把生产外包。大众汽车的垂直整合策略显示它无意遵循同样的打法。迪斯认为，与个人电脑和功能型手机的制造商曾经的处境相比，汽车的长生命周期让他的公司有更多时间来迎头赶上。不管他是对是错，这都让大众汽车成为一个引人入胜的研究案例。

传统企业不仅应该关注大众公司，还应关注迪斯本人。他发动的这些变革表明，他准备彻底改变过去那种以汽油为导向的思维方式。而正如公司正在效仿特斯拉那样，他也在模仿马斯克——尽管是带有德国特色的。他为公司制造了话题热度，稳固了他在集团内的地位，就连以前不安分的员工也服气了。他的影响力越大，就越有可能获得更大的自由度去改革尾大不掉的企业结构，包括把保时捷剥离出来。这个跑车品牌正迅速崛起为电动汽车里的耀眼明星，估值可能超过750亿欧元。如果有一天他打造出了一款价格适中、具有甲壳虫那般招牌地位的无人驾驶电动汽车——或者说现实版“电动赫比”——那特斯拉恐怕只能弃赛了。■



Free exchange

Just the few of us

A shrinking global population could slow technological progress

BUBONIC PLAGUE killed between one and two thirds of Europeans when it struck in the 14th century. Covid-19, mercifully, has exacted nothing like that toll. Its demographic impact, however, is likely to be significantly larger than the nearly 3m tragic deaths so far attributed to the coronavirus thanks to an associated, worldwide baby bust. Births fell by about 15% in China in 2020, for example, while America recorded a 15% drop in monthly births between February and November of last year. As a consequence, the pandemic may have brought forward the projected date of peak global population by as much as a decade—into the 2050s. A shrinking planetary population might seem like a wholly welcome thing given the world's environmental challenges. But fewer people may also mean fewer new ideas, yielding a very different sort of future than optimists tend to imagine.

Humankind did not attain a population of 1bn until the 19th century, but the total then grew rapidly. A second billion was added by the 1920s, and nearly six more in the hundred years since. Plenty of fretting has accompanied this explosion; “The Population Bomb”, a book by Paul Ehrlich published in 1968 (between billions three and four), warned of looming global famine. Most projections before the pandemic, however, suggested that global population would plateau in the latter half of the 21st century. Some analysts have argued that our numbers will not just stabilise but decline. In “Empty Planet”, a book published in 2019, Darrell Bricker and John Ibbitson, two Canadian journalists, wrote that as fertility rates fall—a clear trend across rich and emerging economies—they tend ultimately to sink below the replacement rate of 2.1 children per woman. Nearly half the world’s people now live in countries with fertility rates below replacement levels. Barring

an unforeseen demographic detour, global shrinkage looms.

Messrs Bricker and Ibbetson point to potentially positive consequences of a falling population such as reduced pressure on scarce resources, a decline in environmental damage, and increased autonomy for women, although they also note there would be economic disruptions, such as a scarcity of care workers and problems with the sustainability of government debt. History also suggests population decline can be economically beneficial in some ways. In the wake of the Black Death in the 14th century, a scarcity of labour relative to available land and resources led to higher real wages and more freedom for workers.

Yet a recent paper inspired by their book, by Charles Jones, an economist at Stanford University, argues that over the long run any positive economic effects that come from a shrinking population may be cancelled out by the reduction in humankind's creative capacity. If ideas drive growth and people are the source of ideas, he writes, then the fate of our species depends crucially on long-run population trends.

In the absence of new ideas, growth must eventually grind to a halt. The adding of labour or resources or capital (machinery and such) to an economy can boost income, but with diminishing returns; in the absence of technological progress, ore becomes harder and costlier to mine and there are ever fewer valuable tasks to be done by an extra worker or industrial robot. New ideas, though, allow an economy to do more with less or create new and valuable tasks to occupy labour and capital. Technological progress has thus enabled steady growth in real income per person over the past two centuries even as global population has soared.

But new ideas must themselves be produced. An economy can increase the flow of ideas by adjusting its use of human resources: by investing more

in education and encouraging more people to work in research rather than production, for instance. But while these solutions sufficed to generate lots of new knowledge in the 20th century, Mr Jones says, they are themselves subject to diminishing returns. (The share of a population working in R&D can only rise so high, for example, and as it does the productivity of each additional researcher is likely to drop.) A decline in the absolute number of brains might thus place a serious dampener on innovation, he writes, and thus on prospects for continued growth in incomes. Using a simple model, Mr Jones suggests that the world may face two potential outcomes in future. If fertility stabilises at a high enough level, an “expanding cosmos” scenario awaits, in which the stock of knowledge, population and incomes all rise ever upward. Alternatively, a cycle of falling population and reduced idea creation could lead to an “empty planet” outcome, in which living standards stagnate while population figures dwindle.

Models like Mr Jones’s are less interesting as literal descriptions of how economies work than as illustrations of how different factors might affect future economic developments. It is possible, for instance, that computing advances might increase the productivity of research, or even enable the automation of some forms of idea generation, reducing the constraint he identifies.

At the same time, his work gestures at underappreciated sources of complacency. Rich economies may have worried too little about the growing numbers of researchers needed to generate steady improvement in computing power, for instance, out of a misguided assumption that there will always be more people available to don a lab coat. They may also have undervalued human potential more generally: by failing to prioritise education, or welfare programmes which might allow households that would like to have children to do so comfortably, with the same urgency as they have looked after other critical resources. Strangest of all, in the eyes of future inhabitants of an emptying planet, may be rich governments’

present disquiet at fast-growing populations in the developing world. That advanced economies did not invest lavishly in the talents of the world's poorer billions may come to look existentially foolhardy. ■



自由交流

就我们几个

全球人口减少可能会减缓技术进步

在14世纪爆发的黑死病杀死了三分之一到三分之二的欧洲人。所幸，新冠病毒远没有造成那样的惨状。不过，由于一个与之关联的全球生育低谷期，疫情对人口结构的影响很可能远远不止迄今为止归因于新冠的近300万例死亡。例如，2020年中国的出生人数降低了约15%，而美国在去年2月至11月之间的月出生人数下降了15%。结果就是此次疫情可能令全球人口预期顶峰的到来提前了十年之久——也就是提前到了本世纪50年代。考虑到世界环境面临的挑战，全球人口缩减看似完全值得欢迎。但人更少可能也意味着新想法更少，导致一个与乐观人士的想象迥然不同的未来。

全球人口直到19世纪才达到10亿，但在那之后就快速增长。到1920年代又增长了10亿。那之后的100年里，人口又多了近60亿。伴随着人口爆炸产生了许多担忧。保罗·埃尔利希（Paul Ehrlich）于1968年出版的《人口炸弹》（The Population Bomb）一书（当时人口在30亿到40亿之间）警示了隐隐可见的全球饥荒危机。然而，疫情之前许多预测显示全球人口会在本世纪下半叶达到稳定期。有些分析人士认为人口数量不止会稳定下来，还会减少。在2019年出版的《空荡荡的地球》（Empty Planet）一书中，两位加拿大记者达里尔·布里克（Darrell Bricker）和乔恩·伊博森（John Ibbitson）写道，生育率下降的趋势在发达经济体和新兴经济体都很明显，它们往往最终都会跌至低于人口替代率——即每名女性生育2.1个孩子。目前，全球近一半人口生活在生育率低于替代率的国家里。除非有意想不到的人口结构转折，全球人口缩减正在逼近。

布里克和伊博森指出了人口减少可能产生的积极影响，例如稀缺资源方面的压力减轻，环境破坏减少，女性自主性更强，不过他们同时也提到了可能会造成的经济混乱，比如护理员不足和政府债务的可持续性问题。历史也表明人口下降在某些方面对经济有益。在14世纪的黑死病之后，劳动力

相对于可用土地和资源出现了稀缺，让工人获得了更高的实际工资和更多自由。

不过，在布里克和伊博森这本书的启发下，斯坦福大学的经济学家查尔斯·琼斯（Charles Jones）最近撰写了一篇论文，他认为长远来看，人口减少产生的任何积极的经济影响可能都会被人类创新能力的减少抵消。他写道，如果说想法驱动增长，而人又是想法的来源，那么长期人口趋势对人类的命运至关重要。

缺乏新想法，增长终将停滞。为一个经济体增添劳动力、资源或资本（如机械等）能够提升收入，但是收益递减；没有技术进步，矿石开采会更困难，成本也更高，能交给新增加的工人或工业机器人去做的有价值的任务越来越少。而新想法可以让一个经济体提升效率，或是创造有价值的新任务，让劳动力和资本能尽其效用。因此，过去两百年里全球人口飙升的同时，技术进步令人均实际收入稳定增长。

但是新想法本身需要被生成。一个经济体可以通过调整人力资源部署来产生更多想法：比如在教育上增加投资，鼓励更多人从事研究而非生产。但是，琼斯指出，尽管这些解决方案在20世纪带来了许多新知识，它们本身仍要服从收益递减的规律。（比如研究人员占人口比例只能增长到某个水平，而这时每个新增研究人员的生产率很可能下降。）因此，他写道，大脑绝对数量的减少可能会严重抑制创新，从而影响收入持续增长的前景。琼斯用一个简单的模型展示了未来世界可能面对两种结果。如果生育率稳定在一个足够高的水平，等待我们的情境是“膨胀的宇宙”——知识储备、人口和收入都不断上升。另一种结果是，人口减少，产生的想法减少，这样的循环可能导致一个“空荡荡的地球”，生活水平随人口减少而停滞不前。

相比于准确描述经济的运行方式，像琼斯提出的这类模型更有趣的地方是展示不同因素可能如何影响未来的经济发展。比如，计算的进步可能会提升研究领域的生产率，甚至让想法的生成实现某种形式的自动化，减少他

指出的制约因素。

同时，他的研究指出了一些被低估的自满情绪。比如要让计算能力稳步提升，研究人员的数量需要不断增加，而富裕经济体对此可能担忧得太少了，它们错误地认为总会有越来越多的人等着穿上实验室白大褂。它们可能也更广泛地低估了人力潜能：相比对其他关键资源的关切，像教育或福利这些能为想要生儿育女的家庭提供便利的项目没有得到同等重视。在未来空荡荡的地球上的居民看来，最奇怪的可能是富裕国家的政府在今天对发展中国家人口的迅猛增长深感忧虑。发达经济体没有慷慨投资于世界上数十亿较贫困人口中的人才，在一个关乎人类生存的问题上它们可能显得太过草率了。■



A history of constitutions

The writes of man

Linda Colley charts their history in “The Gun, the Ship and the Pen”

ON NOVEMBER 29TH 1838 Captain Russell Elliott and the crew of HMS *Fly* made landfall on Pitcairn, a tiny island in the South Pacific that 51 years earlier was the refuge for nine mutineers from HMS *Bounty*. That group's hundred or so mixed-race descendants were increasingly vulnerable to predatory visitors, mainly whalers from New England. Elliott quickly saw what the islanders needed: a union flag and a set of regulations that could become a constitution. There was nothing very remarkable about this in an age when the writing of such documents was all the rage, save one thing. This was the first time a constitution anywhere specifically enfranchised all men and all adult women to vote for the head of their ruling executive.

Linda Colley's new book is full of such nuggets of insight. “The Gun, the Ship and the Pen” is an ambitiously wide-ranging account of the forces that propelled the writing of constitutions—documents that have defined the modern world—from the middle of the 18th century until today. The story begins in 1755 in Corsica where Pasquale Paoli, a revolutionary adventurer returning from exile in Naples, imbued with Enlightenment ideas about politics, economics, law and liberty, wrote and established Europe's first modern constitution.

Above all, Ms Colley argues, the need for innovative, written constitutionalism was driven by the evolving nature of war. The Seven Years' War, which broke out in 1756, was described by Winston Churchill as the “first world war”. It introduced what the author calls a new era of “hybrid” wars, in which naval forces with global reach were combined with growing and lethally equipped land armies. Governments' need for ever-

more manpower to fight these wars—and ever-growing tax revenues to pay for them—led to crises at home that could only be tackled by the concession of new rights and promises of wider political participation. Paoli's chance to mobilise his fellow Corsicans came because France was distracted by its struggle with Britain for control of the oceans.

The fashion for constitutionalism was turbocharged by high-speed, steam-powered printing presses, which made it possible to hold a wider conversation with increasingly literate citizens about the laws and principles that should govern their lives. Among others, citizens of the new United States of America and Republican France no longer saw themselves as passive recipients of laws determined by ruling elites.

Thanks to those whirring presses and, a little later, the telegraph, a constitution drafted in one polity could influence and inform the drafters in another. Jeremy Bentham, an English jurist and founding father of utilitarianism, fervently believed that good constitutions had features that could be applied “for every territory, for every race and for every time”. Britain's lack of a written constitution (a consequence of political stability and financial muscle) did not stop Bentham being seen, by himself and others, as a kind of international consultant on their drafting.

For some, constitutions served more practical and less idealistic political aims. Most late-18th- and 19th-century constitutions made it pretty clear that they conferred rights only on the white males who were needed to fight wars and pay taxes. For all its apparent high-mindedness, America's constitution provided a legal cloak for the appropriation of land from indigenous peoples. Napoleon Bonaparte, a prolific constitution-writer, deployed the pen to legitimise territorial conquest and personal power. (A few newly independent Latin American countries produced more racially inclusive constitutions; those drawn up in places such as Haiti, Liberia and

Hawaii reflected their different circumstances and aspirations.)

A constitution could also be a means to announce a country's modernisation, and thus its clout, prosperity and solidity. For trading partners, it could be an open-for-business sign. For potential adversaries, a warning. A case in point is the Japanese Meiji constitution of 1889. The author gives a gripping account of how this document, and the official commentary on its implications, cleverly pick and mix Western principles and Japanese traditions—not least in the idea that the constitution was itself a gift from the “Heaven-descended, divine and sacred” emperor to his subjects. That it survived largely intact until 1947 helps explain subsequent events.

Although this sprawling book sometimes crams in too much, Ms Colley writes with such elegance and verve that the journey, and the characters it involves, are always fascinatingly worthwhile. This is an original global history that adds to readers' understanding of the world they live in. ■



宪法史

书写权利

琳达·科利在《枪炮、船舰和笔杆子》中描绘了这段历史【《枪炮、船舰和笔杆子》书评】

一八三八年11月29日，英国皇家海军“飞越”号（HMS Fly）的船长罗素·艾略特（Russell Elliott）和船员们在皮特凯恩群岛（Pitcairn）登陆。这座南太平洋上的小岛在51年前成为了英国皇家海军“邦蒂”号（HMS Bounty）上的九名叛乱者的避难地，他们的百来个混血后代越来越容易受到主要来自新英格兰捕鲸船的掠夺。艾略特很快就明白了岛民需要什么：英国国旗和一套可以成为宪法的规章。在那个撰写这类文件风靡一时的年代，这也没什么了不起的，除了一件事：在全世界，这是第一次有宪法明确赋予全体男性及所有成年女性投票选举执政委员会首领的权利。

琳达·科利（Linda Colley）的新作满是这样细微的洞见。《枪炮、船舰和笔杆子》（The Gun, the Ship and the Pen）雄心勃勃地广泛记述了从18世纪中叶至今有哪些力量推动了编撰宪法这类界定现代世界的文件。故事始于1755年的科西嘉岛（Corsica），富有革命精神的冒险家帕斯夸里·保利（Pasquale Paoli）从那不勒斯流放归来，头脑中充满了有关政治、经济、法律和自由的启蒙思想，撰写并建立了欧洲第一部现代宪法。

科利论述道，对创新的、成文的立宪制的需要首先受战争逐步演变的特点推动。1756年爆发的英法“七年战争”被温斯顿·丘吉尔描述为“第一次世界大战”，它开启了作者所说的“混合”战争的新时代，期间触角遍及全球的海军部队与日益壮大、极具威慑力的陆军协同作战。政府需要投入更多兵力打赢这些战争，也需要不断增长的税收来为战争买单。这导致了国家内部危机，唯有让与新权力、承诺更广泛的政治参与才能化解。保利动员他的科西嘉同胞的机会来了，因为法国正忙于和英国争夺海上控制权而无暇他顾。

立宪制的风靡还受到高速的蒸汽驱动印刷机的助推。这种机器令越来越有

文化素养的公民可以展开更广泛的交流，讨论他们的生活应受怎样的法律与准则支配。比如，新美利坚合众国和法兰西共和国的公民不再自视为由统治精英决定的法律的被动接受者。

有赖这些轰鸣运转的印刷机以及不久后出现的电报，一个政体起草的宪法可以影响另一处的起草人。英国的法理学家、功利主义创始人杰里米·边沁（Jeremy Bentham）虔诚地相信，好的宪法具有可被应用到“每一片领地、每一个种族和每一个时代”的内容和特点。英国缺乏一部成文宪法（这是政治稳定和财政实力的结果），但这并不妨碍边沁被别人和他自己视为起草宪法的某种国际顾问。

对一些人来说，宪法是为更实用而不那么理想化的政治目的服务。大多数18世纪末和19世纪的宪法都明确表示，它们只赋予那些需要他们去打仗和缴税的白人男性权利。尽管美国的宪法表面上很崇高，但它却为挪用土著的土地披上了法律的外衣。拿破仑·波拿巴就是一位多产的宪法作者，他利用笔杆子将领土征服和个人权力合法化。（少数刚刚获得独立的拉美国家制定了更具种族包容性的宪法；而在海地、利比里亚和夏威夷等地起草的宪法反映出各地不同的境况与抱负。）

宪法也可以成为对一个国家实现现代化的宣示，进而宣示该国的影响力、繁荣和团结稳定。对贸易伙伴而言，它可以是商业开放的信号。对潜在对手来说则可能是一种警告。1889年日本的明治宪法就是一个例子。作者扣人心弦地记述道，这份文件及官方对其影响的评论是如何巧妙地甄选及融合了西方的行为准则与日本的传统——尤其是宪法本身就是“天降神明”的天皇给予臣民的神圣馈赠这一理念。这部宪法能在大体上无改动地施行至1947年，也有助于解释后续发生的事件。

虽然这本内容庞杂的书有时塞进了太多内容，但科利的行文优美热情，让这段旅程以及书中角色总是那么引人入胜而值得一读。这是一部独特的全球史，帮助读者对自己身处的世界有了新的理解。■



The Economist film

Sustainable air travel: will it cost more?

Going green may be the biggest challenge the industry ever faced. It demands the right investment and policies to support a range of technologies - and that might mean passengers need deeper pockets.



经济学人视频

航空业绿色转型：飞行会更贵吗？

减排可能是航空业面临的最大挑战，需要正确的投资和政策来支持一系列新技术——这也可能意味着航班乘客需要掏出更多钱。



Commercial decoupling

Swept up in a storm

A spat over cotton portends more trouble for Western firms in China

BOYCOTTS OF FOREIGN brands are so common in China that managers have a ready-made playbook when caught in a storm of nationalist outrage. Start with an apology. Then stay mostly quiet, perhaps expressing respect for Chinese culture. Wait for the anger to subside. Over recent weeks the list of companies consulting the manual has grown. Chinese consumers, egged on by the ruling Communist Party, vowed to shun some of the world's biggest clothing companies, from Adidas to Zara.

In the eyes of the boycotters, the firms erred by declaring concern over allegations that China's cotton industry includes the forced labour of Uyghurs, a mostly Muslim ethnic minority in the north-western region of Xinjiang. Their bosses hope that the controversy will fizzle out. But they and other Western executives in China cannot shake an unsettling fear that this time is different. Their lucrative Chinese operations are at rising risk of tumbling into the political chasm that has opened between the West and China.

H&M, a Swedish fast-fashion retailer, faces the most immediate trouble. As of March 30th, a week after it was attacked online, its garments were still unavailable on China's most popular e-commerce apps. Its stores have disappeared from smartphone maps. Landlords in several shopping malls have terminated its leases. Its Chinese business, worth \$1bn in revenues and representing 5% of its global sales in 2020, is in jeopardy.

For other companies the Xinjiang rage has not been as devastating. Even as celebrities in China cancelled endorsement deals with Nike, some 350,000

Chinese signed up for an online sale of a limited-edition pair of its swooshy shoes on March 26th. Little by little the social-media mob has dwindled amid signs that government censors were reining it in, perhaps to lower the heat. The share prices of foreign firms entangled in the boycotts have clawed back most of their initial losses.

Foreign executives, however, remain on edge. The issue at the heart of their current problems—China's human-rights violations in Xinjiang, and the West's newfound willingness to punish them—is one for which the tried and tested playbook is ill-suited. It may also be more expansive, seeping into many other corners of their business dealings in the world's second-biggest economy.

The boycotts were apparently triggered by the co-ordinated announcements on March 22nd by America, Britain, Canada and the European Union of sanctions against Chinese officials for abuses in Xinjiang. China responded with sanctions of its own. The Communist Youth League, a party affiliate, then dug up a months-old statement by H&M expressing concern about reports of Uyghur forced labour. Hua Chunying, a foreign-ministry spokeswoman, made the message clear. "The Chinese people will not allow some foreign companies to eat Chinese food and smash Chinese bowls," she said.

The commercial conflagration over cotton illustrates the difficulty of even limited economic decoupling between China and the West. China's cotton industry is worth about \$12bn a year, less than 0.1% of GDP. About 90% of China's cotton comes from Xinjiang, and the government says 70% of that is harvested mechanically. In theory it should be possible for companies to remove hand-picked fibres from supply chains. In practice that would require audits of how the cotton is produced. China will not allow free travel around Xinjiang, let alone unmonitored conversations with Uyghur workers. Last year American clothing-industry groups described the

situation as “of a scale, scope and complexity that is unprecedented during the modern era of global supply chains”.

In January Donald Trump cut through the complexity with a full prohibition on cotton imports from Xinjiang. His successor as president, Joe Biden, who is less China-baiting but more concerned about human rights, has not reversed it. The trouble is that yarn from Xinjiang ends up in factories around China, making it hard to stop the taint from spreading to all Chinese cotton products, which make up a large slice of global supply. China accounts for about 40% of the world’s textile exports. “There is no way we can declare the full supply chain is clean,” observes a consultant based in Shanghai.

Mei Xinyu, a researcher with the Ministry of Commerce, has written that cotton is the “entry point” for America’s strategy of using the Xinjiang allegations to suppress China, which denies any forced labour is taking place. China’s only choice, he says, is to fight back forcefully. The Communist Party is confident of its abilities to do so, thanks to what it calls the “powerful gravitational field” of its market. American-listed firms which regularly report their revenues from China or Asia, and can thus be assumed to have larger exposure to the country, have outperformed those that do not in recent years (see chart).

Yet even gravity has its limits. An apology, the first step in mending fences, is untenable this time. Many people inside foreign companies “recognise the moral gravity of what’s happening in Xinjiang”, says Scott Nova of the Worker Rights Consortium, a labour-monitoring organisation. Those that do not must still comply with the American ban on cotton imports if shipping to America. This earns them little sympathy in China. Foreign firms have found it virtually impossible to get audiences with Chinese officials to explain their legal obligations in America, says a government-

relations expert.

Those obligations may soon multiply. The Uyghur Forced Labour Prevention Act, currently wending its way through Congress with bipartisan support, assumes that all Xinjiang products are made with forced labour. Companies will have to prove otherwise if they want to export to America. “It’s like having to prove a negative,” sighs one representative of American industry. The consequences could be dramatic. Nearly half of the polysilicon in solar panels globally comes from Xinjiang. China’s largest wind-turbine maker, Goldwind, is based there. Xinjiang’s oil and gas power factories around China.

Europe has so far refrained from banning products from Xinjiang. China’s decision to focus its ire on H&M rather than on an American firm may be a warning to EU officials to keep it that way. But the aggression poses a risk. In December the EU and China signed an investment deal which would give European industrial and financial firms greater access to the Chinese market. The European Parliament may now have second thoughts when asked to ratify it. “After seven years of negotiations, we hoped for seven years of wellness. Now it looks like it might be seven years of drought,” says Joerg Wuttke, president of the EU Chamber of Commerce in China.

China still wants some foreign firms to feel welcome. On March 26th Li Keqiang, the prime minister, visited a plant part-owned by BASF, a German chemicals giant. Such comity will almost certainly become rarer as the authorities promote home-grown business, from chipmaking to electric vehicles. China’s newest five-year plan, unveiled in March, is focused above all else on the pursuit of self-sufficiency in the face of a “hostile external environment”, as party leaders describe it. Western bosses had hoped that the fissures between China and the West would start to close under Mr Biden’s administration. Instead they are getting deeper and wider. ■



商业脱钩

卷入风暴

一场围绕棉花的口水仗预示着在华西方企业的日子会更难过

中国抵制外国品牌时有发生，所以企业主管已经有了一套现成的战术手册来应对民族主义怒火。先道歉。接下来基本保持沉默，或许表达一番对中国文化的尊重。等待怒火平息。近日，翻看这本手册的公司不断增加。在中国政府的鼓动下，中国消费者誓言要罢买从阿迪达斯到Zara的一批世界最大的服饰品牌。

在抵制者看来，这些公司错在发布声明，表达对中国棉花产业存在强迫维吾尔族人（生活在中国西北部的新疆，大多为穆斯林的少数民族）劳动的指控的关切。这些公司的老板们希望这场争议能逐渐平息。但他们和其他西方企业在华高管都无法摆脱一种不安：这次的情况不同以往。他们利润丰厚的中国业务陷入中西方之间豁开的政治鸿沟的风险越来越高。

瑞典快时尚零售商H&M尤其火烧眉毛。截至3月30日，也就是该品牌在网上被围攻一周后，在中国最流行的那些电商应用中仍然搜索不到其产品。智能手机的地图应用上也搜不到实体店地点。一些购物中心的业主终止了H&M的租约。该品牌2020年在中国的收入达10亿美元，占其全球销售额的5%，这一部分如今危在旦夕。

这场新疆棉怒火给其他企业带来的损伤要小一些。在中国明星们纷纷解除与耐克的代言合同之时，一款于3月26日在网上开售的限量版耐克鞋引来了约35万中国人预订。有迹象显示政府审查部门开始抑制网上舆论——或许是为了给火势降温——社交媒体上的声浪逐渐减弱。卷入抵制潮的外企的股价纷纷回升，收回了最初的大部分失地。

然而，外企高管们仍然坐立不安。他们当下难题的核心是中国在新疆被控侵犯人权以及西方国家最近图谋惩戒这件事，而那本屡试不爽的战术手册这回并不适用。而且这个问题可能涉及的范围更广，渗透到它们与这个世

界第二大经济体打交道的其他许多方面。

本轮抵制的导火索看起来是美国、英国、加拿大和欧盟在3月22日联合宣布就新疆人权问题制裁中国官员。作为回应，中国实施了反制裁。共产党下属组织共青团随后挖出了H&M几个月前就维吾尔族强迫劳动的报道发布的一份关注声明。外交部发言人华春莹对此明确表态。“中国老百姓也不允许一些外国人一边吃着中国的饭，一边砸着中国的碗。”她说。

这场围绕棉花的商业纷争显示，中西方之间即便是要实现有限的经济脱钩也很难。中国的棉花产业每年价值约120亿美元，不到GDP的0.1%。中国约90%的棉花来自新疆，政府称其中70%是机械采摘。理论上，企业应该可以从供应链中排除手工采摘的部分。实际操作起来，这需要审核棉花的生产方式。中国不允许在新疆自由旅行，更别说在无人监控的情况下接触维吾尔族工人。去年，美国服装业团体描述这一现状时称“其规模、范围和复杂性在现代的全球供应链时代前所未有”。

今年1月，特朗普全面禁止进口新疆棉，直接避免了这种复杂情形。他的继任者拜登没有撤销这道禁令（拜登的注意力更多在人权，而非像特朗普那样故意激怒中国）。问题是，来自新疆的棉纱最终会进入中国各地的工厂，因此难以阻止新疆棉进入各种中国棉制品，而这些产品在全球供应中占了很大一部分。中国约占全球纺织品出口的40%。“我们无法宣称整个供应链不含新疆棉。”一位驻上海的顾问表示。

商务部研究员梅新育撰文称，棉花是美国利用对新疆的指控撼动中国的战略“切入点”。（中国否认存在任何强迫劳动。）中国不能不对此做出有力的反应，他说。共产党有信心中国能这么做，因为中国的市场具有它所说的“强大引力场”。那些定期报告中国或亚洲市场收入的美国上市公司（可据此假定它们更加依赖中国）近年来的表现优于无中国或亚洲业务的公司（见图表）。

不过，即便引力也有其上限。作为修补关系的第一步，道歉在这一次已经站不住脚了。劳工监督组织工人权利协会（Worker Rights Consortium）

的斯科特·诺瓦（Scott Nova）说，外企内部有很多人“意识到新疆发生的事情在道德上很严重”。即便不这样想的人在向美国发货时也还是必须遵守美国政府的棉花禁令。而它们并不会因此在中国收获同情。一位政府关系专家表示，外国公司发现几乎不可能让中国官员听它们解释自己在美国的法律义务。

这类义务也许很快会成倍增加。得到美国两党支持的《防止强迫维吾尔劳动法》（Uyghur Forced Labour Prevention Act）现在正等待国会通过，该法案假定所有新疆产品都是用强迫劳动制造的。要出口产品到美国，企业就必须证明自家产品制造中未用到新疆产品。“这就像必须要自证清白一样。”一位美国工业界代表叹道。后果可能是戏剧性的。全球太阳能电池板中近一半的多晶硅来自新疆。中国最大的风力涡轮机制造商金风科技的总部就在新疆。新疆的石油和天然气驱动着中国各地的工厂。

欧洲目前尚未禁用新疆产品。中国决定把怒火集中发泄在H&M而非一家美国公司身上，这可能是向欧盟官员发出警示，让他们继续保持克制。但这种攻击带来了风险。去年12月，欧盟和中国签署了一项投资协定，让欧洲工业及金融企业更容易进入中国市场。现在，欧洲议会审批该协定时可能要重新考虑了。“经过七年磋商，我们本希望能有七年的好光景。现在看来可能会是七年干旱。”中国欧盟商会主席伍德克（Joerg Wuttke）说。

中国还是想让一些外企感到自己是受欢迎的。3月26日，总理李克强参观了德国化工巨头巴斯夫的一家在华合资工厂。但随着政府推动从芯片制造到电动汽车等领域的本土发展，几乎可以肯定这种礼遇会越来越少见。中国在3月公布了最新的五年计划，重点是在共产党领导人所说的“恶劣的外部环境”之下追求自给自足。西方企业老板曾希望，拜登上台后中西方之间的裂痕会逐渐弥合。结果正相反，这些裂痕正变得更深、更宽。■



The ultra-rich

A plutocratic makeover

The changing profile of billionaires illustrates how India Inc is changing

AT FIRST GLANCE the Indian names on the billionaires list compiled by Hurun Report, which tracks such things, reinforce the image of the powerful growing more so. At the top, to no one's surprise, was Mukesh Ambani (worth \$83bn), followed by Gautam Adani (\$32bn). Both owe their riches to industrial conglomerates (centred, respectively, on petrochemicals, and ports and power plants). Both have a knack for navigating India's obstreperous courts and bureaucracy. Both operate mainly in Maharashtra and Gujarat, the industrial heartlands in the west of the subcontinent.

Yet look more closely and the rich list reveals India's changing economy. Mr Ambani's wealth has soared because of Jio, his firm's digital subsidiary which runs a huge telecoms network and has become an e-commerce prospect. Other members of the billionaire list increasingly represent the businesses of India's future, including drugmaking and technology, rather than heavy industry. They come from across the country. And their ranks are swelling fast.

A record 50 joined Hurun's list last year; only ten dropped out (see chart). India now has 177 billionaires, up from 100 in 2017 and behind only China (with around 1,000) and America (700 or so). Add the Indian diaspora's 30 billionaires, and their combined wealth has nearly doubled over the period, to \$740bn. Both the newcomers and the drop-outs tell a story of transformation.

Start with the deposed tycoons. Enough have been felled by charges of fraud to inspire Netflix to produce a documentary, "Bad Boy Billionaires: India".

Many others owe their relegation to struggles with excessive borrowing. Subhash Chandra, a rice trader turned media mogul, has stepped down from some of his posts. Kishore Biyani has seen the value of his indebted business, a retail empire called Future Group, dwindle. So has Anil Ambani, Mukesh's younger brother, who has seen his \$42bn fortune dwindle to a fraction of that over the past 12 years.

Fortunes built on physical assets are being overtaken by those fuelled by intellectual capital and consumer spending. Industries that used to mint tycoons, such as construction, are in relative decline. Twelve of this year's new billionaires in India owe their status to drugmaking, bringing their number on Hurun's list to 39. Nine peddle consumer goods.

The global surge in technology stocks has boosted software fortunes. Including the diaspora, IT now accounts for \$95bn of Indian billionaires' wealth, up from \$30bn in 2016. The latest software moguls include Jay Chaudhry, who controls Zscaler, a cyber-security firm based in California with a market capitalisation of \$25bn, and the family of Shiv Nadar, founder of HCL Technologies, an IT consultancy whose stockmarket value has doubled in the past year to nearly \$40bn. Their ranks are likely to swell as more privately held companies valued at \$1bn or more go public, observes Anas Rahman Junaid of Hurun, who tracks nearly 100 such "unicorns". Two-thirds of these startups are based abroad, most of them in America.

Not all Indian moguls are entrepreneurs who founded successful firms. Especially in the diaspora, some are professional managers who have successfully run companies created by others. They include Thomas Kurian (a former Oracle executive who heads Google's cloud-computing division), Jayshree Ullal (boss of Arista Networks, a cloud-networking firm) and Ajaypal Banga (former chief executive of Mastercard). They may soon be joined by Sundar Pichai, Mr Kurian's boss at Google's parent company,

Alphabet, and Satya Nadella of Microsoft (with an estimated net-worth of \$800m apiece), as well as Nikesh Arora, CEO of Palo Alto Networks, another big cyber-security firm.

Accomplished Indian executives may help explain why 41 foreign cities were home to Indians with assets of \$150m or more in 2020, up from 14 five years ago. At home these ultra-rich still cluster in Mumbai, the commercial capital (see map). But their ranks are swelling faster in places like Chennai or Hyderabad. They can now be found in 70 cities across the subcontinent, compared with 28 in 2016.

Indian billionaires still make up a much smaller fraction of its 1.4bn people than fellow plutocrats in America, Europe and even China, which is roughly as populous as India but considerably richer. But if the country's plutocratic makeover is a guide, at least the opportunities for great wealth appear to be spreading. ■



超级富豪

富豪大变身

透过印度亿万富翁阵容的变化看该国商界的变化

追踪富豪的胡润百富编制出了新的亿万富翁全球榜。瞥一眼上面的印度人名，果然还是强者愈强。穆克什·安巴尼（Mukesh Ambani）毫无悬念地坐稳首富之位，身家830亿美元；第二名是高塔姆·阿达尼（Gautam Adani），身家320亿美元。这二人的财富都来自各自的工业企业集团，安巴尼的集团以石化产品为核心，阿达尼的以港口和发电厂为核心。二者都有本事在印度喧嚣混乱的法庭和官僚机构间穿梭自如。二人也都主要在南亚次大陆西部的工业中心马哈拉施特拉邦（Maharashtra）和古吉拉特邦（Gujarat）运营业务。

然而仔细观察一番，就会发现这份榜单揭示出印度经济正在发生变化。安巴尼因旗下数字子公司Jio而身家大涨。Jio经营着一个巨大的电信网络，还有望在电子商务方面一展宏图。上榜的其他人越来越多地出自制药和科技等代表印度未来的行业，而不是重工业。他们来自全国各地，队伍也在迅速壮大。

去年有创纪录的50人新加入胡润榜单，只有10人掉出榜单（见图表）。印度在2017年有100名亿万富翁，现在有177名，数量仅次于中国（约1000名）和美国（约700名）。再加上印度侨民中的30人，印度亿万富翁的财富总量在此期间几乎翻了一番，达到7400亿美元。新面孔和落榜者都勾画出了一个转型的故事。

先来看那些掉出榜单的。因欺诈指控而垮台的大亨人数如此之多，奈飞（Netflix）专门拍过一部纪录片《印度亿万富豪陨落记》（Bad Boy Billionaires: India）。其他许多人失势是因为过度借贷令他们不堪重负。米商出身的媒体大亨苏巴什·钱德拉（Subhash Chandra）已经辞去了一些职务。基肖尔·比亚尼（Kishore Biyani）的零售帝国未来集团（Future

Group) 负债累累，价值逐渐缩水。穆克什的弟弟阿尼尔·安巴尼 (Anil Ambani) 也一样，过去12年他420亿美元的财富已缩水至原来的一小部分。

靠实体资产积累起的财富正在被智力资本和消费者支出驱动的财富赶超。建筑业等曾经盛产大亨的行业进入了相对衰落阶段。今年印度的新晋亿万富翁中有12人是做制药生意致富的，这使得上榜的印度药厂富翁达到39人。有九人是消费品卖家。

全球科技股飙升让一些人大发软件财。现在，印度亿万富翁（包括海外侨民富豪）的总财富中有950亿美元来自信息技术领域，而2016年时为300亿美元。新晋软件巨头包括杰伊·乔德里 (Jay Chaudhry)，他控制的网络安全公司Zscaler总部位于加州，市值250亿美元；此外还有HCL Technologies的创始人希夫·纳达尔 (Shiv Nadar) 的家族，这家信息技术咨询公司的市值在过去一年翻了一番，逼近400亿美元。胡润百富的阿纳斯·拉赫曼·朱奈德 (Anas Rahman Junaid) 追踪近100家“独角兽”，他认为，随着这些估值10亿美元或以上的私人控股公司越来越多地上市，信息技术出身的亿万富豪阵容应该还会壮大。这些创业公司中有三分之二总部设在国外，大多是在美国。

并非所有印度亿万富翁都是创建了成功公司的企业家。特别是在侨民中，有些是成功运营了他人创立的公司的职业经理人。他们包括：托马斯·库里安 (Thomas Kurian)，前甲骨文高管，如今负责谷歌的云计算部门；贾什里·乌拉尔 (Jayshree Ullal)，云网络公司Arista网络 (Arista Networks) 的老板；以及彭安杰 (Ajaypal Banga)，万事达卡的前首席执行官。这支队伍可能很快又会有新人加入：库里安在谷歌母公司Alphabet的老板桑达尔·皮查伊 (Sundar Pichai)，以及微软的萨蒂亚·纳德拉 (Satya Nadella)，两人估计各有八亿美元的净资产；尼科什·阿罗拉 (Nikesh Arora)，另一家大型网络安全公司派拓网络 (Palo Alto Networks) 的首席执行官。

印度裔高管如此成就斐然，或许有助于解释为什么到2020年能在41个外国城市中找到资产不少于1.5亿美元的印度人，而五年前这样的城市还是14个。在印度国内，这些巨富仍然聚集在商业之都孟买（见地图）。但在钦奈或海得拉巴等地，这个群体扩张得更快。在2016年，他们分布在整个南亚次大陆的28个城市，现在已增加到70个。

与美国、欧洲甚至中国的富豪相比，印度亿万富翁在其14亿人口中所占的比例仍然小得多。中国的人口与印度大致相当，但要富裕得多。但是，如果印度上演的富豪阵容洗牌可作为一种参考的话，至少可看出赚取巨额财富的机遇正在扩散。 ■



Disability

The unseen

Long ostracised, disabled people are demanding more help

FEW PEOPLE relish a visit to the dentist. For those who are autistic, it can involve unusual torment—some people with the condition have extremely sensitive mouths. Most of China's autistic people avoid going. But bad teeth can also make them miserable. So last year the Shenzhen Autism Society, an NGO in the southern Chinese city, launched an attempt to make dental treatment less scary for some.

The programme has helped about 45 autistic people aged between four and 40 to conquer their fears. Participants have been encouraged to engage in pleasurable distractions while waiting, and to spend time getting comfortable in the dentist's chair before procedures begin. With younger ones, their parents' mouths are sometimes examined first. One nervous father summoned up the courage to undergo a treatment that his son needed, too. Watching this encouraged the autistic boy to allow the same to be done to him.

In China, such grassroots efforts to improve the lives of the disabled are rare. But NGOs—though severely restricted by the government in many other spheres—are being allowed to do more in this one. Their involvement is badly needed. The government is also doing more to help. Yet it does not recognise as disabled many of those who would be officially regarded as such in rich countries. In 2011, when China's most recent available census data were published, over 85m people—about one in 16—were classified as disabled (including 21m who were deaf and 13m blind.) That compares with one in five in Britain and one in eight in America. Unlike in the West, China's definition of disabled does not cover those with chronic illnesses.

It also excludes many people who have use of their limbs, but struggle with routine tasks.

Of those who meet the census definition of disabled, far fewer than half have the government certificates that are needed to obtain disability support such as reduced medical fees and tax breaks. And even among people with the required documentation, only 12m (around one-third) last year received the living allowance to which the disabled with low incomes are entitled. That is striking given that many of the 85m people counted as disabled are poor. Three in four live in rural areas.

Under Mao, people tried to treat mentally disabled people by reading to them from the chairman's works. Later, when the government decreed that couples could have only one child, parents of a disabled child were allowed a second baby—implying that a disabled life had less value. (The two-child policy introduced in 2015 also makes such an exception.)

But among officials and the public, prejudice is fading. In 1988 the government set up the China Disabled People's Federation (CDPF), a charity. It boasted star power: until 2008 its head was Deng Pufang, the paraplegic son of Deng Xiaoping, the late Chinese leader and initiator of the one-child policy. The younger Mr Deng broke his back during the Cultural Revolution after he fell from a window while being tormented by Red Guards. Working alongside him at the CDPF were others injured during those years of mob violence.

The federation encouraged the adoption in 1990 of China's first law on protecting disabled people. The bill said they should enjoy "equal and full participation in society and their share of its material and cultural wealth". The CDPF also campaigned successfully against the then-common use by officials of the word *canfei* to mean disabled (its two characters mean "disabled" and "useless"). It promoted the less pejorative term, *canji* (*ji*

denotes a medical condition).

Improvements are evident. In 2008 less than two-thirds of disabled children aged six to 14 were being educated. Last year 95% were. In 2012 a quarter of working-age Chinese certified as disabled had jobs. By 2018 this rate had doubled. In 2008, just before hosting the Paralympic games, China ratified the UN Convention on the Rights of Persons with Disabilities. Japan did so in 2014 and America still has not.

In education, two particular developments have been celebrated by campaigners for disability rights. The first was the adoption in 2015 of a regulation allowing disabled students to take the *gaokao*, or university-entrance exam, with “reasonable” adjustments including test papers in Braille and extra time to finish. Two years later this dispensation was also applied to those taking the *zhongkao*, the exam for senior secondary-schools. In 2018 the parents of a pupil with cerebral palsy won a case against the education bureau of Xiamen, the coastal city where he lives. The court ruled that the bureau had been wrong to deny some of his requests for special dispensations in the *zhongkao*.

The second development was a decision in 2017 to encourage mainstream schools to accept disabled students. This ended a long-standing policy of segregating them. But the impact of these measures has been limited. Of 9m people admitted to mainstream universities in 2019, just 12,000 were disabled, or one in 750. By contrast, one in five students in America report having a disability.

Universities can still exclude candidates for many subjects for medical reasons. For instance, the visually impaired may not study agronomy, law or medicine. A partially deaf student cannot study journalism or diplomacy. Schools for the disabled take some autistic children. But half are not in school at all. Parents of non-disabled children often object to desegregation.

In 2018 a kindergarten in Guangzhou, near Shenzhen, was reportedly pressed by officials to expel an autistic child following allegations, disputed by teachers, that he had hit other children. Soon after, the mother killed herself and her son.

In employment, huge barriers also remain. Firms with more than 30 staff are required to give at least 1.5% of their positions to the disabled. But they worry that hiring them could harm their image. A survey in 2011 by the CDPF revealed that more than 90% of companies preferred to pay a fine. After bigger fines were imposed on more profitable firms in 2015, some companies began adding disabled people to their payrolls—paying basic wages and making social-security contributions but giving them no work. This illegal practice has been facilitated by agencies that demand high fees from disabled clients who get the sinecures.

The public sector sets a poor example. In 2011 Yirenping, an advocacy group in Beijing, found that only 0.4% of civil-service jobs went to disabled people. (In Britain's civil service, about 10% call themselves disabled.) As in education, they are often barred by medical requirements. But in 2017 a woman with monocular vision sued an education bureau in Zhejiang province for refusing her a teaching licence because of her disability. She won the case last year, on her third attempt. In 2018 hearing-impaired teachers in Sichuan complained about being barred from teaching at a school for the deaf (they had failed an oral exam). Soon after the province began experimenting with the use of sign language in tests. In a few disputes, local branches of the CDPF have begun to help negotiate on behalf of plaintiffs.

Blind people in China are still often shunted into jobs as masseurs or piano tuners. Recently, however, the CDPF has been encouraging them to try other work. It has publicised the case of Ma Yingqing, a visually-impaired 26-year-old in Shanghai, who has set up a business that employs blind people to

record audio books. This year she plans to start a podcast in which blind guests chat to her about their lives. The federation has also drawn attention to Sun Chenlu, a paralysed beauty vlogger who live-streams from her wheelchair (her account has 26,000 followers). Opportunities for the mentally disabled, though, are very rare. Cao Jun set up a car-washing business in Shenzhen in 2015 to employ such people, his son among them. His idea has been replicated in two dozen cities with the support of NGOs or local offices of the CDPF. “My aim is to get rid of the donation box,” says Mr Cao. He returns all tips.

Cities have been trying to make public spaces more accessible to the disabled. Beijing did so with great fanfare in 2008, the year of the Paralympics, spending 600m yuan (\$88m at the time) on the project. But Li Dihua, an academic in Beijing, takes students on field trips around the capital in wheelchairs to help them understand why they see so few disabled people on the streets. He shows them tactile paths for the blind that are broken by manhole covers or blocked by trees, bus stops or roadside magazine stalls. Han Qing, a disabled-rights campaigner in the central city of Zhengzhou, says sticking to paths would “almost certainly cause you to fall”. In 2019 a disabled activist died while inspecting barrier-free facilities in Dali, a southern city, after his wheelchair fell into an underground car park. Chen Xiaoping, another campaigner, died in January while manoeuvring her wheelchair by a pedestrian crossing in Shenzhen.

Only in the past decade have some cities begun allowing the blind to take guide dogs onto metros (Shanghai did so in 2014, see picture). But only about 200 blind people have them—training dogs is costly. Last month Chinese media have reported on a woman in Shanghai who was harassed by neighbours for letting her guide dog urinate in her residential compound. One threatened to poison the animal.

Such incidents prompt more public hand-wringing than in the past, and some officials take note. Shenzhen wants to show it can be a model. In 2019 it became the first city to set a target date for becoming barrier-free: 2035. It offers China's most generous handouts for disabled children—up to 50,000 yuan (\$7,700) a year until they reach 18. Most cities stop paying when a child is seven. But Shenzhen still denies local household-registration, or *hukou*, to disabled migrants. Without it they cannot enjoy subsidised public services, or receive all of their disability benefits.

Still, Shenzhen's officials are becoming more open to advice. And disabled people there are becoming more assertive, says Xin Junhui, the head of a lawyers' group in the city that offers free services to them. More are using city hotlines to complain about inadequate facilities for the disabled, often with success. And despite the crushing of many NGOs under Xi Jinping, China's leader, those helping the disabled are growing in strength, says Amica Ho of the University of Hong Kong. They have their work cut out. ■



残疾

不为所见

残疾人长期受排斥，他们强烈请求更多帮助

没几个人喜欢看牙。对自闭症患者来说，看牙的折磨可能更是非同寻常——他们当中一些人的嘴部非常敏感。中国大多数自闭症患者都尽量不去看牙，但是坏牙同样让他们痛苦。因此，中国南方城市深圳的非政府组织深圳自闭症研究会去年发起了一个项目，以求减轻自闭症患者对看牙的恐惧。

该项目已帮助约45位年龄在4至40岁的自闭症患者克服了恐惧。医护人员鼓励项目参与者在等待就诊时做些开心的事情来分散注意力，并在开始治疗前花些时间在牙科椅上适应一下。对于年纪较小的患者，有时医生会首先检查他们父母的口腔。一位紧张的父亲鼓起勇气接受了他儿子也需要的一种治疗。在爸爸这个榜样的鼓励下，这个自闭症男孩同意接受同样的治疗。

在中国，这类民间改善残疾人生活的努力很少见。政府在许多其他领域都对非政府组织有严格的限制，但现在允许它们在这方面做更多的工作。社会迫切需要它们的参与。政府也在提供更多帮助。不过，许多按富裕国家官方标准可认定为残疾的人在中国不被承认。根据目前已知的最近一份人口普查数据（2011年发布），8500多万人被认定为残疾人（包括2100万聋人和1300万盲人），约占总人口的十六分之一。相比之下，英国和美国的残疾人分别占总人口的五分之一和八分之一。与西方国家不同，中国对残疾人的认定不包括慢性病患者，也排除了许多手脚虽可以活动，但难以应付日常事务的人。

在人口普查所认定的残疾人中，拥有享受残疾人福利（例如医疗费用减免和税收减免）所需的官方残疾人证的远不到一半。而即使在持证残疾人中，去年也只有1200万（约占三分之一）的人得到了面向低收入残疾人发

放的生活补贴。考虑到所认定的8500万残疾人中有许多都是穷人，这一比例十分惊人。四分之三的残疾人生活在农村地区。

在毛泽东时代，人们试图为智障人士朗诵主席的著作来治疗他们。后来，当政府颁布法令规定一对夫妻只能生一个孩子时，残疾孩子的父母被准许再生一个——暗示了残疾人的生命价值较低。（2015年推出的二胎政策也有这种例外规定。）

但是，官员和公众的偏见在减少。1988年，政府成立了公益慈善机构中国残疾人联合会（以下简称残联）。它具有名人效应：2008年以前，领导残联的是下身瘫痪的邓朴方，他是邓小平的儿子，正是这位已故中国领导人发起了独生子女政策。邓朴方在文化大革命中因受红卫兵迫害而跳窗，摔断了脊骨。和他在残联一起工作的还有其他在那些年因群体暴力而受伤致残的人。

中国第一部保护残疾人的法律在残联的支持下于1990年通过。该法案称，残疾人应“平等地充分参与社会生活，共享社会物质文化成果”。残联还开展活动，成功改变了官员当时普遍使用“残废”（既残又废）一词的情况，推广了较少贬义的“残疾”一词（“疾”字意指某种健康问题）。

改进是显而易见的。2008年，6至14岁残疾儿童中只有不到三分之二在接受教育。去年是95%。2012年，有残疾证的劳动年龄残疾人中四分之一有工作。到2018年，这一比例翻了一番。在2008年举办残奥会前夕，中国政府批准了《联合国残疾人权利公约》。日本在2014年批准了该公约，美国至今尚未批准。

在教育方面，两项进展尤其受到提倡残疾人权利的公益人士欢迎。首先是2015年通过的一项法规，要求对高考做“合理”调整以便残疾学生参加考试，包括采用盲文试卷及延长考试时间。两年后，这项便利措施扩展至参加中考的残疾学生。2018年，一名脑瘫学生的父母把他所在沿海城市厦门市的教育局告上法庭，原因是该生向教育局申请的中考便利条件未获允许。法院最后裁定教育局违法。

第二项进展是2017年的一项决策鼓励普通学校接纳残疾学生。这终结了长期以来将残疾学生与普通学生分开教育的政策。但这些措施的影响有限。2019年，在进入普通大学的900万新生中只有1.2万名残疾人，也就是每750人中有一人。相比之下，美国大学有五分之一的学生报告有某种残疾。

大学仍可因身体健康原由将残疾考生排除在许多专业之外。例如，视障学生可能不能就读农艺、法律或医学专业；听障学生不能就读新闻或外交专业。残疾人学校会录取一些自闭症儿童，但一半的自闭症儿童根本无学可上。健全儿童的父母往往反对融合教育。据报道，2018年广州一所幼儿园的一名自闭症男童被投诉打了其他孩子，尽管老师有不同说法，但迫于来自教育局官员的压力，幼儿园开除了该名男童。此后不久，男童的母亲携子自杀身亡。

在就业方面，障碍仍然巨大。按规定，员工超过30人的公司安排残疾人就业的比例不得低于1.5%。但这些公司担心雇用残疾人有损公司形象。残联在2011年进行的一项调查显示，超过90%的公司宁愿缴纳罚金。2015年，在盈利水平较高的公司被调高罚金后，一些雇主开始在工资单上加上残疾人员工——给他们发基本工资，帮他们缴纳社保，但并不安排什么活干。向得到这种闲差的残疾人客户收取高额费用的中介机构助长了这种违法操作。

公共部门树立了一个坏榜样。2011年，北京的一个公益组织益仁平中心发现，只有0.4%的公务员岗位录用的是残疾人。（在英国的公务员系统中，约有10%的人称自己有残疾。）和在教育中一样，残疾人经常因身体健康要求被拦在门外。但在2017年，一名单眼视障女性状告浙江省的一个地方教育局因自己视力残障而拒绝授予她教师资格。去年，她第三次申请终于获批。2018年，四川省的一些听障教师申诉无法获得一所聋哑学校的执教资格（他们未通过口试）。之后不久，该省开始试点在教师资格认定考试中使用手语。四川省残联已开始在部分纠纷中代表原告教师展开谈判。

中国的盲人仍然经常只能选择当按摩师或钢琴调音师。不过近年来，残联一直在鼓励他们尝试其他工作。残联宣传了26岁的上海视障人士马寅青的事迹，她开办的一家公司聘请盲人来录制有声读物。今年，她计划做播客，邀请盲人嘉宾跟她聊聊他们的生活。残联也将人们的目光吸引至瘫痪的美妆视频博主孙晨璐，她坐在轮椅上做直播（她的帐户有2.6万人关注）。但智障人士的就业机会非常少。曹军于2015年在深圳成立了一家洗车中心，专门聘请智障员工，他的儿子也是其中之一。在非政府组织或各地残联的支持下，他的洗车中心模式已经复制到了全国20多个城市。“我的目标是摆脱捐赠箱。”曹军说。他退还了所有小费。

城市一直在努力提升公共场所的无障碍通行设施。在举办残奥会的2008年，北京花费六亿元做了一番大张旗鼓的改造。但北京的学者李迪华带领学生坐上轮椅，实地体验首都各地的无障碍设计，帮助他们理解为什么在大街上很少看到残疾人。他让学生看到盲道经常被井盖、树木、公交车站或报刊亭阻断。中部城市郑州的残疾人权益公益人士韩青说，跟着盲道走“几乎肯定得摔跤”。2019年，一名残疾公益人在南部城市大理考察无障碍设施时，因随轮椅掉进地下停车场入口而死亡。今年1月，另一位公益人陈小平在深圳的一个人行坡道上费力爬坡时从轮椅上摔落离世。

一些城市在过去十年间才开始允许盲人牵导盲犬上地铁（上海是2014年，见图）。但全国只有大约200名盲人有导盲犬——它们的训练成本很高。上个月，中国媒体报道了上海的一名女性因其导盲犬在住宅小区排便而遭邻居投诉排挤。其中一人威胁要毒死她的导盲犬。

与过去相比，此类事件如今激起了更多公众的不满，一些官员也注意到了这点。深圳想证明自己可以起到示范作用。2019年，深圳率先提出了在2035年建成无障碍城市的发展目标。深圳为残疾儿童提供的补贴为全国最高，在18岁以前每年可领取最高五万元的补贴。大多数城市在残疾儿童满七岁后就不再给予补贴。但深圳仍然不接受外地来的残疾人落户。没有本地户口，他们就无法享受受补贴的公共服务，也无法获得所有的残疾福利。

不过，深圳官员越来越愿意听取建议。当地一个为残疾人提供免费法律援助的律师团体的负责人辛钧辉说，深圳的残疾人士也越来越敢于发声了。更多人拨打城市热线投诉残疾人设施不足的问题，而且投诉的问题往往能得到解决。香港大学的亚美加·何（Amica Ho，音译）说，尽管在中国领导人习近平治下许多非政府组织遭到打压，那些帮助残疾人的组织正在壮大。它们可谓任重而道远。 ■



Riding Hon Hai

Hon Hai, Apple's biggest iPhone assembler, is eyeing cars

The contract manufacturer has thrived amid the pandemic, in line with its biggest customer. Now it wants to diversify

HON HAI PRECISION Industry is as obscure as its main client is famous. On March 30th the firm, also known as Foxconn, reported record sales of \$182bn in 2020, thanks to demand for the Apple gadgets it assembles. Its market value has doubled in a year, to \$63bn. It is now eyeing smartphones on wheels. Analysts think it could be making 1m electric cars by 2025. If so, it may overtake Apple, whose iCar plans look less advanced. ■



车轮上的鸿海

苹果最大的手机组装商鸿海盯上了造车

疫情期间这家代工厂随着它最大的客户一道繁荣。现在它想要多元化

鸿海精密工业的最大客户有多出名，它自己就有多不出名。3月30日，又名富士康的鸿海公布了2020年的销售额——达到了创纪录的1820亿美元。这要归功于它所组装的苹果设备需求旺盛。它的市值在一年内翻了一番，达到630亿美元。鸿海现在盯上了智能汽车。分析人士认为，到2025年，它制造的电动汽车可能达到100万辆。果真如此，它可能会赶超苹果，因为苹果的iCar计划看起来进展没那么快。 ■



Commercial property

WeSurvive

A refurbished flexible-office firm begins a humbler second act

IT IS HARD to imagine such shockingly different financial documents. Two years ago a startup in New York that boosters claimed was worth \$47bn issued a flowery prospectus in advance of its initial public offering (IPO). The firm's mission, it declared, was to "elevate the world's consciousness". Such was the backlash against its puffery that it was forced to scrap its flotation. On March 26th a New York firm unveiled a 50-page investor presentation that was rather less effusive, filled with talk of cost savings, efficiency and productivity gains for clients. This humbler company secured a backdoor listing, through a special-purpose acquisition company (SPAC), that would value it at around \$9bn.

Both documents came from WeWork, a trailblazing but troubled pioneer of the co-working industry. After its abortive IPO in September 2019, its lofty valuation came down to earth (see chart). The future looked bleak. Adam Neumann, its flamboyant founder, was discredited and ousted shortly thereafter. It suffered a nasty falling-out with Japan's Softbank, its deep-pocketed backer. Then came the pandemic-induced recession, which led some clients not to renew their contracts, many of which were short-term. That left the company with a huge global overhang of unviable property leases. At times, bankruptcy seemed like a real possibility.

WeWork managed not only to avoid that fate but, as the new paperwork attests, to convert itself into a viable, if less ambitious, business. A disciplined management team replaced Mr Neumann and his inner circle. Sandeep Mathrani, a seasoned property executive who took over as CEO, is as reassuringly straight-laced as his predecessor was seductive. Jamie

Hodari, boss of Industrious, another co-working firm, praises his rival as “the opposite of Adam Neumann in a lot of ways”, who “has helped bring the industry from childhood toward adulthood”.

Mr Mathrani has certainly brought much-needed discipline to WeWork’s finances. By the end of last year the company had dumped more than 100 underperforming or as-yet-unopened offices and wrangled rent reductions or amendments on another 100 or so deals. This allowed the firm to cut future lease payments by some \$4bn. Only 10% of its customers have month-to-month leases; more than half are signed up for a year or more.

All told, WeWork expects to have nearly \$2bn in cash on hand if the SPAC deal closes as expected in the third quarter of this year. Despite the wholesale switch to home-working in the pandemic, global revenues (excluding operations in China, which are run separately) remained roughly flat at \$3.2bn. The corresponding net loss actually narrowed, from \$3.5bn in 2019 to \$3.2bn.

The path to profitability no longer looks as elusive as before for reasons beyond Mr Mathrani’s steady hand. William Rudin, a property developer in New York and an early backer of WeWork, is convinced that as the city starts to recover from covid-19, flexible workspaces “will play a very important role” in supporting the revival of established firms and the rise of startups. In February Mr Mathrani told *The Economist* that three-quarters of American tenants were small and medium-sized companies (the mix in Europe was more even).

More broadly, the pandemic has led many businesses to rethink the need for long-term leases and fixed headquarters, argues Ben Munn of JLL, a large property-management firm. JLL predicts that the share of flexible offices in all office space, which was less than 5% in big global markets before covid-19, will reach 30% by 2030. A year of self-isolation has led many

employees and employers alike to appreciate the value of office banter. Once seen as “window-dressing”, WeWork’s focus on “community”, which was mentioned 150 times in its original IPO prospectus, “might turn out to be an incredible source of strength”, muses Mr Hodari. Its brand, the only one most millennials can name, is strong. It is against this backdrop, Mr Rudin says, that WeWork’s SPAC deal “validates its business model”.

WeWork is not out of the woods. Having been upended by the pandemic, the commercial-property market has yet to find a new equilibrium between landlords, tenants and middlemen like WeWork. Big traditional property firms will increasingly compete with co-working specialists in offering flexible options. On April 1st JLL and Brookfield, a Canadian asset manager with a large property portfolio, were due to open a hip flexible-office space in Brooklyn. Industrious recently secured a \$250m investment from CBRE, another large property manager, and has scooped up “a lot” of distressed WeWork leases, says Mr Hodari. Still, WeWork’s chastened comeback story no doubt appeals more to investors than its earlier tale of hubris. ■



商业地产

办公室重生故事

一家灵活办公空间公司整修一新，拉开了更低调的第二幕

很难想象企业的财务文件会如此天差地别。两年前，纽约一家被追捧者估值高达470亿美元的创业公司在IPO之前发布了花哨的招股说明书，其中宣称公司的使命是“提高全球觉知”。这般大吹大擂引发了强烈的舆论风波，最后它被迫取消上市。3月26日，纽约的一家公司公布了一份50页的投资者演示材料，里面远没有那么多溢美之词，谈论的大多是如何为客户节省成本、提高效率和生产率。这家更谦逊的公司争取到通过一家特殊目的收购公司（SPAC）借壳上市，估值将在90亿美元左右。

两份文件都出自WeWork。这个共享办公行业的先驱勇于开拓，但麻烦不断。2019年9月的IPO流产后，它曾经冲上天的估值落回了地面（见图表）。前景似乎黯淡无光。不久后，浮夸招摇的创始人亚当·诺伊曼（Adam Neumann）名誉扫地，黯然下台。公司和它财力雄厚的日本金主软银撕破了脸。接着疫情引发经济衰退，导致一些客户不再续签租约——其中很多都是短期租约。这让它在全球积压起大量空置的租赁地产。有那么几回，它看起来真的要破产了。

WeWork不仅努力摆脱了破产的命运，而且正如那份新文件所展示的那样摇身一变，成了一家也许没那么雄心勃勃，却是切实可持续的公司。一支严谨守纪的管理团队取代了诺伊曼和他的核心小圈子。接任CEO的桑迪普·马斯拉尼（Sandeep Mathrani）是一位经验丰富的房地产高管，他的前任有多蛊惑人心，他就有多循规蹈矩和叫人放心。另一家共享办公公司Industrious的老板杰米·霍达里（Jamie Hodari）称赞他的对手“在很多方面都和亚当·诺伊曼正相反”，“带动这个行业从童年期步入了成人期”。

马斯拉尼无疑带来了WeWork急需的财务自律。到去年年底，公司已经退出了100多个效益不佳或尚未投入运营的办公空间，还为另外100个左右的

租赁地产争取到了减租或修改租约。这让它在未来可以少付约40亿美元租金。它目前只有10%的客户按月租赁，超过一半客户的租约为一年或更久。

合计下来，如果能够按照预期于今年第三季度通过SPAC上市，WeWork预计将会有近20亿美元现金在手。尽管疫情期间大批公司转为居家办公，但它的全球收入（不包括独立运营的中国业务）仍然大致保持在32亿美元。同期的净亏损实际是收窄了，从2019年的35亿美元降至32亿美元。

除了马斯拉尼稳健的领导之外，还有一些原因让WeWork的盈利之路不再像以前那样幽暗不明。纽约房地产开发商威廉·鲁丁（William Rudin）是WeWork的早期投资者，他深信，随着纽约市开始从疫情中复苏，灵活办公空间将在支持老牌企业的复兴和创业公司的崛起中“扮演非常重要的角色”。马斯拉尼在2月接受本刊采访时说，四分之三的美国租户都是中小企业（欧洲不同规模租户的比例更平均）。

大型房地产管理公司仲量联行（JLL）的本·穆恩（Ben Munn）认为，更广泛来看，疫情已让许多企业重新考虑是否有必要签订长期租约及设置固定的总部。仲量联行预测，到2030年，共享办公空间将占到所有办公空间的30%，疫情之前这个比例在大型全球市场不到5%。一年的居家隔离让许多员工和雇主都体会到在办公室里面对面谈笑的价值。WeWork对“社区”的专注（这个词在最初的招股说明书中被提及150次）曾被视为是“表面工夫”，而现在“可能会成为不可思议的力量之源”，霍达里思忖道。它的品牌很强大，是唯一一个绝大多数千禧一代都说得出来的品牌。正是在这种大背景下，鲁丁表示，WeWork通过SPAC的上市“验证了其商业模式的有效性”。

WeWork还没有完全摆脱困境。受疫情冲击后，商业地产尚未在房东、租户和像WeWork这样的中间商之间找到新的平衡点。大型传统房地产公司将日益多地与专做共享办公的公司在提供灵活办公空间方面竞争。4月1日，仲量联行和拥有大型房地产投资组合的加拿大资产管理公司布鲁克菲尔德（Brookfield）将在布鲁克林启用一处时尚的共享办公空间。

Industrious最近获得了另一家大型房地产业管理公司世邦魏理仕（CBRE）2.5亿美元的投资，还利索地接手了“很多”WeWork经营不佳的办公场所，霍达里说。尽管如此，WeWork历经磨难东山再起的故事无疑比之前那则不可一世的传说更吸引投资者。 ■



Aerial warfare

Blue-sky thinking

Planes can be launched from land and sea. Why not from the air as well?

AIRCRAFT-CARRIERS are juicy targets. They are also increasingly vulnerable ones. Like medieval castles in the age of the cannon, technological advance threatens to make them redundant. Satellites and over-the-horizon radars mean pinpointing their locations is easier. And a single well-aimed, well-armed missile may be enough to render a carrier useless, even if one shot does not sink it outright.

American naval planners are particularly worried about China's DF-26. This weapon, which came into service in 2018, is a so-called manoeuvring ballistic missile (meaning it can vary its final approach path, rather than being subject solely to the laws of gravity) that has been dubbed a "carrier killer". The DF-26 can be launched from a lorry, and can carry either a conventional or a nuclear warhead.

This threat is fearsome enough to keep American carriers at least 1,600km from China's coast, reckons Bryan Clark, a naval strategist at the Hudson Institute, a think-tank. That is much farther than the range of a carrier's warplanes unless they can be refuelled in-flight. America's Department of Defence is therefore looking for a workaround. One back-to-the-future idea being tested (it dates, originally, from 1917) is to turn a suitable plane into an aerial aircraft-carrier capable of launching and recovering uncrewed drones in flight. This would allow seaborne carriers to be kept well out of harm's way.

To that end DARPA, the defence department's advanced research projects agency, is running a programme called Gremlins, a name that also applies to

the individual drones themselves. A Gremlin drone weighs 680kg and has a wingspan of nearly 3.5 metres. Once it has been dropped, deployed its wings and fired up its turbofan engine, it can fly to an area up to 500km away and in the words of Scott Wierzbanowski, the Gremlin programme's head, "go in and create havoc". That done, it would then return to its aerial mothership.

Gremlins would operate in fleets, under ultimate human control. In this, they are similar to the "loyal wingman" idea of drone squadrons accompanying a crewed fighter aircraft into battle. Loyal wingmen, however, would take off from and land on terra firma, or possibly a conventional, naval, aircraft-carrier. Operational Gremlins need never touch the ground.

Gremlins' principal jobs would be intercepting communications, jamming signals and hunting for things to be destroyed, thus softening up the defences in contested airspace to make it safer for crewed aircraft. Such drones could also be armed with small missiles or explosives for a kamikaze attack. And they would both share data and co-operate among themselves, and pass reconnaissance and targeting information back to warships and aircraft able to fire bigger missiles than they could carry.

Gremlin swarms would no doubt suffer losses. But drawing enemy fire would actually be an objective, says Andrew Krepinevich, the boss of a defence consultancy called Solarium, which advises the defence department on aspects of naval and aerial warfare. This way, Gremlins would flush out the position of any hostile missile battery that switched on its targeting radar, marking it for subsequent destruction.

In the calculus of combat, sacrificing a drone or two to knock out an enemy air-defence battery makes for a nice swap. Gremlins should therefore be thought of as "tradable" for systems of greater value, says Mr Wierzbanowski. The better to fool the foe, military planners also envisage

air-launched drones that mimic the radar and heat signatures of bigger fighter jets and bombers. This would be done by using shapes and materials that reflect rather than absorbing radar pings, and by leaving an engine's heat signature unmasked. The illusion could be enhanced by flying drones at speeds and in patterns indicative of larger aircraft.

On top of all this, a defender's need to squander precious attention and pricey missiles on incoming cheap drones will give its adversary's more capable aircraft freer rein. Enthusiasts for air-launched drones therefore see value in numbers. Putting lots of blips on radar screens is a good way to fluster an enemy with "complexity and multiple dilemmas", says Tim Keeter, who manages the Gremlins programme at Dynetics, DARPA's principal contractor for the project.

To that end, costs must be kept low. The defence department plans to pay less than \$800,000 a pop for Gremlins, though that would be for an order of 1,000 of them. So, if a couple were shot down in an operation, "that's okay, it really doesn't matter," says Mr Wierzbowski. In military jargon, he describes the things as "attributable". Dynetics' working assumption is that each Gremlin will fly a maximum of about 20 missions. This means they can be made from less durable, and therefore cheaper materials and components.

The aerial aircraft-carrier of choice for the Gremlin project is a modified C-130 cargo plane, which could carry up to four of the drones in bomb racks slung under its wings. That would make for a small squadron, but numbers could be bolstered by further drones dropped from accompanying fighters or bombers. Deploying the drones is therefore fairly easy. The tricky part is fishing them out of the air when they return from a mission. For this, Dynetics has designed a special recovery system that fits above a C-130's cargo ramp.

When a Gremlin flies back to the mothership, the cargo ramp opens and the recovery system lowers a boom out of it. This boom releases a pod on a ten-metre-long tether, and that pod clamps onto a short engagement arm which pops out of the top of the Gremlin itself. A successful capture shuts off the Gremlin's engine. A winch then hoists the drone on board. This arrangement should be able to pull eight Gremlins an hour out of the air.

That, at least, is the idea. So far, though Gremlins have managed to come within centimetres of successful capture, such capture has not been achieved. But Dynetics hopes some software tweaks will deal with this by the summer, when operational testing of the Gremlins system by the air force is supposed to begin.

This testing will include flights with various sorts of payloads. But the most important thing to be tested will be how well Gremlins are able to co-operate—for instance, by swapping tasks as circumstances evolve. For this, the air force is developing software that emerged from a different DARPA programme, called Collaborative Operations in Denied Environment. It will not be able to orchestrate a fully autonomous “swarm”, at least for now. The goal, rather, is to give individual drones enough autonomy for a single human operator to be able to oversee a cluster of them.

The Gremlin-mothership arrangement is distinguished by its scale. But several smaller versions of the underlying idea are also in development. One is being put together by General Atomics, the maker of Predator drones. Predators are showing their age, but General Atomics hopes to breathe new life into them by producing a version that is a mothership for smaller drones called Sparrowhawks that will carry intelligence, surveillance and reconnaissance equipment, electronic-jamming apparatus and possibly explosives. Flight tests began in September 2020, though Sparrowhawks have yet to be air-launched and the firm has not explained how they will be recovered in-flight.

The American army, for its part, plans to use helicopters fitted with drone-launching pneumatic tubes as motherships. These drones, which, like Gremlins, unfold their wings after launch, have a wingspan of 2.5 metres. In a test conducted last summer six such drones launched in flight were recovered in the air, albeit not by the Black Hawk from which they had emanated. Rather, they were snared by a quadcopter drone dangling a cord that snagged hooks on the target drones' wings. In May the army plans to use rail catapults to launch bigger drones from helicopters.

As with Gremlins and Sparrowhawks, the army's push for what it calls "air-launched effects" is driven by America's shift from counterinsurgency to potential war with a foreign power. Advances in the ability of Chinese and Russian radars to pinpoint troops and aircraft supporting them is a particular concern, says Lieutenant-Colonel Anthony Freude, who is overseeing the technology's development at the Army Futures Command, in Alabama. This will push army helicopters back from the front line, he says, so they will disgorge numerous drones that will zip ahead instead. They are to hunt for targets, distract the enemy, and serve as an extra communications network. The capability should be operational in less than three years.

Aerial aircraft-carriers of these sorts do have drawbacks. Snatching drones from midair eats up precious time. That and the manoeuvring required could make it easier for an enemy to shoot down a mothership. But drones that can be reused 20 times offer advantages, not least of cost, over expendable single-shot alternatives.

Castle builders solved the problems brought by cannons by redesigning fortresses to be low, thick-walled and protected by bastions. That worked well. Whether launching aircraft-carriers into the sky will be an equally successful response to technological advance remains to be seen. ■



空战

蓝天畅想

飞机能从陆地和海上起飞。为什么不能也从空中起飞呢？【深度】

航空母舰是诱人的攻击目标。它们也越来越脆弱。就像大炮时代的中世纪城堡那样，技术进步让它们面临被淘汰的危险。有了卫星和超视距雷达后，要精准定位它们变得更容易了。而一枚瞄准精确、装备精良的导弹即使不能彻底击沉一艘航母，可能也足以让它报废。

中国的东风-26格外让美国的海军规划人员不安。这种武器于2018年开始服役，是一种被称为“航母杀手”的机动变轨弹道导弹（也就是说它可以改变最后的接近路线，而不仅仅遵循万有引力定律运动）。东风-26可从发射车上发射，可以搭载常规弹头或核弹头。

如此强大的威慑力足以让美国航母退至距中国海岸线至少1600公里以外，智库哈德逊研究所（Hudson Institute）的海军战略研究员布莱恩·克拉克（Bryan Clark）认为。这远远超出了航母战机的作战半径，除非它们能在空中加油。因此美国国防部正在寻找对策。有一个“回到未来”式的想法（最早出现于1917年）正在试验中，即把一架合适的飞机改造成能在空中发射和回收无人机的空中航母。这将使海上的航母远离危险。

为此，美国国防部高级研究计划局（DARPA）正在开展一项名为“小精灵”（Gremlins）的项目，参与项目的无人机也叫这个名字。一架小精灵无人机重680公斤，翼展近3.5米。一旦它被投放到空中，展开机翼，启动涡扇发动机，就可以飞到远至500公里外的地方，用小精灵项目负责人斯科特·维尔兹巴诺夫斯基（Scott Wierzbowski）的话来说，“前去大闹天宫”。完成任务后，它将返回在空中的母舰。

小精灵们会在人类的终端控制下编队行动。在这一点上，它们和“忠诚僚机”的设计相似，也就是让无人机中队跟随有人战机参战。但忠诚僚机的起降会在陆地上，或者有可能是在常规的海上航母上。而在执行任务中的

小精灵永远不需要接触地面。

小精灵的主要任务将是拦截通信、干扰信号以及搜寻摧毁目标，从而削弱作战空域中的防御力量，让有人战机的处境更安全。这种无人机还可以装备小型导弹或者自杀式袭击炸弹。它们彼此间会共享数据，相互协作，并将侦察和攻击目标的信息传回给那些能发射它们无力搭载的更大型导弹的军舰和飞机。

毫无疑问，小精灵机群会遭受损伤。但是，为美国国防部提供海空作战建议的国防咨询公司Solarium的老板安德鲁·克雷皮内维奇（Andrew Krepinevich）表示，吸引敌方火力实际上本身就会是一个目的。一旦任何敌方导弹阵地打开瞄准雷达，小精灵就拿到了它的方位，把它标记下来以待后续摧毁。

在作战的得失考量中，牺牲一两架无人机就能摧毁敌方的防空阵地，这笔账很划算。所以应该把小精灵视为“可交易”更高价值的系统，维尔兹巴诺夫斯基表示。为了更好地迷惑敌人，军事规划人员还设想让空基发射的无人机模仿大型战斗机和轰炸机的雷达和热信号。这就需要使用能反射而不是吸收雷达波的外形和材料，并不再遮蔽发动机的热信号。如果无人机再模拟大型飞机的飞行速度和模式，以假乱真的程度还可能更高。

最重要的是，防御一方需要把宝贵的注意力和昂贵的导弹耗费在来袭的廉价无人机上，这就给了对手更厉害的飞机更多机会施展拳脚。空基发射无人机的拥趸因此看到了它们在以量取胜上的价值。让雷达显示屏上出现大量光点是用“复杂性和多重困境”来扰乱敌人的好办法，DARPA小精灵项目的主要承包商Dynetics的项目负责人蒂姆·基特（Tim Keeter）表示。

为此必须保持低成本。美国国防部计划为一架小精灵花费不超过80万美元，不过那是订购1000架的价格。所以，如果一次行动中有几架小精灵被击落，“没关系，真的不要紧”，维尔兹巴诺夫斯基说。用军事术语来说，他称小精灵是“可消耗的”。Dynetics初步假设每架小精灵最多能执行大约20次飞行任务。这意味着它们的制造材料和部件可以不那么耐用，价格也

就更低。

小精灵项目首选的空中航母是经改造的C-130运输机，它机翼下方悬挂的炸弹架最多可以搭载四架无人机。这将形成一个小型中队，但随着同行的战斗机或轰炸机投放更多的无人机，总体数量就会增加。因此无人机的投放还算容易。棘手的部分是当它们完成任务返回时把它们从空中打捞回来。为此，Dynetics设计了一种安装在C-130运输机货舱门上方的特殊回收系统。

当小精灵飞回母舰时，货舱门打开，从回收系统里放下一根吊杆。吊杆释放出一个用十米长的线缆连接的吊舱，吊舱抓住从小精灵顶部弹出的一个短的啮合臂。捕获成功后，小精灵的发动机就会关闭，再由绞盘将它拉上飞机。这种方式应该能在一小时内从空中拉回八架小精灵。

至少想法是这样的。到目前为止，小精灵尚未被成功捕获过——还差那么几厘米。但Dynetics希望一些软件上的改进可以在今年夏天之前解决这个问题，届时美国空军应该会启动对小精灵系统的实操测试。

这次测试将包括携带各种有效载荷的飞行。但最重要的是测试小精灵们的协作能力，比如随环境变化而交换任务。为此美国空军正在开发一款软件，它来自DARPA的另一个项目，名为“拒止环境中的协同作战”（Collaborative Operations in Denied Environment）。该软件并不能组织一个完全自主的“机群”，至少目前不能。确切地说，它的目标是让单架无人机具备足够的自主行动力，这样一名人类操作员就能够监管一群无人机。

小精灵加母舰这一设计的突出特点就是规模大。但是几种规模没那么大而基本理念相同的方案也在研发中。其中一种正在由“捕食者”（Predator）无人机的制造商通用原子能（General Atomics）整合。捕食者已经显现老态，但通用原子能希望它们能重焕新生。它生产了一款新机型用作更小型无人机的母舰。这些小型无人机名为“雀鹰”（Sparrowhawks），它们将携带情报搜集、监视和侦察等设备，以及电子干扰装置，或许还有炸弹。飞

行测试从2020年9月开始，不过雀鹰还没有空基发射过，通用原子能也没有解释将如何在空中回收它们。

而在美国陆军这一边，它计划使用配备了无人机发射气动管的直升机作为母舰。这些无人机和小精灵一样，发射后会展开机翼，翼展有2.5米。在去年夏天的一次测试中，六架这样从空中发射的无人机完成了空中回收，不过并不是由发射它们的黑鹰直升机回收的。捕获它们的是一架四轴无人机，它用投放下来的绳索勾住目标无人机机翼上的挂钩。美国陆军计划在5月使用轨道弹射器从直升机上发射更大的无人机。

和小精灵及雀鹰一样，美国陆军之所以要推动它所说的“空中发射效应”技术，是因为美国已从平息叛乱转向了应对与外国的潜在战争。位于阿拉巴马州的陆军未来司令部（Army Futures Command）负责监督这项技术开发的安东尼·弗罗伊德（Anthony Freude）表示，中国和俄罗斯的雷达在精确定位部队以及支援它们的飞机方面的能力提升之大尤其令人担忧。他说，这迫使军队直升机从前线退后，转而投放一大群无人机来冲锋陷阵。无人机的任务是搜寻目标，分散敌军注意力，并充当额外的通讯网络。这种作战能力应该能在三年内投入使用。

这类空中航母确实有其缺点。从空中捕获无人机会耗费宝贵的时间。这一点加上所需的操作可能会让母舰更容易被敌人击落。但是，可以重复使用20次的无人机还是比一次性的消耗型无人机更有优势，尤其是在成本方面。

为解决大炮带来的麻烦，城堡的建造者们更新了设计，降低了它们的高度，增加了墙体厚度并且修建了防御的棱堡。这卓有成效。把航母发射到空中是否能同样成功地反制技术进步，还有待观察。■



Tycoons on a tight leash

China's rulers want more control of big tech

As the Communist Party whips digital platforms into line, trillions of dollars in market value are at stake

CHINA'S TECH tycoons have not been themselves lately. In early March, at the annual session of China's rubber-stamp parliament, Pony Ma called for stricter regulation of Tencent, the \$700bn online empire he founded. Days later a rising star, Simon Hu, left his post as chief executive of Ant Group, a huge financial-technology firm affiliated with Alibaba, an e-commerce titan. Shortly after that Colin Huang stepped down as chairman of Pinduoduo, rattling investors still celebrating his upstart e-emporium's recent announcement that it had overtaken Alibaba measured by the number of shoppers. Jack Ma, Alibaba's outspoken co-founder and China's most recognisable entrepreneur, has not been seen in public for months, with the exception of a video where he discusses the country's education system.

Their companies' stocks have also been behaving out of character. Having added as much as \$1.2trn to their combined market capitalisation since 2016, Alibaba, Pinduoduo and Tencent have seen their share prices tumble in recent weeks (see chart 1). The unlisted Ant is thought to be worth \$200bn, down from more than \$300bn in October. Throw in a few dozen other big Chinese tech groups and some \$700bn in shareholder value has been wiped out since mid-February.

The share price of Xiaomi, a big smartphone-maker, is down by more than 20% this year. Despite being one of the year's most anticipated flotations, shares in Bilibili, a video-streaming service with zoom users, fell by 6% on its first day of trading in Hong Kong on March 29th. Baidu, a search giant

which had regained some of its sparkle in the past year, has seen half of those gains snuffed out in less than two months. Shares in Meituan, a ride-hailing and food-delivery giant, have lost more than a quarter of their value in the same period, despite a doubling of profits last year. After this drop Chinese headlines asked of Meituan's founder and boss, Wang Xing: "Is he not frightened at all?"

Mr Wang and his fellow tech moguls indeed have plenty to fear. Investors have cooled on frothy tech stocks in America, where many Chinese giants, including Alibaba, Baidu, Bilibili and Pinduoduo, have listings. But China's firms have been hit harder than their American counterparts. They and their shareholders, who include plenty of Western funds, are grappling with three poorly understood developments. After years of tolerating big tech's unbridled expansion, the central government is rewriting the rules, some tacit and some explicit, for how billionaires can behave, the degree of overt state control over data, and who owns the firms' other assets, including stakes in other businesses. This new master plan for Chinese big tech will transform one of the world's most innovative and valuable industries.

Start with the tycoons. Unlike their counterparts in America, tarnished by accusations that their corporate creations harm users' privacy, spread disinformation, mistreat workers and abuse their market power, Chinese tech moguls enjoy a glittering reputation among ordinary Chinese, who see them as embodying the "Chinese Dream" of growing prosperity that propagandists tout on posters across the country. Too glittering, it now seems, for the Communist Party, which under President Xi Jinping increasingly bridles at anything that might challenge its authority. That includes being upstaged by superstar bosses.

The initial affront that led to the tech crackdown was Jack Ma's comparison, at a public event in October, of Chinese state lenders to pawn shops. A

month later China's stockmarket regulator suspended the \$37bn initial public offering of Ant, which would have been the world's biggest ever, in Hong Kong and Shanghai. Since then the authorities have forced Ant to become a financial holding company, undermining its lucrative, asset-light business model of matching consumers with lenders.

The message, says a broker in Hong Kong, is that tech leaders should "stay in their own lane, focus on their core businesses and avoid commenting on politics or economics". It has been heard loud and clear. Pony Ma's parliamentary performance, in which he called for strict regulation of areas that he has invested in, from e-commerce to ride-hailing, has been seen as a signal to the Chinese government that he will not get out of line. One interpretation of Mr Huang's departure from Pinduoduo—ostensibly to explore new opportunities in areas such as food science—is that he is wary of leading what might become China's biggest e-commerce company. He has also recently eclipsed Jack Ma in wealth, which further increased his stature. One person who knows Mr Huang says that as a diligent student of Chinese philosophy he "understands very well that it is not safe to be at the top or at an extreme". "He saw what was going on next door and decided to leave," says an industry watcher.

This de-tycoonification matters, for the firms' fates are bound up in investors' eyes with their visionary founders. Although Mr Ma quit as boss of Alibaba in 2013, and stepped down as chairman a year ago, he has continued to exert control over the direction of both the e-emporium and Ant. Where the company will end up shorn of Mr Ma's acumen is anyone's guess. The share price of Pinduoduo fell by 8% on news of Mr Huang's abrupt departure, possibly for similar reasons.

A second set of questions concerns the government's designs for the firms' most valuable resource—data. Its objective is to pool data and impose more state ownership and control, which could eventually amount to a kind of

nationalisation. The digital firms have built some of the world's largest and most advanced databases, which assess everything from users' loan repayments to their friend networks, travel histories and spending habits. Ant alone is said to hold data on more than a billion people, on a par with Facebook and Google. Because of the breadth of services that many Chinese "super-apps" encompass, they have an even richer picture of users.

Credit-scoring is the front line of the battle with the government over who controls data. Over the years the People's Bank of China (PBOC) has made feeble attempts to create a centralised scoring system. Now the central bank appears to have decided to grab more control over the tech firms' systems. It has approved two personal-credit companies, most recently in December, in which the technology groups and state-controlled entities hold stakes. The state has so far refrained from explicitly commanding the companies to share data. In China personal data belong to the individual, not companies, so laws would need to change in order for such data to be shared with the government. But that is hardly an insurmountable obstacle for an authoritarian regime.

The tech companies have resisted, with reason. The scheme would, in the words of an asset manager in Hong Kong, erode the "information edge" that especially Alibaba and Tencent, which control the bulk of relevant data, currently enjoy. The uncertainty over what types of data would be shared, how and with whom, has weighed on Chinese tech shares, says Robin Zhu of Bernstein, a broker.

The final source of uncertainty relates to the government's plans for the giants' other assets. The big firms are conglomerates that straddle many services and products. Over the past decade companies such as Alibaba and Tencent have also become some of China's biggest venture capitalists (see chart 2), giving them influence over the digital economy that extends far

beyond their operating businesses. Under Mr Ma, Alibaba and Ant Group have accrued assets in media, finance, logistics and health care. Tencent is a big shareholder in JD.com, another e-commerce giant, as well as in Meituan and Pinduoduo. Both Alibaba and Tencent hold stakes in Didi Chuxing, a ride-hailing firm which hopes to go public this year at a valuation of \$100bn. In total the combined investment portfolios of Alibaba and Tencent are worth some \$300bn, making them among the largest tech investors in the world—as well as two of the largest tech firms.

The decision to force Ant to become a holding company, with different activities held in different subsidiaries, suggests the authorities may want to change the structure of the tech empires. Tencent recently confirmed that it is working with regulators and reviewing past investments. Its credit operation, which is similar to Ant's but smaller, may likewise be separated into a holding company under the PBOC's jurisdiction. News reports have suggested that the government has asked Alibaba to sell its media holdings. Alibaba has not confirmed or denied the rumours. Legal experts say that if true, this would be concerning because the government measures would reach beyond antitrust law towards something more expansive and punitive.

Shifts in the relationship between the state and big tech can scar foreign investors, who dominate the Chinese companies' shareholder registers. Yahoo, an American tech group, and SoftBank, a Japanese one, learned this the hard way in 2011, when they had to accept that their large stakes in Alibaba no longer included Alipay, which Mr Ma had quietly spun off owing to regulatory concerns.

Should something similar happen again, big foreign shareholders like SoftBank, which still holds a 24.9% stake in Alibaba, and Naspers, a South African tech conglomerate that is Tencent's biggest shareholder via an Amsterdam-listed holding company called Prosus, could suffer another hit

to their investments, on top of the recent drop in share prices. On April 8th Prosus said it had reduced its stake in Tencent from 30.9% to 28.9% to raise money for other ventures.

The government's unspoken objective is to ensure that foreigners exercise no control over Chinese tech firms, even if they own shares in them. That does not suggest their property rights are top of mind. And Chinese firms are no strangers to abrupt changes of fortune. A handful of traditional conglomerates such as Anbang and HNA, which had splurged billions on accruing assets at home and abroad, were forced to shed some of those holdings in the past few years. The fate of the tycoons behind them has been mixed. A few are in jail; others have been disgraced; a few have continued to do business quietly. Their companies are often shadows of their former selves. China's digital darlings, as well as their founders and investors, will probably avoid a similar fate, because the firms are a source of dynamism and prestige and have succeeded through innovation rather than financial engineering. But such a bleak fate is no longer unthinkable. ■



看紧大佬

中国政府想要加强对科技巨头的掌控

共产党挥鞭驯服数字平台，万亿美元市值岌岌可危

中国的科技大佬们最近过得不大自在。3月初，在中国橡皮图章式的人大举行的年度会议上，马化腾提议加强监管腾讯——一个他自己创办的市值7000亿美元的网络帝国。几天后，后起之秀胡晓明辞去蚂蚁集团（隶属电商巨头阿里巴巴的一家大型金融科技公司）首席执行官一职。不久后，创办了拼多多的黄峥辞任公司董事长，让原本正在庆祝中的投资者深感不安——这家电商新贵刚刚才宣布以用户数衡量它已赶超阿里巴巴。阿里巴巴直言不讳的联合创始人、中国最知名的企业家马云除了现身一段视频讨论中国的教育体系外，已经好几个月没有在公开场合露面了。

这几家公司的股票也表现失常。自2016年以来，阿里巴巴、拼多多和腾讯的总市值增加了1.2万亿美元之多，但最近几周它们的股价均大幅下滑（见图表1）。未上市的蚂蚁集团目前估值为2000亿美元，低于去年10月的3000多亿美元。算上其他几十家中国大型科技集团，自2月中以来被抹去的股东价值已达到约7000亿美元。

大型智能手机制造商小米今年以来股价跌幅超过20%。拥有两亿用户的视频流媒体服务商哔哩哔哩的上市是今年最令人期待的IPO，但在3月29日香港上市首日股价下跌了6%。搜索引擎巨头百度的股价在过去一年里恢复了些许光彩，但在不到两个月的时间里那些回升的部分又跌去了一半。同期，网约车和外卖巨头美团的股价下跌超过四分之一，尽管它去年的利润翻了一番。这之后中文媒体在大标题中向美团的创始人兼首席执行官发问：“王兴一点也不慌？”

王兴和其他科技大佬们确实有很多要担心的。阿里巴巴、百度、哔哩哔哩和拼多多等许多中国巨头都已在美国上市，而投资者对虚高的美国科技股的热情已经冷却下来。但中国公司受到的冲击要大于美国同行。这些公司

和它们包括大量西方基金在内的股东正在努力应对三方面大家还不甚明了的动向。在容忍科技大公司多年不受约束的扩张后，中国的中央政府正在重写规则，包括限制亿万富翁们的言行、确定政府公开的掌控数据的程度，以及谁拥有这些企业的其他资产，包括在其他公司的持股。这些规则有的是明文规定，有的靠大家心知肚明。这个新的针对中国科技巨头的总体规划将改变世界上最具创新力和价值的行业之一。

先说大佬们。中国这些科技界巨子和他们的美国同行有一点不一样。美国巨头们被各种指责折损了光彩，包括说他们的公司侵犯用户隐私、传播虚假信息、压榨员工、滥用市场支配力等。而中国的大亨们在普通老百姓眼里熠熠生辉——他们就是铺满全国各地的海报上宣传的富强“中国梦”的化身。但现在看来，对共产党而言，他们过于耀眼了。习近平领导下的党对任何可能挑战它权威的事物都愈发不满。被明星企业家抢风头就是其中一项。

引发这场科技巨头打压行动的是马云一次冒犯权威的发言：在去年10月的一次公开活动中，他把国有银行比作当铺。一个月后，中国股市监管机构叫停了蚂蚁集团在香港和上海规模达370亿美元的上市，这原本会是全球史上最大的IPO。此后，政府迫使蚂蚁集团转型为金融控股公司，打破了它原本为消费者和放贷者牵线搭桥的高利润、轻资产商业模式。

香港一家券商表示，这当中传达的信息是科技业领袖应该“别越界，专注于自己的核心业务，避免对政治或经济事务指手画脚”。这一信息在听者耳中一清二楚。马化腾在人大会议上提议对自己投资的领域（包括电商、网约车等）进行严格监管，被认为是向中国政府表态自己不会越界。黄峥离开拼多多表面上是为了在食品科学等领域探索新机会，但也有人解读为他对继续领导可能成为中国最大电商的拼多多心怀顾虑。近期他身家已经超越马云，声望进一步提升。一名认识黄峥的人士表示，对中国哲学素有研习的他“很清楚高处不胜寒的道理”。“他看到了同行身上发生的事，所以决定离开。”一位行业观察人士说。

这种“去大亨化”事关重大，因为在投资者眼中，这些公司的命运与它们富

有远见的创始人息息相关。虽然马云已在2013年辞任阿里巴巴首席执行官，并在一年前卸任董事局主席，但之后他仍控制着这个电商王国和蚂蚁集团的发展方向。少了马云的敏锐头脑，这家公司最终会走向何方，谁也不知道。黄峥突然辞任的消息传出后，拼多多的股价下跌了8%，可能也是出于类似的原因。

第二个方面的问题是政府对这些公司最宝贵的资源——数据——有何谋划。政府的目标是汇集数据，加强国家所有权和控制权，这最终可能会相当于某种国有化。这些数字公司建立了一些世界上最大、最先进的数据库，可以评估用户生活的方方面面，包括贷款还款情况、交友圈子、出行记录和消费习惯。据说仅蚂蚁集团就掌握了超过10亿人的数据，堪比Facebook和谷歌。由于中国许多“超级应用”涵盖的服务范围很广，它们更是掌握了异常丰富的用户信息。

信用评分是科技公司与政府争夺数据控制权的前沿阵地。多年来中国人民银行在尝试创建一个中央征信系统上成效平平。现在，人行似乎已经决定转而加强控制科技公司的系统。它已批准成立了两家个人征信公司——最近一次是在去年12月——均由科技公司和国有控股实体共同持股。目前为止，国家没有明确命令这些公司分享数据。在中国，个人数据属个人而非公司所有，因此需要修改法律才能让公司把这些数据分享给政府。但对一个威权政体来说，这也不是什么不可逾越的障碍。

科技公司有所抵抗，这也完全可以理解。香港一位资产管理人表示，这种策划尤其将削弱掌控大部分相关数据的阿里巴巴和腾讯目前享有的“信息优势”。券商盛博的朱镇表示，哪些类型的数据将被共享、如何共享、与谁共享，这种不确定性已对中国科技股造成压力。

最后一个不确定性源自政府对这些巨头持有的其他资产的打算。这些大公司都是横跨许多服务和产品的企业集团。过去十年里阿里巴巴和腾讯等公司也已入列中国最大一批风险投资机构（见图表2），对数字经济的影响力远远超出自身业务范围。在马云的带领下，阿里巴巴和蚂蚁集团已经在

媒体、金融、物流和医疗等领域积累了资产。腾讯是另一个电商巨头京东的大股东，也是美团和拼多多的大股东。阿里巴巴和腾讯都持有滴滴出行的股份，这家网约车公司计划今年以1000亿美元估值上市。本身已是全球最大科技公司之一的阿里巴巴和腾讯的投资组合总值约3000亿美元，这也让它们晋身全球最大的科技投资方之列。

政府决定迫使蚂蚁集团转型为控股公司，在不同的子公司中开展不同业务，这显示当局可能想改变科技帝国的结构。腾讯最近证实了自己正与监管机构合作，核查以往的投资。它的信贷业务与蚂蚁集团的类似，但规模较小，可能会同样被分拆成一家受人行监管的控股公司。有报道称政府已要求阿里巴巴出售其持有的媒体股份。阿里巴巴并未证实或否认这一传闻。法律专家表示，假如属实，这是令人担忧的，因为政府的做法将超越反垄断法的界限，触角更广，惩罚更重。

政府与科技巨头的关系变化会损害到外国投资者的利益，毕竟他们在中国公司的股东名册上地位显要。美国科技集团雅虎和日本软银在2011年就吃到了苦头，当时马云出于对监管的顾虑，悄然把支付宝从阿里巴巴剥离，雅虎和软银不得不接受自己在阿里巴巴的大量持股中不再包括支付宝。

如果再发生类似的事，像软银（目前仍持有阿里巴巴24.9%的股份）及南非科技集团Naspers（通过在阿姆斯特丹上市的控股公司Prosus成为腾讯的最大股东）等外国大股东的投资除了要承受近期股价下跌的损失之外，还可能遭受另外的打击。4月8日，Prosus表示已将所持腾讯股份从30.9%减至28.9%，以便筹集资金做其他投资。

中国政府没有明言的目标是要确保外国人不能掌控中国的科技公司，即便他们拥有这些公司的股份。这并不意味着他们的产权就会被摆在首位。而中国企业早有命运瞬间逆转的先例。安邦和海航等几家曾在国内外挥洒亿万资金积累资产的传统企业集团在过去几年被迫剥离持有的部分资产。这些公司背后的大亨命运不一。有的身陷牢狱，其他人名誉损毁，还有一些继续闷声做生意。他们的公司表现往往大不如前。中国的数字宠儿——以及其创始人和投资者——也许能躲过这样的命运，毕竟这些公司是活力和

声望的源泉，而且它们是通过创新而非金融工程取得成功的。但这样的黯淡前程也不再是不可想象的了。 ■



Bartleby

Their finest hours

People need to work, but not all week

PEOPLE'S RELATIONSHIP with work is complex. For all the complaining about the tedium and bureaucracy, the power-crazed bosses and recalcitrant colleagues, individuals need the security of a job. A century of research has shown that unemployment is bad for mental health, leading to depression, anxiety and reduced self-esteem. On average, it has an even greater effect than divorce.

But how much work do you need to do? A recent paper* by the Centre for Business Research at Cambridge University took the opportunity of the pandemic to examine the impact of reduced working hours on well-being. Many British employees were placed in a furlough scheme, under which their hours were reduced and their wages were subsidised by the government. "We found that people working reduced working hours or being furloughed do not have poorer mental health," the authors conclude. This suggests that social welfare would be improved if governments adopted furlough schemes in future recessions, even when they are not triggered by a virus.

What was particularly surprising is how little work was needed to keep people happy. The threshold for good mental health was just one day a week—after that, it seemed to make little difference to individuals' well-being if they worked eight hours or 48 hours a week. The boost from working clearly comes from the feeling of purpose, from the social status it creates and from the camaraderie of colleagues engaged in the same tasks.

A little bit of work may be satisfying but too much is not. An enterprising

junior analyst at Goldman Sachs recently surveyed his peers and fashioned his report in the style of a research presentation from the investment bank itself. The survey found those first-year analysts had worked an average 98 hours a week since the start of 2021, and only managed five hours of sleep a night. It found that 77% of them had been the subject of workplace abuse, that 75% had sought, or considered seeking, counselling, and that, on average, the cohort had suffered sharp declines in mental and physical health. Unsurprisingly, the analysts thought it was unlikely they would still be working at the bank in six months' time.

To be fair to Goldman Sachs, the survey had only 13 respondents. Discontented workers may have been the most likely to respond. And the bank's reaction was restrained. "A year into covid, people are understandably quite stretched, and that's why we are listening to their concerns and taking multiple steps to address them," a spokesperson said.

Nevertheless, the general reaction to the story was remarkably unsympathetic. In some people's eyes, the young analysts should have expected to be treated in such a fashion; after all, that is why they were being paid so well. Veterans of the investment-banking industry reminisced along the lines of "It was the same in my day. Never did me any harm." But it is hard to see why young Goldman analysts (or indeed, anyone) should expect to suffer workplace abuse. They joined a bank, not the Mafia.

Nor does it make much business sense to have employees working so long that they only get to sleep five hours a night. They can hardly be operating at full efficiency when they are dog-tired. Surely it is better to hire more analysts, and pay each of them a little less. That junior professional staff have always worked long hours is not a good explanation for piling stress onto young people at the start of their careers. It smacks of the legendary navy motto: "The beatings will continue until morale improves."

Clearly, economies cannot prosper if everyone works one day a week. But the need to limit excessive working hours was realised back in Victorian times. For much of the 20th century the length of the average working week fell while output continued to climb.

There will be occasions when people have to work late or rise early to finish a project (Bartleby writes this on a day when the needs of *The Economist* required him to get up at 5am). Day after day, however, a long-hours lifestyle is bad for workers' health. Some organisations may see the appetite for slogging it out as a sign of an employee's willingness to put their job ahead of their families and friends. If so, they don't need to have better employees. They need better managers.

* "Cut hours, not people: No work, furlough, short hours and mental health during the covid-19 pandemic in the UK", by Brendan Burchell, Senhu Wang, Daiga Kamerade, Ioulia Bessa and Jill Rubery ■



巴托比

最好的工作时光

人们需要工作，但不是整周的工作

人与工作的关系很复杂。尽管人们常常抱怨工作枯燥乏味、职场官僚作风、老板醉心权力、同事桀骜不驯，但个体需要工作带来的安全感。一个世纪来的研究表明，失业有损心理健康，会导致抑郁、焦虑和自尊水平下降。平均而言，其影响甚至超过了离婚。

但是，你需要多少工作量？剑桥大学下设商业研究中心（Centre for Business Research）近期发表的一篇论文*借新冠疫情的机会审视工作时长减少对幸福感的影响。这期间，英国许多员工被强制休假（furlough）——工作时间减少，但由政府补贴工资。论文作者们总结道，“我们发现，那些工作时间减少或被强制休假的人的心理健康并未受损。”这表明，如果政府在今后的经济衰退中实行这种强制休假措施，将会提升社会福祉，即使衰退不是由病毒引发的。

尤其令人惊讶的是，只需很少的工作就能让人感到快乐。要保持良好的心理健康状态，一周工作一天就够了——之后，不管是一周工作八小时还是48小时，对个人幸福感的影响似乎都没什么差别。工作的提振作用显然来自使命感、它所带来的社会地位，以及为相同事业努力的同事间的情谊。

少量的工作可能让人开心，太多就不行了。高盛一位颇有魄力的初级分析师最近调查了自己的同事，并以这家投行做研究简报的风格撰写了自己的报告。该调查发现，自2021年初以来，那些入职一年的分析师平均每周工作98个小时，每晚只能睡五个小时。其中77%的人在工作中遭受过欺凌，75%的人寻求过或者考虑过寻求心理辅导。平均而言，这个群体的心理和身体健康都急剧下降。难怪这些分析师认为自己不太可能在六个月后仍在高盛工作。

替高盛说句公道话，只有13人接受了这次调查。而最有可能接受调查的或

许就是心怀不满的员工。高盛的反应很克制。“新冠肺炎肆虐已有一年，人们压力很大，这可以理解，这也是为什么我们正在倾听他们的关切，并采取多项措施来解决这些问题。”一位发言人表示。

然而，出人意料的是，对于这份调查报告，公众并没有显现出多少同情。在一些人看来，这些年轻的分析师本来就应该预料到这种境遇，毕竟他们正是因此而拿到这么高的薪水。投资银行界的老将们回忆当年时也会说：“我也是这么过来的。我不还是好好的。”但是，为什么年轻的高盛分析师（或者实际上应该说任何人）该预料到会在职场受欺凌呢？这好像并无道理。他们可是在为银行而不是黑手党工作。

让员工工作这么长时间，以至于每晚只睡五小时，从经营的角度来看也不太明智。员工疲惫不堪时几乎不可能以最高效率工作。雇用更多分析师，给他们每人少发一点工资想必会更好。拿职场菜鸟从来都要加班加点说事，需要给事业刚起步的年轻人施加那么大的压力，难以令人信服。这让人想起海军的一句著名规训：“持续打击，直到士气提振。”

显然，如果每个人一周工作一天，经济不可能繁荣。但是，早在维多利亚时代，人们就认识到了限制过长工作时间的必要性。在20世纪的大部分时间里，一周平均工时都在下降，产出却持续攀升。

有时候，人们会为了完成一个项目而不得不起早贪黑（为了及时给本刊交稿，笔者撰写本文那天就是凌晨五点起床的）。然而，日复一日长时间工作的生活方式有损员工的健康。一些雇主可能会以为，员工渴望大展拳脚，就表示他们愿意把工作置于家人和朋友之上。如果是这样，那它们需要的不是更好的员工，而是更好的管理者。

* 《减工时，不裁员：英国新冠疫情期间失业、强制休假、短工时与心理健康》（Cut hours, not people: No work, furlough, short hours and mental health during the covid-19 pandemic in the UK）。作者：布兰登·伯切特（Brendan Burchell）、王森虎、戴加·卡米拉德（Daiga Kamerade）、尤利娅·贝萨（Ioulia Bessa）和吉尔·鲁伯里（Jill Rubery） ■



The dirty truth

Totting up bitcoin's environmental costs

Without regulation, mining in China could consume as much energy as Italy by 2024

AS COINBASE'S IPO shows, cryptocurrencies have many fans. But they have detractors, too. Environmentalists, in particular, fret about how much energy bitcoin uses. In a paper in *Nature Communications*, a group of academics led by Dabo Guan of Tsinghua University and Shouyang Wang at the Chinese Academy of Sciences examine bitcoin's energy use in China. They conclude that, in the absence of legal curbs, bitcoin could by 2024 become a "non-negligible" barrier to China's efforts to decarbonise its economy.

Bitcoin's hunger for energy stems from its design. It forgoes centralised record-keeping in favour of a "blockchain", a transaction database that is distributed among users. The blockchain is maintained by "miners", who validate transactions by competing to crack mathematical puzzles with solutions that are hard to find but easy to check. Each successfully mined block of transactions generates a reward, currently 6.25 bitcoins (\$357,000).

The system varies the difficulty of the puzzles to ensure that one new block is created, on average, every ten minutes. High bitcoin prices make it worthwhile to spend more computing power—and therefore electricity—chasing mining rewards. But bitcoin's automatic stabilisers will ramp up the mathematical difficulty in response. Like the Red Queen in "Through the Looking-Glass", competing miners find themselves running faster simply to stand still.

Despite the currency's democratic ambitions, mining is concentrated among a handful of professional operators. About 70% takes place in China.

The researchers use economic modelling to try to work out how much carbon all this make-work produces. They conclude that, without regulation, Chinese bitcoin mining could consume around as much energy as Italy or Saudi Arabia by 2024. Annual carbon emissions, at 130m tonnes, would approach those of Nigeria.

Such numbers should be taken with a good deal of salt. Bitcoin's energy use depends crucially on its price, which swings wildly. The authors assume that the long-term trend will be upward, because the rate at which new bitcoins are created is designed to halve every four years. Reality will doubtless prove more complicated. But the general picture—that bitcoin is a dirty business—fits with other research. One oft-cited model, which uses publicly available blockchain data, reckons its global energy consumption is already equal to that of Kazakhstan, and that its carbon footprint matches Hong Kong's. ■



肮脏的真相

算算比特币的环境账

如果没有监管，到2024年，“挖矿”在中国消耗的能源可能相当于意大利一国耗电量

正如Coinbase的首次公开募股所示，加密货币支持者众。但它们也招来了非议。环保主义者尤其担心比特币会消耗太多能源。在发表于《自然-通讯》（Nature Communications）的一篇论文中，清华大学的关大博和中国科学院的王守阳带领的一组学者研究了比特币在中国耗费能源的情况。他们得出结论称，如果没有法律约束，到2024年，比特币可能会成为中国经济去碳化“不可忽视的”障碍。

比特币对能源的大胃口源于它的设计。它舍弃了中心化的簿记方式，转而选择“区块链”，一个分布在众多用户之间的交易数据库。区块链由“矿工”维护，他们竞相破解数学难题，以此来验证交易。这些难题的答案很难解出，但易于核查。每当有一个交易区块被成功挖出，就会产生一笔奖励，目前为6.25个比特币（35.7万美元）。

系统会改变题目的难度，以确保平均每十分钟创建出一个新区块。比特币价格高企，也就值得花费更多计算力——相应地也耗费更多电力——来追逐挖矿的奖励。但此时比特币的自动稳定机制相应也会加大数学题目的难度。你争我抢的矿工们发现，自己明明加快了奔跑，却停留在原地，就像《爱丽丝镜中奇遇记》中的红皇后一样。

尽管比特币有践行民主的雄心，挖矿还是集中在少数专业运营者那里。其中大约有70%发生在中国。上述研究人员运用经济模型，试图计算出这番无谓的忙碌总共产生了多少碳排放。他们得出的结论是，如果没有监管，到2024年，中国在比特币开采上消耗的能源也许大致相当于意大利或沙特阿拉伯举国的耗电量。届时年碳排放量将达1.3亿吨，接近尼日利亚一国的总排放量。

对这些数字应该打个大大的问号。比特币的能源消耗关键取决于其价格，

而它的价格波动很大。几位作者假设的长期趋势是价格上升，因为按照设计，新比特币的生成速度每四年减半一次。现实无疑会更加复杂。但比特币是一门污染环境的生意这一总体结论与其他研究相吻合。一个采用了公开的区块链数据的模型经常被引用，该模型计算得出，比特币在全球的能源消耗量已经和哈萨克斯坦相当，碳足迹和香港相当。 ■



The race for space

House prices in the rich world are booming

Unusually, suburbs not cities are feeling the heat

ON A SUNNY afternoon in Kingsmere, a new suburb of Bicester, a town 50 miles (80km) north-west of London, the streets are abuzz with people strolling and children playing. In ten years 1,600 homes have been built on the site, and another 900 are soon to follow. In the sales office for Bovis Homes, Flip Baglee says she has “never known it to be so busy”. Sentiment in Rhinebeck, a village 80 miles north of New York City, is similarly buoyant. Many of the properties advertised in the window of Gary DiMauro Real Estate—from mansions to cottages—are already taken.

Kingsmere and Rhinebeck are not the only places warming up. American house prices rose by 11% in the year to January, the fastest pace for 15 years. Those in Britain increased by 8% last year, and in Germany by 9%. The pattern is seen in much of the rich world (see chart 1). Across the 25 countries tracked by The Economist, real house prices have risen by an average of 5% in the latest 12-month period.

In many countries, rises have been rapid enough to attract the attention of politicians and central bankers. In a break with the pattern of the past decade it is prices in less populated, but still commutable, places, rather than city centres, that are rising most. Covid-19 seems to have set off a quest for space that could outlast the pandemic.

At first glance, the robustness of house prices in the face of the economic turmoil inflicted by covid-19 might seem baffling: property prices typically move in tandem with the economy. But furlough schemes and fiscal stimulus have limited distressed sales this time. Interest rates are ultra-

low: in America those on 30-year mortgages are 1.5 percentage points below their level in 2010. Lockdowns and the reduced opportunity to spend mean that those who have kept their jobs have stashed away cash. Lucian Cook of Savills, a property consultancy in Britain, remarks that home values are being “driven by the haves rather than the have-nots”. In America, 14% of all mortgage applications made in February were for second homes, twice the share in April last year.

As covid-19 spread and many countries locked down, people’s homes also became their offices, schools, gyms and bakeries. Many therefore spent more on their properties. Revenues for Home Depot, America’s largest DIY store, rose by 20% last year. In Britain permissions granted for home improvements, such as extensions, increased by a third in 2020 compared with the average in 2016-19, reckons Barbour ABI, a market-research firm.

Other people sought new places to live. Homes in America have taken an average of 47 days to sell since May, compared with 59 days in the previous year. In Britain a temporary holiday on stamp duty (a housing-transaction tax) caused the volume of sales to rise in the final quarter of 2020 to a 14-year high.

For those wanting more space the best solution has been to move out of city centres. Prices per square foot in London, for instance, are 40% higher than in surrounding counties. House prices in less densely populated, but still commutable, areas of Britain have risen faster over the past year than in more populous ones. A similar pattern is also evident in America (see chart 2).

That bucks a trend of the past decade, when megacities such as London and New York surged ahead of quieter locations—a reversal that Zillow, an American property-listings firm, calls the “great reshuffling”. House prices

outside Germany's seven biggest cities rose by 11% last year, compared with 6% within them. Prices in Sydney's northern beaches, within commuting range of the city, are up by 10%.

By contrast, house prices in central London and Sydney rose by just 4% and 3% last year, respectively; those in Manhattan fell by 4%. Rental markets are cooling too. Rents for flats in Sydney fell by 5% last year. Those in Melbourne, which endured a 111-day lockdown last year, fell by 8%. Figures from Zillow suggest that rents fell by 9% in New York City and 15% in Manhattan in particular.

The pandemic has disrupted some of the usual flows into cities. In the years before covid-19, London lost residents to the rest of Britain. But the outflows were made up for by people coming in from abroad. The pandemic, and perhaps Brexit, seem likely to have reduced the inflow. One estimate suggests that London's resident population may have declined by 8% in 2020. Australia's borders have been shut to non-residents since March 2020. Recent graduates, faced with the prospect of working from a shared home, may still be living with their parents.

Outflows from cities have risen, too. A study by the Federal Reserve Bank of Cleveland finds that migration out of cities in America doubled to 56,000 people per month from March 2020 compared with the 2017-19 average.

Some of the flows to cities will pick up as the pandemic ends. Students and international migrants will return in droves. Some investors are therefore betting big on big cities. A new development in Manhattan selling large flats for \$12m offers the "premier answer to post-pandemic living". AXA Investment Managers, a firm that owns properties in 15 countries, has snapped up 1,233 flats in the heart of London, Britain's largest residential site.

Yet the allure of less-dense places seems likely to persist. Government advice to work from home, where in place, could be gone by the summer, but remote working may be here to stay. According to a survey of 20,000 employers around the world by Manpower, a recruitment firm, two-fifths of bosses plan to permit their employees to work from home at least some of the time. People might be willing to put up with longer commuting times in return for more living space or lower housing costs, if they are commuting less often. Suburban property prices would then inch towards those in the city.

The fate of overall house-price growth could well rest with policymakers. Emergency support for homebuyers and homeowners will be withdrawn as the pandemic draws to a close: in Britain, tax holidays are due to end later in the year. Other countries may look to take the heat out of housing markets. The government in New Zealand, where prices are rising at an annual rate of 22%, has taken steps to dampen speculation. The governor of the Bank of Canada has worried about “excess exuberance”, and plans to watch the housing market closely. A fear of jeopardising the economic recovery could mean that policymakers tread gently for now. That would give the race for space more room to run. ■



追逐空间

富裕世界房价大涨

与以往不同的是，感受到这股热浪的是郊区而非市区

一个阳光明媚的下午，在伦敦西北50英里（80公里）的比斯特镇（Bicester）的新兴郊区金斯米尔（Kingsmere），街上到处是闲逛的人和嬉戏的孩子。过去十年里这里新盖了1600栋房子，很快还要再盖900栋。在博维斯家园（Bovis Homes）的售楼处，弗丽普·巴格里（Flip Baglee）说她“从没想到过会这么忙”。在纽约以北80英里的村庄莱茵贝克（Rhinebeck），情绪同样高涨。加里·迪马罗房地产公司（Gary DiMauro Real Estate）的广告橱窗里贴出的物业中，不管是豪宅还是小屋，很多都已售出。

房地产升温的地点不止金斯米尔和莱茵贝克。截至今年1月的一年中，美国房价上涨了11%，是15年来最快的涨幅。去年英国房价上涨了8%，德国上涨了9%。在大多数富裕国家都可以看到这种趋势（见图表1）。在本刊追踪的25个国家中，最近12个月内实际房价平均上涨了5%。

在许多国家，房价上涨之快已经引起了政客和央行官员的注意。与过去十年房价波动的模式不同，这一次涨幅最大的不是市中心，而是人口密度较低但通勤仍算便利的地方。新冠疫情似乎触发了对宽敞居住空间的追求，这一趋势在疫情过后可能仍会持续。

乍一看，在疫情造成经济动荡的背景下，房价走势强劲似乎令人困惑，因为房价通常与经济同步变动。但这一次，员工强制休假和财政刺激措施减少了屋主因缺钱而着急廉价卖房的情形。利率处于超级低位：美国30年期房贷的还款人如今支付的利率比2010年时还低1.5个百分点。封城加上花钱机会减少，使得那些保住了工作的人存下了不少钱。英国房地产咨询公司第一太平戴维斯（Savills）的露西安·库克（Lucian Cook）指出，目前房价是被“有房一族而非无房一族推动的”。在美国，2月提出的所有房贷申

请中有14%是为了买二套房，是去年4月占比的两倍。

随着疫情传播以及多国实施封锁，人们的住所同时也变成了办公室、学校、健身房和面包房。因此，许多人增加了在住房上的花费。美国最大的DIY商店家得宝（Home Depot）去年营收增长了20%。市场研究公司Barbour ABI估计，2020年，英国批准的扩建等房屋改建工程数量较2016至2019年间的平均水平增加了三分之一。

其他人则在寻找新的住所。自去年5月以来，美国一套房屋的销售周期平均为47天，而之前一年为59天。在英国，临时实施的印花税（一种房产交易税）减免假期让2020年最后一个季度的销量升至14年来的最高点。

对于那些想要住得更宽敞的人来说，最好的方案是搬出市中心。以伦敦为例，那里房价要比周边郡县高40%。在过去的一年中，英国那些人口密度较低但仍在通勤范围内的地区的房价涨速要快过人口更稠密的地区。类似的趋势在美国也很明显（见图表2）。

这与过去十年的趋势相反。那会儿伦敦和纽约等特大城市的房价要比那些更僻静的地区冲得更快。美国房地产信息公司Zillow把眼下这种逆转称为“大洗牌”。去年，德国最大的七个城市以外地区的房价上涨了11%，而这七个城市的房价仅上涨了6%。在处于悉尼通勤范围内的北部海滩，房价上涨了10%。

相比之下，伦敦和悉尼市中心的房价去年分别仅上涨了4%和3%，曼哈顿的房价还下跌了4%。租赁市场也在降温。悉尼的公寓租金去年下降了5%。墨尔本去年经历了111天的封城，租金下跌了8%。Zillow的数据显示，纽约市的租金降了9%，曼哈顿的降幅更是达到15%。

疫情打断了一些惯常的向城市的人口流动。在疫情爆发之前的几年里，伦敦就已经出现了常住人口流向英国其他地区的情况。但从国外流入伦敦的人口抵消了人口外流。而疫情——也许还有英国脱欧——很可能减少了来到伦敦的外国人的数量。一项估计表明，伦敦的常住人口在2020年可能减少

了8%。自2020年3月起，澳大利亚的边境就已向非常住居民关闭。应届毕业生们看起来得在与他人合住的房屋中居家工作，目前可能仍与父母住在一起。

城市人口外流也有所增加。克利夫兰联储的一项研究发现，与2017至2019年的平均水平相比，从2020年3月开始，美国城市每月外流人口翻了一番，达到5.6万人。

随着疫情消退，一些流入人口会重新增加。学生和国际移民将大批返回。因此，一些投资者大笔押注大城市。曼哈顿一个新楼盘的大户型公寓售价1200万美元，声称是“疫情后生活的上佳之选”。在15个国家拥有物业的安盛投资管理公司（AXA Investment Managers）已在英国最大的住宅区伦敦市中心购置了1233套公寓。

然而，人口密度较低地区的吸引力看起来很可能会持续下去。有些地方的政府建议人们居家工作，这种号召到夏天可能就会取消，但远程工作模式也许会保留下。招聘公司万宝盛华（Manpower）对全球两万名雇主的一项调查显示，五分之二的老板计划允许员工至少部分时间在家工作。如果通勤次数减少，人们可能愿意为更大的居住空间或更低的房价忍受更长的单次通勤时间。这样，郊区房价将慢慢接近市区房价。

房价总体上涨的走势很可能取决于政策制定者。随着疫情走向尾声，对购房者和屋主的紧急援助将终止。在英国，印花税减免假期将于今年晚些时候结束。其他国家可能会着手为住房市场降温。在房价年增长率达到22%的新西兰，政府已采取措施抑制投机行为。加拿大央行行长担心房市“过度繁荣”，并计划密切关注房市。由于担心危及经济复苏，决策者们可能会暂时出手谨慎。这会留给这场对空间的追逐更大的增长空间。■



Hype club

Clubhouse may fade. Group voice chat is here to stay

What Silicon Valley's latest hype cycle says about the future of social media

ONE OF SILICON VALLEY'S most successful inventions is hype. It usually disappoints. In 2015 live-streaming from smartphones became all the rage. But Meerkat, an app which pioneered it, shut down the following year. On April 1st Periscope, its more successful rival, did too (no joke). Will Clubhouse, a buzzy app that hosts live audio gabfests, suffer the same fate?

Launched at the start of the pandemic last March, Clubhouse quickly became Silicon Valley's most-talked-about app and a favourite stage for rock-star entrepreneurs. Elon Musk offered his views on colonising Mars and rewiring the brain to thousands of listeners. Marc Andreessen and Ben Horowitz, co-founders of a big venture-capital firm, regularly hold forth. More mortal Valleyites discuss everything from the future of San Francisco to the testy relations between tech and the media. This year the Clubhouse craze went global, offering a venue for frank conversations in places from Saudi Arabia to South Korea.

Amid the buzz, problems are emerging. You still need an invitation from an existing user, but these are easy to come by. As newcomers flood the app, the quality of debate has dropped. Without systematic moderation, chats entitled "How to discipline and train your women" or worse are popping up. Despite lower barriers to entry, the app's downloads were down to 2.7m in March, from 9.6m in February, according to Sensor Tower, a data provider.

On the business side, Clubhouse has yet to work out how to make money (ideas include tipping and membership fees for virtual clubs). And, predictably, big tech firms are jumping on the bandwagon. Twitter is testing

a similar feature (and is reported to have considered buying Clubhouse). Facebook is expected to launch a clone soon. On March 30th Spotify acquired Locker Room, a sports-themed group-chat app. Even LinkedIn and Slack, two business-oriented services, are following suit.

It is too early to count Clubhouse out. It has name recognition and could remain the go-to place for virtual talk shows, as Twitter is for instant opinions. It is run by Paul Davison, an experienced social-media entrepreneur. It has plenty of cash: in December it raised \$100m, much of it from Andreessen Horowitz. It is reportedly seeking new funding at a valuation of \$4bn. And it has yet to release a version of its app for Android, Google's popular mobile operating system. Optimists point to Snapchat, a social network beloved of teenagers, which has found a lucrative niche in a market dominated by Facebook.

This suggests that even if Clubhouse looks Perisopic in a year's time, group chats are likely to remain a feature of social media after the pandemic recedes. Meerkat and Periscope may be dead, but live streaming is alive and well—albeit as a service within larger social-media platforms. Tech hype may be grating, but it serves a purpose. Buzz incites consumers to try new things, venture capitalists to put up the cash and entrepreneurs to experiment—even if, more often than not, pioneers wind up in the digital dustbin. ■



造势俱乐部

Clubhouse也许会销声匿迹。语音群聊却会继续下去

硅谷最新一条炒作周期曲线为社交媒体的未来指路

造势是硅谷最成功的发明之一。但结果往往不尽人意。2015年，智能手机流媒体直播风靡一时。但最先推出这一功能的应用Meerkat第二年就关闭了。今年4月1日，比Meerkat强一些的昔日劲敌Periscope也关门大吉（这可不是愚人节的玩笑）。提供即时语音群聊会场的热门应用Clubhouse会不会也有相同的命运？

Clubhouse于去年3月疫情爆发之初上线，迅速成为硅谷最为人津津乐道的应用，也是摇滚明星般的企业家们青睐的舞台。马斯克在Clubhouse上与成千上万听众分享了他对殖民火星和脑机接口的看法。硅谷风险投资巨头安德森-霍洛维茨基金（Andreessen Horowitz）的两位联合创始人马克·安德森（Marc Andreessen）和本·霍洛维茨（Ben Horowitz）也定期在Clubhouse上高谈阔论。更多普通的硅谷人在那里谈天说地，从旧金山的未来聊到科技公司与媒体的紧张关系。今年，Clubhouse热潮更是席卷全球，为从沙特阿拉伯到韩国的人们提供了一个坦诚对话的平台。

喧嚣之下，问题也在显现。要成为用户仍然需要现有用户邀请，不过邀请很容易拿到。随着新用户的涌入，辩论质量每况愈下。因为缺乏系统性管控，不时会出现像“如何调教你的女人”甚至更恶劣的话题。尽管入群门槛降低了，但据数据供应商Sensor Tower统计，Clubhouse的下载量已从2月的960万降至3月的270万。

在商业方面，Clubhouse还没有摸索出赚钱的门道（它想过平台打赏和虚拟俱乐部付费会员等模式）。而且不出所料，科技巨头们也跟风而来。推特正在测试类似的功能（据报道它考虑过收购Clubhouse）。Facebook也有望于近期推出一款翻版产品。3月30日，Spotify收购了体育主题群聊应用Locker Room。甚至连面向企业的领英（LinkedIn）和Slack也跟了上

来。

现在就认定Clubhouse活不下来还为时过早。它有知名度，可能仍会是线上脱口秀的首选平台，堪比推特在即时评论方面的地位。Clubhouse由保罗·戴维森（Paul Davison）运营，他是一名经验丰富的社交媒体企业家。它现金充足，去年12月融资一亿美元，其中大部分来自安德森-霍洛维茨基金。据称它正以40亿美元的估值寻求新一轮融资。另外，它还没有推出安卓系统（谷歌广为流行的手机操作系统）版本。对Clubhouse前景乐观的人以Snapchat为例证，这个深受青少年喜爱的社交网络在Facebook主导的市场中找到了利润丰厚的利基市场。

这表明，即使Clubhouse在一年后步了Periscope的后尘，语音群聊在疫情消退后很可能仍会是社交媒体的一大功能。Meerkat和Periscope死了，但流媒体直播还活得好好的一—尽管是作为更大的社交媒体平台上的一项服务而存在。科技造势可能让人厌烦，但它也有一定用处。在造势的鼓动下，消费者尝试新鲜事物，风险投资家解开荷包，企业家放手一试—尽管先行者最后往往被扔进了数字时代的垃圾箱。■



Art and conquest

The spoils of war

The theft of the Benin bronzes was devastating. But returning them will be hard

BENIN CITY, or Edo as it was known in its heyday at the start of the 17th century, was a confident metropolis, a place of creativity and military power. In 1600 a Dutch visitor described an impressive central avenue seven or eight times broader than Warmoesstraat, one of the main shopping streets in Amsterdam, and a palace for the Oba, or head of the ruling dynasty, “so large, that you can feel no End”. The walls were decorated with ivory sculptures and elaborate metal plaques depicting hunters, musicians, courtiers and animals including leopards, elephants and crocodiles.

As well as being the heart of a great empire that traded throughout west Africa, Edo was the centre of a complex belief system populated by gods and spirits associated with wealth, health and fertility. Ogun, a god’s son, was said to help the city make tools and weapons; he was (and is) the patron of farmers, fighters, hunters, craftsmen and artists. On attaining the throne, each new Oba would commission a bronze head from the local metal-workers as a way of paying homage to his predecessor. The palace’s shrines and altars to past rulers boasted many of these statues—kings with puffed cheeks and shining eyes, their queens with elaborate collars and tall braided hairpieces.

Building Edo and its exclaves meant removing 100 times the amount of material contained in the Great Pyramid of Giza, according to an archaeologist who surveyed the area in the 1960s and 1970s. A modern visitor to the city—now the capital of Edo state in southern Nigeria—finds little to show for that effort. The earthen wall that once surrounded the seat of the Oba’s empire is crumbling, littered with human excrement and plastic

bags and punctuated by electronic billboards for evangelical churches. The old moat stinks.

The bronze and ivory treasures are scattered around the world. Some are held by wealthy private collectors in Europe and America—in 2016 the idealised bronze head of a 16th-century royal, with a long-necked calabash sitting on its crown, was sold privately for over \$10m. Others are divided between more than 160 museums, chiefly in America, Britain and Germany, which often display them with minimal information. One label euphemistically says the objects were “brought” to Britain after a military skirmish.

How they really got there is a question asked ever more loudly by activists who want Western museums to be more transparent about the origins of their collections. Last November Dan Hicks, a curator at the Pitt Rivers Museum in Oxford, published “The Brutish Museums”, which uses military and trade records to lay out the destruction of the kingdom of Benin by a British expeditionary force in 1897. It shows how colonial expansionism was enlisted in the service of great ethnographic collections (such as the one at the Pitt Rivers), which still draw millions of visitors.

Western acquisition, though, is only half of the story. One country’s gain is another’s loss. Barnaby Phillips calls his new book “Loot”, a word that came into English usage in 1788 from Hindustani slang for plunder and mayhem. Mr Phillips, a veteran British correspondent in Africa who knows Nigeria well, adds new and much-needed context to the story of the Edo empire and its bloody finale.

He digs into Edo history to show how the power of the Obas evolved as they encountered the Portuguese, the Dutch and later the British, and tracks what happened to the most important treasures after they were grabbed from the Oba’s palace in 1897. The international market took off in the 1930s

when some of the British perpetrators of that seizure began selling off their holdings. Counterintuitively, British civil servants worked hard to return the treasures to Nigeria after the second world war, while Nigerian politicians raided their country's museums for sculptures to use as instruments of diplomacy. In 1973 General Yakubu Gowon gave a rare bronze—looted by the British, then returned to the National Museum of Nigeria in the 1950s—as a gift to Queen Elizabeth when he made his first state visit to Britain. It now sits in the Grand Vestibule at Windsor Castle.

By demonstrating beyond doubt that the Benin bronzes were seized as military booty, in circumstances that would now be described as the “unlawful destruction of cultural heritage” by the UN Security Council, the new accounts make a powerful moral case for their return to Nigeria. Mr Hicks lays bare the savagery of the British expeditionary force. Mr Phillips is at pains to show how deeply the Edo people feel the loss of their physical culture. He describes a scheme in Edo state whereby Sir David Adjaye, architect of the National Museum of African American History and Culture in Washington, is to build a new museum and education centre in the city.

The story of the Benin bronzes is “a dramatic and tragic tale”, Mr Phillips writes. Returning them to a new museum would do a great deal to right a historic wrong. Germany recently indicated that its own museums may soon return their holdings; on March 24th Aberdeen University announced a plan to send an artefact back to Benin City, the first from a British institution for more than half a century. Other British and American museums are expected to follow. But Mr Phillips is clear-sighted about the political and financial obstacles that must still be overcome.

Young people may be keener on restitution than their forebears, but some Nigerians think money spent on museums would be better directed to schools or hospitals. Others are sceptical about the country’s ability to safeguard its collections. Meanwhile, some in Europe and America would

not mind seeing the Nigerians stumble if it meant hanging on to treasures they have long called their own. Possession still has a powerful allure. ■



艺术和征服

战争夺宝

窃取贝宁青铜器的历史令人震惊。但归还它们会很困难【《战利品》书评】

贝宁城（Benin City）在它17世纪初的鼎盛时期又叫埃多（Edo）。那是一个自信的大都市，富有创造力，也拥有军事实力。1600年，一名荷兰来客描述这里令人叹为观止的中央大道时，说它足有阿姆斯特丹的主要购物街之一瓦姆斯街（Warmoesstraat）的七八倍那么宽，而一座为“欧巴”（Oba）也就是国王建造的宫殿则“大得仿佛无边无际”。宫殿的墙壁上装饰着象牙雕塑和精致的金属饰匾，上面刻着猎人、乐师、朝臣以及豹子、大象和鳄鱼等各种动物。

埃多是一个贸易网络遍布西非的庞大帝国的心脏，也是一个复杂的信仰体系的中心——这个体系里充满了各式各样与财富、健康和生育有关的神灵。据说神的儿子奥贡（Ogun）帮助埃多制造了工具和武器，他到今天依然是农民、战士、猎人、工匠和艺术家的保护者。每个新任欧巴登上王位后都会委托当地的金属匠人制作一座青铜头像，以示对前任欧巴的敬意。宫殿里，敬奉过往统治者的神龛和祭坛展示着许多这样的雕像——国王有着鼓鼓的脸颊和亮闪闪的眼睛，王后有着繁复的衣领和高耸的假髻。

据一位在上世纪六七十年代考察过该地区的考古学家的说法，建造埃多及其飞地所耗费的材料是吉萨大金字塔的100倍。一个现代游客来到这座城市——如今是尼日利亚南部的埃多州的首府——几乎已无从寻觅当年大规模建设的辉煌成果。曾环绕帝国重镇的土城墙已是断壁残垣，到处可见人的排泄物和塑料袋，间或还能看到福音派教会的电子广告牌。老护城河臭气弥漫。

青铜和象牙制的珍宝如今散落在世界各地。其中一些由富有的欧美私人收藏家持有——2016年，一座16世纪的青铜头像以超过1000万美元的价格被私下售出。这是个理想化了的王室成员头像，王冠上立着一个长颈葫芦状

的饰物。其他的珍宝分散在160多家博物馆，主要在美国、英国和德国，它们在展示时提供的信息常常少到不能再少。例如一个标签上就隐晦地写着，这些展品是在一场军事冲突后被“带回”英国的。

它们究竟是怎么来的？一些活动人士日益大声地发出质问。他们希望西方的博物馆在馆藏文物的来源问题上更加透明。去年11月，牛津的皮特·里弗斯博物馆（Pitt Rivers Museum）馆长丹·希克斯（Dan Hicks）出版了《野蛮博物馆》（The Brutish Museums）一书，在参考军事和贸易记录后，历数了1897年英国远征军对贝宁王国的破坏。该书展示了殖民扩张主义如何为大规模人种志收藏（比如皮特·里弗斯的馆藏）提供了便利，如今这些藏品仍吸引着成百上千万游客。

不过，西方的得手并不是事情的全貌。一国有所得，另一国必有所失。巴纳比·菲利普斯（Barnaby Phillips）给自己的新书取名《战利品》（Loot）。“loot”这个词源自印度斯坦俚语，意为掠夺、混乱，1788年进入英语。菲利普斯是一名驻非洲的资深英国记者，对尼日利亚非常了解，他为埃多帝国的故事及其血腥的结局增添了新的、必要的背景信息。

他深入挖掘了埃多的历史，展示了欧巴们在和葡萄牙人、荷兰人以及后来的英国人打交道的过程中的实力演变，追踪了那些最重要的珍品在1897年被从欧巴的宫殿中掠走后的去向。上世纪30年代，一些曾参与了这场掠夺的英国人开始抛售手中的文物，国际市场由此开始腾飞。有违直觉的是，第二次世界大战后英国的公务员费尽周折将部分珍宝归还给了尼日利亚，而尼日利亚的政客却大肆搜刮本国的博物馆，把那里的雕塑拿来用作外交工具。1973年，雅库布·戈翁（Yakubu Gowon）将军在首次对英国进行国事访问时，将一件稀有的青铜器作为礼物送给了伊丽莎白女王。而实际上这件青铜器最初是被英国人抢走，在50年代归还给了尼日利亚国家博物馆。现在它被安置在温莎城堡的大前厅内。

菲利普斯这番新记述论证了贝宁青铜器毫无疑问是作为军事战利品被攫取的，这种情形在今天会被联合国安理会描述为“非法破坏文化遗产”，这就为把它们归还给尼日利亚提供了强有力道德理据。希克斯将英国远征军

的野蛮行径大白于天下。菲利普斯则极力刻画了埃多人对丧失自己文化实体的痛惜之情。他介绍了埃多州的一项计划：华盛顿的非裔美国人历史和文化国家博物馆的设计师大卫·阿贾耶爵士（Sir David Adjaye）将在贝宁城建造一个新的博物馆和教育中心。

贝宁青铜器的故事是“一个戏剧性和悲剧性的故事”，菲利普斯写道。将它们还给一座新的博物馆对于纠正一个历史错误而言意义重大。德国最近透露该国的博物馆可能很快会归还它们的藏品。3月24日，阿伯丁大学宣布计划将一件文物送回贝宁城，这是半个多世纪以来英国机构归还的首件文物。其他英美博物馆预计也会跟进。但是这仍要克服政治和金钱上的重重障碍，菲利普斯对此有着清醒的认识。

年轻人可能比他们的先辈更有热忱追索文物，但一些尼日利亚人认为把钱花在博物馆上还不如用到学校或医院里。其他人则对尼日利亚看管好自己藏品的能力表示怀疑。与此同时，一些欧美人会巴不得尼日利亚人失误，这样他们说不定就可以继续拥有他们早就据为己有的珍宝。占有仍然有着强大的诱惑力。■



Personal transport

New means of getting from A to B are disrupting carmaking

The business of “mobility” in its many forms is huge, and legacy metal-bashers are racing to adapt

IN THE DECADES after the second world war carmakers were the undisputed champions of the personal-transport economy. Competition and economies of scale made cars affordable to millions of motorists in industrialised countries. In the 1980s and 1990s the likes of General Motors (GM) and Toyota boasted some of the world’s richest market capitalisations. When it came to getting around town, nothing beat the automobile.

Today the picture looks different. Of the five most valuable firms in the moving-people-around business only two, Toyota of Japan and Volkswagen of Germany, are established carmakers. Ahead of everyone by a country mile is Tesla, an American company that has disrupted the car industry by turning electric vehicles from an unsightly curiosity (remember the G-wiz?) into a serious challenger to the internal combustion engine. Rounding off the top five are not carmakers at all but Uber, an American ride-hailing giant worth over \$100bn, and Didi Chuxing, a Chinese one that on April 10th was reported to have filed confidentially to go public in New York and hopes for a similar valuation.

After being slow to react to the threat from Tesla, legacy carmakers are—just about—getting to grips with electrification. Now another disruption lurks around the corner. Changing habits and technology are forcing car companies to rethink how their products are sold, used and owned. In a sign of the times, the boss of Volkswagen, Herbert Diess, concedes that “ownership is not necessarily what you want. You want a car when you need a car.” Competitors are elbowing in; Didi is expected to be the star turn at

the Shanghai Motor Show later this month. The private car is not obsolete. But the future business of “mobility”—as the industry has rebranded getting from A to B—will involve much more besides.

The market could be enormous. In 2019, ahead of its flotation, Uber put it at \$5.7trn, based on the 20trn or so kilometres that passengers travel each year in 175 countries using road vehicles, including public transport. Consultancies’ estimates are more subdued, and vary considerably. But all point to rich potential. IHS Markit reckons that what it calls “new transport” will be worth \$400bn in revenues by 2030. KPMG puts the figure at \$1trn. Accenture calculates that revenues from mobility, including car sales, will hit \$6.6trn by 2050; new transport will make up 40% of the total.

Individually owned cars will remain a big part of the new ecosystem. They are still the world’s preferred means of transport. For every ten miles travelled Americans use the car for eight, Europeans for seven and Chinese for six. Even in Europe, which is friendlier to public transport than America or China, only one in six miles was travelled on buses, trains and coaches in 2017. Uber accounts for just 1.5% of total miles driven in its home market.

The pandemic has in some ways cemented the car’s pole position. Many people have shunned shared vehicles, be they cabs or buses, for fear of infection. A survey of American travel habits by LEK, a consultancy, showed that car journeys declined by just 9% last year, compared with 55-65% for public transport and ride-hailing. Although today’s teenagers are less interested in getting behind the wheel than their parents were, that changes when they turn 20. Between 2010 and 2018 America lost 800,000 drivers under 19 but gained 1.8m aged 20-29, estimates Bernstein, a broker. Zeal for cars in China, the biggest market, remains strong. In the first three months of the year Chinese car sales rebounded close to their pre-pandemic peak.

The automobile's appeal endures on the outskirts of cities and beyond. Most driving takes place away from congested urban cores, Bernstein reckons. Nearly 90% of car miles in America are driven in the suburbs, small towns and rural locations, where a private car is often the only choice.

Instead it is in the city centres where a revolution beckons. There the classic ownership model is endangered, new modes of transport are emerging and competition is building from upstart mobility providers that connect customers with a mesh of different services.

Didi, Uber and others enable rides on demand. Having lost money for years, Uber and Lyft, its smaller American rival, should become profitable in 2022, thinks Morgan Stanley, an investment bank. On April 12th Uber reported record monthly gross bookings (including food delivery). Companies like Zipcar let people rent cars by the hour, or even minute. Turo, a Californian firm, is one of several to offer longer-term peer-to-peer car-sharing. BlaBlaCar, a French one that has signed up 90m drivers in 22 countries, connects those with spare seats to travellers headed in the same direction. Bike-sharing schemes jostle in new dedicated lanes with electric scooters for hire. Before the pandemic consultants at McKinsey reckoned that renting e-scooters might generate revenues of \$500bn worldwide by 2030. Even flying taxis may at last be about to take off; some of their developers, such as Joby, have earned multibillion-dollar valuations.

These various modes of transport are being stitched together into seamless trips by specialist journey-planning apps. They let travellers take a scooter to the underground station, take the metro, then jump in an Uber for the last mile—or pick whatever other combination of price and travel time is most suitable. They charge the individual service providers a commission for including them in a journey. Some are experimenting with subscription plans.

Some makers of aggregator apps are startups. Whim of Finland gives access to public transport, taxis, bikes and cars for a single subscription in several European locations. Others are stalwarts of the transport business. Deutsche Bahn, Germany's state-owned railway company, has an app that also lets passengers use a variety of travel options. Frost & Sullivan, a consultancy, forecasts that such aggregators will generate revenues of \$35bn with a decade.

Small wonder carmakers want in. Many have done so by investing in the newcomers. In 2016 GM ploughed \$500m into Lyft and Volkswagen put \$300m in Gett, a European taxi-hailing app. Toyota has invested in Uber, Didi and Grab, a Singaporean ride-hailing company that is going public in a reverse merger valuing it at \$40bn. GM has since sold its stake (at a healthy profit) but Toyota and Volkswagen have held on to theirs.

The car firms have also been competing with the challengers head on. It helps that many are already familiar with the principle of charging for use rather than ownership. In Britain more than 90% of cars use some form of financing. Arrangements where the customer pays a monthly sum over two to four years to offset depreciation are a lot like a long-term rental. It is not a huge leap from that to a subscription service. Hakan Samuelsson, boss of Volvo, thinks the shift from ownership to "usership" could be rapid.

Five years ago, in a bid to convince investors it was a "mobility" firm, not an irrelevant behemoth, GM launched Maven, a brand offering car-sharing and a peer-to-peer rental. The same year Ford, GM's Detroit rival, acquired Chariot, a shared minibus service, and Volkswagen launched MOIA, which employs 1,300 people developing on-demand transport. In 2019 BMW and Daimler, two German makers of luxury cars, combined their mobility businesses into a joint venture called Free Now, and Toyota launched its car-sharing and travel-planning platform, Kinto, which has since expanded to several European countries.

Some upmarket carmakers, including Volvo (a Swedish brand owned by Geely of China), Audi (part of Volkswagen) and Lexus (Toyota's premium brand), have tried to woo back younger city-dwellers with subscription services. For a monthly fee starting at between \$600 (for a Volvo) and \$1,000 (for an Audi or a Lexus), which excludes only fuel, users get access to a vehicle whenever they need one. Lynk & Co charges users €500 (\$595) a month for its cars. Its boss, Alain Visser, calls his marque (also owned by Geely) the "Netflix of cars".

As the relationship between car brands and customers gets more continuous, replacing some one-off sales, it is also becoming more direct. Tesla pioneered selling cars in its own salons, as Apple does with its gadgets. Other carmakers are beginning to follow suit. Lynk & Co sells its cars online. Volvo said in February that it would start doing the same. The trend has been accelerated by the pandemic, which has pushed car buyers away from dealers' forecourts and onto the internet. Selling vehicles directly forges a bond with individual customers that may help car firms flog them other services in the future.

Not all mobility ventures will succeed. Some have already fallen by the wayside. Ford pulled the plug on Chariot in 2019. Maven was put to rest a year later. A few months ago Free Now quietly wrote off its Hive e-scooter business and in March sold ParkNow, an app that allows drivers to find and pay for a parking space. As Ashish Khanna of LEK observes, ride-hailing will always struggle in outer suburbs where passengers are far less thick on the ground. Assaf Biderman, boss of Superpedestrian, which operates shared e-scooters, notes that city peripheries in particular are still "built for cars".

Nevertheless, carmakers are not taking anything for granted as they face up to the reality that a few decades from now they may be selling fewer cars in the time-honoured way. If Tesla taught them anything it is that being caught asleep at the wheel can be awfully costly. ■



个人交通

新出行方式颠覆汽车制造业

“移动出行”形式多样、市场庞大，老牌车厂奋起顺应

二战后的数十年里，汽车制造商是个人交通经济毋庸置疑的大赢家。市场竞争加上规模经济让工业化国家数以百万计的驾驶者都能买得起车。上世纪八九十年代，通用汽车和丰田等公司都曾得意地跻身全球市值最高公司之列。要在城市里行动，没什么比得上汽车。

今天的景象已然不同。个人交通领域里市值最高的五家公司中只有日本丰田和德国大众是传统车企。遥遥领先的是特斯拉，这家美国公司把电动汽车从古怪难看的东西（还记得G-wiz吗？）变成了能真正挑战内燃机的出行工具，颠覆了整个汽车产业。前五大公司中其余的两家甚至根本不是汽车制造商，而是网约车公司——市值过千亿美元的美国巨头优步和中国公司滴滴出行。4月10日有报道称滴滴已经秘密提交了在纽约上市的文件，希望估值与优步看齐。

在对特斯拉带来的威胁做出迟缓的反应后，老牌车厂刚刚要开始顺应电气化的趋势。现在另一场颠覆又悄然逼近。习惯的改变和技术的进步迫使车厂重新思考产品的销售、使用和拥有方式。大众汽车的老板赫伯特·迪斯（Herbert Diess）的话成为了时代的注脚：“人们不一定想拥有汽车了，只是在需要用车的时候才想有车。”竞争对手纷纷涌入：在本月下旬举行的上海车展上，滴滴预计将会是一大主角。私家车并没有完全过时，但所谓的“移动出行”（汽车行业对于从一地到另一地的新称法）的内涵将会丰富得多。

这个市场可能规模巨大。2019年，优步在上市前估计其规模将在5.7万亿美元，其依据是175个国家每年包括公共交通在内的道路车辆出行里程约为20万亿公里。各家咨询公司的估算更为保守，而且差异很大。但所有估算都显示出这一市场潜力深厚。IHS Markit估计，到2030年，它称之为“新交

通”的领域将有4000亿美元的收入。毕马威估计的数字是一万亿美元。而埃森哲计算，到2050年，包括汽车销售在内的移动出行市场收入将达到6.6万亿美元，新交通将占其中的40%。

私家车仍将是这一新生态系统的一大组成部分。它们仍然是全球大众首选的交通工具。在美国，私家车出行里程占总里程的八成，欧洲为七成，中国为六成。即使在公共交通比美国或中国发达的欧洲，2017年人们乘坐公共汽车、火车和长途汽车出行的里程也仅占总里程的六分之一。优步在美国市场仅占车辆出行里程的1.5%。

新冠疫情在一定程度上巩固了私家车的领先地位。许多人因担心感染病毒而避开出租车、公交车这类与他人共乘的车辆。咨询公司艾意凯（LEK）对美国人出行习惯的调查显示，去年私家车出行量仅下降了9%，而公共交通和网约车下降了55%至65%。虽然如今的青少年不像他们父母当年那样喜欢开车，但等他们满20岁后情况就会改变。据券商盛博估计，2010年至2018年间，美国19岁以下的驾驶者减少了80万，而20岁至29岁的驾驶者增加了180万。在中国这个最大的市场，人们对汽车的热情不减。今年第一季度，中国汽车销量已回升至接近疫情前峰值。

在城郊以及更偏远的地方，私家车的吸引力依然如故。盛博认为，大多数驾车里程发生在拥堵的市中心之外。在美国，近90%的汽车行驶里程是在郊区、小镇和乡村地区完成的，在这些地方私家车往往是唯一的出行工具。

倒是在城市中心，一场革命正在降临。在这里，传统的汽车拥有模式危在旦夕，新的出行方式正在浮现，新兴移动出行服务商将客户接入一系列不同服务，竞争正在增强。

滴滴和优步等出行服务商使按需用车成为可能。投行摩根士丹利认为，在多年亏损后，优步和它较小的美国对手Lyft应该能在2022年实现盈利。4月12日，优步公布取得创纪录的月度总预订量（包含送餐业务）。Zipcar等公司提供按小时甚至按分钟计费的租车服务。加州公司Turo是提供较长

期P2P共享租车服务的几家公司之一。法国公司BlaBlaCar把车上有空位的司机和顺路的出行者匹配起来，已经在22个国家有了9000万名注册司机。在新的非机动车专用道上，共享自行车与出租电动滑板车你追我赶。疫情前，麦肯锡的顾问估计，到2030年，电动滑板车出租业务在全球可能带来5000亿美元的收入。就连“飞的”也可能终于要起飞了：Joby等一些“飞的”开发商已取得数十亿美元的估值。

现在，专门的行程规划应用正将这些不同的出行方式无缝拼接起来。它们指引出行者骑滑板车到地铁站换乘地铁，再用优步打车完成最后一英里行程，或根据费用及耗时从其他组合中选择最优方案。这些应用向被纳入行程的出行服务商收取佣金。还有一些正在试验用户订阅模式。

有些聚合应用出自创业公司。芬兰的Whim在欧洲一些地方推出了一站式订阅模式，订户可在行程中用到公共交通、出租车、自行车和汽车等各类方式。有些应用出自交通行业的老牌企业。德国国有铁路公司德国联邦铁路（Deutsche Bahn）的一款应用也让乘客能够混合使用各种出行方式。弗若斯特沙利文咨询公司（Frost & Sullivan）预测，这类聚合服务商将在10年内创造350亿美元的收入。

难怪汽车制造商也想分一杯羹。许多公司采取的方法是投资新的出行服务商。2016年，通用汽车向Lyft投资五亿美元，大众汽车向欧洲网约车应用Gett投资三亿美元。丰田投资了优步、滴滴和Grab（这家新加坡网约车公司将以反向合并的方式上市，估值400亿美元）。通用汽车后来又出售了在Lyft的股份（获利不菲），丰田和大众汽车则一直持有这些股份。

这些车厂也一直在与挑战者正面竞争。还好许多车厂已经熟悉了不再买车而是按使用付费的原则。在英国，超过90%的汽车涉及某种形式的融资。客户在两到四年内支付月费抵消汽车折旧的做法就很像长期租赁，从这种方式转为订阅服务不算什么大飞跃。沃尔沃的老板哈坎·萨缪尔森（Hakan Samuelsson）认为，从有车到“用车”的转变可能很快就会完成。

五年前，通用汽车为了让投资者相信自己是一家“移动出行”公司，而非与

时代脱节的汽车巨头，推出了提供汽车共享和P2P租赁服务的平台Maven。同年，它的底特律竞争对手福特收购了共享小巴服务商Chariot；大众汽车也推出了MOIA，雇用1300名员工开发按需出行服务。2019年，德国豪华车制造商宝马和戴姆勒把各自的出行业务合并为合资公司Free Now；丰田则推出汽车共享和行程规划平台Kinto，后来推广至欧洲多个国家。

一些高端车厂试图通过订阅服务吸引年轻的城市用户，它们包括中国的吉利汽车旗下的瑞典品牌沃尔沃、大众子品牌奥迪和丰田的高端品牌雷克萨斯。月订费从600美元（乘坐沃尔沃）到1000美元（奥迪或雷克萨斯）不等，包含除油费外的所有花费，用户可随时使用车辆。领克向用户收取每月500欧元（595美元）的汽车订阅费，该公司老板魏思澜（Alain Visser）称其品牌（也归属吉利旗下）是“汽车中的Netflix”。

汽车品牌与客户之间关系的变得越来越有延续性，取代了一部分一次性销售，同时这种关系也变得越来越直接。特斯拉率先在自己的展厅里销售汽车，就像苹果公司销售电子产品那样。其他车厂也开始效仿。领克在网上直销汽车。沃尔沃2月表示也将这样做。疫情加速了这一趋势，把汽车买家从经销商的展场推上了互联网。直接销售车辆让车厂与客户个人建立了连结，这也许有助于在未来向他们推销其他服务。

并非所有移动出行方面的尝试都能成功。有些已经中途放弃。福特在2019年关停了Chariot服务。一年后Maven也停止了运营。几个月前，Free Now悄然注销了它的Hive电动滑板车业务，并在3月出售了帮助驾驶者寻找停车位并付费的应用ParkNow。正如艾意凯的阿什什·坎纳（Ashish Khanna）观察到的，在乘客数量稀少得多的远郊，网约车业务总归难以起飞。创业公司Superpedestrian经营共享电动滑板车业务，其老板阿萨夫·比德曼（Assaf Biderman）特别指出，城市外围地区仍旧是“为私家车而建”的。

然而，几十年后以传统方式销售的汽车可能会更少，直面这种现实的汽车制造商并不敢对任何事掉以轻心。如果说特斯拉有什么前车之鉴，那就是

在开车时睡着代价会非常惨重。 ■



Photography

Taking selfies with a liquid lens

A smartphone with a fluid lens

SERIOUS PHOTOGRAPHERS are usually laden with serious amounts of serious kit, especially multiple lenses. The paparazzi use zoom lenses to get a telescopic view of their subjects. Mid-range lenses are well-suited to street-scenes and portraits. Wide-angle lenses are good for capturing sweeping cityscapes. A macro lens is ideal for close-ups. But what if it were possible to build a single lens that could cover all such eventualities? Xiaomi, a Chinese electronics and consumer-goods company, is taking a shot in that direction.

On April 16th, Xiaomi's new Mi Mix Fold smartphone will go on sale, priced from 9,999 yuan (\$1,526). Like most new smartphones it is packed with whizzy features, including a flexible screen that can be folded open and shut. But what makes this new phone special is that it is the first to come equipped with a liquid lens.

A conventional camera lens consists of several specially shaped and polished glass or Perspex elements inside a tube. These act to deflect incoming light. By moving them closer or farther away, it is possible to focus an image onto the camera's sensor and, if it is a zoom lens, to adjust the magnification. In modern cameras the lenses are moved by electric motors.

There is little or no such paraphernalia involved with liquid lenses. They work a bit like the human eye, in which muscles squash or stretch an elasticated lens, altering its curvature so that a person can focus on objects at different distances. Most liquid lenses consist of an aqueous fluid, sometimes with an associated layer of oil, sitting on a water-repelling

surface. This surface causes the fluid to form into a spherical blob, like a bead of water sitting on a lily pad. Applying an electric charge to the edge of the blob attracts molecules in the liquid to the perimeter. This flattens the lens, thus changing its focal length. Conversely, reducing the charge sends the molecules back to the middle, causing the lens to fatten up again.

Liquid lenses of this type already have a number of uses, mostly in industry and medicine. Because they can focus rapidly on objects at different distances and tend not to wear out, they are sometimes employed as image sensors on automated production lines, and to read bar codes. They can also be made tiny, which means they are ideally suited for use with the laparoscopic cameras that are inserted into people's bodies during keyhole surgery.

Xiaomi, however, has taken a different direction in its new phone. It uses a thin, solid film to contain the lens fluid and a small, high-speed electric motor to stretch or relax this film in order to change the lens's curvature. The company says its lens can work as a 3x optical zoom (a figure that rises to 30x with "digital enhancement") and as a macro lens, focusing down to 3cm for taking close-up shots.

The company has not explained why it has taken this route with its liquid lens. Perhaps it is more familiar with the technology involved. Nor is it risking putting all its eggs in one basket, as the new phone is also equipped with a standard lens and an ultra wide-angle one. As it will be sold only in China it is, perhaps, partly experimental. Xiaomi did not respond to a request for more information.

As other smartphone-makers have been investigating the technology, it seems only a matter of time before liquid lenses replace some or all of the multiple lenses now appearing on phones. And with phones rivalling even some high-end cameras in picture quality, the makers of conventional

cameras might follow with liquid lenses of their own. Snappers, then, can look forward to their gadget bags getting a good deal lighter. ■



摄影

液态镜头玩自拍

一款配备液态镜头的智能手机

正经摄影师少不了要配备一大堆正经器材，特别是各种各样的镜头。狗仔队用长焦镜头远远窥探他们的跟踪对象。中焦镜头很适合拍摄街景和人像。广角镜头适于捕捉广阔的城市风光。微距镜头则是特写的最佳选择。但是如果能造出一个镜头来满足所有这些场景呢？中国电子和消费品公司小米朝这个方向按下了快门。

小米新一代Mix Fold折叠屏手机4月16日开售，起价9999元。和大多数新款智能手机一样，它也搭载了大量的炫酷功能，包括可折叠开合的柔性屏。但这款新机真正的独到之处在于其搭载的业内首个液态镜头。

传统相机镜头通常由几片经过特殊成型和研磨的玻璃或树脂镜片构成。它们可以使入射光线发生偏转。缩短或拉远镜片间的距离，便可以将图像聚焦到相机的传感器上。如果是变焦镜头，还可以调整放大倍率。现代相机一般用电动马达来移动这些镜片。

液态镜头则几乎或者完全不需要这样的装置。其工作原理有点类似人眼——通过肌肉挤压或拉伸有弹性的晶状体，改变其曲率，让眼睛聚焦于不同距离的物体上。多数液态镜头都包含一种水性液体，有时还附带一层油膜覆盖在一个斥水表面上。液体在这种表面会形成一个球形液滴，就像荷叶上的水珠一样。在液滴边缘施加电荷，就会吸引液体分子向四周扩散。这会让透镜变得扁平，从而改变焦距。相反，减少电荷会让分子向中部聚拢，让透镜再次隆起。

这种液态镜头已有多种用途，主要是在工业和医学领域。它们可以快速对焦不同距离的物体，而且一般不会磨损，因此有时被用于自动化生产线上的图像传感器，也用于读取条形码。它们还可以做得很细小，因而非常适合在微创手术中插入人体的腹腔镜。

但小米的新手机采用了另一种方式。它使用一层固体薄膜来容纳镜头中的液体，通过一个小型高速电动马达来拉伸或放松薄膜，从而改变镜头的曲率。该公司表示其镜头可以实现三倍光学变焦（通过“数字增强”可以达成30倍变焦效果），也可以用作微距镜头，以最小三厘米的对焦距离拍摄特写。

小米没有解释它的液态镜头为何走这条路线。也许是因为它对其中用到的技术更加熟悉。该公司也没有孤注一掷，因为这款新手机还配备了一个标准镜头和一个超广角镜头。由于只在中国销售，所以这可能有一定的实验性质。小米没有回应了解更多信息的请求。

其他智能手机制造商也已在研究这项技术，液态镜头部分或完全取代手机现有的各种镜头似乎只是时间问题。随着手机在拍照质量上甚至媲美一些高端相机，传统相机制造商可能也会跟风推出自己的液态镜头。如此一来，摄影师们的器材包就有望大大瘦身了。■



Fantastic beasts

Researchers have created embryos that are part-human and part-monkey

They could one day provide organs for transplant

THE ANCIENT GREEKS were good at inventing fantastical animals. The chimera, for instance, was “a thing of immortal make, not human, lion-fronted and snake behind, a goat in the middle”. It was eventually slain by Bellerophon, with help from his flying horse.

Not all chimeras are mythological. To biologists, the term describes organisms whose bodies consist of cells from two distinct lineages. In twin pregnancies, for example, one twin can occasionally absorb the other. The resulting individual is built from cells with separate genomes. A 2019 forensic-science conference discussed the case of a man who had received a bone-marrow transplant. Since bone marrow produces blood cells, subsequent DNA tests on the man’s blood matched his donor’s genome, not his own. (More unexpectedly, the donor’s DNA also turned out to be present in swabs taken from the man’s cheeks, and in his semen.)

For several decades scientists have been experimenting with cross-species chimeras, organisms which, as in the Greek myths, are composites of different animals. They have created mouse-rats, sheep-goats and chicken-quails. Now, in a paper published in *Cell*, Tao Tan, a biologist at Kunming University of Science and Technology, and a team of American, Chinese and Spanish researchers, report efforts to extend the principle to humans. They have managed to create embryos that are part-monkey and part-human.

The work builds on earlier endeavours by many of the same researchers. In 2017 Juan Carlos Izpisúa Belmonte, a biologist at the Salk Institute in San Diego, announced the creation of chimeric human-pig embryos. But

quite how successful those efforts were is uncertain. Only about one cell in 100,000 in the embryos were human, and it was unclear whether they contributed to the organism's growth. This time things are different. The human cells seem happy to co-operate, at least some of the time, with the monkey ones.

The researchers began with 132 embryos of the crab-eating macaque. Six days after fertilisation these were injected with human extended pluripotent stem cells, which can develop into any other cell type found in the body. Tagging the human cells with fluorescent markers allowed the researchers to track where in the developing embryo they, and their descendants, went.

In the early stages of development, mammal embryos develop into four distinct cell types. Epiblasts go on to form the organism itself; hypoblasts develop into the yolk sac; trophectoderms become the placenta and extra-embryonic mesenchyme cells make a membrane that surrounds the embryo. The chimera's human cells made their way into all four types of tissue, though they were outnumbered in every case. No more than 7% of the epiblast was made up of human cells, and just 5% of the hypoblast (in other areas the numbers were lower still).

The cells' location seemed to influence which proteins they produced. Human cells in the chimera's epiblast behaved more like those found in human embryos than those found in monkey embryos. But that was not true of human hypoblast or extra-embryonic mesenchyme cells, both of which behaved more like monkey cells.

The monkey cells, in turn, were affected by the presence of the human ones. The researchers found 126 different sorts of cell-to-cell interactions among monkey cells in the chimeric embryos, compared with just 19 in non-chimeric ones, as well as differences in the activity levels of many

genes.

The cells were grown in a lab, which imposed limitations. The number of surviving embryos began falling by day 15. By day 20 none was left. But that was enough time for a process called gastrulation to take place. Gastrulation is a vital development stage in which embryonic cells become primed to form different organs and tissues. The human cells took longer to reach this point than the monkey ones did. But they managed nevertheless, providing more evidence that the human cells were not merely passive passengers, but were “mucking in” to help with the process of embryonic development.

The researchers hope this biotechnological wizardry will help with two goals. One is to shed light on the complicated process of embryological development, which might eventually lead to treatments for some congenital diseases. Chimeras may offer a way around some of the ethical difficulties involved in experimenting on human embryos.

The other is the hope that chimeric animals might one day provide a source of organs to be transplanted into sick humans. In 2017 Japanese researchers demonstrated the principle by transplanting parts of a pancreas that had grown inside a mouse-rat chimera into a diabetic mouse, curing it. Whether that can work in people is, for now, unclear. And research into human chimeras is ethically fraught. America, for instance, forbids federal funding of such work. Most of the work reported in this latest paper happened in China.

But if chimeric human organs do become a reality, macaques are unlikely to be the animal of choice, says Dr Izpisúa Belmonte. The most likely donor would probably be pigs (this is why his 2017 experiment focused on the animals). Their organs are roughly the size of their human equivalents, and, fairly or unfairly, they seem to provoke fewer moral qualms. (Pigs already provide thousands of people with replacement heart valves, for instance.)

The advantage of working with monkeys, at least for now, is that they are much closer, in evolutionary terms, to humans. That may have helped smooth out any compatibility issues between the two sets of cells. The hope is that lessons from experiments with humanity's close cousins might allow the researchers to revisit their work with its more distant, porcine relatives—and get better results. ■



神兽

研究人员创造出了半人半猴的胚胎

它们某天或许可以提供移植器官

古希腊人擅长想象神奇动物。比如，客迈拉（chimera）是“一种不朽的创造物，非人类，狮头，蛇尾，羊身”。柏勒洛丰（Bellerophon）在他的飞马的助力下，最终将其杀死。

并非所有chimera都是神化虚构。在生物学家口中，这个词意指那些身体由来自两个不同谱系的细胞组成的生物。例如，在双胎妊娠中，一个胎儿偶尔会把另一个“吸收”掉，最后出生的个体是由具有不同基因组的细胞组成的。2019年，一次法医科学会议讨论了一名男性接受骨髓移植的案例。由于骨髓产生血细胞，后续对这名男子的血液DNA检测显示它匹配的是供体的基因组，而不是他自身的基因组。（更出人意料的是，在他的口腔拭子和精液中也发现了供体的DNA。）

几十年来，科学家一直在试验创造跨物种嵌合体——和希腊神话中的神兽一样，它是不同动物的复合体。他们创造了小鼠-大鼠、绵羊-山羊以及鸡-鹌鹑嵌合体。现在，昆明理工大学的生物学家谭韬和一个由美国、中国和西班牙的研究人员组成的团队在《细胞》期刊上发表的研究尝试将这种原理扩展到人类。他们成功地创造出了部分猴子、部分人类的胚胎。

这项研究建基于许多团队成员此前的探索之上。2017年，圣地亚哥的索尔克研究所（Salk Institute）的生物学家胡安·卡洛斯·伊兹皮苏亚·贝尔蒙特（Juan Carlos Izpisúa Belmonte）宣布创造出了人-猪嵌合胚胎。但这些研究到底有多成功仍不确定。这些胚胎中每十万个细胞里大约有一个人类细胞，而且也不清楚它们是否对生物体的生长有贡献。这次情况有所不同。至少在某些时候，人类细胞似乎乐于和猴子细胞合作。

研究人员从食蟹猕猴的132个胚胎着手。在受精后的第六天向它们注射人类扩展多能干细胞（EPSC）。这些干细胞可以发育成嵌合体内的任何其

他细胞类型。用荧光标记物标记人类细胞，研究人员就能够追踪这些细胞及其后代在发育的胚胎中的位置。

在发育的早期，哺乳动物的胚胎会形成四种不同的细胞类型。外胚层继续形成生物体本身；内胚层发育成卵黄囊；滋胚层变成胎盘；胚外间充质细胞形成包裹胚胎的膜。嵌合体中的人类细胞参与生成了所有四类组织，尽管在每一类中的数量都少于猴子细胞。人类细胞在外胚层中的占比不超过7%，在内胚层只有5%（在另两类中占比还要少）。

细胞所在的位置似乎会影响它们生成何种蛋白质。嵌合体外胚层中的人类细胞的行为更近似于人类胚胎细胞，而不像猴子胚胎细胞。但内胚层或胚外间充质细胞中的人类细胞的行为却都更像猴子细胞。

反过来，猴子细胞也受到了人类细胞存在的影响。研究人员发现，嵌合胚胎中的猴子细胞之间有126种不同类型的细胞间相互作用，而在非嵌合体中只有19种。此外许多基因的活性水平也存在差异。

这些细胞是在实验室里生长的，这带来了局限性。到了第15天，存活的胚胎数量开始下降。到第20天已一无所剩。但这段时间已经足以发生一个名为“原肠胚形成”的过程。原肠胚形成是一个至关重要的发育阶段，胚胎细胞在此期间准备好形成不同的器官和组织。人类细胞达到这个节点所花的时间比猴子细胞更久，但它们还是做到了。这就提供了更多证据，证明人类细胞不仅仅是被动的搭乘者，而是在“一同出力”帮助了胚胎的发育过程。

研究人员希望这种生物技术的巫术能够帮助实现两个目标。一是阐明胚胎发育的复杂过程，这最终可能导向对某些先天性疾病的疗法。嵌合体可能提供了一个办法来绕过在人类胚胎上做实验所涉及的某些伦理困境。

另一个希望是有朝一日嵌合动物或许能提供可移植给患者的器官。2017年，日本的研究人员演示了这个原理。他们把在小鼠-大鼠嵌合体中生长的胰腺的某些部分移植给了一只糖尿病小鼠并治愈了它。这是否能运用于人体目前尚不清楚。而对人类嵌合体的研究充满了伦理争议。例如美国就

禁止联邦资助这类研究。这篇最新的论文中所述的研究大部分发生在中国。

但如果嵌合人体器官真的成为现实，伊兹皮苏亚·贝尔蒙特博士说，猕猴不太可能成为首选动物。最有可能的供体来源或许是猪（这就是为什么他2017年的实验专注于猪）。它们的器官与人类的对应器官差不多大小。而且，不管是否公平，它们似乎更少引发道德上的不安。（举例来说，猪已经成为成千上万人提供了替代心脏瓣膜。）

至少目前而言，与猴子合作的好处是从进化的角度来说它们和人类要亲近得多。这可能有助于消除两组细胞之间的任何排异问题。值得期待的是，从与人类的近亲合作中所获的经验或许可以让研究人员改进在猪这种远亲上所做的研究，获得更好的结果。 ■



They think it's all over

Europe's Super League scores a spectacular own goal

The football clubs' failed venture has weakened their future bargaining position

THEY PROMISED to “deliver excitement and drama never before seen in football”, and for a few short days they succeeded—just not in the way they had hoped. On April 18th a dozen of Europe’s top football clubs announced plans to disrupt the game with a breakaway “Super League”. Investors cheered. But fans revolted, broadcasters turned up their noses and governments vowed to block the plan. Within 48 hours half of its founding members dropped out. It was soon declared dead.

What began as a daring bid to seize control of elite football now looks like a damaging own goal. The Super League promised its members financial security and sporting prestige. Instead the “dirty dozen” rebels have been forced to grovel to supporters and in some cases jettison their bosses. Their bargaining power over rival teams and league organisers has been weakened. They may face tighter regulation by governments responding to furious fans.

The plan was for 20 clubs to compete in a Europe-wide league, kicking off in August. Fifteen “founding” clubs would be guaranteed a spot every year, with the remaining five places awarded competitively. The 12 clubs that broke cover comprised England’s “Big Six” (Arsenal, Chelsea, Liverpool, Manchester City, Manchester United and Tottenham), plus three from Spain (Barcelona, Atlético Madrid and Real Madrid) and three from Italy (AC Milan, Inter Milan and Juventus, whose part-owner, Exor, also owns a stake in The Economist’s parent company). JPMorgan Chase was to stump up €3.3bn (\$4bn) of financing to get the league off the ground. An equivalent women’s competition was planned.

The venture's stated aim was to give the world's best clubs more chances to play each other than Europe's main existing club competition, the Champions League. Barcelona and Bayern Munich have faced each other fewer than a dozen times in their history. Big clashes would bring in more viewers and more money: the Super League's organisers had hoped that broadcasting rights might generate €4bn a year, nearly double the €2.4bn brought in by the Champions League in the 2018-19 season.

Automatic qualification looked even more appealing. Unlike American teams, European sides play in open leagues, where poor performers get demoted to a lower tier, with stingier broadcasting and sponsorship deals. Club owners thus gamble on making it to the top, investing generously at the expense of profits. In closed contests like America's National Football League (no relation to what Americans insist on calling soccer), clubs face no risk of relegation and so co-operate more. "Draft" systems allocate talent more equally and wages are often capped—something that the Super League hinted it might do, via an agreed "spending framework". Clubs in closed leagues must worry only about economic competition from rival leagues, which require more upfront investment to start than an individual club.

The combination of less risk and less competition for talent produces higher profits for owners. Forty-three of the world's 50 most valuable sports teams are American, according to a ranking last year by Forbes magazine. By contrast, European sport is a dicey business: between 1992 and 2014 there were 45 insolvencies in the top three tiers of English football, 40 in France and 30 in Germany. "Football is essentially insolvent," notes Stefan Szymanski, a sports economist at the University of Michigan. Without their deep-pocketed owners, most clubs would not be going concerns. The American owners of teams such as Manchester United and Liverpool look at the European system and wonder, "Why this insecurity?" says François Godard of Enders Analysis, a research firm. That explains why investors

liked the Super League. United's share price rose by as much as 10% the day after it was announced and that of Juventus by 19%.

Fans saw it differently. "Created by the poor, stolen by the rich", read one of the banners displayed outside Manchester United's ground. A poll by YouGov found that 79% of British football fans opposed the Super League, 68% of them "strongly"; opposition was fiercer still among fans of clubs outside the "Big Six". Sensing the mood, broadcasters including Sky and Amazon hurried to distance themselves from the league. Boris Johnson, Britain's prime minister, vowed to "do everything I can to give this ludicrous plan a straight red". All six British teams pulled out on April 20th, followed by Atlético Madrid and the two Milanese teams. At that point the league's organisers pronounced it dead.

Some of the clubs involved are thought to have seen the idea as, at worst, a bargaining chip to negotiate better terms with their existing league. The top clubs have long argued that, as the main attraction, they deserve a bigger slice of revenues and a bigger say in how leagues are run. Breaking away has always been used as a threat—and has often worked. In 1998, the last time the idea of an elite European competition was raised, Europe's football association responded by enlarging the Champions League, as the big teams had requested.

The Super League's implosion shows the threat was empty, says a director of another top-flight Premier League club. The debacle presents "an opportunity for the wider community to drive a harder bargain", he says. A new round of Premier League broadcasting rights is to be auctioned soon. The Big Six are in a weaker position than before to negotiate their cut.

Another threat comes in the form of regulation. Britain's sports minister, Oliver Dowden, promised to "put everything on the table" to stop the new league, from competition law to governance reform. On April 19th the

government launched a wide-ranging review into how football is run. British fans have noted that no German club joined the rebels, which they attribute to Germany's community-ownership model (though ownership by fans did not dissuade Barcelona and Real Madrid from joining). The French, Spanish and Italian leagues, which are in poorer financial health than England's, will be watching the outcome closely. "Owners should remember that they are only temporary custodians of their clubs; they forget fans at their peril," Mr Dowden declared. Spectators who enjoy a sporting upset could be in for an exciting season. ■



他们以为都结束了

欧洲超级联赛大摆乌龙

各大足球俱乐部冒险失败，未来议价能力下降

他们承诺“带来足球界前所未见的精彩刺激”，短短几天，这目标就实现了，但不是以他们希望的方式。4月18日，12家欧洲顶级足球俱乐部宣布计划，要打破现有游戏方式，自立门户，推出“欧洲超级联赛”（Super League，以下简称欧超）。投资者欢呼雀跃，但球迷们群起抵制，转播商嗤之以鼻，各国政府誓言阻止。不到48小时，就有一半创始成员俱乐部退出。计划随即宣告流产。

这次为抢夺精英足球圈控制权的大胆尝试，如今看来就像一个后果严重的乌龙球。欧超向其成员俱乐部承诺资金支持和体育声望。结果却是“十二大”叛徒被迫向球迷屈服道歉，有些甚至换掉了老板。他们在对手球队和联赛组织者面前的议价能力被削弱。在球迷的群情激愤下，政府可能对这些俱乐部施加更严格的监管。

这项叛逃计划是在全欧洲组织一个20家俱乐部参加的联赛，于今年8月开赛。15支“创始”球队保证每年获得参赛名额，其余五个名额则通过竞争获得。12家叛逃俱乐部包括英超“六强”（阿森纳、切尔西、利物浦、曼城、曼联和托特纳姆热刺），三家西班牙俱乐部（巴塞罗那、马德里竞技和皇家马德里）和三家意大利俱乐部（AC米兰、国际米兰和尤文图斯；尤文图斯的股东Exor集团同时也是本刊母公司的股东）。摩根大通将提供33亿欧元（40亿美元）帮助启动欧超。他们还计划创办相应的女足联赛。

欧超对外宣称的目标是让全球顶级俱乐部在欧洲现有的主要俱乐部赛事欧洲冠军联赛之外能有更多对垒的机会。这么多年来，巴塞罗那和拜仁慕尼黑交手还不到12次。重量级碰撞能带来更多观众和收入：欧超的组织者本来期待靠转播权每年能进账40亿欧元，是2018至2019赛季欧冠联赛24亿欧元收入的近两倍。

自动入围机制看起来就更有吸引力了。不同于美国的足球队，欧洲球队目前参与公开的联赛，表现不好的球队会被降级，转播和赞助收入都会缩水。因此，俱乐部老板们以牺牲利润为代价投入巨资，押注球队打入顶级圈子。在美国职业橄榄球大联盟（America's National Football League，和美国人坚持叫soccer的足球没什么关系）这类封闭性赛事中，俱乐部没有降级的风险，所以相互合作更多。“选秀”制度让人才能更均匀地分配到各个俱乐部，通常还设有工资帽——欧超暗示可能会通过协定“支出框架”来效仿。除了和其他联赛在收益上的竞争，参与封闭式联赛的俱乐部没什么好担心的。而启动一个联赛所需的前期投资要多于打造一家俱乐部。

风险较低，加上不用争夺人才，球队老板就能赚到更高的利润。《福布斯》杂志去年的排名显示，全球50支价值最高的职业运动队中有43支在美国。相比之下，在欧洲投资球队是门有风险的生意：1992年至2014年，英格兰足球三个最高级别联赛中有45家俱乐部破产，在法国是40家，德国30家。“足球基本上都是资不抵债的。”密歇根大学的体育经济学家斯蒂芬·希曼斯基（Stefan Szymanski）指出。如果没有资金雄厚的老板支撑，这些俱乐部大多难以持续经营。研究公司恩德斯分析（Enders Analysis）的弗朗索瓦·格达德（François Godard）说，曼联和利物浦等球队的美国老板看着欧洲的联赛机制心下纳闷，“为什么要这么不安全？”这正是投资者欢迎欧超的原因。组建欧超的消息宣布后翌日，曼联的股价上涨了10%之多，尤文图斯的股价更是上涨了19%。

球迷们不这么看。“由穷人创造，被富人偷盗。”曼联球场外的一条标语写道。YouGov的民意调查显示，79%的英国球迷反对欧超，68%“强烈”反对；在“六强”以外俱乐部的球迷中，反对声更是激烈。感觉到了这种情绪后，英国天空电视台和亚马逊等广播商急忙与欧超划清界线。英国首相约翰逊誓言要“尽我全力给这荒唐的计划直接亮红牌”。4月20日，六支英国球队全部退出，马德里竞技和米兰双雄紧随其后。至此，欧超的组织者宣布计划告终。

一些人认为，有些俱乐部加入欧超是以这至少可以作为筹码，与现有联赛谈判更好的条件。长期以来，顶级俱乐部一直提出自己作为赛事的焦点

所在，应该拿走更大比例的收入，并在联赛运作上有更多发言权。退赛一贯被用作威胁手段，也往往能奏效。上一次有人提出组织顶级欧洲联赛的想法是在1998年，当时欧足联的应对办法是如大球队所愿扩大了欧冠。

另一家顶级英超俱乐部的某位董事表示，欧超的自我瓦解表明这样的威胁只是空话。他说，这次失败为“更广泛群体提供了更大的杀价机会”。很快将举行新一轮的英超联赛转播权拍卖。“六强”在分成问题上的议价能力有所减弱。

另一个麻烦会以监管的形式出现。英国体育大臣奥利弗·道登（Oliver Dowden）承诺“以一切可行手段”来阻止新联赛，包括竞争法规和治理改革。4月19日，英国政府启动了对足球运作机制的全面审查。英国球迷注意到没有一家德国足球俱乐部加入叛军之列，他们将之归因于德国俱乐部的社区所有权模式（但是，归球迷所有并没有阻止巴塞罗那和皇家马德里加入欧超）。财务状况不如英格兰联赛的法国、西班牙和意大利联赛将密切关注最终结果。“俱乐部的老板们要记住他们只是球队一时的监护人，不把球迷放眼里，只会自己吃亏。”道登宣称。喜欢爆冷的观众或许将迎来一个刺激的赛季。 ■



Reformulated

Pfizer's boss thinks covid-19 is reshaping Big Pharma for the better

The industry is becoming nimbler and more innovative

"THE IMPOSSIBLE can many times become possible," reflects Albert Bourla, boss of Pfizer. He is talking about the giant American drugmaker's speedy development (with BioNTech of Germany) of a vaccine against covid-19. The sentiment also applies to the turnaround in the fortunes of the pharmaceutical industry.

Before the pandemic Big Pharma was in big trouble. It was widely criticised for investing more in marketing than in research, for pursuing "me too" drugs over novel therapies, and for alleged price-gouging. When Gallup, a pollster, asked Americans in 2019 to rank two dozen big industries by favourability, the drugs business came in last. That year its bosses were subjected to a Big Tobacco-style bipartisan hazing in Congress, which threatened price controls. Concerns over diminishing research gains, and returns, weighed on drugmakers' share prices (see chart).

At first, the pandemic looked like another blow. Supply chains for essentials such as precursor chemicals were disrupted. As hospitals focused on covid-19, lucrative elective treatments were postponed. So were clinical trials of new medicines, on which future profits depend. Then something happened. As economies gradually reopened last year, drug sales began to recover. Several firms have, like Pfizer, come up with effective vaccines against covid-19. Pfizer reckons the sales of its jab will surpass \$15bn in 2021. The firm reckons it could add more than \$4bn to its adjusted profits before tax. Investors are becoming more bullish on the sector.

The reasons for optimism extend beyond the covid-19 jab. Another pharma

boss recently declared to a private audience that the pandemic was “a significant inflection point for the industry”. Unlikely as it may have seemed a year ago, a nimbler, more innovative business is emerging from adversity.

The breathless race against covid-19 led pharma to “break all of the rules”, says Tim van Biesen of Bain, a consultancy. This prompted CEOs to ask why they weren’t more agile in their day-to-day operations. John Reed, head of research and development (R&D) at Sanofi, a French giant, says the pandemic has pushed decision-making lower down the corporate ladder, helping his firm move with a greater sense of urgency. “We got trial concepts together in three or four days that took three or four months in the past,” he marvels.

Sam Glick of Oliver Wyman, a consultancy, notes that new patient enrolment for clinical trials, which plunged by nearly 80% amid the pandemic, has rebounded as firms have embraced digital tools such as remote monitoring, electronic patient-screening and tele-consultations. David Ricks, who runs Eli Lilly, another big American drugmaker, has said that virtual trials could prove faster and better, as well as bringing in harder-to-reach populations, for instance in rural areas. Andrew Badley of the Mayo Clinic, a leading American hospital chain, argues that drugmakers’ boffins are for the first time making good use of unstructured data such as clinicians’ notes. Digitisation allowed Pfizer to keep all of its trials on track in 2020. “We wouldn’t have dared to test these things before the pandemic but they passed with flying colours,” Mr Bourla says. They are here to stay.

Pharmaceutical sales reps, whom the pandemic has deprived of the opportunity to put on “educational” junkets for doctors, are also going digital. Eli Lilly’s boss has estimated that his firm’s virtual contacts rose more than ten-fold in 2020 compared with a year earlier. He reckons they, too, will be maintained, as they may allow the firm to “reach those physicians who wouldn’t see our sales representatives”. Mr Bourla agrees,

reporting that “doctors like it”. McKinsey Global Institute (MGI), the consultancy’s in-house think-tank, calculates that the shift to digital sales could raise industry-wide productivity by a quarter, since it means a smaller staff and leaner budgets in marketing and sales departments, which account for nearly 40% of drugmakers’ operating costs.

Big Pharma’s sclerotic innovation model is also being shaken up. In the past there were “way fewer targets” for drug firms to pursue, says Mr Bourla, so it made sense to bet big on a few blockbusters. Now, he observes, firms must choose among hundreds of possibilities. This “explosion of new platforms and drug candidates will result in much more collaboration” of the Pfizer-BioNTech sort, predicts David Risinger of Morgan Stanley, an investment bank. Drugmakers are obsessed with guarding intellectual property but many industry watchers, including Mr van Biesen of Bain, have long argued that they should embrace more open-source innovation. A flurry of recent collaborations suggests that they may at last be listening.

Perhaps the most surprising reason for optimism about Big Pharma’s prospects arises from its burnished image. Many Americans had never heard of Pfizer and those that did probably thought of it as money-grubbing. Now the company is hailed by ordinary people as a life-saving innovator. “Big Science is good, and Big Pharma now has a seat firmly at the table and has a chance to be ‘good’ again,” thinks David Frey of KPMG, a consultancy. A recent Harris Poll found that public approval of the industry has shot up from around 30% last year to over 60%.

Will drugmakers seize the moment? Mr Bourla says that Pfizer does not support the status quo on drug prices in America. These are high by global standards, and contribute the lion’s share of profits for the global drugs business. He goes further, insisting that Pfizer is “willing to contribute financially” to reforms that give “access for all”, so long as insurers and government chip in too. If he can persuade his fellow pharma bosses to

support this new social contract, it could be an even bigger feat than those incredible covid-19 shots. ■

Dig deeper

All our stories relating to the pandemic and the vaccines can be found on our coronavirus hub. You can also listen to The Jab, our new podcast on the race between injections and infections, and find trackers showing the global roll-out of vaccines, excess deaths by country and the virus's spread across Europe and America. ■



新药方

辉瑞老板认为疫情让大药厂变得更好

制药业正变得更灵活、更具创新力

“很多时候，不可能也会成为可能。”美国制药巨头辉瑞的老板艾伯乐（Albert Bourla）在谈到（与德国拜恩泰科[BioNTech]合作）快速研新冠疫苗时沉思道。这一感受也可以用来描述制药业的命运转折。

在新冠疫情之前，大型制药公司可是遇到了大麻烦。它们更多投资于营销而不是研发，追求推出“派生药”而不是钻研创新疗法，还被指控哄抬药价，因而广受批评。2019年，民调机构盖洛普（Gallup）让美国人按喜爱程度给20多个大型行业排名，结果制药业垫底。同年在国会，药厂老板像大烟草公司一样受到两党责难，国会威胁要实施价格管制。市场担心研发收益和投资回报衰减，令制药公司的股价承压（见图表）。

起初，这场疫情看似是又一记沉重打击。前体化学品等关键物资的供应链中断。医院忙于应对新冠肺炎，推迟了利润丰厚的择期治疗。新药的临床试验也因疫情延后，而它们是未来利润所在。然后，转机出现了。随着去年各经济体逐渐重新开放，药品销售开始复苏。包括辉瑞在内的几家公司研制出了有效的新冠疫苗。辉瑞估计2021年它的疫苗销售额将超过150亿美元。它还估计，这将使它调整后的税前利润增加40多亿美元。投资者开始看好这个行业。

乐观的理由不仅仅在于新冠疫苗。另一位药厂老板最近在一个私人场合宣称这次疫情是“制药业的一个重大转折点”。一个更灵活、更有创新力的产业正从逆境中崛起，这在一年前似乎还不可想象。

咨询公司贝恩的蒂姆·范比森（Tim van Biesen）表示，在与新冠病毒争分夺秒的赛跑中，制药公司“打破了一切规则”。这让CEO们开始自问，公司的日常运营为什么不能更灵活一些。法国巨头赛诺菲（Sanofi）的研发主

管约翰·里德（John Reed）表示，疫情将公司的决策推到了更低的层级，推动公司以更多的紧迫感行动。“我们只花三四天就拿出了试验概念，这在过去要三四个月。”他惊叹道。

奥纬咨询（Oliver Wyman）的山姆·格里克（Sam Glick）指出，疫情期间，临床试验的新病人入组人数骤减了近80%，但随着公司采用诸如远程监护、电子病人筛查和远程会诊等数字工具，人数已经回升。美国另一家大药厂礼来（Eli Lilly）的掌门人戴文睿（David Ricks）表示，虚拟临床试验可能会被证明更快更好，还能覆盖以往较难接触到的人群，例如农村居民。美国领先的连锁医院妙佑医疗国际（Mayo Clinic）的安德鲁·巴德利（Andrew Badley）认为，药厂研究人员有史以来第一次得以充分利用非结构化数据，如临床医师记录。得益于数字化手段，辉瑞的所有试验在2020年均保持正常推进。“在疫情之前，我们是不敢测试这些东西的，但它们出色地通过了考验。”艾伯乐说。这些做法将会保留下。

疫情之下，医药销售代表没有机会为医生组织“进修”旅游，于是也走上了数字化路线。礼来的老板估计，2020年公司的虚拟联系人数量比一年前增长逾十倍。他估计这些人脉关系也将维系下去，因为公司可以用这种方式“联系上那些不愿见我方销售代表的医生”。艾伯乐同意这种说法，表示“医生喜欢这种方式”。麦肯锡的智库麦肯锡全球研究院计算认为，转向数字化销售可以将整个行业的生产率提高四分之一，因为这意味着员工人数缩减，营销与销售部门预算也可以更精益，而这部分占了药厂运营成本的近40%。

大药厂僵化的创新模式也被撼动。艾伯乐表示，过去制药公司能追逐的“靶点少得多”，自然而然就会在少数几款重磅产品上押下重注。而现在，他注意到它们必须在数百种可能性中做选择。投资银行摩根士丹利的戴维·瑞辛格（David Risinger）预测，“新平台和候选药物的激增将导致更多协作”，就像辉瑞和拜恩泰科那种。制药公司极为看重知识产权保护，但包括贝恩的范比森在内的许多行业观察人士一直都在呼吁制药公司拥抱更多开源创新。近期一系列的合作表明它们可能终于听进去了。

大药厂的前景乐观，最意想不到的原因可能是它们焕然一新的形象。许多美国人从未听说过辉瑞，而听说过的人可能也只认为它是个敛财机器。现在，普罗大众将这家公司奉为拯救生命的创新者。咨询公司毕马威的方大伟（David Frey）认为：“‘大科学’是好公司，而大药厂现在上了台面，牢牢地占据了一席之地，有机会再次变‘好’。”哈里斯民调（Harris Poll）最近一次调查发现，公众对该行业的认可度从去年的30%左右飙升至60%以上。

制药公司能把握住这个机会吗？艾伯乐表示，辉瑞并不支持美国药价的现状。按全球标准来看它们过高了，而且为全球制药业贡献了最大一块利润。不止于此，他还坚称辉瑞“愿意做出财务贡献”，推进“让人人用得起药”的改革——只要保险公司和政府也参与进来。如果他能说服其他药厂老板支持这一新的社会契约，这可能比研发出不可思议的新冠疫苗更加功德无量。

欲了解更多：

本刊所有疫情和疫苗相关文章都可以在官网的新冠专题页面查看。您还可以收听我们关于接种与感染的赛跑的新播客《接种》(The Jab)，并通过我们的追踪示意图了解疫苗的全球接种进度、各国的额外死亡人数以及病毒在欧美的传播情况。 ■



From handshake to clenched fist

CEO activism in America is risky business

Firms used to keep politics at arm's length. What went wrong?

IF YOU ARE an emblem of American harmony like Coca-Cola, you play your politics carefully, especially on issues as divisive as race and voting. The soft-drinks company did so brilliantly in 1964 when the elite of Atlanta—home to both Coca-Cola and Martin Luther King—threatened to snub the civil-rights leader on his return from winning the Nobel peace prize. Appalled at the potential embarrassment, Coca-Cola's current and former executives worked quietly behind the scenes to persuade other industrialists to attend a dinner in King's honour. They even sang “We Shall Overcome”.

Coca-Cola has weighed in this year, too, before and after Brian Kemp, Georgia's Republican governor, signed a new law on March 31st that critics said would suppress black voters. The firm's discreet efforts to soften aspects of the bill before its passage backfired twice over. First, civil-rights groups accused it of pusillanimity. When its boss, James Quincey, subsequently joined other Atlanta natives such as Delta Air Lines in expressing disappointment at the outcome, Republicans branded Coke and the others “woke” hypocrites.

On April 14th hundreds of companies, including giants like Amazon and Google, and big-name businesspeople, among them Warren Buffett, published a letter opposing “any discriminatory legislation” making it harder to vote. One prominent signatory, Kenneth Frazier of Merck, a drugmaker, told the New York Times it was meant to be non-partisan. In the words of William George of Harvard Business School, himself a former CEO, voter suppression “puts democracy at risk, and that puts capitalism at risk”.

Republicans, who have been pushing the bills in response to Donald Trump's big lie that he was denied a second presidential term by widespread fraud, call the corporate finger-wagging nakedly political. That so many household brands and boardroom grandes nevertheless increasingly wag their fingers at the traditionally business-friendly Republican Party shows that they are prepared to break a code of political silence that has served corporations well since the dawn of American capitalism. Why? And what effect will it ultimately have on their business?

America Inc was built on top of a legal innovation: the limited liability company. Originally such corporate structures still needed to secure a government charter to operate, which often involved greasing plenty of official palms. A succession of court rulings in the first half of the 19th century allowed firms to put politics at arm's length. Afterwards they needed only ambition and willing investors. The result was the most fecund business environment of all time.

In the early 20th century some bosses rediscovered politics, using their companies' wealth to buy cronies in government. In the aftermath of the second world war, the door between industry and political office was not so much revolving as wide open. "Electric Charlie" Wilson, boss of General Electric, and "Engine Charlie" Wilson, boss of General Motors, worked for several administrations in the 1940s and 1950s. The period until the 1960s was a time of what John Kenneth Galbraith, a gadfly economist, called "countervailing power". Big business was in a well-balanced scrum with big government and big labour. Some CEOs behaved like industrial statesmen, offering jobs for life to workers, building villages and golf courses, and presenting themselves as guardians of society.

That equilibrium was shaken in 1970 by Milton Friedman, a Nobel-prizewinning champion of laissez-faire economics. He argued that

executives' sole responsibility was to shareholders. So long as markets were free and competition fierce, maximising shareholder value would help society, by ensuring better products for customers and better conditions for workers. Firms that failed on either count would see buyers and employees defect to rivals. Republicans like Ronald Reagan embraced Friedman through shrinking government and deregulating the economy. This gave rise to superstar firms and the cult of the celebrity CEO in the 1980s and 90s.

Even so, businessmen held their tongues on political matters. Instead, they put their faith in paid lobbyists and used industry groups like the Business Roundtable to campaign on their behalf. The lobbying concerned almost exclusively matters of direct concern to their bottom lines, such as taxes, regulations or immigration policies that might affect their employees. They studiously kept out of the broader political hurly-burly.

Corporate cash continues to flow into politics. But in recent years it is accompanied by a parallel stream of CEO activism. Weber Shandwick, a public-relations firm, dates this phenomenon back to 2004, when Marilyn Carlson Nelson, boss of Carlson Companies, a travel business, took a stand against sex trafficking. Her fellow travel bosses thought such pronouncements would hurt the industry's neutral image. Instead, she was treated as a heroine by customers. CEOs in other industries took note. gingerly at first and more conspicuously in the past five years or so, they began weighing in on subjects from the #MeToo and Black Lives Matter movements to religious-freedom laws, gun control, gay rights and transgender-bathroom bills. Mr Trump's divisive actions, such as a temporary ban on visitors from some Muslim countries, withdrawal from the Paris climate agreement or reaction to racist protests in Charlottesville, caused outrage across corporate America (even as it lapped up his tax cuts).

Mr Trump's tenure also coincided with a period when public trust in government was already in decline, while that in business was rising.

Despite corporate America's image as handmaiden of heartless capitalism, Americans trust business a bit more than they do government or NGOs. Edelman, another PR firm, finds that 63% of Americans think CEOs should step in when governments do not fix societies' problems. Heeding the call, in August 2019 members of the Business Roundtable, including bosses of 150 blue chips in the S&P 500 index, pledged to consider not just shareholders but also workers, suppliers, customers, the environment and other "stakeholders" in corporate decisions.

The trouble with such CEO advocacy is a lack of clarity about its motivations and impact—on the issues themselves, as well on the businesses in whose name it is undertaken. Although a lot of it is probably well-meaning, it is muddied by suspicions of hypocrisy and grandstanding. Before Christmas The North Face rejected an order from a Texas oil company for 400 of its pricey outdoor jackets because it did not want its brand associated with fossil fuels. Last month an oil-industry group in Colorado awarded the company a tongue-in-cheek "extraordinary customer award". It noted that many of its clothing products are made with products of petroleum—including its jackets.

In terms of its impact on hot-button issues, corporate activism can backfire if it causes the party against which it is directed to dig in its heels. Jeffrey Sonnenfeld of the Yale School of Management, who organised a gathering of CEOs on April 10th to discuss voter laws, acknowledges partisanship is involved. He believes both business and Mr Biden share a common interest in the centre ground. In the face of opposition from "liberal elites", to which many bosses are seen to belong, Republicans may be more emboldened to press on with restrictive voter laws—just to rub it in.

Chief executives claim that they simply have no choice but to tackle societal concerns because in the age of social media their customers, employees and shareholders demand it. The evidence for such assertions is mixed.

Start with consumers. Some polls show that supporters of each party would buy more goods from companies that lean either right or left. But other research has found that consumers were more likely to remember a product they stopped using in protest at what a CEO said rather than one they started using in support. After a shooting spree in one of its superstores in 2019 Walmart banned some sales of gun ammunition. A subsequent study found that footfall in Walmart stores in Republican districts fell more sharply as a result than it rose in Democratic ones.

The impact on employees is also inconclusive. Many tech firms in the knowledge economy are happy to wear their leftie leanings on their sleeves, believing this will attract bright millennial workers who tend to share such views. But it can go too far. Lincoln Network, a conservative-leaning consultancy, found that firms promoting a political agenda can have an oppressive internal monoculture, which stifles creativity rather than fostering it.

Then there are the shareholders. Bosses rarely consult them before making political statements. Lucian Bebchuk of Harvard Law School found that among signatories of the Business Roundtable's stakeholder pledge only one of 48 for whom data were available had consulted their board beforehand. That suggests a lot of the pro-social rhetoric is lip service.

Investors seem to see it that way. The share prices of S&P 500 companies whose bosses signed that declaration—which, if taken at face value, would mean that shareholders would have to share the spoils with other stakeholders—performed almost identically to those of companies whose CEOs were not among the signatories. That implies that markets did not consider the rhetoric to be of material importance. The fact that some of the loudest proponents of stakeholder capitalism, such as Salesforce, laid off workers amid the pandemic despite record revenues suggests that investors may be onto something.

In time, shareholders themselves may become more political. The rise of investment funds that consider environmental, social and governance (ESG) factors suggests an appetite for certain forms of social stance-taking when allocating capital. ESG investors are often willing to accept somewhat lower yields for corporate bonds tied to some do-gooding metrics. After studying ten years' worth of public-interest proposals at S&P 500 companies, on everything from economic inequality to animal welfare, Roberto Tallarita, also of Harvard Law School, found that virtually no such motions pass. But support for them is on the rise. In 2010 18% of shareholders voted for them, on average. By 2019 this had risen to 28%. One day the boardroom may become as political as the corner office. In the meantime, CEO pontificating is likely only to get louder. ■



从握手到握拳

美国的CEO行动主义是在冒险

企业过去和政治保持距离。哪里出了问题？

如果你的公司和可口可乐一样是美国和谐的象征，你在打政治牌的时候会非常小心，尤其是在种族和投票这样容易造成分歧的问题上。这家软饮料公司在1964年的做法绝妙。当时民权领袖马丁·路德·金在获得诺贝尔和平奖后返回故乡亚特兰大（也是可口可乐的诞生地），当地的精英们扬言要抵制他。可能出现的尴尬场面让可口可乐不寒而栗，公司时任和前任高管们于是在私下悄悄说服了其他企业家出席一场为金举行的晚宴。他们甚至唱起了《我们一定会胜利》（We Shall Overcome）这首歌。

今年，可口可乐也涉足是非地。3月31日，佐治亚州的共和党州长布莱恩·肯普（Brian Kemp）签署了一项在批评者看来会压制黑人选民的新法律，可口可乐在这前后都有所行动。在该法案通过之前，可口可乐小心翼翼地试图软化其中的部分条款，结果引来了双重炮轰。先是多个民权组织指责它懦弱。当老板詹鲲杰（James Quincey）之后加入达美航空等其他亚特兰大的本土公司，对法案结果表示失望时，共和党人给它和其他公司扣上了“警醒文化”伪君子的帽子。

4月14日，包括亚马逊和谷歌等巨头在内的几百家公司以及巴菲特等知名商界人士发表了一封联名信，反对提高投票门槛的“任何歧视性立法”。一位有头有脸的签名者——制药公司默克（Merck）的肯尼斯·弗雷泽（Kenneth Frazier）——告诉《纽约时报》，这次行动应当超越党派之见。用曾经担任过CEO、现在就职于哈佛商学院的威廉·乔治（William George）的话来说，压制选民“把民主置于险境，继而把资本主义置于险境”。

为了圆特朗普称自己连任失败是因为大范围欺诈的弥天大谎，共和党人一直在推动相关法案。他们称企业指手画脚是赤裸裸的政治行为。然而，这

么多家喻户晓的品牌和董事会的大人物不断加入到对历来亲商的共和党摇手说“不”的阵营中，表明他们准备打破自美国资本主义诞生以来对企业大有好处的政治沉默准则。这是为什么？最终又会对他们的生意产生怎样的影响？

美国企业界是建基于有限责任公司这项法律创新之上的。最初，这样的公司结构仍然需要获得政府许可才能运营，这常常需要贿赂众多官员。19世纪上半叶，一连串的法庭裁决让公司得以与政治保持距离。之后，它们需要的只是雄心壮志和心甘情愿的投资者。结果就是造就了有史以来最繁荣的商业环境。

上世纪初，一些老板重新发现了政治，用公司财富在政府中勾朋结党。第二次世界大战后，工业界与政界之间的大门与其说是旋转的，不如说是敞开的。上世纪四五十年代，通用电气的老板“电气查理”·威尔逊和通用汽车的老板“引擎查理”·威尔逊曾在几届政府中任职。按政府的“眼中钉”、经济学家约翰·肯尼斯·加尔布雷斯（John Kenneth Galbraith）的话说，一直延续到上世纪60年代的这段时间就是“抗衡力量”时期：大企业与大政府和大工会之间的角力势均力敌。一些CEO表现得像工业政治家——为工人提供终身职位，建设村庄和高尔夫球场，并以社会守护者的形象示人。

1970年，诺贝尔奖得主、自由放任经济学的领军人物米尔顿·弗里德曼撼动了这种平衡。他认为，CEO只需要对股东负责。只要市场自由、竞争激烈，股东价值最大化就会有助于社会，因为这能确保为客户提供更好的产品，为工人提供更好的工作条件。而这两条只要有一条做不到，公司就将看到自己的客户和员工转投竞争对手。罗纳德·里根等共和党人信奉弗里德曼的思想，他们缩减政府规模，放松对经济的管制。这催生了上世纪八九十年代超级明星公司的兴起以及对名人CEO的崇拜。

即便如此，企业家们在政治问题上还是保持缄默。他们相信花钱请来的说客，并利用商业圆桌会议（Business Roundtable）等行业组织替自己奔走活动。游说几乎只涉及直接关系到自身盈亏的事务，比如税收、法规，或

可能影响到员工队伍的移民政策。他们刻意让自己置身于更广泛的政治喧嚣之外。

企业的资金持续流入政界。但近些年，它伴随着一股并行的CEO行动主义的潮流。公关公司万博宣伟（Weber Shandwick）认为这种现象始于2004年。当时旅游公司卡尔森酒店（Carlson Companies）的老板玛里琳·卡尔森·纳尔逊（Marilyn Carlson Nelson）明确表示反对性交易。同行的老板们认为这样的声明会损害旅游业的中立形象。结果客户们却将她捧为英雄。其他行业的CEO们注意到了这点。他们开始就各种话题发表意见，一开始还很谨慎，但在过去五年左右的时间里变得更加高调，涉及的话题从“我也是”（#MeToo）、“黑人命也是命”（#Black Lives Matter）等运动，到宗教自由法律、枪支管制、同性恋权利和跨性别厕所法案等。特朗普一些造成分歧的行动，比如临时禁止部分穆斯林国家公民入境、退出《巴黎气候协定》、对夏洛茨维尔（Charlottesville）的种族主义抗议事件的反应等，引起了美国企业界的普遍愤怒（尽管特朗普的减税计划它们也笑纳了）。

特朗普上台时也正值这样一个时期：公众对政府的信任度已经下降，而对商业的信任度在增加。尽管美国企业界被看作是无情的资本主义的女仆，但美国人对企业的信任度还是略高于对政府或非政府组织。另一家公关公司爱德曼（Edelman）发现，63%的美国人认为，当政府不解决社会问题时，CEO们应该介入。作为对这种呼声的响应，2019年8月，包括150家标普500蓝筹股公司的老板在内的商业圆桌会议成员承诺，公司在做决策时不仅考虑股东，还会考虑员工、供应商、客户、环境和其他“利益相关者”。

问题是，这类CEO倡议的动机和影响力都不明确——无论是对议题本身的影响还是对加入倡议的企业的影响。尽管很多倡议很可能是善意的，却因为有伪善和哗众取宠的嫌疑而含混不清。去年圣诞节前，北面（North Face）因为不想让自己的品牌与化石燃料联系在一起，拒绝了得克萨斯一家石油公司400件高价冲锋衣的订单。上个月，科罗拉多州的一个石油工业行业组织半开玩笑地给北面颁发了“非凡客户奖”，它指出北面的许多服

装产品都是用石油制品制成的，包括它的冲锋衣。

就对热点问题的影响而言，如果企业行动主义导致它所针对的党派一意孤行，可能就会事与愿违。耶鲁大学管理学院的杰弗里·索南菲尔德（Jeffrey Sonnenfeld）承认其中涉及党派之争。他在4月10日组织了一次活动，请一些CEO讨论选举法。他相信商界和拜登在中间地带有共同利益。面对来自“自由派精英”——许多老板都被认为属于该群体——的反对，共和党人可能会更有胆量推进限制性的选举法——只是为了戳对手痛处。

CEO们声称，对于社会关切的问题，除了亲自应对，他们别无选择，因为在社交媒体时代，客户、员工和股东有这样的要求。对于这种说法，相关证据混杂不一。

先说消费者。一些民意调查显示，两个党派各自的 supporters 会分别从立场偏右或偏左的公司购买更多商品。但其他研究发现，消费者更有可能记住的是自己因反对某位CEO的言论而停用的产品，而不是因支持某位CEO而开始使用的产品。沃尔玛在2019年一家门店发生枪击案后，禁止了一些枪支弹药的销售。随后的一项研究发现，受此影响，沃尔玛在共和党选区的客流量的跌幅比在民主党选区的增幅更大。

对员工的影响也没有定论。知识经济中的许多科技公司都乐于展示自己的左翼倾向，相信这会吸引那些持同样观点的优秀的千禧一代员工。但这可能会走过头。保守倾向的咨询公司 Lincoln Network 发现，推动政治议程的公司可能具有令人压抑的一元内部文化，这会扼杀而不是促进创造力。

再说股东。老板们在发表政治声明之前很少征求股东的意见。哈佛法学院的卢西恩·拜伯切克（Lucian Bebchuk）发现，在商业圆桌会议上签署声明承诺造福利益相关者的人当中，可以查到相关信息的48人中只有一人事先咨询过董事会。这透露出很多亲社会的言论不过是嘴上说说而已。

投资者似乎也是这么看的。从上述声明的字面意思看，股东将必须与其他利益相关者分享获利。但不管是老板签署了该声明的标普500指数公司，还是CEO不在签名者之列的公司，股价表现几乎相同。这表明市场并不认

为这些言论具有实质重要性。在支持利益相关者资本主义上口号喊得最响的一些公司，如Salesforce，尽管营收创了纪录，却仍在新冠疫情期间裁员。这样的现实表明投资者的看法可能是对的。

最终，股东们自己可能会变得更具政治倾向。考虑环境、社会和治理（ESG）因素的投资基金的兴起表明，投资者在配置资本时期望看到企业对某些社会问题持一定的立场。ESG投资者通常愿意接受那些与行善指标关联的企业债券稍低一些的收益率。同样来自哈佛法学院的罗伯托·塔拉里塔（Roberto Tallarita）研究了标普500指数公司十年来从经济不平等到动物福利等形形色色的公益提案，发现这样的提案几乎无一获通过。但它们获得的支持在上升。2010年，平均有18%的股东投票支持这类提案。到2019年，这一比例上升到了28%。有朝一日，董事们可能会变得像老板们一样关心政治。与此同时，CEO们自以为是的发声应该只会越来越响亮。





Free speech and social media

Will Facebook's "Supreme Court" reinstate Donald Trump's account?

A landmark test for the social-media giant's experiment in content moderation

SINCE JANUARY, Donald Trump has been missing from Facebook, Twitter and YouTube, after his online posts about the Capitol riot in Washington, DC, caused the firms to suspend his accounts for inciting violence. For many Americans, the sound of silence is welcome. Without the megaphone of social media, Mr Trump is muted. Facebook has not just blocked his account but is scrubbing other users' content that features his voice.

The ban raises questions about free speech and online platforms' power. Even Senator Bernie Sanders, no Trump fan, confesses to feeling uncomfortable that the ex-president has been silenced by a "handful of high-tech people". YouTube's boss, Susan Wojcicki, has said the video firm will lift its suspension only "when we determine that the risk of violence has decreased". Twitter will not relent, full-stop.

Facebook is taking a different approach. Mark Zuckerberg, its boss, made the call to suspend Mr Trump's account. But whether to reverse that will be decided later this month by 19 experts on the firm's Oversight Board (OB), in effect its "Supreme Court". The board's decision will be a high-profile test of whether a middle ground between unfettered corporate autonomy and government regulation can be an effective tool in tackling thorny decisions on content.

Mr Zuckerberg floated the idea of the board in 2018, and its first slate of members was announced last year. It is meant to be an independent body that can render binding decisions on the social-media giant and suggest policy tweaks. Facebook has put \$130m into a trust to fund it for at least six

years. Board members are a global bevy of brainiacs: ten are academics, five work in non-profits and think-tanks, two hail from journalism, one from politics and one is a Nobel peace laureate. “All the members have free speech as part of their core values,” says Ronaldo Lemos, a Brazilian lawyer who is an OB member.

After posts are removed, users of Facebook and its sister social network Instagram can appeal to the OB; this has happened some 300,000 times. The board sifts through appeals to choose cases, which it has 90 days to adjudicate. Facebook itself can also refer cases directly to the OB, as it did with Mr Trump. A computer randomly assigns each case to a five-member panel. Board members are part-time, but the OB employs 40 staff, who help with case selection and research, rather like Supreme Court clerks. Just as interested parties in Supreme Court cases can submit briefs, people can submit comments to the board.

So far it has taken up 12 cases and received 10,000 comments, 9,800 of them related to the Trump ban. When the panel reaches a conclusion, the majority of the board has to approve the decision, which is then written up and made public.

The dozen cases are a varied bunch. Was Facebook right to take down images of blackface? Or a photo of a bare nipple raising awareness of breast cancer? Or a video arguing for access to an unproven treatment for covid-19? Of the seven cases it has ruled on, the board overturned Facebook’s decision five times. It does not take into account the laws of any specific country but weighs Facebook’s “community standards” and “values” with international human-rights law. It can also coax Facebook to make changes to its policies. Some of Facebook’s tweaks to handling anti-vax content were a response to the board’s criticisms.

Which way will it go on Mr Trump? From its first decisions “it was clear

how highly the board prizes freedom of expression,” says Evelyn Douek, a law lecturer at Harvard. “That made me think Trump’s odds just got better.” Not everyone agrees. A lot will depend on how the board interprets human-rights law, as opposed to Facebook’s standards, which Mr Trump violated routinely. “Trump’s account involves not just his free speech but has an impact on other people’s rights,” says David Kaye, a former UN rapporteur for freedom of expression, who will be “really surprised” if the OB contradicts Facebook’s decision.

Either way, controversy will continue. “Facebook is still holding the reins far too tight,” says Ms Douek. On April 13th it announced that the board would have authority to review appeals related to content that had been kept on the platform. Until now the board has only been able to review appeals against the removal of content.

Despite criticism, the board is worth watching for several reasons. One is that it will help bring some of Facebook’s decisions into the light. “One of the challenges has been the lack of information that’s available in how exactly Facebook works and how its automated systems are trained and evaluated,” says Nicolas Suzor, an Australian law professor and OB member.

Second, in ruling on Mr Trump the board will guide Facebook on how to treat other politicians, such as Brazil’s Jair Bolsonaro and the Philippines’ Rodrigo Duterte. Facebook and Twitter have operated with a “newsworthiness exemption” for such leaders, allowing speech that violated their own policies because of the speakers’ position and the potential benefit to users from hearing them. “There’s the saying, ‘with great power comes great responsibility’. But with the newsworthiness exemption, great power comes with indemnification from responsibility,” says Renee DiResta of the Stanford Internet Observatory.

And, third, the board’s verdicts will ripple across social media. Its decision

on Mr Trump will put pressure on Twitter and YouTube. It will become a de facto standard-setter. “If the Oversight Board could be the germ that gets buy-in from industry, that’s wonderful,” says Sir Nick Clegg, Britain’s former deputy prime minister, who is Facebook’s communications chief.

Still, Facebook’s experiment is just a start. The Trump decision will be contentious. But if there is one thing all can agree on, it is that a single board will not alone solve social media’s ills. ■



言论自由与社交媒体

脸书“最高法院”是否会恢复特朗普的帐户？

社交媒体巨头的内容审核实验大考

今年1月份，特朗普在网上发布了有关华盛顿特区国会大厦暴动的帖子后，账号被Facebook、推特和YouTube以煽动暴力为名冻结，就此消失。许多美国人喜欢这种沉默的声音。没有了社交媒体的扩音器，特朗普的声音变得微弱。Facebook不仅封锁了他的帐户，还在清理其他替他发声的用户的内容。

这个封杀引发了有关言论自由和在线平台权力的质疑。哪怕并非特朗普粉丝的参议员伯尼·桑德斯也对前总统被“少数高科技人”禁言感到不适。

YouTube的老板苏珊·沃西基（Susan Wojcicki）表示，仅在“我们确定暴力风险有所降低时”，公司才会取消冻结。推特则完全不会让步，没得商量。

Facebook正在采取一种不同的做法。老板马克·扎克伯格做出了冻结特朗普帐户的决定。但是，是否将其撤销，将在4月底由该公司的监督委员会（OB），即事实上它的“最高法院”的19名专家决定。委员会的决定将是一次备受瞩目的测试，检验介于不受约束的公司自治与政府监管之间的中间地带是否可以成为一种有效的工具，来解决有关内容的棘手决策。

扎克伯格于2018年提出了委员会的想法，并于去年宣布了其首批成员。它旨在成为一个独立的机构，可以对社交媒体巨头做出具有约束力的决定，并提出政策调整的建议。Facebook已经向信托基金注资1.3亿美元，为其提供至少六年的资助。委员会成员是一群全球的脑力精英：十名学者，五人在非营利组织和智库工作，两人来自新闻界，一位来自政界，一位诺贝尔和平奖获得者。“所有成员都把言论自由作为其核心价值观的一部分。”OB成员巴西律师罗纳尔多·莱默斯（Ronaldo Lemos）说。

如果Facebook及其姐妹社交网络Instagram的用户有帖子被删除，用户可

以向OB提出上诉；这已经发生了约30万次。委员会筛选上诉以选择案件，并有90天的时间来做出裁定。与对特朗普的处理一样，Facebook本身也可以将案件直接提交给OB。计算机将每个案子随机分配给一个五人小组。委员会成员是兼职的，但OB雇有40名员工，就像最高法院的书记员一样，帮助选择和研究案件。就像最高法院案件的当事方可以提交案情摘要一样，人们也可以向委员会提交评论。

到目前为止，它已经受理了12起案件，收到了1万条评论，其中9800条与封禁特朗普相关。小组得出结论后必须经由委员会多数成员批准，再撰写意见并公开。

这12个案件千差万别。Facebook有权删除把脸抹黑的图像吗？或者用于提高公众对乳腺癌认识的裸露乳头的照片？或者是支持提供未经证实的新冠疗法的视频？在已裁定的七起案件中，委员会五次推翻了Facebook的决定。它没有考虑任何特定国家的法律，而是根据国际人权法权衡了Facebook的“社区标准”和“价值观”。它还可以劝导Facebook更改政策。Facebook对处理反疫苗内容的一些调整就是应委员会的批评而做出的。

它会对特朗普下什么判决呢？从最初那些裁定来看，“委员会珍视言论自由的程度是显而易见的，”哈佛大学的法学讲师伊夫林·杜耶克（Evelyn Douek）说，“这让我觉得特朗普的机会更大了。”并非所有人都同意。这很大程度上取决于委员会如何解释人权法，而不是特朗普经常违反的Facebook标准。“特朗普的言论不仅仅涉及他自己的言论自由，也影响其他人的权利。”前联合国言论自由问题报告员戴维·凯伊（David Kaye）说。如果OB推翻Facebook的决定，他将“非常惊讶”。

不管结果如何，争论都将继续。杜耶克说：“Facebook仍然把缰绳抓得太紧了。”Facebook于4月13日宣布，委员会将有权审查与平台上保留的内容有关的申诉。到目前为止，委员会只能审查有关删除内容的申诉。

尽管存在批评，但出于几个原因还是值得关注这个委员会。其一是它将有助于让Facebook的某些决定公之于众。“挑战之一是无从知晓Facebook到

底如何运作，以及它的自动化系统是怎样训练和评估的。”澳大利亚法律教授、OB成员尼古拉·苏泽尔（Nicolas Suzor）说。

其次，通过对特朗普的裁决，委员会将指导Facebook如何对待其他政客，例如巴西的贾尔·博尔索纳罗和菲律宾的罗德里戈·杜特尔特。鉴于这些言说者的地位和听取其言论对用户的潜在利益，Facebook和推特对此类领导人实行了“新闻价值豁免”，允许其发表违反公司政策的言论。“俗话说，‘权力越大责任越大’。但有了新闻价值豁免，强大的权力却伴随着责任的免除。”斯坦福大学互联网观测站的瑞内·迪雷斯塔（Renee DiResta）说。

第三，委员会的裁定将波及其他社交媒体。它对特朗普的裁定将给推特和YouTube施加压力。它将成为事实上的标准制定者。“如果监督委员会这个尝试可以得到行业认可，那就真是太好了。”Facebook的沟通负责人、英国前副总理尼克·克莱格爵士（Sir Nick Clegg）说。

尽管如此，Facebook的实验仅仅是一个开始。对特朗普的裁定将引起争议。但是，如果说有一件事人人都同意，那就是单靠一个委员会解决不了社交媒体的痼疾。 ■



Charlemagne

Netflix Europa

How streaming became a tool of European integration

“BARBARIANS”, A NETFLIX drama set 2,000 years ago in ancient Germania, inverts some modern stereotypes. In it, sexy, impulsive, proto-German tribesmen take on an oppressive superstate led by cold, rational Latin-speakers from Rome. Produced in Germany, it has all the hallmarks of a glossy American drama (gratuitous violence and prestige nudity) while remaining unmistakably German (in one episode someone swims through a ditch full of *scheisse*). It is a popular mix: on a Sunday in October, it was the most-watched show on Netflix not just in Germany, but also in France, Italy and 14 other European countries.

Moments when Europeans sit down and watch the same thing at roughly the same time used to be rare. They included the Eurovision Song Contest and the Champions League football, with not much in between. Now they are more common, thanks to the growth of streaming platforms such as Netflix, which has 58m subscribers on the continent. For most of its existence, television was a national affair. Broadcasters stuck rigidly to national borders, pumping out French programmes for the French and Danish ones for the Danes. Streaming services, however, treat Europe as one large market rather than 27 individual ones, with the same content available in each. Jean Monnet, one of the EU’s founding fathers, who came up with the idea of mangling together national economies to stop Europeans from killing each other, was once reputed to have said: “If I were to do it again from scratch, I would start with culture.” Seven decades on from the era of Monnet, cultural integration is beginning to happen.

Umberto Eco, an Italian writer, was right when he said the language of

Europe is translation. Netflix and other deep-pocketed global firms speak it well. Just as the EU employs a small army of translators and interpreters to turn intricate laws or impassioned speeches of Romanian MEPs into the EU's 24 official languages, so do the likes of Netflix. It now offers dubbing in 34 languages and subtitling in a few more. The result is that "Capitani", a cop drama written in Luxembourgish, a language so modest it is not even recognised by the EU, can be watched in any of English, French or Portuguese (or with Polish subtitles). Before, a top French show could be expected to be translated into English, and perhaps German, only if it was successful. Now it is the norm for any release.

The economics of European productions are more appealing, too. American audiences are more willing than before to give dubbed or subtitled viewing a chance. This means shows such as "Lupin", a French crime caper on Netflix, can become global hits. It is worth taking a punt on an expensive retelling of an early-20th-century detective series about a gentleman jewel thief in Paris, if it has the potential to explode beyond France. In 2015, about 75% of Netflix's original content was American; now the figure is half, according to Ampere, a media-analysis company. Netflix has about 100 productions under way in Europe, which is more than big public broadcasters in France or Germany.

And European officials wield a stick to encourage investment. European film-makers rival farmers in the ranking of cosseted European industries. To operate in the EU, streaming companies are required to ensure at least 30% of their catalogue hails from the bloc—and to promote it. Buying a back catalogue of 1990s Belgian soap operas and hiding them in a digital cupboard does not count. France compels big media firms to kick back revenues into domestic production. If European governments are intent on shaking down big American firms, it is better for everyone that the money is spent on something watchable.

Not everything works across borders. Comedy sometimes struggles. Whodunits and bloodthirsty maelstroms between arch Romans and uppity tribesmen have a more universal appeal. Some do it better than others. Barbarians aside, German television is not always built for export, says one executive, being polite. A bigger problem is that national broadcasters still dominate. Streaming services, such as Netflix or Disney+, account for about a third of all viewing hours, even in markets where they are well-established. Europe is an ageing continent. The generation of teens staring at phones is outnumbered by their elders who prefer to gawp at the box.

In Brussels and national capitals, the prospect of Netflix as a cultural hegemon is seen as a threat. “Cultural sovereignty” is the watchword of European executives worried that the Americans will eat their lunch. To be fair, Netflix content sometimes seems stuck in an uncanny valley somewhere in the mid-Atlantic, with local quirks stripped out. Netflix originals tend to have fewer specific cultural references than shows produced by domestic rivals, according to Enders, a market analyst. The company used to have an imperial model of commissioning, with executives in Los Angeles cooking up ideas French people might like. Now Netflix has offices across Europe. But ultimately the big decisions rest with American executives. This makes European politicians nervous.

They should not be. An irony of European integration is that it is often American companies that facilitate it. Google Translate makes European newspapers comprehensible, even if a little clunky, for the continent’s non-polyglots. American social-media companies make it easier for Europeans to talk politics across borders. (That they do not always like to hear what they say about each other is another matter.) Now Netflix and friends pump the same content into homes across a continent, making culture a cross-border endeavour, too. If Europeans are to share a currency, bail each other out in times of financial need and share vaccines in a pandemic, then they need to have something in common—even if it is just bingeing on the same

series. Watching fictitious northern and southern Europeans tear each other apart 2,000 years ago beats doing so in reality. ■



查理曼

奈飞欧罗巴

流媒体如何成为了欧洲一体化的工具

奈飞（Netflix）的电视剧《蛮战》（Barbarians）的背景设在两千年前的古日耳曼尼亚（Germania），它成功颠覆了一些现代的刻板印象。剧中，性感而冲动的原始日耳曼部落对抗压迫他们的超级帝国，领导后者的是冷酷、理性、满口拉丁语的罗马人。该剧在德国制作，具备了浮华美剧的一切特征（无端的暴力和华丽的裸体），同时又带有明白无误的德国味（其中一集中有人游过了一条满是粪便的水沟）。这种组合大受欢迎：在10月的一个周日，它不仅是德国地区收视率最高的奈飞剧集，在法国、意大利和其他14个欧洲国家也一样。

在过去，欧洲人在差不多同一时间坐下来收看同一档节目的时候可不多。欧洲歌唱大赛和欧冠联赛是其中两档，在它们之间就寥寥可数了。如今这种时刻更常见了，这要归功于流媒体平台的发展，比如在欧洲大陆已拥有5800万订户的奈飞。电视自诞生以来，大部分时间里都是国家事务。广播电视台严守国界，为法国人提供法国节目，为丹麦人提供丹麦节目。然而，流媒体服务把欧洲看做一个大市场，而非27个单独市场，在每个市场都提供相同的内容。欧盟的创始人之一让·莫内（Jean Monnet）提出了融合各国经济来避免欧洲人自相残杀的理念。据说他曾表示：“如果可以从头再来一次，我会从文化入手。”莫内的时代已经过去了70年，文化正开始融合。

意大利作家安贝托·艾柯（Umberto Eco）曾说过，欧洲的语言就是翻译。此言不虚。奈飞和其他财大气粗的跨国公司把这门语言说得很好。正如欧盟雇用了一大批笔译和口译人员，将错综复杂的法律或欧洲议会里罗马尼亚议员的激情演讲翻译成欧盟的24种官方语言，奈飞这样的公司也干差不多的事。它现在已提供34种语言的配音，字幕的语种还要再多几个。这样一来，用原本非常小众、甚至不被欧盟认可的卢森堡语写就的探案剧《秘

林迷村》（Capitani）也能以英语、法语或葡萄牙语配音（或加上波兰语字幕）观看。在此之前，一部法国大剧只有在获得成功之后才有望被翻译成英语，可能还有德语。而现在，这是所有节目的标配。

欧洲剧集在经济效益上也变得更有吸引力了。美国观众比以前更乐意尝试配音或配字幕的节目。这意味着奈飞的法国犯罪喜剧《亚森·罗平》（Lupin）也有机会成为全球热门剧集。这部20世纪初的系列侦探小说描绘了一个风度翩翩的巴黎珠宝大盗，如果它有可能在法国以外的地方爆红，那么即使花费重金拍成电视剧也是值得的。媒体分析公司Ampere称，2015年，奈飞约75%的原创内容来自美国，而现在只有一半。奈飞正在欧洲制作约100部作品，比法国或德国的大型公共广播公司还多。

而欧洲官员挥舞大棒鼓励投资。在受保护的行业中，欧洲影视制作人受到的关照和农民不相上下。要想在欧盟运营，流媒体公司必须确保至少30%的剧目来自欧盟，而且必须加以推广。光是买一堆1990年代的比利时老肥皂剧来埋进数字橱柜里可不算数。法国要求大型媒体公司必须把收入再投入到本地节目制作上。既然欧洲各国政府执意要让美国的大公司下点血本，那还是把钱花在一些值得一看的作品上才皆大欢喜。

并不是所有内容都能跨越国界。喜剧有时就比较难。侦探剧比较容易被普遍接受，高高在上的罗马人与桀骜不驯的部落之间的血腥混战也有普遍的吸引力。有些做得比其他好。一位德国高管客气地表示，除去《蛮战》，德国电视并不都适合出口。更大的问题是，国家广播公司仍然占据主导地位。奈飞或迪士尼+等流媒体服务只占总观看时长的三分之一，即使在它们地位稳固的市场也是如此。欧洲正在老龄化。整天捧着手机的青少年数量还是比不上喜欢坐在电视机前的长辈。

在布鲁塞尔和各国首都，人们担心奈飞有朝一日会成为文化霸主。欧洲企业高管担心美国人会蚕食他们的地盘，经常把“文化主权”挂在嘴边。说句公道话，奈飞的节目内容有时就像困在大西洋中部的某个诡异谷，全然没有地方特色。市场分析公司恩德斯（Enders）认为，与本国竞争对手制作的电视剧相比，奈飞原创剧往往较少涉及特定的文化因素。该公司过去采

用了一种帝国式的委托模式，由洛杉矶的高管炮制出法国人可能会喜欢的创意。现在，奈飞在欧洲各地都设有办事处。但重大决策最终还是由美国高管做出。这让欧洲政客感到紧张。

其实他们不应该担心。讽刺的是，促进欧洲一体化的往往是美国公司。对于那些不懂多种语言的欧洲人来说，尽管谷歌翻译有点生硬，但毕竟让他们都能读懂欧洲的报纸了。美国的社交媒体公司也让欧洲人更容易跨越国界谈论政治。（他们并不总喜欢听到对彼此的看法又是另一回事了。）如今，奈飞等美国公司为整个欧洲大陆的家庭提供同样的内容，使文化也可以跨国界传播。如果欧洲人打算共用一种货币，在经济困境中互相救助，在疫情中分享疫苗，那么他们也需要有一些共同点——哪怕只是在刷同一部电视剧。观看两千年前北欧人和南欧人互相厮杀的虚构情节，总比在现实中打得你死我活要好。 ■



Espionage

Ears in the sky

By listening for radio and radar signals, a new generation of satellites can track human activity, both licit and illicit

IN THE MIDDLE of last year, Ecuadorians watched with concern as 340 foreign boats, most of them Chinese, fished just outside the Exclusive Economic Zone (EEZ) around their country's westernmost province, the Galapagos Islands. The law of the sea requires such vessels to carry GPS-based automatic identification systems (AIS) that broadcast where they are, and to keep those systems switched on. Some boats, however, failed to comply. There were more than 550 instances of vessels not transmitting their locations for over a day. This regular radio silence stoked fears that the boats concerned were sneaking into Ecuador's waters to plunder its fish.

Both local officials and China's ambassador to Ecuador denied this, and said all the boats were sticking to the rules. In October, however, HawkEye 360, a satellite operator based in Virginia, announced it had detected vessels inside Ecuador's EEZ on 14 occasions when the boats in question were not transmitting AIS (see map). HawkEye's satellites could pinpoint these renegades by listening for faint signals emanating from their navigation radars and radio communications.

HawkEye's satellites are so-called smallsats, about the size of a large microwave oven. They are therefore cheap to build and launch. HawkEye deployed its first cluster, of three of them, in 2018. They are now in an orbit that takes them over both of Earth's poles. This means that, as the planet revolves beneath them, every point on its surface can be monitored at regular intervals.

Initially, the data the satellites collected were downloaded to a tracking station on Svalbard, a Norwegian island in the Arctic Ocean. But business has since boomed. HawkEye now counts a dozen governments among its customers, as well as private clients. The firm has therefore recruited the services of a second ground station, in Antarctica, and it put a second cluster into orbit on January 24th. It plans three more such launches this year, and also intends to widen its network of ground stations yet further.

Given this success, it is hardly surprising that at least six other companies are operating or developing similar systems. Quilty Analytics, a research firm in Florida, expects the number of radio-frequency (RF) intelligence satellites of this sort in orbit to multiply from a dozen at the beginning of January to more than 60 by the end of next year.

RF-intelligence satellites detect where a transmission is coming from in two ways. One, trilateration, relies on measuring minute differences in a signal's arrival time at each member of a cluster. The other uses the Doppler effect—the shift in a signal's frequency if the transmitter is moving relative to the receiver. Together, according to HawkEye, these can pinpoint a signal's source to within 500 metres of its true origin. Kleos Space, a Luxembourgois company that launched its first cluster in November and hopes to put two more up later this year, says its accuracy ranges between 3,000 and 200 metres.

A cluster sweeps a band of territory 2,000km wide so, circling the planet every 90 minutes or so, it can revisit many areas several times a day. Moreover, unlike spy satellites fitted with optical cameras, RF satellites can see through clouds. Their receivers are not sensitive enough to detect standard mobile phones. But they can pick up satellite phones, walkie-talkies and all manner of radar. And, while vessels can and do illicitly disable their AIS, switching off their communications gear and the radar they use for navigation and collision-avoidance is another matter entirely.

“Even pirates don’t turn those things off,” says John Beckner, boss of Horizon Technologies, a British firm that plans its first launch in August.

RF data are also cheap to collect. Satellites fitted with robotic high-resolution cameras are costly. Flying microwave ovens that capture and timestamp radio signals are not. Horizon says that building, insuring and launching its August mission should cost no more than about \$1.4m.

America’s National Geospatial-Intelligence Agency (NGA), one of that country’s numerous spying operations, is a big user of RF intelligence. It employs HawkEye’s data to find guerrilla camps and mobile missile-launchers, and to track both conventional warships and unconventional ones, like the weaponised speedboats sometimes deployed by Iran. Robert Cardillo, a former director of the agency who now advises HawkEye, says dozens of navies, Russia’s included, spoof AIS signals to make warships appear to be in places which they are not. RF intelligence is not fooled by this. Mr Cardillo says, too, that the tininess of RF satellites makes them hard for an enemy to destroy.

Beside matters military, the NGA also uses RF data to unearth illicit economic activity—of which unauthorised fishing is merely one instance. Outright piracy is another. And the technique also works on land. In 2019, for example, it led to the discovery of an illegal gold mine being run by a Chinese company in a jungle in Gabon. And in 2020 the managers of Garamba National Park in the Democratic Republic of Congo began using HawkEye data to spot elephant poachers and dispatch rangers to deal with them.

There are commercial uses, too. Andy Bowyer, Kleos’s boss, reports interest among telecoms firms keen to locate rogue transmitters, such as unlicensed ham radios, that are operating within their domains. Regulators, meanwhile, would like the firm to create “heat maps” of shifting patterns

of legitimate transmissions. These would help them select sites for mobile-phone towers and also give them a better idea of the value in particular places of licences to use parts of the radio spectrum that are going up for auction. Some charities, too, have an interest in Kleos's data. RF information can, for example, flag up routes taken by migrants likely to need food and other aid.

Using satellite clusters to gather RF intelligence is clever. But engineers at Unseenlabs, a firm in Rennes, France, reckon it is already outdated. At the moment, Unseenlabs has three satellites in orbit and sells data to about ten navies, including France's, as well as to maritime insurers and a handful of big defence contractors. But its satellites operate independently, rather than as a cluster, for Unseenlabs' engineers have devised a detection system, which they claim is accurate to within 5,000 metres, that requires but a single satellite.

How this system works remains a secret—and one that, according to Clément Galic, Unseenlabs' boss, is protected by the French state. After several attempts were made to steal it, he says, the defence ministry's Directorate General of Armaments offered its assistance in defending the details from cybertheft.

Secret or not, though, Unseenlabs may soon have competitors in the single-satellite-RF-intelligence market, for Horizon, too, says that it has worked out how to perform the trick—a claim backed up by the fact that its launch in August will loft but a single device. Shortly after it filed an application for a patent in America on the wizardry involved, the government there classified it. Even so, Mr Beckner drops a hint. The method involves assessing differences in the angles at which a target's signals arrive during the satellite's arc across the sky. Horizon says its system will be accurate to within 3,000 metres. By the middle of next year, it, too, plans to operate three satellites in different orbits—enough to scan most of the planet every

two hours or so.

Horizon also plans to compile a library of unique radar-pulse “fingerprints” of the world’s vessels, for the tiny differences in componentry that exist even between examples of the same make and model of equipment mean that signals can often be linked to a specific device. It will thus be able to determine not merely that a vessel of some sort is in a certain place, but which vessel it is, and where else it has been.

Unseenlabs, for its part, has already catalogued the radar fingerprints of many thousands of vessels, several hundred of which have, subsequent to the events of last summer, spent time in the Galapagos EEZ with their AIS beacons switched off. It remains to be seen what Ecuador’s authorities will do with that information. But no one can say they weren’t told. ■



间谍活动

天上有耳

通过收听无线电和雷达信号，新一代卫星可以追踪人类活动，无论是合法还是非法活动

去年年中，厄瓜多尔关切地盯紧340艘外国渔船——主要是中国渔船，它们正紧贴着该国最西部省份加拉帕哥斯群岛（Galapagos Islands）周边的专属经济区边缘捕鱼。按照海洋法的规定，这类船只须携带基于GPS的自动识别系统（AIS），以播报自己所处的位置，并且必须保持该系统一直打开。但有些船只没有遵守规定，出现了550多起超过一天未发送位置的情况。这种经常性的无线电静默让人们担忧这些船只正潜入厄瓜多尔的海域掠夺鱼类资源。

当地官员和中国驻厄瓜多尔大使都否认了这一点，并表示所有船只都遵照规定。然而，去年10月，总部位于弗吉尼亚州的卫星运营商鹰眼360（HawkEye 360）宣布，它曾14次探测到有船只在关闭AIS期间位于厄瓜多尔的专属经济区内（见地图）。鹰眼的卫星可以通过收听这些不守规矩的船舶的导航雷达和无线电通信发出的微弱信号，来确定它们的位置。

鹰眼的卫星是所谓的小卫星，和一台大号微波炉差不多大，因此造价和发射成本都很低。2018年，鹰眼部署了它的首个由三颗卫星组成的卫星集群。它们目前都处在飞越地球两极上空的轨道上。这就意味着，随着地球在它们下方旋转，地表上的每个地点每隔一定时间都能被监测到。

最初，这些卫星收集的数据被下载到北冰洋中的挪威斯瓦尔巴群岛（Svalbard）上的一个跟踪站。但自那以后，生意日渐兴隆。现在除了私人客户，还有12个政府客户。因此，鹰眼公司已经完成了在南极洲的第二个地面站各项服务的招募工作，并于1月24日把第二个卫星集群送入了轨道。它计划今年再完成三次这样的发射，并打算进一步扩大自己的地面站网络。

生意如此红火，也难怪至少还有六家公司也在运营或研发类似的系统了。位于佛罗里达州的调研公司Quilty Analytics预计，在轨运行的这类射频情报卫星的数量将从今年1月初的12颗激增到明年底的60多颗。

射频情报卫星通过两种方法探测信号传输的源头。一种是三边测量法，测量信号抵达集群中的每颗卫星的微小时间差。另一种使用多普勒效应——如果信号发射机相对于卫星信号接收机在移动，信号的频率就会发生变化。鹰眼表示，把这两种方法结合在一起，可以准确定位信号的来源——误差不超过500米。去年11月，卢森堡的Kleos Space公司发射了自己的第一个卫星集群，并希望在今年晚些时候再发射两个，该公司声称自己的定位精度在200米到3000米之间。

一个卫星集群可扫视2000公里宽的区域，大概每90分钟左右环绕地球一周，因此一天内可以多次重访许多地区。此外，不同于安装了光学相机的间谍卫星，射频卫星可以透过云层监视地面。它们的接收机不够灵敏，无法探测到手机信号。但它们可以接收卫星电话、无线对讲机和各种雷达的信号。而且，尽管船舶能够关闭自己的AIS系统，也会非法故意将它们关掉，但关闭用于导航和避碰的通讯设备和雷达就完全是另一回事了。“连海盗也不会关掉这些东西。”计划在8月进行第一次发射的英国公司Horizon Technologies的老板约翰·贝克纳（John Beckner）说。

射频数据的收集成本也很低。搭载自动高分辨率相机的卫星价格昂贵，而捕捉无线电信号并为它们标记时间戳的“飞行微波炉”并不贵。Horizon表示，它8月的任务的制造、投保和发射成本应该不超过140万美元。

美国众多间谍机构之一的国家地理空间情报局（NGA）是使用射频情报卫星的大户。它利用鹰眼的数据搜寻游击队营地和移动式导弹发射器，并追踪常规和非常规战舰，比如伊朗有时候部署的配备武器的快艇。前局长罗伯特·卡迪罗（Robert Cardillo）现在是鹰眼的顾问。他表示，俄罗斯等许多国家的海军经常发送欺骗性的AIS信号，让战舰看上去在实际地点之外的地方。但射频情报卫星不会被这种手段欺骗。卡迪罗还说，由于体积小，射频卫星很难被敌人摧毁。

除了军事用途，NGA还利用射频卫星数据来发现非法经济活动，未经许可的捕鱼只是其中之一。还有彻头彻尾的海盗行为。并且，这项技术在陆地上同样有用。例如，2019年，人们使用该技术在加蓬的丛林中发现了一家中国公司经营的非法金矿。2020年，刚果民主共和国的加兰巴国家公园（Garamba National Park）的管理者开始使用鹰眼数据来发现大象偷猎者，并派遣公园管理员对付他们。

还有商业用途。Kleos的老板安迪·鲍耶（Andy Bowyer）说，电信公司就很有兴趣，它们想要查找在自己网络范围内启用的流氓信号发射机的位置，比如无证业余无线电。与此同时，监管机构也希望Kleos创建合法信号变动模式的“热图”，这将帮助它们为移动信号发射塔选址，也让它们更好地了解那些即将拍卖的射频频谱牌照在特定地区的价值。一些慈善机构也对Kleos的数据感兴趣。比如，射频信息可以指出那些可能需要食物和其他援助的流动人口的移动路线。

使用卫星集群来收集射频情报是个聪明的办法。但是位于法国雷恩（Rennes）的公司Unseenlabs的工程师们认为这种技术已经过时了。目前，Unseenlabs拥有三颗在轨卫星，它的数据不仅出售给船舶保险公司和几家大型国防承包商，也出售给包括法国在内的大概十个国家的海军。但它的卫星是各自独立运行的，而不是作为一个集群，因为Unseenlabs的工程师已经设计出了只需要一颗卫星的探测系统，他们声称定位精度在5000米以内。

这个系统如何运作仍然是个机密——而且根据Unseenlabs的老板克莱门特·加利奇（Clément Galic）的说法，是一个受法国政府保护的机密。他表示，在遭遇了几次未遂的窃密图谋之后，法国国防部的国防采购局（Directorate General of Armaments）提供了帮助，防范有人通过网络窃取细节。

然而，不论机密与否，Unseenlabs可能很快就会在单卫星射频情报市场上遇到竞争对手，因为Horizon公司也说自己找到了解决方法——这一说法的事实依据就是它8月的任务将只发射一颗卫星。它的相关技术在美国申

请专利后不久就被美国政府列为机密。不过贝克纳还是透露了些许信息。其方法涉及估测目标物信号到达卫星在天空的行经位置时的角度差异。Horizon表示，它的系统定位精度会在3000米以内。到明年中旬，它也计划在不同的轨道上运行三颗卫星——足以做到每两小时左右对地球的大部分区域扫视一遍。

Horizon还计划编制一个独一无二的全球船只的雷达脉冲“指纹”库，因为即使是同一品牌和型号的设备，其部件也存在微小差异，这意味着信号往往可以对应到特定的设备上。因此，它不仅能够确定有一艘什么类型的船出现在了什么位置，还能够确定具体是哪艘船，以及它还去过哪些地方。

在Unseenlabs这边，它已经把成千上万艘船的雷达指纹登记在册了，其中有几百艘船在去年夏天的事件发生之后，曾关闭AIS信标在加拉帕哥斯群岛专属经济区内停留。厄瓜多尔当局对这一消息会作何反应还有待观察。但没人能说自己没被告知这件事。 ■



In grandpa's charge

The plight of China's "left-behind" children

Some 31m live apart from both parents, who have moved for work in cities

EVERY SPRING, the Qingming festival brings families together for displays of respect and sorrow at the burial sites of their deceased relatives. Some travel a long way to reunite over the three-day holiday, which ended on April 5th. Among them this year were the Zhaos of Leyun, a village in the lush Daba mountains of Sichuan province in the south-west. For migrant parents like them, there are living relationships that cause quiet grief, too. When their daughter, Lin, was just one month old the couple left her with her grandmother to allow them to return to their factory jobs on the coast. That was six years ago. Since then, Lin has spent only about 30 days with her parents. To her, this holiday's get-together was with virtual strangers.

There are about 31m people in China like Lin—children who have been left behind in their home towns or villages, usually in the care of relatives, while both of their parents work elsewhere. The largest wave of internal migration in history—involving about 300m people who have moved to cities over the past four decades—has battered many other families, too. In 2015 Unicef, the UN agency for children, estimated that more than one in three children in China, or close to 100m, had experienced the prolonged absence of at least one parent. In nine out of ten cases, the main reason was migration.

Another important cause has been China's rigid system of household registration, known as hukou. Someone without hukou in the city where he or she lives is frequently denied access to local government-funded services, such as health care and schooling. Migrants therefore often have little choice but to leave children behind in their registered place of residence. Across China, many lives are racked by the pain this causes. At

first Lin pined for her parents, says the girl's 57-year-old grandmother, a bean farmer. Then her pleas grew fainter, until one day they stopped. Now Lin refuses to speak to her parents when they ring home. She shrinks from their attempts to hug her during their rare, fleeting visits back to Leyun.

In recent years concern has grown in China about the plight of such children. State media have reported on their sufferings, including the torment of those abandoned with no one to look after them (in 2010 there were at least 2m without carers). About six years ago huge public debate was triggered by two such stories. One involved four siblings in the south who killed themselves with pesticide. They had been left behind with no guardian. The second was about another two left-behind siblings in the same region. They were murdered by two relatives who had been raping one of the children, a disabled 15-year-old girl.

In February 2016 the government responded to the outcry by publishing guidelines for the protection of left-behind children. These called for their numbers to be reduced "significantly" by 2020. They advised local authorities to monitor guardianship arrangements—it is illegal to let minors live alone. They also urged hospitals and schools to do a better job of reporting cases of suspected harm. In 2017 a new rule required village officials to register all left-behind children. Another, in May 2020, made failure to report neglect or abuse a possible crime. According to official figures, in 2018 local governments paired 76,000 unsupervised children with guardians, and helped the return to school of 160,000 left-behind children who had dropped out. Since 2017 the central government has kept a database of left-behind and vulnerable children, based on the records supplied by villages.

Officials have focused their attention on a subset of those affected. The guidelines in 2016 count as left-behind only those who are under 16 and have two parents working elsewhere. That year the government said there

were just 9m children who could be classified as left-behind according to this definition. By 2018 the tally had fallen to under 7m. But children who have been separated from only one parent are often harmed, too. And it can matter which parent has left them. A Chinese study published in 2017 found that school drop-out rates were lower among rural children living with only a mother rather than only a father (rates were highest when both parents were away). In 2019 a paper in *Frontiers in Psychology*, a peer-reviewed journal, concluded that the presence of at least one parent at home, especially a mother, lessened the risk that a left-behind child would self-harm as a teen.

Rural parents often believe their presence is most vital when a child starts school. So they are more inclined to work elsewhere before their children reach that age, says Lu Shuang of the University of Hong Kong. More than a quarter of children in China under the age of two are cared for by people who are not their mothers, reports Unicef. The Chinese study of 2017 found that, as a proportion of all left-behind children, the number of under-fives had grown from 30% in 2000 to 40% in 2015. Many are never breastfed, depriving them of lifelong health benefits. That was so for Lin.

As they grow older, children face other traumas. Since 2015 surveys by On the Road to School, an NGO based in Beijing, have revealed consistently high levels of depression among left-behind children. In 2019 nine in ten of them said they had suffered from emotional abuse, and six in ten reported physical harm. Close to one in three had been sexually abused.

Such abuse often goes undetected. “The separation from parents means that children do not have the impulse to open up to them,” says Wan Miaoyan, a lawyer in Chengdu who has worked on cases related to such crime. She recalls one in which relatives discovered what had happened only when they came across a letter that the victim had written to herself. In it she

described being raped by a teacher. A child therapist says current systems of support rely on people from the same village who may themselves be abusers, rather than on professional outsiders.

Those systems are thinly stretched. Provinces with high numbers of left-behind children—Sichuan, a populous one, tops the ranking—tend to be among the poorest, with scant resources to devote to the task of protecting the vulnerable. But local governments are making an effort. Keep the Children Company, an official scheme in Sichuan, has involved setting up “children’s homes” (a space in the village where they can play, read books and receive help with their homework), and appointing “mothers” to whom children can turn for emotional support. The central government has helped. Since 2010 it has trained people in 660,000 villages as “child-welfare directors”, that is, to perform social work. It has also allowed the use of poverty-alleviation funds for spending on children’s welfare.

In 2015 Lin’s village of Leyun was among the first to introduce a Keep the Children Company project. Liu Chunhua, an energetic kindergarten teacher, was chosen to lead it. In Chengdu, the provincial capital, she learnt how to broach sex and mental health with the village’s 20 children. Her efforts have paid off. A shy teen in Leyun was bewildered when she got her first period. A friend, also puzzled, prodded her to speak to “Mama Liu”. The teacher explained to the girl what was happening to her body and taught her how to wear pads. Village elders often gossip unkindly about the parents of left-behind children. Ms Liu has put a stop to that. She knows the harm it can do. Villagers had once taunted her own left-behind daughter with the false notion that Ms Liu only came back to see her eldest son. Her daughter became so dejected that Ms Liu quit her factory job and moved back to the village.

But keeping tabs on children is getting harder. Most villages once had a

school, where teachers could check that students were not hurt, sick or distressed. In the past two decades, however, over 360,000 underused village schools have been closed to save money. Leyun's hangs on by a thread. A decade ago it had 70 pupils. Now it has only two, in the youngest year-groups. Other children go to a school in Pujia, a town an hour's walk down the mountain. They usually return to the village at weekends. Lin attends a kindergarten there. Asked if she gets good marks, Lin says she is slapped on the hand fewer times than her classmates.

One glimmer of hope is that growing numbers of migrants are able to find jobs closer to their native villages, as factories move inland. Some parents from Leyun are settling with their children in nearby towns. And the covid-19 pandemic is a cause of unexpected joy for some: it has forced many migrant workers to return to their original homes. Half of Leyun's youngsters are currently living with both of their parents. That is "unheard of", says Ms Liu, the teacher.

Many of these parents were also once left-behind children. But rural conditions have improved immensely since those days. Zhu Yidan, a 25-year-old volunteer teacher who grew up as a left-behind child in Sichuan, says that when she was growing up people had to walk cross-country to reach villages. Now there are paved roads and children have enough food, clothing and toys. Parents can video-chat with them daily and buy presents for them online.

But a new problem is emerging. Increasing numbers of children are being left in urban areas by one or both parents who move away for work. There were about 28m such children in 2015, nearly three times as many as in 2000. Those who follow their parents from village to city have better diets and mental health than those who remain in the countryside, studies show. But those who are subsequently left behind in cities suffer higher rates of violence than those who stay in villages. Ms Wan, the lawyer, says there is

“a debt owed by this country to its left-behind children”. The account is far from settled. ■



爷爷带娃

中国留守儿童的困境

大约3100万儿童因父母都在城市打工而与他们分离

每年春天的清明节是很多家庭团聚的日子。人们回乡给已故的亲人上坟，表达敬意和哀思。一些人要在三天的清明假期里长途跋涉赶回家。今年的假期是4月3日至5日，赶路的人当中有乐云村的赵姓夫妇。乐云村位于西南省份四川植被茂盛的大巴山里。对于像他俩这样为人父母但在外地打工的人来说，与尚在人间的亲人间的关系也让他们有说不出的难过。女儿赵琳（音译）刚满月时，夫妇俩就把她留给了她的祖母照顾，自己返回沿海城市的工厂打工去了。六年过去了。这些年里赵琳和父母在一起的日子只有30来天。对她来说，这个假期与自己团聚的人实际上和陌生人并无差别。

在中国，大约有3100万像赵琳这样的孩子——父母都在外地打工，自己被留在老家的城镇或村子，通常由亲戚照看。过去40年里中国约有三亿人进城打工，这波历史上最大的国内移民潮让其他许多家庭也和赵家一样备受折磨。2015年，联合国负责儿童事务的机构联合国儿童基金会（Unicef）估计，中国超过三分之一的儿童（也就是将近一亿名）曾经历父母至少有一方长期不在身边，其中九成都是因为外出务工。

另一个重要原因是中国僵化的户籍制度，也就是“户口”。没有所在城市的户口，一个人往往无法享受医疗、教育等受地方政府补助的服务。因此，农民工往往别无选择，只能把孩子留在户口所在地。中国各地有许多人都深受其苦。赵琳的祖母今年57岁，靠种大豆为生。她说，一开始，孩子很想和父母待在一起。后来这样的恳求渐渐变少，直到有一天再也不提了。现在她爸妈给家里来电话时，她不肯接听。他们偶尔匆匆回一趟乐云，想抱一下她，她都躲躲闪闪。

近年来，中国越来越关注这些儿童的困境。官方媒体报道了他们的不幸遭

遇，包括无人照看的留守儿童承受的身心磨难（2010年至少有200万名儿童无人看护）。大约六年前，两则新闻报道激起公众热议。在南方，有四兄妹喝农药自杀。他们是没有监护人的留守儿童。在同一地区，另一对留守姐弟被两个亲戚杀害，其中15岁的残疾女孩生前曾遭这两个亲戚强奸。

面对强烈的社会反应，2016年2月，政府发布了有关保护留守儿童的指导文件。文件号召，到2020年留守儿童人数要“明显”减少。文件指示地方政府加强对留守儿童的监护监督——让未成年人独自生活是违法的。文件还敦促医院和学校在报告疑似伤害事件方面做得更好。2017年的一项新规要求村干部将所有留守儿童登记在册。根据2020年5月的另一项规定，发现未成年人被疏于照看或受到侵害而知情不报者，有可能构成犯罪。官方数据显示，2018年，地方政府为7.6万名无人看护的儿童配备了监护人，帮助16万名辍学的留守儿童重返校园。自2017年以来，中央政府根据各村提供的记录，建立起一个留守儿童和弱势儿童数据库。

官员们已经将重点放在了受影响群体中的一个子集上。2016年出台的指导文件只将16岁以下且父母双方都在外地打工的儿童划为留守儿童。政府表示，根据这一定义，当年能被列为留守儿童的只有900万人。到2018年，这一数字降至不到700万。但是，即便只与父母其中一方分开也常常给孩子造成危害。而离开他们的是父亲还是母亲，影响也不同。中国2017年发表的一项研究报告发现，只有母亲陪伴的农村儿童的辍学率比只有父亲陪伴的低（父母双方都不在身边的辍学率最高）。2019年，一篇发表在同行评议期刊《心理学前沿》（Frontiers in Psychology）上的论文认为，父母双方至少有一方（尤其是母亲）在家陪伴，可以降低留守儿童在青少年时期自残的风险。

农村父母常常认为，自己的陪伴在孩子上学后的阶段才是最重要的。因此他们更倾向于在孩子入学前外出打工，香港大学的卢霜说。据联合国儿童基金会报道，中国二岁以下的儿童中超过四分之一未由母亲照看。中国2017年的那项研究发现，五岁以下儿童占所有留守儿童的比例已从2000年的30%上升至2015年的40%。许多孩子从未喝过母乳，未享受到这一有益

于终身健康的福利。赵琳也是其中之一。

随着年龄的增长，孩子们还会面临其他精神创伤。据北京的非政府组织“上学路上”调查显示，自2015年以来，留守儿童的抑郁水平一直居高不下。在2019年，他们中有90%表示遭受过精神虐待，60%称遭受过人身伤害。近三分之一遭遇过性侵。

这些侵害往往不被察觉。“与父母分离让孩子不愿意主动向父母敞开心扉。”代理过此类犯罪案件的成都律师万淼焱表示。她记得有这样一起案件，亲戚们直到发现受害的孩子写给她自己的一封信才知道发生了什么事。她在里头描述了自己被老师强奸的经历。一名儿童治疗师说，目前的援助体系依赖的是本身就可能是侵害者的同村人，而不是外来的专业人士。

这些体系的力量也很薄弱。留守儿童众多的省份——以人口大省四川为最——往往也是最贫困的一批省份，缺乏保护弱势群体所需的资源。但是地方政府正在努力。四川政府部门推出了“童伴计划”，其中包括设立“童伴之家”（在村里设置一块空间，孩子们可以在那里玩耍、读书，有人辅导作业），以及指定“童伴妈妈”，孩子们可以向她寻求情感支持。中央政府也提供了支持。自2010年以来，它为66万个村庄培训了从事社会工作的“儿童福利主任”。它还允许将扶贫资金用于儿童福利。

赵琳所在的乐云村在2015年成为加入“童伴计划”的首批村庄之一。干劲十足的幼儿园老师刘春华被选为当地的负责人。她在四川省会成都学习了要如何去和村里的20名儿童聊性和心理健康话题。她的努力得到了回报。在乐云村，一个腼腆的十几岁女孩第一次来月经时不知所措。她的朋友也不知道怎么办，就鼓励她去跟“刘妈妈”说。刘春华给女孩解释了她身体的变化，教她怎么使用卫生巾。村里的大人们经常在背后对留守儿童的父母说三道四。刘春华制止了这种习气。她知道流言的杀伤力。她的女儿也曾是留守儿童，被村民取笑，说刘春华回家只是为看大儿子。眼看着女儿变得郁郁寡欢，刘春华辞掉了工厂的工作，回到了村里。

但是要密切关注孩子变得越来越困难。过去，大多数村庄都有一所学校，学校老师可以检查学生是否受伤、生病或不开心。然而在过去20年里，超过36万所利用不足的乡村学校为节约资金而关闭。乐云村的那间也命悬一线。十年前该校有70名学生，现在只剩两名最低年级的学生。其余的孩子到山下走路一小时到的蒲家镇上学。他们通常周末回村里。赵琳也在那里上幼儿园。问她是不是拿了好成绩，她说自己被打手的次数比同学少。

随着工厂向内陆迁移，越来越多的农民工能够在离农村老家更近的地方找到工作，这带来了一线希望。乐云村的一些父母开始带着孩子在附近的城镇定居。而新冠疫情让许多农民工不得不返回老家，这对有些人来说是意外之喜。目前，乐云村一半的孩子都和父母双方住在一起。这是“从没听说过”，刘春华说。

这些父母中的许多人自己也曾经是留守儿童。但和他们小时候不同，现在农村的条件已经大有改善。25岁的志愿者老师朱一丹（音译）长在四川，也曾是名留守儿童。她说，小时候，人们进村要徒步穿越山野。现在已经修了路，孩子们也不缺吃穿和玩具。父母每天能和孩子视频聊天，在网上给他们买礼物。

但又出现了一个新问题。由于父母一方或双方外出务工，越来越多的孩子被留在了城市。2015年，这样的儿童大约有2800万，差不多是2000年的三倍。研究表明，那些跟随父母从农村进城的儿童比留在农村的儿童吃得更好，心理也更健康。但那些之后在城里成了留守儿童的孩子比留在农村的孩子遭受暴力的比率更高。万焱律师表示，“国家欠留守儿童一笔债”。这笔账还远未结清。 ■



Old ideas, new problems

David Cameron, the Greensill affair and a British government scandal

The connections between government insiders and a failed finance firm raise awkward questions

WHEN SOMEONE claims to have found a new way to make money out of an old idea, it usually pays to treat them with suspicion. Greensill Capital, a now-failed finance company, lent firms money secured against their invoices. This type of finance existed in ancient Mesopotamia. Lex Greensill, the business's founder, updated it with some shiny new technology and what an early backer calls "homespun stories of growing up on a farm and seeing how late payments hurt his father".

Britain's government greeted the charming Mr Greensill not with suspicion, but with a job in 10 Downing Street and a contract with the National Health Service (NHS). He was aided by the equally charming David Cameron, now embroiled in a lobbying scandal that will scotch any hope of restoring a reputation ruined by Brexit. The pair's reach ran far. On April 13th it emerged that a senior public servant had combined his Cabinet Office job with one for the failed company. A day earlier Boris Johnson announced an inquiry into the government's links with Greensill, led by Nigel Boardman, a corporate lawyer.

Supply-chain finance is a simple solution to a common business problem: long payment terms. A retailer, for example, will want goods from its wholesalers upfront but may delay paying their invoices for weeks. Greensill, and firms like it, offer an alternative to waiting. They pay the money at once, for a small charge, and then cash in the invoices when they fall due. Greensill took the model a step further by bundling up its loans to firms as bonds for sale to yield-hungry investors. This year questions

were raised about the creditworthiness of some of the companies issuing the invoices on which Greensill's bonds were secured. That prompted Credit Suisse, a bank, to freeze funds linked to the firm. Companies that relied on liquidity provided by Greensill, such as Liberty Steel, a large British-based manufacturer, now face a financing gap.

The affair has revealed some unflattering quirks of the British state. One is a readiness for quick fixes. In 2018, Greensill won a contract to help the NHS pay high-street pharmacies quicker. Neither that contract, nor another one to allow NHS staff access to their pay earlier, made Greensill much money. They did, however, feature in the firm's pitches and boosted its credibility. An alternative solution—for the government simply to speed up payments—would have meant difficult reform of bureaucracy, while Greensill appeared to offer an instant fix.

The second is a permeability to outside interests. Mr Greensill was made an unpaid government adviser on supply-chain finance in 2012, and had a Downing Street business card. He had previously worked alongside Jeremy Heywood, then the head of the civil service, as an investment banker at Morgan Stanley. Hardest to explain is how Bill Crothers, formerly the government's chief procurement officer, was allowed to work part-time for Greensill while still holding his government post. Mr Crothers argues that he did not need to seek permission from the Advisory Committee on Business Appointments (itself a pretty flimsy body) because the role was approved under an internal conflicts-of-interest policy at the Cabinet Office. There is no central register of second jobs. Civil servants now worry that Mr Crothers' case will not be unique.

Mr Cameron's role exposes the weakness of Britain's lobbying rules. He stood to make millions if the firm succeeded. He bombarded ministers and civil servants with messages, asking them to tweak the rules to allow Greensill to benefit from government-backed lending schemes for stricken

companies. To the Treasury's credit, the rules were not changed. As Mr Cameron was employed by the firm, rather than a third-party lobbyist, such messages were not subject to the disclosure rules put in place by his government. It has since emerged that, on a trip to Saudi Arabia to seek contracts, Mr Cameron and Mr Greensill (pictured, above) went camping with Crown Prince Mohammad bin Salman.

Mr Boardman's report, due by the end of June, is not expected to pull punches. "He's a hard-edged lawyer who understands finance and has no incentive to go easy on anybody," says one former colleague. Mr Johnson and Mr Cameron have been rivals since they were at Eton together and the affair has yielded a striking volume of leaked material. Mr Johnson may hope the inquiry bolsters him while embarrassing his predecessor. Some Tories fear this is a dangerous move, and the government may get damaged in the fallout. ■



旧点子，新问题

卡梅伦、Greensill事件和英国政府的丑闻

政府人员与一家倒闭的金融公司之间的关系引发了令人尴尬的质疑

要是有人声称他找到了靠旧点子赚钱的新方法，通常还是留点心为好。

Greensill Capital是一家现在已倒闭的金融公司，它贷款给企业，而企业以付款通知单作抵押。这样的金融模式在古美索不达米亚就已存在。

Greensill的创始人莱克斯·格林希尔（Lex Greensill）把它发扬光大，用上一些炫目的新技术，外加说一段——用一位早年支持者的话说——“自己在农场长大，眼看着别人迟迟不付款如何伤害了父亲的朴实故事”。

英国政府对魅力十足的格林希尔非但不怀疑，还给了他一份在唐宁街10号的工作，以及和英国国家医疗服务体系（NHS）的一份合同。他得到了同样充满魅力的前首相卡梅伦的帮助。卡梅伦如今身陷游说丑闻，令他再无希望挽回因英国脱欧而毁掉的声誉。二人影响波及甚广。4月13日曝出消息，一名高级公职人员在内阁办公厅任职的同时受雇于Greensill。前一日，现任首相约翰逊宣布，由公司律师奈杰尔·博德曼（Nigel Boardman）牵头，调查政府与Greensill的关系。

供应链金融为长账期付款这个商业上常见的问题提供了简单的解决方案。例如，零售商想先从批发商那里进货，但可能会延迟数周才按付款通知单付清货款。Greensill及类似企业提供了等待付款之外的另一种选择。它们立刻向批发商支付全款，只收取少许费用，然后在付款通知单到截止期时从零售商那里收款。Greensill把它给企业的贷款打包成债券，出售给渴求收益的投资者，将这一模式更推进了一步。今年，Greensill债券中一些开具付款通知单作为抵押的公司的信誉遭到了质疑。这促使瑞士信贷银行冻结了与该公司有关的资金。依靠Greensill提供流动资金的企业现在面临融资缺口，英国大型制造商利百德钢铁（Liberty Steel）就是其中一家。

此事件暴露了英国政府一些有损自身形象的怪癖。其一是喜欢用权宜之

计。Greensill在2018年赢得了一份合同，帮助NHS加快向零售药店付款。无论是这份合同，还是另一份让NHS员工更早领到工资的合同，都没让Greensill赚到多少钱。不过这些合同确实成了公司自我推销的重点，提高了它的信誉。另一种解决方案——也就是让政府直接加快支付速度——意味着要对官僚作风展开艰难的改革，而Greensill看似提供了一个即时解决方案。

其二是外部利益的渗透。2012年，格林希尔被任命为供应链金融方面的政府无薪顾问，并配有唐宁街的名片。那会儿杰里米·海伍德（Jeremy Heywood）担任文官长，他曾是格林希尔从前在摩根士丹利做投资银行家时的同事。最难解释的是，为何允许政府前首席采购官比尔·克罗瑟斯（Bill Crothers）在政府任职的同时在Greensill兼职。克罗瑟斯辩称，他不需要获得商业任职咨询委员会（Advisory Committee on Business Appointments，本身是一个相当不靠谱的机构）的许可，因为这个职位是根据内阁办公室的内部利益冲突政策批准的。官员们的第二份工作并没有集中记录在案。公务员们现在担心克罗瑟斯的情况不是个案。

卡梅伦的角色暴露了英国游说制度的缺陷。如果Greensill成功，他势必能赚上几百万。他向部长们和公务员发送大量短信，请求他们调整规则，好让Greensill从为受困企业提供政府担保贷款计划中受益。值得表扬财政部的是，它没有更改规则。由于卡梅伦受雇于该公司，而不是第三方说客，因此这些短信不受他那届政府制定的信息披露法规的约束。此后有消息称，在一次前往沙特谋求签约的行程中，卡梅伦和格林希尔（见上图）曾与王储穆罕默德·本·萨勒曼（Mohammad bin Salman）一起露营。

博德曼的报告定于6月底前完成，预计不会手下留情。“他是一位性格强硬的律师，懂金融，也没有缘由对任何人心慈手软。”他的一位前同事说。约翰逊和卡梅伦从一起上伊顿公学时起就开始竞争了，而这桩事件已经泄露出大量内幕资料。约翰逊可能希望这次调查能抬高自己，同时让他的前任难堪。一些保守党人担心这一步有危险，政府可能会受到牵连。■



Methane leaks

Put a plug in it

Governments should set targets to reduce methane emissions

THE ORACLE of Delphi's trance-like state is thought to have been induced by gases seeping into her chamber through a crack in the ground. Some say methane was part of the cocktail. If true, the gas has shaped the course of civilisations at least three times: in ancient Greece when wars were waged and kingdoms fell on the strength of the Oracle's prophecies, in the 20th century when methane-fuelled machines helped power industrialisation, and today, when the gas is a central but under-appreciated part of the fight against climate change.

Human activity emits far less methane than carbon dioxide, but methane packs a heavier punch. Over the course of 20 years, a tonne of the gas will warm the atmosphere about 86 times more than a tonne of CO₂. As a result methane, sometimes called carbon dioxide on steroids, is responsible for 23% of the rise in temperatures since pre-industrial times. Carbon dioxide gets most of the attention, but unless methane emissions are limited there is little hope of stabilising the climate.

Unfortunately methane emissions have been anything but stable. After briefly stalling in the early 2000s, atmospheric concentrations of the gas started rising again in 2007. A global inventory, concluded last year, found that humans were largely to blame. Chief among the reasons for the rise are the gassy output of livestock farming (cows belch it), rice cultivation (soggy environments harbour micro-organisms that make it) and the fossil-fuel industry (pipelines and rigs leak it). Agriculture and energy each account for roughly one-third of annual methane emissions. China, America, Russia and other big energy producers and consumers are heavy polluters.

Countries with lots of livestock produce a disproportionate share of farming-related emissions, too.

By how much do methane emissions need to fall? Carbon dioxide lingers in the atmosphere for centuries, making it hard to reduce its atmospheric concentrations. By contrast, methane has a half-life of roughly ten years, which means that it degrades quickly. If new emissions can be cut to below the rate at which old emissions deplete, the concentration of methane lingering in the atmosphere will soon fall, slowing global warming. The Intergovernmental Panel on Climate Change estimates that, to keep temperatures between 1.5°C and 2°C above pre-industrial levels, human methane emissions must drop to 35% below where they stood in 2010 by mid-century.

That is entirely plausible. A big step would be to stop millions of tonnes of methane from leaking out of fossil-fuel infrastructure each year, through pipes with holes, leaky valves and carelessness. Natural-gas operators will be able to sell more gas in exchange for a moderate investment in monitoring and repairing leaks. The International Energy Agency, a global forecaster, estimates that 40% of methane emissions from fossil fuels, equivalent to 9% of all human methane emissions, can be eliminated at no net cost for firms. The harder task is to reduce emissions from agriculture, but even here farmers can draw on new ideas, including developing new forms of feed for livestock, and altering how rice is irrigated.

Politicians and the public tend to worry about carbon-dioxide emissions and neglect the effects of cutting methane. But dealing with the gas would have a large effect rapidly and at relatively low cost. Governments are busy firming up their commitments to cut emissions under the Paris agreement, as they prepare for the COP26 climate summit in November. On April 22nd President Joe Biden will convene his own summit. America is expected to make its targets public around that time, which will almost certainly

include a pledge to reduce emissions to net zero by the mid-2000s. It should go further and include a specific target for methane. Then other nations should follow its lead. ■



【首文】甲烷泄露

加个塞子

各国政府应该设定减少甲烷排放的目标

女祭司在德尔菲神庙中传达神谕时会进入一种迷狂恍惚的状态，据说是因
为有一些气体通过地面的裂缝渗入她所在的内殿。有人说其中一种气体就
是甲烷。果真如此，那么甲烷至少三次塑造了文明的进程：在古希腊时
期，因为神谕的力量，战争爆发，一些王国陷落；在20世纪，用甲烷作燃
料的机器推动了工业化；而今天，在对抗气候变化时，影响至关重要的甲
烷没有受到足够重视。

人类活动排放的甲烷远少于二氧化碳，但甲烷的影响更大。20年的时间
里，一吨甲烷让大气变暖的程度大概是一吨二氧化碳的86倍。因此，甲烷
有时被称为加强版二氧化碳，它导致自前工业时代以来的气温上升23%。
绝大部分的关注都放在了二氧化碳上，但是除非限制甲烷的排放，否则稳
定气候的希望微乎其微。

不幸的是，甲烷排放量一直没有控制住。在本世纪初的短暂停滞之后，大
气中的甲烷浓度在2007年又开始上升。去年的一项全球调查得出结论，人
类在很大程度上是罪魁祸首。排放量攀升的主要原因是畜牧业的气体排放
(牛会释放甲烷)、水稻种植(潮湿的环境孕育了产生甲烷的微生物)和
化石燃料行业(管道和钻机会泄露甲烷)。农业和能源各占每年甲烷排放
量的三分之一左右。中国、美国、俄罗斯和其他大型能源生产国和消费国
都是排放大户。畜牧业发达的国家也在农牧甲烷排放中占有过高的比例。

甲烷排放量需要减少多少？二氧化碳在大气中能存留几个世纪，因此它的
大气浓度难以降低。相比之下，甲烷的半减期大约为10年，这意味着它的
降解速度很快。如果新增排放的速度能够下降到低于既有排放消解的速
度，那么大气中的甲烷浓度会很快下降，从而减缓全球变暖。联合国政府
间气候变化专门委员会(Intergovernmental Panel on Climate Change)估

计，要想将气温保持在比工业化之前高1.5到2摄氏度的水平，到本世纪中叶人类的甲烷排放量必须下降到2010年水平的35%。

这是完全有可能实现的。一项重大举措是防止每年数百万吨的甲烷从化石燃料基础设施里泄漏，比如通过管道孔洞和阀门的泄露，或是粗心大意引发的泄漏。如果在监测和修补泄漏方面适度投资，天然气运营商就能换来更多的天然气供出售。全球预测机构国际能源署（International Energy Agency）估算，化石燃料甲烷排放的40%，即人类所有甲烷排放的9%，可以在不增加企业净成本的情况下消除。减少农业排放会更困难。但即便如此，农民也可以运用一些新点子，比如开发新式畜牧饲料、改变水稻的灌溉方式等。

政客和公众往往担心二氧化碳的排放，而忽视减排甲烷的效果。但对付这种气体能够迅速产生巨大的影响，而且成本相对较低。各国政府正在加紧落实《巴黎协议》的减排承诺，为11月的第26届联合国气候变化大会（COP26）做准备。4月22日，美国总统拜登要召开自己的峰会，预计美国将在这段时间前后公布其减排目标，其中几乎肯定会包括到本世纪中减排至净零的承诺。美国应该更进一步，设定甲烷的具体减排目标。之后其他国家应该跟上。 ■



China's lending

Neither predator nor pal

What 100 contracts reveal about China's development lending

WHAT DO THE following have in common? Subway cars in Argentina; digital TV in the Republic of Congo; thermal power in Kyrgyzstan; turboprop planes in Vanuatu; and the Queen Elizabeth II quay in Sierra Leone? All have benefited from Chinese lending, which has helped finance transport, power and telecommunications projects across the developing world.

China insists it is helping poor countries follow in its own debt-financed footsteps, offering the kind of patient capital other lenders are now too wary to provide. China's critics instead accuse it of drenching countries in red ink, then grabbing strategic assets, such as ports or mines, as collateral when a country defaults.

Judging these claims can be tricky because the terms and conditions of loans are mostly hidden from view. Mostly. An enterprising team including Brad Parks at AidData, a research centre at the College of William and Mary in Virginia, has scoured parliamentary websites, official registers and debt databases in over 200 countries, looking for any loan documents that might have slipped out into the open. They have found 100 contracts signed by 24 borrowing countries, mostly with two state-directed "policy banks", the Export-Import Bank of China (China Eximbank) and China Development Bank.

The contracts suggest China's loans are not conspicuously expensive. China Eximbank's commercial loans charge a rate of 0.5-4.5% above a floating benchmark rate (the London Interbank Offered Rate, which averaged about 1% over the past decade). These are "in line with market terms", say the

authors.

Nor are the loans obviously predatory. In 99 out of 100 cases, China does not require the borrower to pawn a physical asset as collateral. This should not be a surprise. Taking possession of physical assets is “a pain”, points out Anna Gelpern of Georgetown University, one of the study’s authors. (The one potential exception is the port loan to Sierra Leone, which mentions “equipment and other assets” detailed in another, unlocated document.)

China’s lenders are, however, keen on less painful forms of collateral. They sometimes insist that countries maintain a separate bank account that the lender could seize or block in a dispute. When combined with unusually broad confidentiality clauses (in some cases, borrowers cannot even reveal the existence of the loan), these accounts make it harder for a country’s other creditors, or indeed its citizens, to keep track of the government’s financial standing.

Chinese lenders do not play nicely with other creditors. They typically insist on being left out of any broader efforts to provide debt relief to a stricken borrower (although any demand for special treatment may not be enforceable in practice). Chinese banks do, however, show solidarity with their compatriots. They can recall a loan if the borrower damages the interest of any Chinese entity, including, but not limited to, other banks.

China lends more than most to inhospitable corners of the world. The 100 contracts include loans to some countries with awful credit ratings (Venezuela) and some with no rating at all (Sierra Leone). Countries like this sometimes struggle to borrow because they have too much freedom to default and cannot convince a lender otherwise. The unusual terms in China’s loan contracts make it harder for countries to bilk it. But that presumably also makes it easier for countries to borrow from it. ■



中国放贷

不是掠夺者，也不是好兄弟

从一百份合约看中国的发展贷款

下面这些东西有什么共同之处？阿根廷的地铁车厢、刚果共和国的数字电视、吉尔吉斯斯坦的火力发电厂、瓦努阿图的涡轮螺旋桨飞机，还有塞拉利昂的伊丽莎白二世码头。答案是它们都从中国的贷款受益，这些贷款帮助为发展中国家的运输、电力和电信项目融资。

中国坚称它是在帮助穷国走上自己曾走过的债务融资之路，像它们提供今时今日其他贷款机构因警惕而不愿提供的长期资金。而中国的批评者则指责中国是在用债务压垮那些国家，然后在一国债务违约时夺取用作抵押的港口或矿山等战略资产。

要判断这些说法孰是孰非可能很棘手，因为贷款的条款大多没有公开——是大多，并非全部。一个勇于求索的研究团队遍阅了200多个国家的议会网站、官方记录和债务数据库，以寻找任何可能意外流入公开领域的贷款文件。团队成员包括弗吉尼亚州的威廉与玛丽学院（College of William and Mary）下设AidData研究中心的布拉德·帕克斯（Brad Parks）等人。他们找到了24个借款国签署的100份合约，其中大多数是与中国进出口银行（以下简称口行）和国家开发银行（下称国开行）这两家国家主导的“政策银行”签定的。

从这些合约看，中国的贷款并不算特别贵。口行的商业贷款利率比浮动基准利率（即伦敦银行同业拆借利率，过去十年平均约为1%）高0.5%到4.5%。这与“市场行情相符”，研究报告的作者说。

这些贷款也不明显具有掠夺性。100个合约中有99个都没有要求借款国以有形资产作抵押。这也没什么好奇怪的。接手实物资产是件“让人头疼的事”，报告作者之一、乔治敦大学（Georgetown University）的安娜·盖珀恩（Anna Gelpern）指出。塞拉利昂的港口贷款可能是个例外，合约中提

到在另一份文件（研究团队未找到）中详列了“设备和其他资产”。

但是，中国的贷款机构热衷于使用不那么让人头疼的抵押形式。它们有时坚持要求借款国开一个单独的银行帐户，让贷方可以在出现争议时查封或冻结该账户。如果结合以涵盖范围异常广泛的保密条款（在某些情况下借款国甚至不得透露贷款的存在），这些帐户让一国的其他债权方——当然还有该国民众——更难以了解政府真实的财政状况。

中国的贷款机构也不与其他债权方无间合作。对于共同为某个陷入困境的借款国减免债务的举措，它们通常坚持置身事外（尽管任何对特殊待遇的要求实际上可能也无法强制执行）。但是，中国的银行确实与自家人团结一致。如果借款方损害了任何中国实体（包括但不限于其他银行）的利益，它们可以收回贷款。

中国为世界上财政状况最恶劣的国家提供的贷款比大多数国家都多。这100份贷款合约中就包含一些信用评级非常糟糕的国家（如委内瑞拉）和一些根本没有评级的国家（如塞拉利昂）。像这样的国家有时很难借到钱，因为它们违约太容易了，也无法说服贷方相信自己不会违约。中国的贷款合同中不寻常的条款让贷款国更难赖账。但这大概也让各国更容易从中国借到钱。 ■



Don't be fooled by randomness

The method in Microsoft's merger madness

Making sense of the software giant's acquisitive streak

TAKE OUR cash, or at least our shares. That appears to be Microsoft's mantra these days. After failing to acquire the American operations of TikTok, a short-video app, last year, the software giant was recently rumoured to be in takeover talks with Pinterest, a virtual pin-board, and Discord, an online-chat service. And on April 12th the firm announced that it would acquire Nuance, a speech-recognition specialist, for nearly \$20bn in cash—its second-biggest acquisition ever.

Even before this latest flurry Microsoft had acquired a reputation for coveting tech firms that looked as alien to its core business of selling office software as TikTok's dance videos are to Word and Excel. Five years ago, in its biggest purchase, it paid \$26bn for LinkedIn, a business-oriented social network. In 2018 it picked up GitHub, a development platform for open-source programs, for \$7.5bn. "Is Satya Nadella getting bored?" wondered *The Information*, a website covering the tech industry. Having successfully turned Microsoft around, observers murmured, its boss might be in the grip of merger madness. In fact, there might be a method to it.

For starters, Microsoft's merger activities are unexceptional by big-tech standards, says Mark Moerdler of Bernstein, a broker. The industry is rife with takeover rumours; most are probably true. Large firms talk regularly to each other about potential deals. It is safe to say that Microsoft has term sheets for many potential targets on file. It still invests far more in expanding its existing businesses than on buying new ones. Excluding the Nuance deal, the company has spent only \$33bn on big acquisitions in the past four years, compared with \$64bn on research and development. It has

oodles of cash in the bank (\$132bn at the end of last year) and a valuable currency (its share price is up by more than 600% since Mr Nadella took over in 2014). Unlike rivals such as Alphabet and Facebook, both of which face antitrust cases and have steered clear of big deals lately, Microsoft is no longer on trustbusters' radar.

By its relatively timid standard, though, Microsoft has indeed become more acquisitive in recent years (see chart). Having provided textbook examples of what not to do, most notably after buying Nokia, a phonemaker, and Skype, an internet phone service, it has learned how to integrate targets successfully. Under Mr Nadella it has taken on a shape that better lends itself to this process.

Simply put, it has become a giant computing cloud that can digest any data and offer any service. An acquisition can thus add to the business in more ways than one—and “feed the beast”, in the words of Brent Thill of Jefferies, an investment bank. Even TikTok would have brought new computing tasks for the cloud, provided reams of videos to train artificial-intelligence algorithms and allowed the firm to beef up its consumer business.

Purchases also help Microsoft to keep growing rapidly by allowing it to ride big industry trends. Discord, like GitHub before it, looked to be a bet on the shift toward creating content and related user communities, which Mr Nadella thinks will dominate life online. A bit like LinkedIn, Pinterest would give Microsoft access to data about people’s interests, which could enable new forms of e-commerce.

The Nuance deal encapsulates all these considerations. The firm is best known for its speech-recognition software and a health-care platform used in 77% of American hospitals. This technology, along with lots of valuable health data, will beef up Microsoft’s “health cloud”. Nuance’s portfolio of

patents can be used elsewhere in Mr Nadella's empire. Though \$20bn looks pricey for a firm with a net profit of \$29m last year on revenues of \$1.5bn, Microsoft can afford it. Discord and Pinterest seem to be off the table for now. But expect Microsoft to surprise with more deals. And don't be fooled by their apparent randomness. ■



看似任性，实则不然

微软疯狂并购背后的章法

读懂这家软件巨头大举收购的逻辑

收下我们的现金，或者至少收下我们的股票。这似乎已经成了微软这阵子的口头禅。在去年试图收购短视频应用TikTok的美国业务失败后，最近有传言称，该软件巨头正与虚拟看板Pinterest和在线聊天服务Discord进行收购谈判。而在4月12日，微软宣布将斥资近200亿美元现金，收购语音识别公司Nuance。这是该公司有史以来第二大收购案。

早在最近这一轮收购潮之前，微软就已经以热衷收购各种科技公司而闻名。目标公司与其销售办公软件的核心业务并不搭界，正如TikTok上的跳舞视频和Word及Excel格格不入一样。五年前，它斥资260亿美元收购了面向企业的社交网络领英（LinkedIn），这是它迄今最大的一笔收购。2018年，它以75亿美元收购了开源程序开发平台GitHub。“萨蒂亚·纳德拉是太无聊了吗？”科技媒体网站The Information质疑道。观察家们嘀咕，在成功扭转微软的颓势之后，这位掌门人似乎陷入了并购狂热而无法自拔。但实际上，这当中或许有章可循。

首先，经纪公司盛博的马克·莫德勒（Mark Moerdler）认为，以科技巨头的标准来看，微软的并购活动并不稀奇。这个行业充斥着收购传言，大多数很可能是真的。大公司之间经常就潜在的交易机会互相沟通。可以肯定地说，微软手头已经有针对许多潜在标的公司的投资意向书。与收购新业务相比，这家公司在扩大现有业务上的投入还是要大得多。除了Nuance那笔交易外，微软过去四年在大型收购上的支出仅为330亿美元，相比之下研发支出达到640亿美元。它的银行账户上拥有大量现金储备（去年年底达1320亿美元），同时公司市值不菲（自纳德拉2014年上任以来，股价已经上涨超过600%）。Alphabet和Facebook等竞争对手面临反垄断调查，近期都避开了大型交易，但微软已经不在反垄断机构的目标范围。

不过，以微软相对谨小慎微的标准来看，近年来它的收购欲望确实变得更强烈了（见图表）。它曾提供了一些教科书般的失败案例，最突出的是收购手机制造商诺基亚和互联网电话服务Skype，但此后微软已经学会了如何成功地整合目标公司。在纳德拉的领导下，这家公司已经转变形态，变得更加适合收购。

简单地说，它已成为一个巨大的计算云，能够消化任何数据，提供任何服务。因此，每一宗收购都可以在不止一个维度上为业务增加价值，并且——用投资银行杰富瑞（Jefferies）的布兰特·希尔（Brent Thill）的话说——不断“喂养巨兽”。即使TikTok这样的公司也会为云带来新的计算任务，提供海量视频来训练人工智能算法，从而增强微软的消费者业务。

收购也有助于微软搭乘行业大趋势，保持快速增长。与之前收购GitHub一样，收购Discord看来是在押注向创建内容和相关的用户社区的转变——纳德拉认为这将是网络生活的主流。Pinterest有点像领英，可以让微软获得关于人们的兴趣爱好的数据，继而可能催生新的电子商务形式。

收购Nuance集中体现了所有这些考量。这家公司以其语音识别软件和医疗平台闻名，77%的美国医院都使用该平台。这项技术，连同大量宝贵的健康数据，将大大充实微软的“健康云”。Nuance的专利组合还可以用于纳德拉的商业帝国的其他角落。尽管对于一家去年收入15亿美元、净利润2900万美元的公司来说，200亿美元的收购价格似乎有些昂贵，但微软负担得起。目前看来，Discord和Pinterest似乎已经不在考虑之列。但等着看微软达成更多出人意料的交易吧。也别被它们表面上的毫无章法给迷惑了。 ■



India Inc

India has proved to be a popular—and clever—investor in poor countries

It cannot match China's heft in foreign investment, but offers lessons for other investors

IN CENTRAL Lusaka a brand-new flyover flutters with the green, white and saffron of the Indian flag. Throughout the Zambian capital lorries produced by Tata Motors, part of the steel-to-tech Tata empire, are used for everything from construction to rubbish collection. Signs inside the vehicles instruct drivers in both English and Hindi. The lorries' occupants phone each other over a mobile network run by Bharti Airtel, an Indian telecoms firm.

Many Zambians, like people in many other developing countries, complain loudly and often about the Chinese firms that are big local investors. India is also a big commercial presence but no one bats an eyelid. Tata Motors has huge assembly plants in many countries, including South Africa and Malaysia. Bharti Airtel is one of the biggest telecoms operators in Africa. The Aditya Birla Group is the world's largest producer of carbon black, an ingredient in car tyres. It is one of Egypt's biggest industrial investors and exporters.

Even in sectors governments deem strategic, such as infrastructure and communications, Indian foreign direct investment (FDI) is not viewed as geopolitical scheming or hegemonic ambition. “That’s one of the selling points for India,” says Gareth Price of Chatham House, a British think-tank. “With the obvious exceptions of Pakistan and China, everyone is kind of all right with India.”

India was once compared to China as an emerging-market power with capital to splurge. The spectacular rise in Chinese investment over the past

decade or so has scotched that analogy. Now poor countries are trying to finance their recovery from covid-19 without deepening their debt or their dependence on China. India's forays are tiny in comparison—around 7% of China's total stock of FDI in developing economies (not counting investment in Hong Kong, which is sometimes included). But its approach has lessons for foreign investors trying to go about their business without setting off alarm bells.

Firms from emerging markets have long invested in other emerging markets. Their experience at home of delays, chaos and financing constraints provide useful preparation. India helped organise the Bandung conference in 1955, which discussed "South-South" co-operation.

Indian investments in the rich world are more likely to grab headlines. Deals such as the Tata Group's acquisition of Tetley Tea or Jaguar Land Rover involve household names, hundreds of millions of dollars and a smack of reverse imperialism. But India's stock of outward FDI to the poor world is about the same as its stake in rich countries, and has been growing more steadily over time. In 2019 it reached roughly \$46bn, according to the latest estimates by the UN Conference on Trade and Development, up from around \$40bn in 2010. About \$30bn of that is in Asia and around \$13bn in Africa.

Some of the data are sketchy. Multinational companies headquartered in India generally set up local subsidiaries. They route money through tax havens such as Mauritius. And the 18m-odd overseas Indians (those born in the country or holding Indian citizenship) include entrepreneurs who switch passports and register businesses locally. "It becomes a jigsaw," says Jai Bhatia of Cambridge University.

Even if some pieces of the puzzle are missing, those that remain

demonstrate the most obvious reason investment from India is viewed with less suspicion than that from China: scale. Even as Indian investment has grown steadily, Chinese investment in the poor world has soared: from \$83bn in 2010 to \$645bn in 2019.

Another reason is that, unlike Chinese investment, little of India's FDI comes from state-controlled companies, which are often suspected of operating with one eye on geopolitical strategy and foreign-policy goals. ONGC Videsh is one of the few sizeable government-owned Indian businesses operating abroad. It has bought up assets in countries as far apart as Mozambique and Colombia.

But its firepower is not in the same league as its Chinese peers. Sinopec, a state-owned oil company, first muscled its way into the Angolan oil industry in the mid-2000s. It gazzumped ONGC to buy a stake in a block from Shell, an oil-and-gas giant. Jonathan Hillman of the Centre for Strategic and International Studies, a think-tank in Washington, points out that India has nothing comparable to China's Belt-and-Road Initiative, a global infrastructure-building scheme. "The Indian government hasn't spent as much time presenting grand visions," he says.

Most of India's FDI comes instead from privately held businesses, which undertake projects overseas for purely commercial reasons. They include recently arrived entrepreneurs, (disparagingly dubbed "Rockets" in Kenya for their intention of making fortunes and quickly heading home), multinational investors headquartered in India and diaspora families who have been doing business abroad, especially in Africa, for generations.

Indian traders began settling around the edges of the Indian Ocean centuries ago. In the 19th century thousands more were sent to far corners of the British empire, to work on plantations in Mauritius and build railways in Kenya. Many stayed and built their own businesses. Others braved long

journeys on dhows to join them in Africa. “We tend to view things ahistorically and through a geopolitical prism, so it is all about China,” says Parag Khanna, an international-relations expert whose father worked for the Tatas in Africa. In a sign of China’s rise on the continent, the railway that drew Indians to Kenya in the 1890s has been replaced by the Madaraka Express, a Chinese-built line named after the anniversary of Kenyan independence from Britain (madaraka means “ruling power” in Swahili).

The Indian diaspora has sometimes experienced resentment. In the 1970s, for example, Idi Amin, a despot, expelled Asians from Uganda and seized their property. But by and large, a shared history has bred familiarity. Kenya’s government has gone so far as to recognise Asians as the country’s 44th official tribe. Vimal Shah, whose grandfather emigrated from India, started the Bidco Africa juice-to-cattlefeed empire with his father and brother about 35 years ago. He knows the best Indian food in Nairobi and volunteers at the Jain community centre, but has a Kenyan passport and sees himself as thoroughly Kenyan. “I’m not a desi [local] from India,” Mr Shah says.

After independence, industrialists looked beyond India’s borders to free themselves from red tape. One of India Inc’s first foreign ventures was a textile mill built by the Birla Group in Ethiopia in 1959. The conglomerate then expanded across South-East Asia, where economies were opening up. A second, bigger, rush of FDI came in the 1990s, when India loosened capital controls. Last year Indian businesses set up 4,590 projects abroad, up from 395 in 2000, according to data crunched by Prema-chandra Athukorala of the Australian National University.

A third reason Indian investment tends to arouse less resentment than that from China is that Indian companies have a largely justified reputation for trying harder than the Chinese to hire and buy locally. In 2006 the World Bank surveyed almost 450 businesses in Africa. On average, Chinese firms

employed almost a fifth of their workers from China and other East Asian countries, whereas Indian firms brought less than 10% of their workers from India. The Chinese businesses imported 60% of new machinery from China; their Indian peers bought just 22% from India. That trend continues today, says Harry Broadman, the economist who led the research.

The fact that many Indian companies are still family-run may have something to do with that. Executives worry about both their founders' reputation and the way their actions reflect on Mother India. Rudrarup Maitra, who looks after Tata Motors' international commercial-vehicles business, talks about the company's contributions to development in its overseas markets, including its efforts to get ambulances to Sri Lanka and rubbish trucks to Nigeria. "There is definitely a responsibility we have to brand India," he says.

Some think India does too little to parlay its diaspora into investment. India's first prime minister, Jawaharlal Nehru, was a staunch believer in anti-colonial solidarity and refused to use overseas businesses as a tool for foreign policy. Successive governments have followed his lead and offered at best limited support to Indian businesses' efforts abroad. Diplomats complain that they can do little to help their compatriots beyond courting local governments and rolling out the red carpet for visiting industrialists. Manu Chandaria, who was born in Kenya over 90 years ago to Gujarati parents and is now one of east Africa's best-known industrialists, laments that the government in New Delhi has not made the most of ethnic Indians abroad, using them as neither "a tool" nor "a resource".

Gurjit Singh, a former Indian ambassador to Ethiopia, Germany and Indonesia, suggests that India Inc might pack a bigger punch if India's government increased support to cut the local cost of financing investment overseas. India provided \$7bn in official medium- and long-term export credit in 2019, according to the Export-Import Bank of the United States.

That makes it the world's fourth-largest provider, but is still far behind China's \$33.5bn.

But Indian companies' independence from their home government also brings an advantage: it contrasts favourably with the perception that Chinese ones will unquestioningly do the Chinese state's bidding. Bharti Airtel, which has had a large share of Africa's telecoms market since its 2010 acquisition of Zain Africa, a Kuwaiti telecoms company, has obvious strategic power. Akhil Gupta, a high-up at the company, says Airtel would "without question" do anything an African government asked, including disconnecting its service. But he would certainly not take orders from the Indian government on how to run Airtel's overseas operations, he says. "That is the beauty of democracy."

Not all businessfolk with Indian roots excel as ambassadors for the motherland. Mahatma Gandhi, who spent time in South Africa as a shipping lawyer, created a good impression. The Gupta brothers, less so. The trio, who moved from Uttar Pradesh to South Africa in the 1990s, were at the centre of the corruption scandal that helped end the presidency of Jacob Zuma in 2018. Elsewhere, Vedanta Resources is locked in a bitter dispute with the Zambian government over its copper mines.

The arms-length relationship between New Delhi, India's political capital, and Mumbai, its commercial centre, works well in good times. But when India Inc messes up abroad, India looks bad. And when the state's relationship with another country gets complicated, investors find doing business there harder. "Does flag follow trade or does trade follow flag?" asks Tanvi Madan of the Brookings Institution in Washington. "What you find is that they become intertwined." ■



印度企业界

在贫穷国家，印度已成为受欢迎的精明投资者

在海外投资实力方面它无法与中国比肩，但为其他投资者提供了经验【深度】

在赞比亚首都卢萨卡（Lusaka）的中部，一座新建的天桥上飘动着绿、白、橙这三种印度国旗包含的颜色。在这座城市里，从建筑工地到垃圾收集，几乎处处都在用塔塔汽车公司（Tata Motors，其所属的塔塔帝国的业务涵盖从钢铁到科技的众多部门）生产的卡车。卡车内的驾驶员指示以英语和印地语两种语言写成。车内人员通过印度的巴帝电信（Bharti Airtel）运营的移动网络相互通话。

和其他很多发展中国家的人一样，许多赞比亚人也常常大声抱怨在当地大举投资的中国公司。印度在这里的商业投资也很多，倒没什么人有意见。塔塔汽车在包括南非和马来西亚在内的许多国家都设有大型装配厂。巴帝电信是非洲最大的电信运营商之一。埃迪亚贝拉集团（Aditya Birla Group）是全球最大的炭黑生产商，炭黑是生产汽车轮胎的一种材料。该集团是埃及最大的工业投资者和出口商之一。

即使在基础设施和通信等政府认为具有战略意义的领域，印度的外商直接投资（foreign direct investment，以下简称FDI）也不被认为存在地缘政治图谋或霸权野心。“这是印度的卖点之一，”英国智库查塔姆研究所（Chatham House）的加雷斯·普莱斯（Gareth Price）说，“除了巴基斯坦和中国这两个明显的例外，似乎人人都不反对印度的投资。”

人们曾把印度与中国相提并论，视之为有大把资本可挥洒的新兴市场大国。过去十来年里中国海外投资的惊人增长让两国失去了可比性。现在，贫穷国家正努力为疫情后的复苏筹措资金，但不想加重债务负担或增加对中国的依赖。印度的进军相对而言规模微小——约为中国在发展中经济体FDI存量的7%左右（不包括在香港地区的投资，有些统计会将此计算在内）。但是，在如何能推进投资而不触发警铃这一点上，印度的做法为外

国投资者提供了经验。

来自新兴市场的公司对其他新兴市场的投资由来已久。它们在本国市场遭遇过的拖延、混乱和融资限制为它们做了很好的准备。印度在1955年协助组织了探讨“南南”合作的万隆会议。

印度在富裕国家的投资更有可能登上头条新闻。塔塔集团收购的公司包括泰特莱茶叶（Tetley Tea）和捷豹路虎（Jaguar Land Rover）等家喻户晓的企业，投资金额以亿美元计，带有那么点“反向帝国主义”的意思。但是，印度对穷国的FDI存量与在富国的投资大致相当，并且长期以来增长更为稳定。根据联合国贸发会议的最新估计，2019年，印度对穷国的FDI存量为约460亿美元，而2010年为约400亿美元。其中约300亿美元在亚洲，约130亿美元在非洲。

部分数据不太完整。总部设在印度的跨国公司一般会设立地方子公司。它们通过毛里求斯等避税天堂转移资金。1800多万海外印度人（在印度出生或拥有印度国籍的人）当中，有些企业家用别国护照在当地注册公司。“像拼图一样复杂。”剑桥大学的贾伊·巴蒂亚（Jai Bhatia）说。

即使这个拼图不完整，但从已有的部分看，来自印度的投资之所以引发的疑虑少于中国，有一个最显著的原因——规模。尽管印度的投资稳步增长，但中国对贫困国家的投资却是暴涨，从2010年的830亿美元激增至2019年的6450亿美元。

另一个原因是，与中国的投资不同，印度的FDI很少来自国家控股的公司，而这类公司常被怀疑在投资的同时兼顾地缘政治战略和外交政策目标。ONGC Videsh是为数不多在海外经营的印度大型国有企业之一，它已在像莫桑比克和哥伦比亚这样天南地北的国家收购了资产。

但这家公司的火力和它的中国同行不在一个级别。国有石油公司中石化在2005年前后首次强势挤入安哥拉的石油工业。它压过本已签署了初步协议的ONGC，抢购了石油和天然气巨头壳牌手中一个石油区块的股权。华盛

顿智库战略与国际研究中心的乔纳森·希尔曼（Jonathan Hillman）指出，印度没有可与中国的全球基建计划“一带一路”倡议相提并论的东西。“印度政府没花那么多时间来描述宏伟的愿景。”他说。

印度的FDI大部分来自私人企业，在海外投资纯粹是出于商业目的。它们包括近期来到海外的企业家（因为打算赚一票就回国而在肯尼亚被贬称为“火箭党”）、总部设在印度的跨国投资者，以及已经好几代侨居海外（尤其是非洲）做生意的印度裔家庭。

几个世纪前，印度商人开始在印度洋沿岸定居。19世纪，成千上万的人被派往大英帝国的各个遥远角落，在毛里求斯的种植园干活，在肯尼亚修建铁路。许多人留了下来，建立了自己的企业。另外一些人冒险乘坐单桅三角帆船长途跋涉，加入已经在非洲的印度人队伍。“我们倾向于撇开历史，从地缘政治的角度看问题，所以满眼都是中国。”国际关系专家帕拉格·卡纳（Parag Khanna）说，他的父亲曾在非洲为塔塔工作。作为中国势力在非洲大陆崛起的标志，19世纪90年代吸引印度人前往肯尼亚的铁路已被中国修建的马达拉卡快线（Madaraka Express）取代，这条新铁路的名字来自纪念肯尼亚脱离英国的自治日马达拉卡节（马达拉卡在斯瓦希里语中意为“统治权力”）。

印度侨民有时也会遭遇怨憎。例如，在上世纪70年代，独裁者伊迪·阿明（Idi Amin）将亚洲人赶出乌干达，并没收了他们的财产。但总的来说，共同走过的历史建立了亲切感。肯尼亚政府甚至承认亚洲人为该国第44个正式部落。祖父是印度移民的维纳姆·沙阿（Vimal Shah）在大约35年前与父亲和兄弟一起创立了博达集团（Bidco Africa），这个企业帝国的业务覆盖从果汁到牛饲料的众多领域。他知道内罗毕哪里有最地道的印度美食，还在印度耆那教社区中心当志愿者，但他拿的是肯尼亚护照，并且认为自己完完全全是肯尼亚人。“我不是印度来的移民。”沙阿说。

印度独立之后，实业家们将目光投向海外以摆脱官僚主义繁文缛节的束缚。印度企业界的第一批外国投资项目中就有埃迪亚贝拉集团于1959年在埃塞俄比亚建立的一家纺织厂。随后，这家企业集团将业务拓展到了逐步

开放的东南亚经济体。上世纪90年代，印度放宽了资本管制，掀起了规模更大的第二波FDI热潮。根据澳大利亚国立大学（Australian National University）的普雷玛-钱德拉·阿杜克拉拉（Prema-chandra Athukorala）整理的数据，去年印度企业在海外投资了4590个项目，2000年的数字是395个。

印度投资引起的不满往往少于中国的第三个原因，是印度企业有一个总体来说名副其实的声誉，那就是它们在从当地聘雇和采购方面比中国企业更尽心。2006年，世界银行调查了非洲近450家企业。平均而言，中国企业从中国和其他东亚国家雇用了将近五分之一的员工，而印度企业从印度带去的员工不到10%。中国企业在进口了60%的新机械设备，而印度企业仅从印度购买了22%。这种趋势持续至今，领导这项调研的经济学家哈里·布罗德曼（Harry Broadman）说。

这可能和许多印度公司仍是家族企业有一定关系。公司高管会顾及创始人的声誉，以及自身行为对祖国形象的影响。塔塔汽车负责商用车辆国际业务的鲁德拉普·迈特拉（Rudrarup Maitra）谈到公司为其所在海外市场的发展所做的贡献，比如为斯里兰卡提供救护车，给尼日利亚带去垃圾运输车。“我们对印度这个品牌绝对负有责任。”他说。

有些人认为印度没有很好地利用侨民扩大对外投资。印度第一任总理贾瓦哈拉尔·尼赫鲁坚信要团结起来反对殖民统治，拒绝把海外企业用作外交政策工具。后来的历届政府都继承了他的做法，顶多为印度企业的海外投资提供一些有限的支持。外交官们抱怨说，除了讨好地方政府和隆重欢迎到访的实业家之外，他们帮不上海外同胞什么忙。马努·坎达利亚（Manu Chandaria）90多年前出生于肯尼亚，父母是印度古吉拉特人，他现在是东非最著名的实业家之一。他对印度政府没有充分利用海外印度裔感到痛惜，认为政府确实没有把他们当“工具”，但也没有把他们用作“资源”。

曾任印度驻埃塞俄比亚、德国和印度尼西亚大使的古吉特·辛格（Gurjit Singh）表示，如果印度政府加大支持力度，削减海外投资融资的本地成本，印度企业可能会有更大的影响力。根据美国进出口银行的数据，印度

在2019年提供了70亿美元的官方中长期出口信贷。这一规模位居全球第四，但仍远远落后于中国的335亿美元。

不过，独立于印度政府对印度公司而言也是一项优势，这与人们眼中会无条件唯中国政府马首是瞻的中国公司形成了鲜明的对比。自2010年收购科威特电信公司Zain Africa以来，巴帝电信在非洲电信市场占据了很大的份额，拥有显而易见的战略力量。公司高管阿克希尔·古普塔（Akhil Gupta）说，巴帝电信“毫无疑问”会满足非洲政府提出的任何要求，包括断网。但在运作公司的海外业务方面，他肯定不会听从印度政府的命令，他说。“这就是民主的魅力。”

并非所有印度裔商人都是祖国的优秀大使。在南非做过航运律师的圣雄甘地为印度树立了良好的形象。古普塔三兄弟就差远了。这三人于上世纪90年代从印度的北方邦（Uttar Pradesh）移居到南非，曾身陷南非政治腐败丑闻的中心，这起丑闻推动了前总统雅各布·祖马在2018年下台。而资源公司瓦达塔（Vedanta Resources）就赞比亚的铜矿问题与当地政府陷入了激烈纠纷。

一切顺利的时候，印度的政治中心新德里与商业中心孟买之间所保持的距离收效不错。但当印度公司在国外惹了麻烦，印度也颜面无光。而当印度与另一国的关系变得复杂时，投资者会发现在那个国家生意更难做了。

“是国旗跟着买卖走，还是买卖跟着国旗走？”华盛顿布鲁金斯学会（Brookings Institution）的坦维·马丹（Tanvi Madan）问道，“你会发现它们是相互交织的。”■



Domestic heating

If you can have microwave ovens, why not microwave boilers?

A small British firm plans to try

DECARBONISING AN ECONOMY is a big job. Coal- and gas-fired power plants must be swapped for wind, solar or nuclear ones. Petrol-driven cars must be replaced by electric versions. Less attention is paid to heating. But in cold countries such as Britain, warming houses, offices and the like consumes more fossil fuel than either electricity generation or transport.

The fuel involved is usually natural gas. This is burned in a central boiler in order to heat water that flows to radiators elsewhere in the building. Britain's government would like to change this. From 2025 gas-fired boilers will be banned in newly built homes. By the mid-2030s installing new gas boilers in existing houses will be banned, too.

The question is what will replace them. Unlike electricity generation, where renewables are proving popular, or cars, where battery-powered vehicles are rapidly becoming established, the market for green heating is anyone's to play for. The usual suspects (assuming any electricity supplied is generated using appropriately carbon-free means) include electric immersion heaters, heat pumps (devices that work a bit like refrigerators in reverse, in that they extract heat from a building's surroundings and then pump it into that building), and burning hydrogen instead of natural gas. Engineers at a small British company called Heat Wayv, though, think they have another contender: microwaves.

The principle is the same as in a microwave oven. Many molecules, water included, are electrically dipolar. This means they have a positive charge at one end and a negative one at the other. They will therefore rotate to align

themselves with a strong electromagnetic field. If that field is oscillating, as is the case with electromagnetic radiation such as microwaves, then the molecules themselves will oscillate too—bumping and jostling their neighbours as they do so, and thus creating heat.

But there is more to building a microwave boiler than simply repurposing the parts used for an oven, says Phil Stevens, one of Heat Wayv's founders. Most microwave ovens employ magnetrons—chunky devices built by surrounding a cathode with a carefully shaped anode that is designed to produce electromagnetic radiation of a specific frequency. With the help of a pair of big chipmakers, Heat Wayv has come up with a solid-state device that performs the same job, but which fits on a 10-square-centimetre silicon chip.

Arrays of these devices beam microwaves into water in a boiler, heating it up. The pipes that carry the water are also made of microwave-sensitive materials, as is the insulation that lags them. And a heat exchanger recycles residual waste warmth. The upshot, says Mr Stevens, is a boiler that is about 96% efficient. The best existing gas boilers rarely exceed 90%.

Efficiency matters, because the move away from gas may mean higher heating bills. Electricity generated from fossil fuels is necessarily more expensive than the fuels themselves. In Britain, at the moment, a given amount of energy delivered as electricity costs three or four times as much as the same amount delivered by natural gas. Switching to renewables is unlikely to change that much. Though the “fuel” involved (wind or sunlight) is free, other costs are often higher than for conventional power stations. Forced by law to switch from gas, then, customers will surely have their eyes on the cost.

Heat Wayv argues its technology offers advantages over rival methods. Immersion heaters must run continuously to deliver water at a suitable

temperature. That often warms water which is never used. By contrast, and like existing gas boilers, microwaves heat water quickly enough to provide it only when it is needed.

Heat pumps, too, have drawbacks. Their efficiency plummets on cold days, when they are needed most. They are also bulky. And they generate water that is warm rather than hot, often requiring the retrofitting of bigger radiators or underfloor heating.

Hydrogen, meanwhile, must either be extracted from natural gas or created by running electrical currents through water. Both processes are inherently inefficient and the former is hardly green. Also, the infrastructure needed to produce and deliver hydrogen in quantity does not yet (and may never) exist.

Heat Wayv hopes to be producing microwave boilers for sale by 2024, in time for the first stage of the government's ban. Mr Stevens says the idea has attracted interest from most of Britain's big housebuilders. Soon, perhaps, microwaves may heat people's water as well as their food. ■



家庭采暖

既然可以有微波炉，何不再加个微波锅炉？

一家英国小公司打算尝试一下

为经济体脱碳是个大工程。燃煤和燃气发电厂必须被风电厂、太阳能发电厂和核电站取代。汽油驱动的汽车必须被电动汽车取代。供暖受到的关注就没那么多了。但在英国这类寒冷的国家，为房屋、办公室及类似建筑供暖而消耗的化石燃料比发电或运输都要多。

供暖用到的燃料通常是天然气。天然气在中央锅炉内燃烧，给水加热，热水再流向建筑物中其他地方的暖气装置。英国政府想要改变这种情况。从2025年起，新建住宅将禁用燃气锅炉。到2035年前后，在现有住房内安装新的燃气锅炉也将被禁止。

问题是用什么取代燃气锅炉。在发电领域，可再生能源正广受欢迎；在汽车产业里，电池驱动的车辆正迅速成为寻常事物。绿色供暖市场不同，人人尚可参与。意料之中的方案（假设用于驱动的电力全都是通过适当的无碳方式产生）包括浸没式电加热器、热泵（这种设备的工作原理有点像冰箱的反面，因为它们从建筑物的周围环境吸收热量，再将热量泵入建筑物），以及燃烧氢气而非天然气。不过，英国一家名为Heat Wayv的小公司的工程师认为他们手头还有一样东西可以加入战局：微波。

微波供热的原理和微波炉一样。包括水在内的很多分子都是电偶极的。这意味着它们的一端带正电荷，另一端带负电荷。因此，它们会旋转，使自己与强电磁场对齐。如果这个强电磁场是振荡的，就像微波等电磁辐射一样，那么这些分子本身也会振荡——在振荡过程中会碰撞、推挤相邻的分子，从而产生热量。

但是，Heat Wayv的创始人之一菲尔·史蒂文斯（Phil Stevens）表示，制造微波锅炉可不是随便把微波炉的零件改一改就可以用了。大多数微波炉采用的是磁控管——这种笨重的装置是用精心设计的阳极环绕阴极制成，以

产生定频电磁辐射。在两家大型芯片制造商的帮助下，Heat Wayv构想出了一种可以完成相同工作的固态装置，但却是将它安装在10平方厘米的硅片上。

这些设备的组合将微波射入锅炉中，给水加热。输水管道与管道外用于保温的绝缘层一样，也是由微波敏感材料制成的。另外还有一个热交换器回收利用剩余的废热。史蒂文斯说，由此制造出的锅炉效率高达约96%。现有最好的燃气锅炉的效率很少超过90%。

效率很重要，因为不使用燃气可能意味要交更多取暖费。燃烧化石燃料生产出来的电必然比燃料本身更贵。在英国，目前以电的形式提供一定量的能源所需的成本是用天然气提供同样多的能源的三到四倍。转向可再生能源也不太可能改变多少。虽然可再生能源使用的“燃料”（风能或太阳能）是免费的，但其他成本往往比传统发电站高。所以，在法律强制下弃用天然气的消费者肯定会紧盯成本。

Heat Wayv认为其技术比竞争对手的方法更具优势。浸没式加热器必须持续运转才能提供适温的水。这往往把从未派上用场的水也加热了。相比之下，和现有的燃气锅炉一样，用微波把水加热足够迅速，只在需要时才会提供。

热泵也有缺陷。在热泵需求最旺的严寒时节，它们的效率却大幅下跌。热泵的体积也很庞大。而且产生的水是温水而非热水，这通常需要加装更大的暖气片或地暖。

而说到使用氢气，它必须从天然气中提取或经由电流通过水产生。这两种过程本身就低效，而且前者已经不算环保了。此外，大规模生产和输送氢气所需的基础设施还不存在（可能永远也不会存在了）。

Heat Wayv希望在2024年之前生产出供出售的微波锅炉，这样就能赶上政府颁布禁令的第一阶段。史蒂文斯表示，这个想法已经引起了英国大多数大型房屋建筑商的兴趣。也许不久之后，微波就能在给人们加热食物的同时也加热水了。 ■



Free exchange

How to think about vaccines and patents in a pandemic

Do public-health crises call for a departure from the rules?

WITH ANY luck, the world will be awash in covid-19 vaccines by the end of the year. For now, though, it is not, and of the billion or so doses that have been produced the vast majority have been administered in richer countries. Deaths, by contrast, are increasingly concentrated in poorer ones, like India, where only about nine in every 100 people have been jabbed, compared with 64 in America. Some governments are floating radical options to remedy the mismatch. India and South Africa, for instance, propose that members of the World Trade Organisation waive intellectual-property (IP) protections for covid-fighting technologies, including vaccines. Some in the rich world are warming to the idea; in America, ten Democratic senators recently urged President Joe Biden to back it. Drugmakers, however, warn that it would deal a crippling blow to innovation. Even though IP protections are not a big constraint on vaccine production today, the experience of covid-19 suggests that a re-examination of IP rights in the context of health emergencies is overdue.

The economic argument for IP protections seems compelling enough. Innovation is costly and risky. Pharmaceutical companies invest heavily in drug development with no guarantee of success. If other firms could freely copy a newly discovered treatment, then its price would quickly fall to the marginal cost of production, leaving the innovator unable to cover the costs of development. A short-term monopoly on production granted to innovating firms is needed to make the upfront investments economically worthwhile. Patents provide this protection.

IP protections do not always work in quite this way, however. Studies

routinely find little or no evidence that strengthening them boosts subsequent innovation, argue Michele Boldrin and David Levine of Washington University in St Louis; pharmaceuticals, where IP rights are often assumed to be essential, are no exception. Patents award rich profits to firms even though private investment accounts for only about a third of spending on American biomedical research, they estimate. Other rewards to innovation, such as financial prizes, could yield more breakthrough drugs at lower cost. Yet for now, IP protections are crucial to the businesses of most of the firms developing covid-19 vaccines.

Should some of these be waived in a pandemic that continues to claim more than 10,000 lives a day? Advocates argue that the pandemic is clearly an extreme event that warrants an exemption from IP laws. The rapid creation and production of so many covid-19 vaccines is a testament to the long years of private investment in the associated technologies and the urgency with which experts at biotech firms moved when the pandemic began. But there is no ignoring the vast public resources that made these efforts possible, from support for basic research to piles of government cash. Nor would a waiver endanger pharma firms' viability. Pfizer would still be highly profitable even if you excluded its expected vaccine-related profits of \$4bn in 2021.

Yet industry interests are right to say that liberating vaccine IP would not unleash a flood of new production. Most of the world's vaccine-making capacity is already in use, in some cases because developers signed licensing agreements with other manufacturers. AstraZeneca, for instance, struck just such a deal with the Serum Institute of India, the world's largest vaccine-maker. Other constraints on production have bound more tightly than IP rules, including the limited availability of raw materials and expertise needed to safely produce doses. Some of those have been imposed by governments themselves, through export restrictions that interfere with supply chains.

Moreover, the biggest obstacle to expanding capacity is not IP protections, but proprietary resources and other know-how, which are not shielded by patents. Many poorer countries face no patent barriers to using the mRNA technologies employed by Pfizer and Moderna; the obstacle is instead a lack of familiarity with new techniques. Similarly, would-be producers of adenovirus-type vaccines, such as that developed by AstraZeneca, lack access to the specially developed cell lines needed to create them.

This state of affairs illustrates deficiencies in how both drugmakers and governments have handled the vaccine effort. Firms have been reluctant to share cell lines, data and tacit know-how with producers that could one day pose a competitive threat, slowing the creation of new, and life-saving, production capacity. In some cases trade rules permit governments to grant compulsory licences—the right to use a patented invention without the inventor's consent, for a price. But such licences are of no use if developers do not also share the other information and resources needed to produce doses. An initiative to aid such sharing set up by the World Health Organisation, for instance, has been all but ignored by the industry.

Yet the experience of the past year also suggests how governments might do better when they next negotiate contracts, say for vaccines to counter new variants. Having invested so much in development, they neglected to include measures in contracts to compel drugmakers to share the information other manufacturers need to quickly produce vast amounts of vaccines. Nor have they sought to press firms to transfer the technology needed to expand manufacturing. In the meantime, governments could do more to rethink the ground rules for technology transfer and the sharing of intellectual property, so as to be prepared for the next pandemic. Costly errors were made, their toll measured in lives. But they need not be repeated. ■



自由交流

在一场大流行病中如何看待疫苗和专利

面对公共卫生危机，是否应该打破规则？

走运的话，到今年年底全球将有充足的新冠疫苗供应。但目前还不够，而在已经生产出来的约十亿剂疫苗中，绝大多数都用在了较富裕国家。形成鲜明对比的是，死亡病例越来越集中于较贫穷的国家，例如印度，该国每百人只有9人接种了疫苗，而美国每百人有64人接种。一些政府正在提出激进的方案以弥合这种差距。例如，印度和南非建议世贸组织成员国放弃对抗疫技术的知识产权保护，包括疫苗。富裕国家的一些人开始接受这个建议。在美国，十名民主党参议员最近敦促总统拜登对此给予支持。但制药企业警告说，这将严重打击创新。尽管知识产权保护并没有对眼下的疫苗生产造成很大的限制，但新冠疫情的经验表明，早就应该重新讨论在面对突发卫生事件时的知识产权问题了。

知识产权保护的经济效益论证似乎足够有说服力。创新的成本高，风险大。制药公司在药物研发方面投入大量资金，但无法保证成功。如果其他公司可以随意仿制新发现的药物，其价格将迅速下降到边际生产成本的水平，让创新者无法收回研发成本。为了使前期投资在经济上是值得的，需要让创新公司在短期内垄断生产。专利提供了这种保护。

但是，知识产权保护并不总能发挥这种作用。圣路易斯华盛顿大学（Washington University in St Louis）的米歇尔·博尔德林（Michele Boldrin）和戴维·莱文（David Levine）表示，各种研究一再表明，没有多少证据或完全没有证据显示加强知识产权保护促进了后续创新，就算是在知识产权通常被假定为立身之本的制药业也不例外。他们估计，即使私人投资仅占到美国生物医学研究支出的三分之一左右，专利也为公司带来了丰厚的利润。其他创新回报——例如财务奖励——可能会以更低的成本催生出更多突破性药物。不过在目前，对于大多数研发新冠疫苗的公司而言，知识产权保护对它们的业务至关重要。

那么在一场每天仍在夺走过万条性命的大流行病期间，是否应该放弃一些知识产权保护呢？主张这么做的人认为，疫情显然是极端事件，有理由豁免知识产权。之所以能有这么多不同的新冠疫苗得以迅速研发和生产出来，有赖于私人投资对相关技术的长期投入，以及疫情开始后生物科技公司的专家们紧急行动。但是，这些努力之所以成为可能，离不开巨大的公共资源投入。从支持基础研究到提供大量政府资金，这部分投入发挥了不可忽视的作用。而且豁免知识产权也不会危及制药公司的生存。即使不把辉瑞2021年与疫苗相关的40亿美元预期利润计算在内，它仍将实现高额利润。

但是，业界利益方指出豁免疫苗知识产权并不会释放出大量新产能的说法有其道理。全球大部分疫苗产能都已经投入生产，在一些情况下是因为研发方与其他生产商签署了许可协议。例如，阿斯利康（AstraZeneca）就与全球最大的疫苗生产商印度血清研究所（Serum Institute of India）达成了这样的协议。比起知识产权法规，其他约束条件对产能的限制更大，包括原材料供应不足、安全生产疫苗所需的专业技术不足等。其中一些约束正是政府自己造成的一一出口限制干扰了供应链。

此外，扩大产能最大的障碍不是知识产权保护，而是专有资源和其他专门知识，它们并不在专利保护范围内。许多较贫穷的国家在利用辉瑞和莫德纳（Moderna）所采用的mRNA技术方面没有专利障碍，真正的障碍是对新技术不熟悉。同样，有潜力生产腺病毒载体疫苗（比如阿斯利康开发的疫苗）的机构缺乏专为生产这种疫苗而开发的细胞系。

这样的现状说明制药公司和政府在疫苗事务上都存在不足。制药公司一直不愿与有朝一日可能构成竞争威胁的生产商分享细胞系、数据和隐性专业知识，拖慢了形成新产能、挽救生命的步伐。在有些情况下，贸易规则允许政府授予强制许可，也就是支付一定费用，在未经发明人同意的情况下使用其专利发明。但是，如果研发方不同时分享生产疫苗所需的其他信息和资源，这样的许可就毫无用处。比如，世卫组织提出了一个辅助这种信息和资源共享的倡议，但制药业基本没有理会。

不过，过去一年的经验也显示出政府在以后谈判合同（比如抗击新变种病毒的疫苗的合同）时可以改进的地方。政府在研发上投入了巨资，却没有在合同中包含一些条款来迫使制药公司向其他公司分享要快速生产大量疫苗所需的信息。它们也没有试图敦促企业转让扩大生产所需的技术。同时，政府可以更多地反思技术转让和知识产权共享的基本规则，为应对下一次大流行病做好准备。代价高昂的错误已经犯下，付出的是一条条生命。但我们可以避免重蹈覆辙。 ■



Liquefied natural gas

The polar silk road

Warmer Arctic waters could turn the tides in LNG markets

EXPLORERS TRIED for centuries to find a viable route through the Arctic to link Europe and Asia. SS Vega was the first to transit the north-east passage connecting the two, in 1879, but it was only in 1932 that a ship—the icebreaker *A. Sibiryakov*—made the trip in one go, without having to stop for the winter. What little commercial shipping there was along the route all but vanished after the fall of the Soviet Union.

The discovery and extraction of vast liquefied natural gas (LNG) reserves on the Yamal peninsula in Siberia in the past decade has renewed interest in bulk transport on the waters of the high north. The warming of the Arctic, and the development of ice-strengthened tankers able to cleave their way through floes up to two metres thick, now make it possible to ship gas and other materials year-round, though especially cold winters may still hinder traffic.

In January this year, thanks to a rise in Asian economic activity and high consumer demand, it was profitable for three vessels carrying LNG to travel between the Sabetta terminal on the Yamal peninsula and north Asian ports. As hydrocarbons begin their decline, Novatek, the Russian company that commissioned these shipments, is gambling on sustained or even growing demand from Asian and European markets.

The three ships were new Arc-7 class tankers, with engines running on the same gas contained in their hulls. This makes them far less polluting than conventional ships powered by bunker diesel. Russia is especially nervous about maritime accidents after the 1989 *Exxon Valdez* disaster in Alaska,

which was difficult to clean up and caused extensive environmental damage. Russian lawmakers raged against Nornickel, a miner of metals, after a diesel spillage last year, whacking it with a fine of 146bn roubles (\$2bn)—the biggest environmental penalty ever imposed on a Russian company. If the Arc-7 ships did run aground or get crushed in the ice, there would be next to no slick and their cargo of LNG would evaporate.

Non-ferrous metals constitute some of the traffic along the Northern Sea Route (NSR), which runs from the Kara Sea to the Bering strait, but gas is fuelling the revival. And Novatek, which owns the LNG exploitation rights and infrastructure on the Yamal peninsula, is behind it.

Vladimir Putin's government provided a leg-up to Novatek, including through generous tax breaks. These have accelerated Russia's LNG capabilities. Novatek used to rely on Japanese expertise to extract and compress gas in the extreme Arctic conditions. "Now Russia is fully self-sufficient in LNG technology," says Alexander Sergunin of St Petersburg State University.

Novatek's main advantage is a much shorter sail to market. The NSR makes a voyage between some Asian and European ports about 4,000 miles shorter than the Suez canal route, saving an average of ten days at sea. New shipment hubs near Murmansk in the west, and in Kamchatka in the east, will further speed up conveyance.

The idea is to use the Arc-7 tankers as ice shuttles between Sabetta and these new hubs. Standard tankers, which are cheaper to build and operate, will then move the gas to customers. The distance between Murmansk and the big north European ports, and Kamchatka and the big north Asian ones, is about a quarter of the distance between the Middle Eastern LNG export hubs and the Asian or European hubs. Arild Moe of the Fridtjof Nansen

Institute, a think-tank in Lysaker, Norway, notes that the Yamal peninsula could supply at least 70m tonnes of LNG a year by the end of the decade—almost as much as Qatar, the world's biggest exporter, manages today.

If the overseas bet does not pay off, there are always domestic consumers. Only 70% of Russia is on the gas grid. LNG is generally accepted as the preferred short-term replacement for diesel fuel in deep-sea cargo vessels. And the plastics and composites sector is growing, too. Russia is also working on a hydrocarbon diversification plan. Last year Alexander Novak, a deputy prime minister, launched a committee with big producers, including Novatek and Gazprom, to set the strategy.

As for the route itself, container shipping currently attracts little interest. Because Russia imposes certain rules on transit through the NSR, ships must seek permission for passage. That annoys the Americans, who call for free movement in all waters. But the Panama and Suez canals are increasingly crowded; untenable tailbacks there, or a war in the Middle East, could perhaps tempt shipping companies north. By that time, Russia may have built a fleet of ice-strengthened behemoths. ■



液化天然气

极地丝路

北极水域升温可能扭转LNG市场的形势

几个世纪里，探险家试图找到一条穿越北极连接欧洲和亚洲的可行航线。1879年，织女星号（SS Vega）率先穿越了连接欧亚的东北航道，但中途不得不停下来过冬，直到1932年，西比里亚科夫号（A. Sibiryakov）破冰船才首次不间断地完成航程。苏联解体后，这条航线上零星的商业航运也几乎完全消失了。

过去十年，随着在西伯利亚亚马尔半岛（Yamal）发现储量巨大的液化天然气（LNG）并实现开采，在北极水域运输散装货物的兴趣重燃。由于北极变暖，加之开发出了能够穿过厚达两米的浮冰的破冰油轮，现在已经能够在这些航线上全年无休地运输天然气和其他原材料，尽管在特别寒冷的冬天里交通仍可能受阻。

今年1月，由于亚洲经济活动升温以及消费者需求旺盛，有三艘船从亚马尔半岛的萨贝塔港（Sabetta）向北亚港口运输LNG并实现了盈利。随着油气价格开始下跌，委托这些运输的俄罗斯公司诺瓦泰克（Novatek）正押注于亚洲和欧洲市场的需求将持续下去甚至增长。

这三艘船都是新型Arc-7级油轮，它们的发动机使用的燃料正是船上装载的天然气，这使得它们的污染程度远小于使用船用柴油的传统船只。1989年埃克森·瓦尔迪兹号（Exxon Valdez）油轮在阿拉斯加发生海难，油污难以清理并造成广泛的环境破坏，自那以后俄罗斯对海上事故尤为紧张。去年金属矿业公司诺镍集团（Nornickel）发生了一起柴油泄漏事故，俄罗斯议员大为光火，对它开出了1460亿卢布（20亿美元）的罚单，创下有史以来俄罗斯企业环保罚金的最高记录。如果Arc-7级油轮搁浅或撞冰破裂，基本上不会产生浮油，船上装载的LNG只会挥发殆尽。

在从喀拉海到白令海峡的北方海路（Northern Sea Route）上，有色金属占据了一部分运输量，但天然气才是这条航路复兴的主要驱动力。拥有亚马尔半岛LNG开采权和基础设施的诺瓦泰克是幕后推手。

普京政府为诺瓦泰克提供了支持，包括慷慨的税收优惠。这加速了俄罗斯LNG产业的发展。诺瓦泰克过去依靠日本专业技术在北极的极端条件下提取和压缩天然气。“现在俄罗斯的LNG技术已经完全自给自足了。”圣彼得堡国立大学的亚历山大·谢尔古宁（Alexander Sergunin）说。

诺瓦泰克的主要优势是大大缩短了通向市场的航程。与苏伊士运河航线相比，通过北方海路运往部分亚洲和欧洲港口的航程要短4000英里左右，平均能节省10天的海上运输时间。海路西端的摩尔曼斯克附近和东端的堪察加半岛（Kamchatka）新建的航运中心还将进一步加快运输速度。

其构想是使用Arc-7级油轮在萨贝塔港和这些新航运中心之间破冰往返。然后使用造价更低、运营更便宜的标准油轮将天然气运送给客户。从摩尔曼斯克到北欧大型港口，以及从堪察加半岛到北亚大型港口，距离只有中东LNG出口中心到亚洲或欧洲大型港口的四分之一左右。位于挪威吕萨克（Lysaker）的智库南森研究所（Fridtjof Nansen Institute）的阿里尔德·莫伊（Arild Moe）指出，到2030年，亚马尔半岛每年可以供应至少7000万吨LNG——几乎和世界最大LNG出口国卡塔尔如今的供应量差不多。

如果海外市场的表现不如人意，那还有本国消费者。俄罗斯只有70%的地区接入了天然气管网。LNG是公认的远洋货船柴油燃料的首选短期替代品。塑料和复合材料行业也在增长。俄罗斯还在制定一项油气产业多元化计划。去年，俄罗斯副总理亚历山大·诺瓦克（Alexander Novak）与诺瓦泰克和俄罗斯天然气工业公司（Gazprom）等大型生产商成立了一个委员会来制定相关战略。

回到这条航线本身，目前市场对集装箱运输的兴趣不大。由于俄罗斯对北方海路运输实施了某些规定，船只必须申请通行许可。美国人对此十分不满，他们呼吁在所有水域允许自由航行。但是，巴拿马和苏伊士运河正变

得越来越拥挤；一旦运河大排长龙的局面难以维续，或者中东爆发战争，就可能会吸引航运公司绕行北方。到那时，俄罗斯可能已经造好一支破冰巨轮舰队了。 ■



The energy transition

Oil supermajors' mega-bet on natural gas

Is the least grubby hydrocarbon a bridge fuel to a greener future, or a trap?

ENERGY COMPANIES have no seat at the climate high table convened by President Joe Biden on April 22nd and 23rd, to which he has invited 40 other world leaders to discuss how to speed up the shift from dirty energy. From the sidelines, coal firms will scowl at efforts to curb demand in Asia and oil drillers will wince at support for electric cars. Watching particularly closely will be those companies which have bet big on natural gas. As the energy transition gathers momentum, no fuel's future is hazier than that of the least grubby hydrocarbon.

Proponents see gas as the “bridge fuel” to a greener world. They include the five largest international oil firms: ExxonMobil, Chevron, Royal Dutch Shell, Total and BP. These supermajors saw gas rise from 39% of their combined hydrocarbon output in 2007 to 44% in 2019 (see chart 1). That year producers approved a record level of liquefied natural gas (LNG) capacity. Those projects will come online in a few years. Shell, which in 2016 paid \$53bn for BG, a British gas group, now says its oil production peaked in 2019, but that it will expand its gas business with annual investments of about \$4bn. Total expects its crude output to sink over the next decade, but for gas to rise from 40% to 50% of sales. In February Qatar Petroleum, a state-owned giant, said it would begin the largest LNG project in history.

Yet debate is intensifying over whether gas will be a bridge or a dead end. Mr Biden and his counterparts elsewhere appear to be serious about achieving net-zero emissions by 2050. That would require accelerating the phase-out of all fossil fuels, gas included, unless paired with technology to capture and store emissions. Inexpensive wind and solar power already threaten

gas-fired electricity, particularly in America and Europe. Even as demand looks uncertain, cheap gas from state-owned firms such as Qatar's will add to global supply. Some companies' bets will go bad.

On the demand side, gas remains a sensible gamble in some ways. A gas-fired power plant belches about half the emissions of a coal-fired one per unit of energy. The fuel benefits from diverse sources of demand, too. In addition to producing electricity, gas is used to make fertiliser and generate heat for buildings and industry. Unlike exhaust from a car, emissions from a factory can theoretically be captured and stored below ground. Gas can also be used to generate hydrogen, which may in turn serve as a form of long-term energy storage.

However, companies' investments have not always gone as planned. A rush for gas between 2008 and 2014 was part of a broader stampede by energy giants, as higher energy prices spurred investments with little regard for costs, explains Michele Della Vigna of Goldman Sachs, an investment bank. In 2019 Chevron said it would write down as much as \$11bn, largely owing to underperforming shale-gas assets in Appalachia. Gas comprised the bulk of the \$15bn-22bn of impairments announced by Shell last June. In November ExxonMobil said it would write down the value of its gas portfolio by \$17bn-20bn, its biggest impairment ever. Its \$41bn purchase in 2010 of XTO Energy, a shale-gas company, may be the worst-timed investment made by an oil major in the past 20 years.

Two big questions now hang over future demand, each difficult to answer with any certainty. The first is how fast governments limit carbon emissions. The extraction, liquefaction and transport of gas produce their own emissions, on top of those from its eventual combustion. Gas production also releases methane, a greenhouse gas that is about 80 times more potent than carbon dioxide over a 20-year period. Adding methane

leaks from fracking or pipelines, the Natural Resources Defence Council, an environmental group, calculates that American LNG exports in the next decade may produce greenhouse gases equivalent to the annual emissions of about 45m new cars—not counting burning the stuff for energy.

Responding to climate concerns, the Netherlands and some Californian cities have banned gas in new buildings. Britain will do so from 2025. “To put it mildly,” Werner Hoyer, president of the European Investment Bank, declared in January, “gas is over.” John Kerry, Mr Biden’s climate envoy, warned in January that natural-gas assets risked becoming stranded. The International Energy Agency, an intergovernmental group, reckons that demand growth will slow to about 1.2% a year until 2040, from an average of 2.2% in 2010-19. If governments move more aggressively to restrain temperatures, demand could be lower in 2040 than it was in 2019 (see chart 2). BP offers a more bearish scenario: if the world were to reach net-zero emissions by 2050, gas demand would peak within the next few years and nearly halve by mid-century. “For the business to survive,” argues Massimo Di Odoardo of Wood Mackenzie, an energy consultancy, “it’s not just about marketing gas. It’s about marketing gas and managing emissions.”

The second question with respect to demand is how quickly rival technologies advance. Already, about two-thirds of the world’s population lives in places where power from new wind and solar farms is cheaper than from new gas plants, according to BloombergNEF, a data provider. Electric heat pumps threaten gas in buildings. In future, gas with carbon capture and storage (CCS) may prove pricier than hydrogen generated by renewable electricity. Mr Biden’s proposed \$2trn infrastructure bill includes support for CCS, but also for things that may challenge gas’s role in industry, power and heating. The European Union aspires to make its members leaders in hydrogen, hoping it could one day replace gas in many applications while using existing pipelines and other infrastructure.

Then there is the matter of supply. Maarten Wetselaar, Shell's gas chief, says the industry used to expect the market to be undersupplied and the price set by the marginal buyer. Instead, the world has plenty of gas courtesy of American shale, he notes. On top of that, private firms must compete with state ones in Qatar and Russia, which can extract gas cheaply and have a political imperative to monetise reserves while they can. Qatar's new project will raise its LNG capacity by 40% by 2026. And a growing spot market and shaky demand have made LNG buyers less interested in traditional long-term contracts. At least a quarter of LNG supply is now uncontracted, estimates Mr Di Odoardo. As approved projects come online, the share of uncontracted LNG may exceed 50% by 2030.

All this is prompting some in the industry to rethink their embrace of gas. Last July Dominion Energy, an American utility, cancelled plans for a controversial pipeline and sold its entire pipeline business to Berkshire Hathaway, a huge conglomerate, for \$9.7bn. In November Engie, a French energy company, scrapped plans to sign an LNG contract with NextDecade, an American firm, over concerns about shale emissions. Other firms are trying to adapt to a gas business that looks set to grow both more competitive and more complex.

Big players are now applying a higher cost of capital to their hydrocarbon investments, with a greater focus on profitability, notes Mr Della Vigna. Scale is turning to their advantage, too.

Shell's share of gas production actually fell in recent years, as it sold off less profitable gas assets in America and Nigeria. Mr Wetselaar maintains that Shell is well positioned to deal with the market's new realities. Unlike smaller players, which depend on long-term supply contracts to attract financing for new projects, Shell can use its balance-sheet. Trading capabilities make it easier to sell LNG to diverse buyers. For those who want zero-emissions energy, Shell has already sold ten "carbon neutral"

LNG cargoes, paired with offsets. Total plans to double its LNG sales over the coming decade, while touting its plans to reduce methane emissions. ExxonMobil reckons that its new investments in CCS will both limit emissions and support its traditional business.

Such plans are unlikely to sway those who want investment in all fossil fuels to plunge. Companies' plans can be disrupted by any number of forces—in March an attack in Mozambique prompted Total to suspend a giant LNG project there. The changing market means only the safest, most profitable projects backed by the strongest firms are likely to move forward.

NextDecade, having failed to secure Engie as a client, has delayed a final investment decision on a proposed facility in Texas and scrapped another. It had sought to build an LNG import terminal in Ireland but in January Irish officials let a preliminary agreement with NextDecade expire. Gas may not quite be over. But the industry could soon be defined not by the projects that advance but those that don't. ■



能源转型

石油巨头对天然气的巨额押注

这种污染最少的烃类燃料是通往更环保未来的桥梁还是陷阱？

美国总统拜登于4月22日和23日召开气候峰会，邀请40位世界领导人讨论如何加速从肮脏能源的转型，能源公司人士不在其中。从旁观望的煤炭企业会对抑制亚洲需求的努力皱眉，石油钻探商会对支持电动汽车的举措感到不适。而尤其密切关注会议动向的将是那些对天然气押下重注的公司。随着能源转型势头渐起，相比其他燃料，天然气这种污染最少的烃类燃料的未来最为扑朔迷离。

天然气的支持者视之为通往更环保世界的“过渡性燃料”。它们包括埃克森美孚、雪佛龙、荷兰皇家壳牌、道达尔和BP这五家最大的国际石油公司。这些巨头的天然气产量从2007年占其烃类燃料总产量的39%上升到2019年的44%（见图表1）。2019年，生产商们核准建设的液化天然气（LNG）产能达到历史最高水平。这些项目将在几年内上马。壳牌在2016年斥资530亿美元收购了英国天然气集团BG，它目前表示自己的石油产量已在2019年达到峰值，但它计划每年投资约40亿美元来扩大天然气业务。道达尔预计，未来十年，自己的原油产量将下降，但天然气的销量占比将从40%上升到50%。今年2月，国有巨头卡塔尔石油公司（Qatar Petroleum）表示将启动史上最大的LNG工程。

然而，关于天然气到底是过渡的桥梁还是死胡同，争论越发激烈。对于到2050年实现净零排放的目标，拜登和其他国家的领导人看起来是认真的。这将需要加速淘汰包括天然气在内的所有化石燃料，除非配有排放捕获和存储技术。不再昂贵的风能和太阳能已经对燃气发电构成了威胁，尤其是在美国和欧洲。即便此时市场需求看上去并不确定，卡塔尔石油公司等国有企业生产的廉价天然气将提高全球供应量。一些公司的赌注将落空。

从需求看，天然气在某种程度上仍然值得一赌。燃气发电厂每单位能源产

生的排放物是燃煤发电厂的一半左右。对天然气的需求也很多样，这也是它的一个优势。除了发电，天然气还可以用来制造肥料、为建筑物和工业生产供暖。与汽车尾气不同，工厂的排放理论上可以被捕获并储存在地下。天然气还可以用来制取氢气，而氢气可能成为一种长期存储能源的形式。

然而，企业的投资并不总能按计划发展。2008年至2014年的天然气热潮是能源巨头们更广泛投资狂热的一部分——能源价格上涨刺激了投资，成本问题几乎被抛诸脑后，投资银行高盛的米凯莱·德拉维尼亚（Michele Della Vigna）解释说。2019年，雪佛龙表示将减记多达110亿美元的资产，主因是美国阿巴拉契亚地区的页岩气资产表现不佳。壳牌去年6月宣布减记150亿至220亿美元的资产价值，其中天然气占了一大部分。去年11月，埃克森美孚表示将对天然气投资组合的价值减记170亿至200亿美元，这是该公司有史以来最大的资产减记。2010年，它以410亿美元收购了页岩气公司XTO Energy，这可能是过去20年中石油巨头择时最糟的一次投资。

对于未来的需求，目前有两大问题悬而未决，每个问题都很难有确切答案。首先是政府限制碳排放的进展速度。在最终燃烧产生的排放外，天然气的提取、液化和运输本身也会产生排放。天然气生产还会排放甲烷，这种温室气体在20年跨度里的温室效应大约是二氧化碳的80倍。加上水力压裂和管道泄漏的甲烷，环保组织自然资源保护协会（Natural Resources Defence Council）估计，美国未来十年的LNG出口可能产生的温室气体相当于约4500万辆新车一年的排放量——这还没有包括燃烧LNG发电的排放。

为了应对气候挑战，荷兰以及加州部分城市已经禁止在新建筑中使用天然气。英国将从2025年开始效法。“毫不夸张地说，”欧洲投资银行（European Investment Bank）的总裁沃纳·霍耶（Werner Hoyer）今年1月宣布，“天然气的日子到头了。”同月，拜登的气候特使约翰·克里（John Kerry）警告，天然气资产面临搁浅的风险。政府间组织国际能源署（International Energy Agency）估计，到2040年，需求增长将从2010年至2019年间的平均每年2.2%减缓到每年1.2%左右。如果各国政府采取更积

极的行动来遏制全球变暖，2040年的需求可能会低于2019年（见图表2）。BP提出了一个更悲观的前景：如果世界到2050年实现净零排放，天然气需求将在未来几年内达到峰值，到本世纪中叶几乎减半。“这个行业若要生存下去，”能源咨询公司Wood Mackenzie的马西莫·迪奥多尔多（Massimo Di Odoardo）认为，“重要的不仅仅是营销天然气，而是营销天然气和管理排放。”

关于需求的第二个问题是替代性技术的进步有多快。数据供应商彭博新能源（BloombergNEF）称，在世界大约三分之二的人口生活的地区，新的风能和太阳能电厂的发电已经比新的天然气电厂更便宜了。电热泵可能会取代建筑物中使用的天然气。未来，带有碳捕获和存储（CCS）的天然气的价格可能会超过利用可再生电力生产的氢气。拜登提出的2万亿美元的基础设施法案中包括对CCS的支持，但也包括可能挑战天然气在工业生产、发电和供暖方面的地位的替代性技术。欧盟渴望让其成员国成为氢气领域的领跑者，希望有朝一日氢气能在许多应用领域取代天然气，同时继续使用现有的管道和其他基础设施。

此外还有供应方面的问题。壳牌的天然气业务主管魏思乐（Maarten Wetselaar）表示，业界过去预计天然气的市场供应不足，价格因而由边际买家决定。他指出，实际上正相反，美国的页岩为世界提供了大量的天然气。除此之外，私营企业必须与卡塔尔和俄罗斯的国有企业竞争，而后者能以更低廉的成本开采天然气，而且出于政治上的需要，它们会在可能时将储量变现。到2026年，卡塔尔的新项目将把自己的LNG产能增加40%。而日渐增长的现货市场和不稳定的需求使得LNG买家对传统的长期合同兴趣下降。迪奥多尔多估计，目前至少有四分之一的LNG供应没有签订合同。随着获批项目的上马，到2030年，未签合同的LNG比例可能超过50%。

所有这些都在促使一些业内人士重新考虑他们对天然气的投入。去年7月，美国公用事业公司道明尼能源（Dominion Energy）取消了一项有争议的天然气管道计划，并将其整个管道业务以97亿美元的价格出售给了大

型企业集团伯克希尔·哈撒韦。去年11月，出于对页岩排放的担忧，法国能源公司Engie取消了与美国公司NextDecade签订一项LNG合同的计划。其他公司也在努力适应一个看上去势必会有更多竞争也更复杂的天然气行业。

德拉维尼亚指出，现在大公司为烃类燃料投资付出更高的资本成本，同时更加注重盈利能力。规模也正在成为它们的优势。

由于出售了在美国和尼日利亚的利润较低的天然气资产，近年来壳牌的天然气产量的份额实际上有所下降。魏思乐坚称，壳牌已做好了应对市场新形势的准备。和依赖长期供应合同来为新项目吸引融资的小公司不同，壳牌可以利用自己的资产负债表。强大的交易能力让它更容易向形形色色的买家出售LNG。对那些想要零排放能源的买家，壳牌已经售出了10船“碳中和”（即相应碳排放已被抵消）的LNG。道达尔计划在未来十年将其LNG销量翻番，同时大力宣传自己减少甲烷排放的计划。埃克森美孚认为，自己在CCS上的新投资既能限制排放，又能支持自己的传统业务。

这类计划不太可能说服那些希望所有化石燃料投资都大幅下降的人。公司计划可能会受到许多力量的干扰——3月，莫桑比克的一次袭击事件让道达尔暂停了当地的一个大型LNG项目。不断变化的市场意味着只有实力最强的公司所支持的最安全、最赚钱的项目才有较大的可能向前推进。

没能把Engie变成客户的NextDecade已经推迟了对得克萨斯州一项提议设施的最终投资决定，并取消了对另一项设施的投资。它曾试图在爱尔兰建造一个LNG进口接收站，但今年1月爱尔兰官员没有延续双方一个到期的初步协议。天然气的日子可能还没有完全到头，但是这个行业可能很快就要由那些未能推进而不是正在推进的项目来定义了。■



Bartleby

Life after the C-suite

The adjustment process can be painful

THERE COMES a time when even the most glittering career must come to an end. Choosing the right moment to retire is difficult enough, but many people also struggle to imagine what they could possibly do next. In their new book, “Changing Gear”, Jan Hall, a former headhunter, and Jon Stokes, a psychologist, discuss the strategies that people can follow when approaching the “third stage” of life, after their childhood and their careers.

As the authors note, the third stage involves individuals redefining their role in the community. This process may be particularly difficult for those who have been in high-powered jobs. They must come to terms with a loss of their status and the realisation that they are both replaceable and mortal. Employment provides people with a lot more than just an income: it gives a structure to the day, opens up new friendships and provides a purpose that comes from taking part in a shared endeavour.

Those who have reached the top of the tree often neglect the other areas of their life—indeed, they may not have got so high if they didn’t. For such people, retiring may be a lot like the five stages of grief: denial, anger, bargaining, depression and acceptance. Denial is particularly significant. As Ms Hall and Mr Stokes observe, “those in power gradually become insulated from reality” and “develop an inflated sense of their own importance”. Executives may not realise they have grown out of touch with new market developments or so overweening in their behaviour that they are alienating their staff. When others suggest that it is time for them to step down, they may feel angry at the apparent betrayal.

It can also be hard for high-powered people to map out a future after they quit their posts. While they are working, they may have no time to consider alternative activities. Leaving their jobs may be a little like a drug addict going “cold turkey”. The word “retirement” conjures up ideas of passivity and retreat that many find unattractive, Ms Hall and Mr Stokes point out. Individuals may have chosen leadership roles because they like having power over others or sway over events. Shifting into a role as a non-executive, or volunteering for a charity, will not seem like an adequate substitute. They still want to be in charge of something.

Nor will home life necessarily be easy. Spouses and children have often become used to coping without a parent who has worked long hours. They have built their own networks of friends and activities. They may find it hard to adjust to the presence of a bored pensioner knocking about the house. On top of that, it may have been tricky for those in positions of authority to develop close friendships themselves, particularly at work.

The book presents a series of case studies of people who have been through this kind of upheaval, some a lot more successfully than others. There is, inevitably perhaps, a bit of psychobabble. But readers who tolerate talk of “transition mindsets” and “potential desired competences” will discover that the individual stories are instructive and the questions posed by the authors are important. Those near retirement must work out who they have been, who they are now and who they would like to become.

The answers will vary from person to person; there is “no one size fits all” solution. Bartleby’s father was never happier than when, after retiring from his job as a headmaster, he was able to spend his time reading, gardening and listening to Mozart. Other people would be bored to tears by such a life. The authors suggest that people be willing to experiment, to try new activities, develop new skills and talk to others who have been through the same process. Another approach is to keep a journal and make a list of

things that you like to do, or have also wished to do.

In addition, those approaching retirement should consider the type of role they like to play. Do they enjoy working with others or working alone? Do they draw satisfaction mainly from developing ideas or from co-ordinating teams? Since self-awareness is a difficult skill, people should talk to a few trusted contacts to discover how they are perceived by the wider world. They may find the answers are surprising.

This is a critical issue. Think of all the time people spend deciding which university they would like to attend, which course they would like to study and which career they would wish to follow. Deciding on their post-career lifestyle is just as important. They may have decades left to enjoy. ■



巴托比

卸任高管后的生活

调整的过程可能会很痛苦

即使最辉煌的职业生涯某天也会走到头。选择合适的退休时机就够难了，许多人更是琢磨不出自己接下来还可以做些什么。前猎头简·霍尔（Jan Hall）和心理学家乔恩·斯托克斯（Jon Stokes）在新书《换档》（Changing Gear）中探讨了人们在结束了童年和职业生涯后迈入人生“第三阶段”时可以遵循怎样的策略。

正如两位作者所指出的，到了第三阶段，个人就要重新定义自己在社区中的角色。对于那些长期身居高位的人来说，这个过程可能尤其困难。他们必须接受自己地位丧失的事实，并意识到自己不仅是可替代的，而且终有一死。就业给予人们的远不只是收入：它让人把日子安排得井井有条，有机会建立新的友谊，从参与某项共同的事业中获得一种使命感。

那些已经爬到塔尖的人经常忽视生活中的其他方面——事实上，若非如此，他们可能也不会爬到那么高。对于这样的人来说，退休可能非常像悲伤的五个阶段：否认、愤怒、讨价还价、沮丧和接受。否认这一点尤为显著。正如霍尔和斯托克斯观察到的，“位高权重的人渐渐脱离了现实”，并且“自视过高”。高管们可能意识不到自己已与新的市场动向脱节，或者因为行事倨傲而和员工渐行渐远。当其他人建议他们该卸任了，他们可能会把这理解为一种背叛而感到恼怒。

有权有势的人退休后可能也很难规划自己的未来。他们还没退休时可能也没时间考虑如果不工作的话还能做什么。离开工作岗位后，他们的表现可能有点像瘾君子猛然戒断时的反应。霍尔和斯托克斯指出，“退休”这个词让人联想到被动和退缩的意味，让许多人避之不及。个体选择领导的角色可能是因为他们喜欢高高在上和呼风唤雨的感觉。转向非管理层角色或者给慈善机构做志愿者似乎不是个合适的替代方案。他们还是想管点儿什

么。

家庭生活也不一定会顺遂。配偶和子女往往已习惯了另一半和父母一方因长时间工作而在生活中缺席。他们已建立起了自己的朋友和活动圈子。家里突然多了一个百无聊赖的退休人士来回晃荡，他们可能还会不适应。除此之外，那些身居要职的人自己可能也很难发展出亲密的友谊，特别是在工作中。

这本书展示了一系列案例，主角就是那些经历过这种重大转变的人，其中有些人调适得明显比其他人好。也许免不了的是，他们会发出一些故作高深的絮叨。但是，读者们若能把那些个“转型思维”和“期望潜力”的段落忍过去，就会发现这些个人故事很有启发性，作者提出的问题也很重要。临近退休的人必须弄清楚自己曾经是谁、现在是谁，今后又想成为谁。

答案会因人而异，并没有“放之四海而皆准”的解答。笔者的父亲从校长的职位上退休后感到从未有过的快乐，因为他有时间阅读、做园艺和听莫扎特了。换做别人，这样的生活也许会让他们无聊到犯困。作者建议人们要乐于实验、尝试新活动、开发新技能，找经历过相同过程的人聊聊。还有一种方法是写日记，把自己喜欢做或曾经希望做的事情列个单子。

此外，那些行将退休的人应该考虑自己想扮演什么类型的角色。是喜欢和别人一起工作，还是单干？自己主要是从哪里获得满足感？是发掘创意，还是协调团队？自我认知不是一项容易掌握的技能，因此，人们应该跟一些可信赖的人谈谈，以了解外界对自己的看法。答案可能会出乎他们意料。

这个问题非同小可。想想看，人们花了多少时间决定自己想上哪所大学、学哪门课程、从事哪种职业。决定职业生涯结束后的生活方式同样是件要紧的事，因为今后说不定还有几十年的人生要安享呢。 ■



Economic development

How to promote African factories

A sub-Saharan industrial revolution need not be a pipe dream

FEW BUILDINGS symbolise the rise and fall of manufacturing in South Africa better than the old General Motors plant in Gqeberha (previously Port Elizabeth). During apartheid the factory was sheltered from international competition by sanctions and tariffs. Now its vast silvered assembly halls stand bare. It was closed in 2017, an emblem of South Africa's car industry, which shed almost one in four jobs between 2009 and 2017. That is typical of a wider decline of manufacturing across the continent. In 1975-2014 manufacturing's share of GDP in sub-Saharan Africa fell from 19% to 11%.

This collapse has plenty of causes. In countries such as Zambia, firms were nationalised and run into the ground by bureaucrats. In resource-rich places such as Nigeria exports of oil or other commodities led to an overvalued local currency, making it cheaper to import things than make them. As much of the continent opened up to imports in the 1990s, manufacturers struggled to hold their own against hyper-competitive Chinese firms with the scale to drive down costs.

In 2015 Dani Rodrik, an economist at Harvard, wrote of "premature deindustrialisation" in Africa. The continent seemed to be missing out on an important means of boosting productivity and creating jobs. The ladder that hundreds of millions of Asians had climbed up out of poverty had been taken away just as Africans were putting a foot on the first rung, some feared. Since by around 2035 there will be more young people joining the workforce in Africa than in the rest of the world combined, it matters whether this idea is right.

Thankfully, newer data suggest it is not. Sub-Saharan Africa's manufacturing slump bottomed out in the 2000s. Since 2010 the number of workers in African factories has steadily risen. So has factory output. Worries about deindustrialisation now look as if they are premature.

Many African leaders are eager to promote manufacturing, partly to avoid dependence on volatile commodities and partly because their countries have found it so frustratingly hard to import medical supplies quickly enough during the pandemic. To get the best results, they should start by learning from past failures. That means avoiding nationalising companies, subsidising national champions or raising import barriers to cosset home-grown industries. Many leaders are wisely embracing a continent-wide free-trade agreement that came into force this year. It offers hope: a mattress-maker in landlocked Rwanda is more likely to grow by winning orders in next-door Congo than in far-off Japan.

Yet it is not enough for African governments to do no harm. Companies also need reliable power, educated workers and good infrastructure to improve productivity. Since hard choices are inevitable, governments should pick investments that diversify away from commodities. This would mean building ports with roads to industrial areas rather than to mines in the middle of nowhere. Some governments are giving tax incentives to companies in a bid to break into prestigious industries like carmaking. They might do better to focus on easier targets, such as processing food for local stomachs, or making dull products like packaging for neighbouring countries.

If infrastructure and governance improve, more firms may choose to build factories in Africa to make components for global supply chains using parts from local suppliers. Industrialisation in Africa will not look the same as it did in Asia. Circumstances are different, and technology has moved on. But the notion that Africa has missed out on manufacturing seems to be

mistaken. With better policies, its firms can find a path. ■



【首文】经济发展

怎样让非洲工厂晋级

撒哈拉以南地区的工业革命未必是妄想

很少有建筑比通用汽车在格贝哈（Gqeberha，原伊丽莎白港[Port Elizabeth]）的旧工厂更能象征南非制造业的兴衰。在种族隔离时期，这家工厂因南非受到制裁和关税保护而免于国际竞争。如今它那些巨大的银白色装配车间里已空无一物。它于2017年关闭，是南非汽车工业的缩影，该行业在2009年至2017年间裁员近四分之一。这是整个非洲制造业普遍衰退的典型表现。1975年至2014年，撒哈拉以南非洲地区制造业占GDP的比重从19%下降到11%。

这种衰落有很多原因。在赞比亚等国家，企业都国有化了，被官僚们经营得一团糟。在像尼日利亚这样资源丰富的地方，出口石油或其他大宗商品导致本币估值过高，使得从国外进口商品比自己生产更便宜。上世纪90年代，随着非洲大陆大部分地区放开进口，本地制造商很难招架中国企业的攻势，后者通过规模压低成本，具有超强的竞争力。

2015年，哈佛大学的经济学家丹尼·罗德里克（Dani Rodrik）曾撰文探讨非洲“过早地去工业化”。非洲大陆似乎错失了一条提高生产率和创造就业的重要途径。有人担心，那条曾让数亿亚洲人爬出贫困沼泽地的梯子在非洲人刚踏上第一级时就被撤走了。到2035年前后，非洲加入劳动力大军的年轻人数量将超过世界其他地区的总和，因此，这种看法正确与否非常重要。

所幸，最新数据表明情况并非如此。撒哈拉以南非洲的制造业衰退在21世纪的头十年达到了最低点。自2010年以来，非洲工厂里的工人数量稳步上升。工厂产出也是如此。目前看来，对去工业化的担忧本身似乎倒是为时过早了。

许多非洲领导人如今渴望促进制造业的发展，一方面是为了避免依赖波动

性强的大宗商品，另一方面是因为他们发现自己国家在疫情期间很难及时进口医疗用品，这非常令人沮丧。前事不忘，后事之师。这意味着要避免将企业国有化、补贴本国的领先企业，或提高进口壁垒以扶持本土产业。许多领导人明智地拥抱已于今年生效的覆盖整个非洲的自由贸易协定。它带来了希望：内陆国家卢旺达的床垫制造商更有可能通过赢得邻国刚果的订单来实现增长，而不是指望遥远的日本。

但是，仅仅靠政府不办坏事还不够。企业还需要可靠的电力、受过教育的工人和良好的基础设施来提高生产率。既然艰难的抉择不可避免，政府应该选择从大宗商品转向多元化投资。这意味着要建造港口，并从港口修建公路连接工业区，而不是连接位于不毛之地的矿山。一些政府正在为那些试图进入汽车制造等声名显赫的行业的企业提供税收优惠。它们或许应该关注更容易实现的目标，比如加工适合当地人口味的食品，或是为邻国制造包装材料等标准化产品。

如果基础设施和治理能够改善，更多的公司可能会选择在非洲建厂，使用当地供应商的零件为全球供应链制造部件。非洲的工业化不会和亚洲一个模样。境况并不相同，技术也已进步。但是认为非洲已经错失制造业良机的观点似乎是错误的。有了更好的政策，非洲企业就能找到出路。■



Frenzy with benefits

Making sense of the SPAC spectacle

How to snatch sanity from the jaws of financial absurdity

SUSPEND YOUR disbelief. That seems to be what modern financial markets require of investors. GameStop, a tiny and humble retailer that was swept up in an online-trading mania earlier this year, is still worth \$11bn. Digital animations are being sold through online tokens for millions of dollars. The stock of Dogecoin, a digital currency that was until recently considered to be a parody, is valued at almost \$50bn. Crypto, meme-stocks, NFTs—each new financial fashion seems to bring its own termi-nology and the whiff of absurdity.

Many investors would add to that list special-purpose acquisition companies (SPACs). They are an alternative way of taking firms public that bypasses the cumbersome initial public offering (IPO) process. The pace of deals has been furious. Between January and April some \$100bn was raised through SPACs, many of which are now hunting for firms to buy. Some 84 companies have announced they will float via SPAC mergers so far in 2021, versus 123 using IPOs. The SPAC trend is a giant experiment with a different way to take firms public. And it is also a test of the firms involved, most of which have either been hidden away in private markets for years, or are so nascent that they are more concepts than companies.

So just how mad is the SPAC frenzy? At first glance, pretty mad. This boom has occurred in spite of the dodgy track record of some firms that have gone public in this way in the past. Regulators grumble that the process is easy to manipulate. The executives who run SPACs frequently take a whopping slice of equity for themselves, to the detriment of the outside investors who usually stump up far more cash. Often they make fanciful promises. The

Economist has totted up the management forecasts of a panel of 50 recent or pending SPAC deals. Around half of the firms are loss-making. In aggregate the 50 firms generate about \$1bn of annual gross operating profits today but have forecast to investors that this will rise to a miraculous \$15bn by 2023. There are pockets of extreme delusion. Of the eight electric-vehicle (EV) firms ushered into public markets by SPACs in 2020, five expect to progress from making no revenues to \$10bn-worth in under five years. Not even Google, one of the most successful firms in history, pulled that off. It took it eight years.

Yet while the overall figures look wild, the good news is that the SPAC boom is becoming more discerning. The market capitalisation of Virgin Galactic, a space-technology company, has fallen from \$13bn to \$5bn since February. Shares in Opendoor, a real-estate firm, have halved. Investors who funded the VectoIQ Acquisition corporation saw their money grow seven-fold after it merged with Nikola, an electric-truck maker, in June 2020. But shares in the firm have since dropped back below its debut price. Investors have cooled on SPACs that are still hunting for targets. Bill Ackman, a Wall Street tycoon, has a \$4bn vehicle that was trading at a 50% premium to its cash value in February, in anticipation of it doing a deal that would be instant alchemy. The premium has since fallen to just 17%.

There are other signs of market discipline in action. Short interest is growing as sceptical investors bet against SPACs and the firms they have backed. After a spectacular start to the year just \$2.5bn has been raised through new SPACs since March 29th, as fund managers grow less giddy and warier of writing blank cheques. This scepticism is a healthy sign of the market maturing.

Institutional investors should use their clout to improve the process. That means making sure that the slice of shares that SPAC creators are awarded is not excessive, insisting managers' pay is tied to delivering on the forecasts

they make, and applying a discount to firms that give outside investors limited voting rights. Not all companies that go public through SPACs will succeed, but having an alternative way to float companies is welcome. Still, if anyone comes up with a SPAC for a firm selling NFTs in EVs, run for the hills. ■



【首文】利益迷乱

看懂SPAC奇观

如何从金融荒诞的魔爪中夺回理智

别不信——这句话似乎是现代金融市场对投资者提出的要求。今年早些时候，一家不起眼的小零售商游戏驿站（GameStop）卷入了一场线上交易狂潮，目前其市值仍高达110亿美元。数字动画在线上发售，接受数字货币支付，售价达数百万美元。数字货币狗狗币（Dogecoin）直到最近还被视为一种戏谑的模仿品，但其总市值接近500亿美元。加密货币、散户神股、NFT（非同质化代币）——每一种金融时髦品似乎都自带一套术语和一丝荒谬气息。

许多投资者会把SPAC（特殊目的收购公司）也归于此类。这是公司上市的另一种途径，可以绕过繁琐的IPO程序。这类交易发展迅猛。今年1至4月，SPAC已经筹集了约1000亿美元的资金，其中许多正在寻找收购对象。今年以来已有84家公司宣布将通过SPAC合并上市，而宣布将使用IPO的有123家。大行其道的SPAC是一场巨大的实验，为公司上市另辟蹊径。这对相关公司而言也是一场考验，其中大多数公司要么已在私人市场上隐匿多年，要么才刚刚起步，准确地说还只是概念而非公司。

那么这轮SPAC热到底有多疯狂？乍一看，那可是非常疯狂。尽管过去以这种方式上市的公司有一些不光彩的记录，但这股热潮还是兴起了。监管机构抱怨这种上市程序很容易被操纵。运营SPAC的高管经常给自己分配大量股权，损害了外部投资者的利益，后者通常得掏出多得多的现金。他们也常常做出不切实际的承诺。本刊汇总了50宗近期完成或进行中的SPAC交易的管理层预测。大约一半的公司处于亏损状态。50家公司目前每年运营毛利总计约为10亿美元，但它们向投资者预测，到2023年，这一数字将奇迹般地升至150亿美元。其中一些预测纯属异想天开。在2020年通过SPAC上市的八家电动汽车公司中，有五家预计自己将在五年内从颗粒无收发展到进账百亿。即便是历史上最成功的公司之一谷歌都没能做到这一点——

它花了八年。

不过，尽管总体数据看起来已经失控，好消息是这轮SPAC热正在变得更加有辨别力。自2月以来，太空技术公司维珍银河（Virgin Galactic）的市值已从130亿美元跌至50亿美元。房地产公司Opendoor的股价已经腰斩。VectoIQ Acquisition去年6月与电动卡车制造商Nikola合并后股价上涨了七倍，但之后一路跌破发行价。对于仍在物色目标的SPAC，投资者的热情已经冷却下来。华尔街大亨比尔·阿克曼（Bill Ackman）的一家40亿美元的SPAC在2月的交易价格比其现金价值高出50%，市场期待着他能达成一笔点石成金的交易。此后，溢价已经缩小至只有17%。

还有其他迹象表明市场自律正在发挥作用。心存疑虑的投资者看空SPAC及其支持的公司，做空的比例正在增加。SPAC在年初的表现令人瞩目，但3月29日以来，随着基金经理们头脑冷静下来，对开出空白支票更加谨慎，通过新的SPAC筹集到的资金仅有25亿美元。这种怀疑态度是市场走向成熟的健康迹象。

机构投资者应该利用他们的影响力来改进SPAC的流程。具体地说就是确保SPAC创始人不会获得过多股份，坚持管理层的薪酬水平与他们实现预测的程度挂钩，并且给那些给予外部投资者有限投票权的公司的股价打折扣。通过SPAC上市的公司并不一定都能成功，但能多一种上市方式总是好事。不过，如果有人发起一个SPAC，目标公司发行用电动汽车充当的NFT，那还是避之则吉吧。 ■



Lab life

Can Merck's new boss maintain the drugmaker's winning streak?

Belén Garijo takes over as chief executive in May

FEW COMPANIES have a history as long and interesting as Merck. Founded in 1668 by Friedrich Jacob Merck as a pharmacy in Darmstadt, the world's oldest apothecary has survived several European wars, two world wars and the Nazi regime. In 1917 America's government confiscated its American subsidiary under the Trading with the Enemy Act. It has operated as a rival business, based in New Jersey but, confusingly, also named Merck, ever since.

Belén Garijo, the no-nonsense 60-year-old Spaniard who will take over as Merck's chief executive on May 1st, says she is keenly aware of her company's heritage and its unique ownership structure. Fully 70% of the company is still in the hands of the 13th generation of Mercks (the rest is owned by public investors). And it was at the family's instigation that Stefan Oschmann, the outgoing CEO, and Ms Garijo, his deputy, transformed Merck through a series of bold acquisitions from a drugmaker living off legacy medicines into a conglomerate that makes gear and chemicals for biotechnology labs as well as pharmaceuticals. "Diversification is strength," insists Ms Garijo, who herself embodies diversity, becoming only the second woman ever to head a firm in the DAX 30 index of Germany's bluest chips.

Investors applauded the strategic shift under Mr Oschmann (see chart). Merck's market value increased from €36bn (\$41bn) in 2016 when he took the helm to €63bn, more than Bayer, another big German drugmaker, which has almost twice as many employees as Merck, and nearly as much as BASF, a chemicals giant. Last year the group's revenues rose by 9% to €17.5bn; net

profit shot up by 51% to €2bn.

The most immediate task for Ms Garijo is to manage a shake-up of the executive suite. The company is installing new heads of drugmaking, research and development, and the American pharmaceuticals business. It is also looking for a new head of the lab division; Udit Batra, who used to run it, left after Ms Garijo pipped him to the top job last year.

The new boss must also ensure that the commercial potential of the course charted by her predecessor is realised, says Matthew Weston of Credit Suisse, a bank. Some big bets appear to have disappointed. Bintrafusp alfa, a drug to fight lung cancer that is in the late stages of development, did not show any benefit over a rival drug in trials. Only two other drugs are close to potential clinical use, a lung-cancer treatment and one to fight multiple sclerosis. In 2020 sales of the medicines business edged down by 1%.

In the pandemic year this was handily offset by the strong performance of Merck's lab division, which has become the firm's biggest arm. Its sales increased by nearly 10% to €7.5bn in 2020. In February Merck announced that it will significantly accelerate the supply of the fatty bubbles needed to make the Pfizer-BioNTech vaccine against covid-19. Few companies in the world are able to produce these custom lipids in large quantities for vaccine production. The company has also said it will invest in production capacity for disposable plastic materials for bioreactors, another essential ingredient for makers of covid-19 vaccines.

The lab business should continue to thrive once the pandemic abates, thinks Mr Weston. That will let Ms Garijo focus on medicines, which as former head of the pharma division she is well placed to do. Mr Oschmann will be a tough act to follow—but not an impossible one. ■



实验室生活

默克的新老板能保持公司的连胜势头吗？

葛丽鹤于5月出任首席执行官

很少有公司的历史像默克这样悠久又有趣。它成立于1668年，当时弗雷德里克·雅各布·默克（Friedrich Jacob Merck）在达姆施塔特（Darmstadt）开了一家药房，之后这家世界上最古老的药剂商挺过了几次欧洲战争、两次世界大战和纳粹的统治。1917年，美国政府依照《与敌国贸易法》（Trading with the Enemy Act）将默克在美国的子公司没收充公。自那以后它成了原母公司的竞争对手，总部设在新泽西，但保留了原来的名字，让人很容易混淆。

现年60岁、朴实干练的西班牙人葛丽鹤（Belén Garijo）将于5月1日接任德国默克的首席执行官，她说自己对这家公司的传统及其独特的所有权结构了如指掌。该公司足足70%的股份仍掌握在第13代默克家族的手中（其余由公众投资者持有）。正是在这个家族的发起下，即将离任的首席执行官欧思明（Stefan Oschmann）和他的副手葛丽鹤通过一系列大胆的收购，将默克从一家靠卖传统药剂为生的制药商转变成了为生物技术实验室和制药公司生产设备和化学品的企业集团。“多元化就是实力。”葛丽鹤强调。她本人就是多元化的体现，她是有史以来执掌德国最优蓝筹股DAX30指数公司的仅仅第二位女性。

投资者对欧思明治下的战略转型拍手叫好（见图表）。默克的市值从2016年欧思明上任时的360亿欧元（410亿美元）升至630亿欧元，超过另一家德国大型制药商拜耳（而拜耳的员工数量几乎是默克的两倍），与化工巨头巴斯夫（BASF）相当。去年默克的收入增长了9%，达到175亿欧元；净利润飙升51%，达到20亿欧元。

对葛丽鹤来说，首当其冲的任务是处理好高层人事变动。公司正在为制药、研发和美国制药业务等部门安排新负责人。它也在寻找实验室部门的

新负责人；去年，负责该部门的吴博达（Udit Batra）在不敌葛丽鹤、无缘最高职位后离开了公司。

这位新老板还得确保由其前任划定的路线将实现商业潜力，瑞士信贷银行的马修·韦斯顿（Matthew Weston）说。一些大赌注似乎已经让人失望了。治疗晚期肺癌的药物Bintrafusp alfa在临床试验中没有显现出相比一种对照药物的任何优势。目前只有另外两种药物有可能接近临床应用，一种用于治疗肺癌，另一种用于多发性硬化症。2020年，药品业务的销售额小幅下降了1%。

在新冠肺炎肆虐的一年里，这点降幅被默克实验室部门的强劲表现轻松抵消，该部门已经成为默克最大的一支。2020年该部门销售额增长了近10%，达到75亿欧元。今年2月，默克宣布将大幅度加快供应生产辉瑞-BioNTech联合开发的新冠疫苗所需的脂质体。全球能大量生产这些用于疫苗生产的定制脂质体的公司寥寥无几。默克还表示将投资生产用于制造一次性生物反应器的塑料材料，生物反应器也是新冠疫苗制造商必需的物料。

韦斯顿认为，实验室业务在疫情平息后应该会继续繁荣。这让葛丽鹤能专注于药品，而作为制药部门的前负责人，她在这一个领域更是得心应手。欧思明的成就的确让继任者难以望其项背，但也并非全然不可企及。■



Time's up

Warren Buffett should step aside for his chosen successor

Berkshire Hathaway needs a leader who will take a fresh look at performance and governance

AT 90, WARREN BUFFETT continues to lead Berkshire Hathaway, wearing the three hats of chief executive, chairman and chief investment officer. For years, the question of whom the feted investor would anoint as his successor to run the giant conglomerate has been the subject of boardroom gossip. The world now knows the answer, though only because of a slip of the tongue by Mr Buffett's 97-year-old right-hand man, Charlie Munger, at the annual shareholders' meeting on May 1st. That forced Mr Buffett to confirm that his heir apparent as chief executive is Greg Abel, 58, a trusted lieutenant who runs Berkshire's non-insurance businesses.

The cack-handed way in which the succession plan became public fits a bigger pattern. Berkshire is a huge public company, with a stockmarket value of \$645bn and an army of devoted retail investors. It is, though, structured and run in much the way it was when Mr Buffett took it over in the 1960s. He has never hidden his reluctance to retire. He once joked that he'll step down five years after he dies. However, Berkshire needs to make changes if it is to keep up with the times—and that includes having a new person at the top.

That is not to denigrate Mr Buffett or his achievements. In his 56 years in charge, Berkshire's total returns have been double those of the S&P 500 index. He can claim to be the greatest value-investor who ever lived. He has instilled an admirable trust-based culture at Berkshire. The dozens of fawning books he has inspired constitute their own genre of business publishing.

However, cracks have started to appear. One is Berkshire's financial performance, which has been mediocre over the past decade. Mr Buffett has made some costly mistakes, such as bad bets on airlines and Kraft Heinz, a consumer-goods giant. He has admitted to overpaying for acquisitions, including a big metal-parts-maker that later wrote off \$11bn. Were it not for a valuable stake in Apple, the bottom line would have looked limper still. Suspicion is growing that Mr Buffett has lost his magic touch in allocating capital, perhaps because, like other star fund managers, he is too big to outperform the market by much.

Berkshire's governance needs rethinking, too. For all the autonomy its divisions enjoy, Mr Buffett still has to sign off on the big decisions. He has special shares with greatly enhanced voting power. The board is stacked with Friends of Warren; five of its 14 members are 89 or over. Berkshire's failure to write or disclose its policies on investor priorities such as climate risk and diversity irks some shareholders, including big institutions like BlackRock. When investors called Buffett-style governance "unique" they used to mean it as a compliment. No longer.

The company's lousy disclosure looks out of step with the times, too. Berkshire offers little beyond mandatory filings and the occasional press release. It does not hold analyst meetings or investor days; it does not even have a functioning investor-relations department. The closest thing to outside scrutiny it tolerates is the three hours of friendly shareholders' questions, teed up by a genial reporter from CNBC, at the annual conclave.

The company needs to start dealing with these deficiencies now, or face the increased risk of a drama—such as an attempt by activist investors to break up Berkshire, or a regulatory rumble—when Mr Buffett does eventually leave. There is no need to stoop to the box-ticking corporate conformity that he so loathes, an aversion reflected in his public criticism of the metrics and questionnaires wielded by ESG campaigners.

New blood and greater openness would be a good start. Naming a successor is a first step. The next should be to replenish the board with outside appointments. Investors must get the information they need to make informed decisions, including analysis of where the firm is creating value, and the tax and other synergies that justify keeping the conglomerate intact.

The biggest question of all is when Mr Buffett should go. He may want to die at his desk, but the longer he stays, the more he risks becoming a liability. He said at this year's AGM that bad leaders are the biggest risk companies face. Good leaders who stay too long are not far behind. Mr Buffett has had a wonderful run. But now that the succession is out in the open, it is time to move aside and let Mr Abel fix what isn't working. ■



【首文】时间到

巴菲特应该让位给自己选中的接班人

伯克希尔·哈撒韦需要一位以新角度审视公司业绩和治理模式的掌舵人

九十岁的巴菲特依然掌管着伯克希尔·哈撒韦公司，身兼首席执行官、董事长和首席投资官三职。多年来，董事会里私下揣测不休的一大主题就是这位股神会选中谁来接手这庞大的企业集团。现在全世界都知道答案了，尽管只是因为巴菲特97岁的搭档查理·芒格（Charlie Munger）在5月1日的年度股东大会上说漏了嘴。这逼得巴菲特承认将接任首席执行官的是58岁的格雷格·阿贝尔（Greg Abel），这位很受他信任的副手目前负责伯克希尔的非保险业务。

继任人计划以这种笨拙的方式公之于众，符合这家公司的一个整体模式。伯克希尔是一家巨型上市公司，股票市值达6450亿美元，有一大批忠实的散户投资者。但它的结构和运作方式大体上还是上世纪60年代巴菲特接管时的样子。巴菲特也从不掩饰不愿退休的态度，他曾开玩笑说会在自己离世五年后卸任。然而，伯克希尔若要跟上时代的步伐就必须做出改变，包括更换最高负责人。

这并不是贬低巴菲特或是他的成就。在执掌伯克希尔的56年里，他取得的总回报是标普500指数的两倍。他可以说是史上最伟大的价值投资者。他给伯克希尔注入了一种值得赞美的基于信任的文化。几十本颂扬巴菲特的书作在商业出版界已然自成一派。

但问题已经开始显现。一是伯克希尔的财务业绩，过去十年一直表现平平。巴菲特犯了一些代价高昂的错误，比如对几家航空公司和消费品巨头卡夫亨氏的糟糕押注。他承认在一些收购上出价过高，包括一家最终冲销了110亿美元的大型金属零件制造商。如果不是持有的苹果股份的价值高涨，伯克希尔的盈利还会更显低迷。人们越来越怀疑巴菲特在资本配置上魔力不再，这也许是因为，跟其他明星基金经理一样，他的投资规模太大

了，已经难以大幅跑赢大市。

伯克希尔的治理模式也需要反思。虽说公司各部门各司其职，但重大决策还是需要巴菲特拍板。他持有的特殊股份极大地加强了他的投票权。董事会里满是“巴菲特的朋友”，14名董事中五人在89岁或以上。伯克希尔没有就气候风险和多样性等投资者关注的议题制定或披露相关政策，引起了一些股东不满，包括贝莱德（BlackRock）等大型机构。投资者称巴菲特式的治理“独树一帜”，以往这是赞美，如今不是了。

伯克希尔的信息披露不足，也显得与时代格格不入。除了必须提交的文件和偶尔发布的新闻稿之外，它很少公开其他信息。它不举行分析师会议，没有投资者日，甚至没有一个正常运作的投资者关系部门。在外部监督上，这家公司能接受的就是年度股东大会上三小时气氛友好的问答，由一位和蔼可亲的CNBC记者主持。

伯克希尔现在就要着手补足这些短板，否则等到巴菲特最终离任时，公司面临戏剧性变化的风险将加大，比如激进投资者要求拆分伯克希尔，或者引来监管部门不满。但也没必要屈从那种条条框框式的企业治理方式，巴菲特对此深恶痛绝，曾公开批评环境、社会和企业治理活动人士拿各类指标和问卷当令箭。

可以从注入新鲜血液和提高透明度开始。指定接班人是第一步。接下来应该任命外部人士来补充董事会。投资者要能获得必需的信息以做出明智的决定，包括对公司正在何处创造价值的分析，以及能证明应当保持现有企业集团结构不变的税务状况和其他协同效应。

最大的问题是巴菲特何时该离任。他可能想在办公桌前坚持到生命最后一刻，但他留任越久，就越可能成为公司的负累。他在今年的股东大会上说，糟糕的领导者是公司面临的最大风险。但好的领导者如果在任太久，结果也好不到哪里去。巴菲特的掌舵成就辉煌。但现在接班人既已公开，是时候退位让贤，让阿贝尔来解决问题了。 ■



Schumpeter

The magical realism of Tesla

Versus the blunt reality of geopolitics

YOU HAVE to hand it to the “technoking”. For all his impish self-aggrandisement, mockery of deadlines, baiting of regulators and soon-to-be sideline as a “Saturday Night Live” comedy host, Elon Musk is deadly serious about technology. So serious, in fact, that as he was discussing the nitty-gritty of neural networks on an earnings call on April 26th, Tesla’s boss did not miss a beat when what sounded like his infant son let out a wail in the background. The electric-car maker’s record net profit of \$438m in the first quarter, the seventh straight in the black, came as an afterthought.

Such is the allure of Tesla’s whirring money machine that many now give the benefit of the doubt to Mr Musk’s more eccentric claims. His latest involves artificial intelligence (AI). In the future Tesla will be remembered not just as an electric-vehicle (EV) and renewable-energy pioneer, he says, but also as an AI and robotics company. He bases this on a belief that it is close to cracking the challenge of self-driving cars using just eight cameras, machine learning and a computerised brain in the car that reacts with superhuman speed. He calls full self-driving “one of the hardest technical problems...that’s maybe ever existed”.

Amid the techno-optimism, though, Tesla also faces the dreary reality of everyday life. Though it expects to deliver about 50% more vehicles this year than in 2020, or around 750,000, like other carmakers it is struggling with a shortage of computer chips. The fiery crash of a Model S in Texas, killing two, has raised concerns about its self-driving technology (reports that its Autopilot function was involved are “completely false”, Mr Musk said). A pandemic-related shortage of engineers hit its output in China,

source of much of its recent growth. And the Chinese authorities, which used to shower love on the American firm, are showing signs of Tesla fatigue. Mr Musk may one day find the boundaries of his kingdom constrained not by physics but by geopolitics.

He is no longer alone in talking in grandiose terms about Tesla. These days sober sorts vie to justify the firm's valuation of \$700bn or so, which puts all other carmakers in the shade. When describing its potential, Jed Dorsheimer of Canaccord Genuity, a Canadian asset manager, starts with the invention of the printing press in 15th-century Europe. Adam Jonas of Morgan Stanley, an investment bank, believes Mr Musk's EVs are in the midst of something akin to a "Model-T moment"—provided he can, like Henry Ford, crack mass manufacturing to make Teslas more affordable. Both compare Tesla to Apple, the American technology giant, to illustrate how Mr Musk could create a money-spinning ecosystem of gadgets and services that reinforce each other.

For Tesla bulls, the maker of EVs indeed has more in common with that of iPhones than it does with established car firms. Its boosters get excited about Silicon Valley-like innovation, not car sales. On Wall Street the value ascribed to Tesla's relatively low-margin EV business is being eclipsed by the promise of more nebulous but potentially more lucrative ones, mostly involving software: the sort of connected services, such as maps, entertainment, ride-sharing, semi-autonomous driving and over-the-air upgrades that make Teslas a geek's dream. Few assume, as Mr Musk does, that fully autonomous "robotaxis" are imminent. But some, such as Mr Jonas, think Tesla ride-sharing fleets, probably with someone at the wheel, will soon be rolling through city streets.

The magical realism may go beyond that. Besides AI and software, Mr Musk is also doubling down on Tesla's original plan to build, alongside an affordable car, a zero-emission energy business. He has said his intention

is to produce three terawatt-hours of battery capacity within a decade, more than 12 times as much as the goal of Volkswagen, its nearest EV competitor. Besides bringing the cost of cars down to \$25,000 each, the batteries will also go towards Tesla's home-energy-storage business. That would create what he calls a "giant distributed utility" that can cope with increased electricity demand as more people use EVs, as well as provide grid stability at times of bad weather. Mr Dorsheimer, who is particularly bullish on Tesla's solar and storage business, thinks its energy brand could become "Apple-esque".

Apple, worth more than three times as much as Tesla, is a flattering firm to be compared to. It is also the prime example of how deftly an American company can handle the ebb and flow of superpower rivalry. Yet when it comes to geopolitics, Tesla may be at a disadvantage. It is just as global as Apple: last year it made half its sales outside America; 21% came from China. But the \$2trn global car market is more than four times the size of the one for mobile phones. With many more firms involved, cars are more politically sensitive than smartphones. Initially countries like China and Germany threw down the welcome mat for Tesla's gigafactories, partly to goad local firms into producing better EVs. Now that this is happening, the pressure to keep Tesla down is increasing.

If Mr Musk is right that self-driving is the future of getting around, concerns about data-gathering and national security are bound to rise. China has already hinted it is sensitive to them. This year the government restricted the use of Tesla vehicles by military personnel and employees of some state-owned firms because of data-security concerns. Mr Jonas, for one, thinks Tesla's position in China will be "substantially diluted" during the coming decade, as the car market morphs into a transportation utility run and regulated by the state in concert with local champions.

Cyber-paranoia may, of course, make it as hard to sell a Chinese car in

America as an American car in China. And compared with the “insanely hard” problems Tesla is trying to crack, even superpower politics must seem like a minor irritation. But although Mr Musk can claim to rule over the realm of physics, politicians, bureaucrats and spooks run much of the real world. That is a source of power that even the technoking cannot disrupt. ■



熊彼特

特斯拉的魔幻现实主义

对阵赤裸裸的地缘政治现实

你不得不服这位“技术之王”。尽管他常常恶搞式地自吹自擂、嘲讽最后期限、故意激怒监管机构，而且很快还会客串主持喜剧节目《周六夜现场》（Saturday Night Live），但马斯克对技术的态度是极其认真的。认真到什么程度呢？4月26日他在财报电话会议上讨论神经网络的细节时，背景似乎传来了他尚在襁褓中的儿子的尖声啼哭，但这位特斯拉老板一个格楞都没打，继续往下说。而关于这家电动汽车制造商在一季度净利润达到创纪录的4.38亿美元，连续七个季度实现盈利，他不过是在最后随意提了一句。

特斯拉就像一台开动的印钞机，其吸引力之大，以至于现在很多人都愿意搁置疑问，选择相信马斯克的奇谈怪论。他最新的言论涉及人工智能（AI）。他声称，未来，特斯拉将名留青史不仅因为它是电动汽车和可再生能源的先驱，还因为它是一家人工智能和机器人技术公司。这是因为他相信只需要八个摄像头、机器学习，以及一个能以超越人类的速度做出反应的车载计算式大脑，很快就能克服无人驾驶汽车面临的挑战。他称完全自动驾驶“可能是有史以来……最棘手的技术问题之一”。

然而，即便满怀技术乐观主义，特斯拉也还是要面对无趣的日常现实。尽管它预计今年的交付量比2020年高50%左右，也就是交付约75万辆，但和其他汽车制造商一样，它也受到芯片短缺问题的困扰。最近一辆Model S在得克萨斯州撞毁并起火，造成两人死亡，引发了人们对特斯拉无人驾驶技术的担忧（马斯克表示，说事故起因与特斯拉的辅助驾驶系统Autopilot有关的报道是“完全错误的”）。新冠疫情造成的工程师短缺影响了特斯拉在中国的产量，而中国是它近年增长的主要来源。而过去对这家美国公司宠爱有加的中国当局现在也显现出对特斯拉的审美疲劳。或许有一天，马斯克会发现限制自己王国边界的并非物理，而是地缘政治。

马斯克不再是王婆卖瓜了。如今，头脑冷静的人也都纷纷认可该公司7000亿美元左右的估值是合理的，这让所有其他汽车制造商相形见绌。在描述特斯拉的潜力时，加拿大资产管理公司Canaccord Genuity的杰德·多西默（Jed Dorsheimer）从15世纪欧洲发明印刷机说起。投资银行摩根士丹利的亚当·乔纳斯（Adam Jonas）认为马斯克的电动汽车的现状类似于福特的“T型车阶段”——如果他能像亨利·福特那样解决量产问题，让大家更买得起特斯拉的话。这两人都把特斯拉和美国技术巨头苹果相提并论，以阐明马斯克如何能够创造出一个设备和服务相互加强的盈利生态系统。

在看涨特斯拉的人眼里，这家电动汽车制造商确实与苹果而不是老牌车厂有更多共同点。让支持者兴奋的是它的硅谷式创新，而不是汽车销量。在华尔街，人们认为特斯拉利润相对较低的电动汽车业务的价值要逊于那些尚不清晰但可能更赚钱的业务，后者主要涉及软件，也就是诸如地图、娱乐、拼车、半自动驾驶和OTA空中软件升级等联网服务，它们让特斯拉汽车成为极客的梦想。很少有人像马斯克一样，认为完全自主的“机器人出租车”已近在眼前。但包括乔纳斯在内的一些人认为，特斯拉的拼车车队——很可能是有人驾驶的——很快就会行驶在城市的街道上。

带有魔幻现实主义色彩的可能还不止这些。除了人工智能和软件，马斯克也在特斯拉最初的计划上加倍投入，即在制造平价汽车之外，还要开发零排放的能源业务。他曾表示自己要在十年内实现三太瓦时的电池产能，是它最强劲的电动汽车竞争对手大众的目标的12倍还多。除了把每辆车的成本降至2.5万美元之外，这些电池还将用于特斯拉的家庭储能业务。这将创造出他所说的“巨型分布式电力”，不但能够确保电网在恶劣天气里稳定供电，还能应对随电动汽车用户增加而水涨船高的用电需求。多西默尤其看好特斯拉的太阳能和储能业务，他认为特斯拉在能源上可以成为“类似苹果的”品牌。

苹果的市值是特斯拉的三倍多，跟它相提并论无疑是一种褒扬。苹果也是美国公司在风云变幻的超级大国角力中巧妙周旋的典范。然而说到地缘政治，特斯拉可能有点吃亏。它和苹果一样是一家全球化的公司：去年它一

半的销售额来自美国以外，21%来自中国。但全球2万亿美元的汽车市场的规模是手机市场的四倍多。鉴于参与其中的企业数量要多得多，汽车比智能手机更具政治敏感性。起初，中国、德国等国家都敞开大门欢迎特斯拉的超级工厂，一定程度上是为了刺激本土企业生产出更好的电动汽车。既然这已经在发生了，抑制特斯拉的压力也就越来越大。

马斯克认为无人驾驶是出行的未来，如果他是对的，那么对数据收集和国家安全的担忧势必会上升。中国已经暗示自己对这类问题很敏感。今年，出于数据安全的考虑，中国政府限制了部队人员和一些国企员工使用特斯拉汽车。乔纳斯的看法是，未来十年，随着汽车市场转变为由政府与本土领军企业共同运营和监管的公共交通事业，特斯拉在中国的地位将会“大幅下滑”。

当然，网络攻击妄想症可能会使得在美国卖中国车和在中国卖美国车一样难。而与特斯拉正试图攻克的“让人抓狂的棘手”问题相比，即使是超级大国的政治争斗应该也会显得无足轻重。但是，尽管马斯克可以声称自己统领物理王国，现实世界在很大程度上是由政客、官僚和情报人员运转的。这是一种即便是技术之王也无法颠覆的权力来源。■



Cancer research

Mapping cancer as if it were the universe

Techniques from astronomy are being applied to medicine

OVER THE past two decades Alexander Szalay, an astronomer at Johns Hopkins University in Baltimore, has helped create the most detailed maps of the cosmos yet made. His raw material comes from the Sloan Digital Sky Survey, which began in 2000. So far, this project has charted a third of the heavens and observed nearly 1bn astronomical objects.

The survey's telescope, which sits on a mountain top in New Mexico, collects its data by recording the arrival of photons of light on a charge-coupled device. This turns them into an electrical signal that Dr Szalay and his confrères translate into a representation of reality by winnowing out the noise and determining, from what remains, what sorts of objects the telescope is looking at and how far away they are.

Now, Dr Szalay has added a microscope to his telescope. In collaboration with Janis Taube, a colleague at Johns Hopkins who is a pathologist, he is developing AstroPath. This is a project that combines his knowledge of astronomy with hers of pathology into a system which does for images of cancer cells and tissues what the Sloan survey does for images of the universe.

Dr Szalay, ever handy with an astronomical analogy, compares the most common current approach to the examination of images of cancers—which is to look in great detail, but at only a few tumours—to studying the universe using the Hubble Space Telescope. This instrument can focus on only a restricted area of the sky, but is then able to record what it sees with immense precision by spending lots of time taking long exposures.

As a consequence, the Hubble has surveyed only 45 of the 41,253 square degrees which constitute the celestial sphere. By contrast, the Sloan survey has so far covered, in a more cursory manner, about 15,000 square degrees of that sphere. This sweeping approach lets astronomers understand the universe's large-scale structure by seeing entire clusters of galaxies and the relationships between them.

Both methods are valuable. But because fewer cancer biologists use the second than the first, AstroPath is designed to fill the gap. The specialised microscopes the project uses capture images of broad slices of tumours, and do so in multiple wavelengths. These images are then subjected to data-analysis techniques developed as part of the Sloan survey.

In particular, AstroPath employs a technique called immunofluorescence to make its images. This works by using antibodies to attach fluorescent tags to specific sorts of protein molecules. That permits the distributions of these proteins throughout a tumour to be mapped cell by cell. So far, AstroPath can do this simultaneously for between 20 and 30 proteins. Dr Taube's long-term goal is to do likewise for hundreds of individual tumours of more than 20 different types, enabling comparisons to be made both within and between types.

Currently, AstroPath has scanned more than 226m cells from three types of tumour—lung cancer and two skin cancers, melanoma and Merkel-cell carcinoma. Dr Szalay points out that dealing with these three alone meant processing more pixels than the whole Sloan survey to date. But this is only a start. Eventually, he and Dr Taube aspire to collect and process 1,000 times more data than this.

For herself, Dr Taube particularly hopes AstroPath will flag up molecules that will help her develop blood tests for melanoma and lung cancer, and will improve her understanding of how tumours respond to a form of

treatment called immunotherapy. Some cancers are able to put the brakes on the immune system's anti-tumour activity. Disable this ability and the immune system can return to the fray. She hopes to identify markers, such as the levels of a substance called PD-1, a so-called immune checkpoint protein, that will be able to predict whether a patient will respond to such therapy—and, if so, precisely which sort of it.

The project's wider aim, though, is to make the results available to the world as a cancer atlas in a format similar to Google Maps. Then, any interested oncologist can take a look and draw conclusions relevant to his or her own area of interest and expertise. If that can be done, it really will enable cancer researchers to reach for the stars. ■



癌症研究

像绘制宇宙地图一样绘制癌症地图

天文学技术正被应用于医学

过去二十年，巴尔的摩的约翰·霍普金斯大学的天文学家亚历山大·萨莱（Alexander Szalay）协助绘制了迄今为止最详尽的宇宙地图。他的原始材料来自于自2000年启动的斯隆数字化巡天项目（Sloan Digital Sky Survey）。到目前为止，这个项目已经测绘了整个天空的三分之一，观测了近10亿个天体。

项目所使用的望远镜位于新墨西哥州的一座山的山顶，通过记录抵达电荷耦合器件的光子来收集数据。光子在这里被转化为电信号，萨莱和他的同事们从中过滤掉干扰信号，用余下的部分确定望远镜看到的物体属于哪类、距离多远，从而将电信号转化成具体的图像。

现在，萨莱又在他的望远镜上加上了一台显微镜。他正与约翰·霍普金斯大学的同事、病理学家詹尼斯·陶贝（Janis Taube）合作，开发AstroPath。这个项目将萨莱的天文学知识和陶贝的病理学知识融合起来，打造一个系统来测绘癌细胞和癌组织，就像斯隆项目绘制宇宙的图像一样。

拿天文学做类比在萨莱是信手拈来。他将目前最常用的癌症影像检查方法与用哈勃太空望远镜观测宇宙做比较。前者的观察十分细致，但每次只看为数不多的几颗肿瘤。哈勃望远镜只能聚焦天空中有限的区域，但也就可以通过长时间曝光非常精确地记录下观测到的东西。

也因此，哈勃只观测了天球41253平方度总面积中的45平方度。相比之下，斯隆项目采用的方法更粗略，目前为止覆盖了天球的大约15000平方度。借助这种笼统而全面的方法，天文学家可以观察整个星系团以及它们之间的关系，从而在宏观层面了解宇宙的结构。

两种方法都有价值。但是，癌症生物学家使用第二种方法的时候要少于第一种，AstroPath有意消除这一差距。该项目使用的专门显微镜可以捕捉较大肿瘤切片组织的图像，并且可以在多种波长下进行。之后，斯隆项目所使用的数据分析技术会对这些图像进行分析。

具体来讲，AstroPath采用了一种叫做免疫荧光的方法来生成图像，方法是用抗体将荧光标签附着到特定种类的蛋白质分子上。这样就可以将这些蛋白质在整个肿瘤中的分布情况绘制出来，精确到每个细胞。AstroPath目前可以同时对二三十种蛋白质进行这样的操作。陶贝的远期目标是对20多种、数量达几百个的肿瘤开展类似的成像操作，以便对同类型和不同类型的肿瘤做比较。

目前，AstroPath已经扫描了超过2.26亿个细胞，它们来自三种肿瘤——肺癌，以及黑色素瘤和默克尔细胞癌这两种皮肤癌。萨莱指出，光是测绘这三种肿瘤要处理的像素就比整个斯隆项目迄今为止已处理的像素还要多。但这还只是个开始。他和陶贝希望最终能收集和处理的数据会是现在的1000倍。

陶贝则尤其希望AstroPath能够标记出一些分子来帮助她开发针对黑色素瘤和肺癌的血液测试，并让她更好地了解肿瘤如何对免疫疗法这种治疗形式做出反应。有些癌症能够抑制免疫系统的抗肿瘤活性。如果能阻止它们发挥这种能力，免疫系统就可以重返战场。她希望能够识别出一些标记物，例如一种叫做PD-1的物质的水平。PD-1是一种所谓的免疫检查点蛋白，能够预测患者是否会对免疫疗法有反应，以及如果有的话，确切来说是哪一种免疫疗法。

不过，该项目更宏伟的目标是以类似谷歌地图的形式将结果制作成一本癌症图册，向全世界开放。这样，任何感兴趣的肿瘤学家都可以查阅它，并得出与自己的研究兴趣和专业领域相关的结论。如果能够做到这一点，它就真的可以将癌症研究人员送上九天揽月了。■



Innovate to accumulate

How Schumpeter would view the economy today

A new book offers a strikingly upbeat take on modern capitalism

The Power of Creative Destruction. By Philippe Aghion, Céline Antonin and Simon Bunel. Translated by Jodie Cohen-Tanugi. Belknap Press; 400 pages; \$35 and £28.95

JOSEPH SCHUMPETER thought capitalism was doomed. Incumbent firms would grow too powerful, leading to corruption and, eventually, socialism. His mid-20th-century pessimism has become fashionable today, as societies grapple with inequality, climate change and tech giants. Yet some of Schumpeter's professional heirs are optimists. In "The Power of Creative Destruction" Philippe Aghion, Céline Antonin and Simon Bunel, three economists, apply his most powerful idea to contemporary debates in their discipline. The result is sweeping, authoritative and—for the times—strikingly upbeat.

Elementary models of growth focus on the accumulation of capital, with technological progress and advances in productivity assumed but poorly explained. The Schumpeterian paradigm of creative destruction, of which Mr Aghion is a modern champion, puts innovation at its core. In this view, ideas drive long-term growth. People are motivated to innovate by the prospect of monopoly rents (an aberration in simplistic economics). But innovation also destroys rents by displacing the previous generation of entrepreneurs.

Take development. Critics of free markets like to argue that the fast growth of Asian economies such as South Korea in the late 20th century proves the desirability of state intervention, given that these places often sheltered

firms from competition and subsidised their exports. The Schumpeterian paradigm emphasises knowledge. When countries are far from the frontier of innovation, the important thing is to learn how to imitate the best, which the government and businesses might manage arm-in-arm. But economies must later become innovative themselves. In South Korea this was achieved fortuitously. In the late 1990s the Asian financial crisis bankrupted some chaebols (industrial conglomerates) and exposed others to competition in part because of policies imposed as a condition of an IMF bail-out. The happy result was an economy that produces ideas.

The authors are not market fundamentalists. They emphasise that innovation is self-perpetuating. Advances in one area, such as internal-combustion engines, will naturally lead to more—and the state can nudge firms down the right path. To tackle climate change, they recommend subsidies for green innovation alongside taxing carbon emissions. They are unafraid of calling for industrial policy in sectors such as aerospace, where the initial costs of entry are high and demand is uncertain (meaning the private sector has an incentive to wait for someone else to innovate first). It is crucial, they urge, that governments always encourage new entrants rather than impeding them.

What about labour markets and inequality? The authors are sceptical about some contemporary doom and gloom. Automation creates more jobs than it eliminates, they reckon. Innovation yields fortunes at the very top but does not seem to boost overall inequality, as measured by the Gini coefficient—a subtle rejoinder to those who think that the success of billionaires is America's biggest problem. Creative destruction is a force for social mobility: California's elites have higher incomes than Alabama's, but its poorest have more opportunities too. Tax cuts on capital income, like Sweden's in the early 1990s, stimulate innovation and growth.

Inequality resulting from lobbying and regulatory capture, however, is

cancerous: it brings slower growth and less social mobility. The authors also call for an “insurer state” to redistribute wealth and protect workers against the vicissitudes of a dynamic economy. And they worry about the runaway success of technology giants stifling ingenuity, arguing that competition regulators should be as concerned with the incentive to produce ideas as with companies’ market shares.

Schumpeter was an outsider among the Keynesian economists of his day. His ideas were rooted in the real world of business, not the ivory tower. This book, by contrast, is in part a defence of economics (and of third-way liberalism). Its brevity relative to its ambition means that it is not always convincing; sometimes the evidence adduced is thin. But the overall argument is compelling and, with creative destruction falling out of political favour, it carries a trace of Schumpeterian subversion. ■



通过创新积累资本

熊彼特会如何看待今天的经济

一本新书对现代资本主义的看法乐观得惊人【《创造性破坏的力量》书评】

《创造性破坏的力量》。菲利普·阿吉翁、席琳·安东尼和西蒙·布内尔著。

英译者：朱迪·科恩-塔努吉。Belknap出版社；400页；35美元；28.95英镑。

约瑟夫·熊彼特（Joseph Schumpeter）认为资本主义在劫难逃。老牌公司会变得过于强大，导致腐败，最终令社会走向社会主义。今天，在社会努力应对不平等、气候变化和科技巨头之际，他在20世纪中期的那种悲观主义成为了一种风尚。不过，一些继承了熊彼特衣钵的经济学家是乐观主义者。在《创造性破坏的力量》一书中，菲利普·阿吉翁（Philippe Aghion）、席琳·安东尼（Céline Antonin）和西蒙·布内尔（Simon Bunel）将熊彼特最有力的思想应用于经济学的当代辩论中。其成果是一本全面而具权威性的著作，而且对如今这个时代来说乐观得出人意料。

基本的经济增长模型聚焦资本的积累，假定在此过程中技术会进步，生产率会提高，但对此解释不足。阿吉翁是熊彼特创造性破坏范式的当代拥护者，这一范式把创新放在核心位置，认为创意驱动了长期增长。获得垄断租金（在过分简化的经济学中被视为反常现象）的前景激励人们去创新。但创新也会通过取代上一代企业家而摧毁垄断租金。

以发展为例。自由市场的批评者喜欢主张说，20世纪末韩国等亚洲经济体的快速增长证明了国家干预的可取性，因为这些地方的政府经常保护企业免于竞争，还会补贴其出口。熊彼特范式强调的是知识。当国家远离创新前沿时，学习如何效仿最佳范例就变得很重要，而政府和企业可能会合力成就此事。但是，这之后经济体本身必须成为创新者。韩国做到了，但纯属偶然。上世纪90年代末，亚洲金融危机导致一些财阀（工业企业集团）破产，而另一些必须直面竞争——在一定程度上是因为韩国为获得国际货

币基金组织的援助，作为条件而实施了某些政策。这带来了可喜的结果：一个创意迸发的经济体。

三位作者不是市场原教旨主义者。他们强调，创新是自我延续的。一个领域的进展——如内燃机——自然会带来更多的进步——而政府也可以轻轻推动企业朝正确的方向走。在应对气候变化方面，他们建议在对碳排放征税的同时也为绿色创新提供补贴。他们直截了当呼吁在航空航天等行业实行产业政策，在这些部门，进入的初始成本高昂，需求也不确定（因此私营部门就有动机等待他人先行创新）。他们敦促政府始终都要鼓励新进者而不是阻碍它们，这一点至关重要。

那么劳动力市场和不平等问题呢？作者们对眼下的一些悲观论调持怀疑态度。他们认为自动化创造的工作岗位比它淘汰的多。正如基尼系数的衡量结果所示，创新在最高层产生了财富，但似乎并未增加整体的不平等——这对那些认为亿万富翁的成功是美国最大的问题的人来说，是个微妙的反驳。创造性破坏是一股推动社会流动性力量：加州的精英比阿拉巴马州的精英收入高，但加州最贫穷的人拥有的机会也更多。对资本收入的减税，如上世纪90年代初瑞典的做法，刺激了创新和增长。

然而，由游说和“监管劫持”造成的不平等就有如毒瘤了：它致使增长放缓，社会流动性降低。作者们还呼吁建立一个“保险国家”对财富进行再分配，保护工人免受充满活力的经济兴衰起伏的影响。他们还担心科技巨头大获成功会扼杀创造力，指出竞争监管部门应该像在意公司的市场份额那样关注催生创意的激励机制。

在同时代的凯恩斯主义经济学家，熊彼特是个局外人。他的思想植根于真实的商业世界，而不是象牙塔。但这本书在某种程度上却是对经济学（以及第三条道路的自由主义）的辩护。相对于它宏伟的立意而言，本书的简洁意味着它不是从始至终都有说服力；有时它给出的证据很薄弱。但它的总体论点令人信服，而且在创造性破坏在政治上日渐失宠的当下，它颇有些熊彼特式颠覆的意思。 ■



The Economist film

The future of shopping - trailer

Over 4 billion dollars were spent buying stuff online in 2020, almost a third more than a year ago.



经济学人视频

购物的未来 - 预告片

2020年全球线上消费超过40亿美元，比2019年增加近三分之一。



Living on the edge

How TSMC has mastered the geopolitics of chipmaking

Make yourself indispensable to both America and China

CHIPMAKERS' CRAFT can seem magical. They use light to stamp complex patterns on a dinner-plate-sized disc of crystal silicon, forming arrays of electric circuits. Once cut out of the disc, each array is called a chip. The chip's job is to shuttle electrons in a mathematical shimmer prescribed by computer code. They do the maths which runs the digital world, from Twitter and TikTok to electronics in tanks. Without them, whole industries cannot function properly, as carmakers forced to pause production because of microprocessor shortages are discovering.

The most important firm in this critical business is Taiwan Semiconductor Manufacturing Company (TSMC). It controls 84% of the market for chips with the smallest, most efficient circuits on which the products and services of the world's biggest technology brands, from Apple in America to Alibaba in China, rely. As demand for the most sophisticated chips surges thanks to the expansion of fast communication networks and cloud computing, TSMC is pouring vast additional sums of money into expanding its dominance of the cutting edge.

This has proved to be a successful business model. Last year TSMC made an operating profit of \$20bn on revenues of \$48bn. It is, in the words of Dan Hutcheson of VLSIresearch, a firm of analysts, "the Hope Diamond of the semiconductor industry"—and, with a resplendent market capitalisation of \$560bn, the world's 11th-most-valuable company. It is also an astute geopolitical actor, navigating the rising Sino-American tensions, including over the fate of its home country, which China claims as part of its territory and to which America offers military support. In 2020, 62% of TSMC's

revenue came from customers with headquarters in North America and 17% from those domiciled in China. It has managed the geopolitical divide by making itself indispensable to the technological ambitions of both superpowers.

TSMC was founded in 1987, and for the first quarter-century it made mostly unremarkable microprocessors. That began to change in 2012, with its first contract to make powerful chips for the iPhone. Apple wanted TSMC to push its manufacturing technology as far and as fast as it could, to gain an edge over rival gadget-makers. The notoriously secretive American firm liked the way Morris Chang, TSMC's founder, made trade-secret protection one of his priorities; guests to TSMC premises would have their laptops' USB ports sealed even if they only visited a conference room.

Two years later the Taiwanese firm's chips were powering the iPhone 6, the best-selling smartphone of all time. Revenue from the 220m units sold kick-started TSMC's ascent. Some of Apple's competitors also used TSMC as a supplier, and wanted the same thing. All paid handsomely for the chipmaker's efforts.

This windfall set TSMC steaming ahead. It overtook Intel, the American giant which once enjoyed a monopoly on the leading edge, then left it in the dust (see chart 1). Its remaining rival in top-flight chips, Samsung of South Korea, is barely able to keep up. Such is TSMC's manufacturing prowess that Peter Hanbury of Bain, a consultancy, reckons it has given Moore's Law, the industry's prediction-cum-benchmark of doubling processing power every two years or so, at least another 8-10 years of life.

Its lead over rivals is growing. It is pouring cash into cutting-edge chip factories (known as fabs) at an unprecedented rate. In January it said it would raise its capital expenditure to \$25bn-28bn in 2021, up from \$17bn

in 2020. In April TSMC raised the figure again, to \$30bn; 80% will go on advanced technologies. It plans to spend \$100bn over the next three years.

It has also stopped cutting prices—which in chipmaking, where processing power has only got cheaper, is tantamount to raising them. Its chief executive, C.C. Wei, has said it will skip a planned price cut in December 2021 and keep things that way for a year. IC Insights, a research firm, calculates that TSMC can charge between twice and three times as much per silicon wafer made using its most advanced processes, compared with what the next-most-advanced technology will fetch.

This creates a positive feedback loop. Developing the latest technology before anyone else allows TSMC to charge higher prices and earn more profit, which is ploughed back into the next generation of technology—and so on. The cycle is spinning ever faster. Four technological generations ago it took TSMC two years for those cutting-edge chips to make up 20% of revenues; the latest generation needed just six months to reach the same level (see chart 2). Operating income, which grew at an average rate of 8% year in the decade to 2012, has since risen by 15% on average. Combined with revenues that chip-designers make from semiconductors ultimately forged by TSMC, the company and its customers account for 39% of the global market for microprocessors, according to VLSIresearch, up from 9% in 2000 and a third more than once-dominant Intel.

This is an enviable position to be in. But it is not an unassailable one. The experience of Intel, which has fallen behind in the last two generations of chips because of technological missteps, shows that even the most masterful manufacturers can trip up. Chipmaking is also notoriously cyclical. Booms lead to overcapacity, and to busts. Demand may slacken as the rich world emerges from the pandemic, when purchases of gadgets that made it possible to work and relax at home were brought forward. That

would hit TSMC's bottom line and strain its balance-sheet. The company has \$13bn of net cash, a modest rainy-day fund for a big tech firm. To help finance its most advanced fabs, it has issued \$6.5bn-worth of bonds in the past six months.

The most serious danger to TSMC comes from the Sino-American ructions. The company's position at the cutting edge offers a buffer against geopolitical turmoil. Chip-industry insiders say that the Taiwanese government encourages all its chipmakers, including TSMC, to keep their cutting-edge production on the island as a form of protection against foreign meddling. Taiwanese contract manufacturers account for two-thirds of global chip sales.

Reflecting this, 97% of TSMC's \$57bn-worth of long-term assets reside in Taiwan (see chart 3). That includes every one of its most advanced fabs. Some 90% of its 56,800 staff, of whom half have doctorates or masters degrees, are based in Taiwan.

The firm has made soothing noises to America and China, offering to invest more in production lines based in both countries. But it is hard not to see this as diplomatic theatre. Its Chinese factory in Nanjing, opened in 2018, produces chips that are two or three generations behind the cutting edge. By the time its first American fab, designed to be more advanced than the one in Nanjing, is up and running in 2024, TSMC will be churning out even fancier circuits at home. By our estimates, based on disclosed investment plans, the net value of TSMC's fabs and associated equipment will roughly double by 2025, but 86% will still be in Taiwan.

In the past three years the American government has begun to disrupt the delicate balance. It has tightened export controls that prohibit any foreign company from using American tools to make chips for Huawei, a Chinese

technology giant. That applies to TSMC, which in 2019 sold more chips to Huawei than to any other customer bar Apple. Most of these were destined for smartphones, and other Chinese handset-makers such as Oppo happily snapped up what Huawei (which on April 28th reported its second year-on-year decline in quarterly revenues in a row) could not.

Further American attempts to prevent TSMC from doing business with China could invite meddling by the regime in Beijing, which refuses to rule out taking back Taiwan by force. President Joe Biden's administration has also announced a \$50bn government plan to revive chipmaking at home: it is doubtful whether subsidies will restore Intel's supremacy, but the initiative could involve putting more pressure on TSMC to put cutting-edge production in America, a strategic trap the firm has been keen to resist.

The rival powers have so far refrained from interfering with TSMC directly, perhaps concluding that this is the most reliable way of achieving their technological objectives. If the chipmaker's importance keeps growing, one of them may decide that it is too valuable to be left alone. ■



刀尖起舞

台积电如何应对芯片制造的地缘政治

让自己对中美都不可或缺

芯片制造商的工艺可谓神乎其技。它们在餐盘大小的晶体硅片上用光刻出复杂的图案，构成一组组电路。从硅片切割下来的每组电路就叫做芯片。芯片的任务是按计算机代码的设定传输电子进行数学运算。芯片的运算撑起了整个数字世界，从推特、TikTok，到坦克中的电子设备。缺了芯片，一个个行业整体都无法正常运作。眼下汽车制造商就领教了这一点，它们因为微处理器短缺而被迫暂停生产。

在这个至关重要的行业中，最举足轻重的是台湾积体电路制造公司（以下简称“台积电”）。该公司生产的芯片制程最小，电路最高效，市场占比高达84%。从美国的苹果到中国的阿里巴巴，全球最大科技公司的产品和服务都依赖这些芯片。随着高速通信网络和云计算的扩展，市场对最尖端芯片的需求激增，台积电正进一步投入巨资，加强自己在这一尖端领域的主导地位。

事实证明，这样的商业模式是成功的。去年，台积电取得了480亿美元的收入，营业利润达200亿美元。按分析公司VLSIresearch的丹·哈奇森

（Dan Hutcheson）的说法，台积电是“半导体行业的希望之钻”。它拥有5600亿美元的辉煌市值，排名全球第11位。同时，它也是个精明的地缘政治玩家，在中美不断升级的摩擦中游刃有余，包括在台湾问题上的摩擦

（中国对台宣誓主权，美国对台提供军事支持）。2020年，台积电62%的收入来自总部在北美的客户，17%来自注册地在中国大陆的客户。通过让自己在两个超级大国的技术雄心中占据不可或缺的地位，台积电成功跨越了地缘政治的鸿沟。

台积电创立于1987年，在头25年主要生产普通的微处理器。这在2012年开始改变，当年台积电与苹果公司签下第一份合同，为iPhone制造功能强大

的芯片。苹果希望台积电能尽快且大幅提升其制造技术，让它可以获得相比其他设备制造商对手的优势。这家以重视保密著称的美国公司看中了台积电创始人张忠谋把保护商业机密作为头等大事的作风——进入台积电工厂的访客携带的笔记本电脑的USB端口都会被密封起来，即便他们只是去一间会议室。

两年后，史上最畅销的智能手机iPhone 6搭载了台积电代工的芯片，它2.2亿台的销量带来的收入开启了这家台湾公司的腾飞之路。苹果公司的一些竞争对手也找台积电供货，对它的期望也和苹果一样。这些公司全都为它的水准支付高价。

这笔意外之财令台积电从此高歌猛进。它赶超了曾经垄断前沿阵地的美国巨头英特尔，后来更是把对方远远抛在后头（见图表1）。它在顶级芯片领域剩余的对手韩国三星也只是在勉强追赶。咨询公司贝恩的彼得·汉伯瑞（Peter Hanbury）认为，台积电的制造实力之强，让摩尔定律这一半导体行业的预测基准（认为芯片性能每两年左右提升一倍）的效力至少又延长了八至十年。

台积电的领先优势正在扩大。它正以前所未有的速度向尖端芯片工厂（通常叫fab，即晶圆厂）投入资金。今年1月，台积电表示2021年的资本支出将从2020年的170亿美元提高到250亿至280亿美元。4月，它又把数字调高至300亿美元，其中80%将用于投资先进技术。它计划未来三年总共投资1000亿美元。

它还停止了降价，在处理能力越来越便宜的芯片制造领域，这相当于提价。其首席执行官魏哲家已经表示，原计划2021年12月的降价行动取消，在一年内维持原价。据研究公司IC Insights计算，台积电使用其最先进工艺制造的硅片的售价可能是上一代工艺的二到三倍。

这就形成了一个良性循环。先于他人开发出最新技术让台积电能叫价更高，利润更丰，而这些利润又可以投入开发下一代技术，如此往复。这一

循环的速度也在不断加快。往前回溯四个技术世代，台积电那会儿要花两年时间让尖端芯片的收入占比提升至20%；最新一代技术只用了六个月就达到了这一水平（见图表2）。在截至2012年的十年里营业收入平均每年增长8%，此后平均增速达到15%。据VLSIresearch的数据，加上芯片设计公司从最终由台积电制造的半导体所获的收入，台积电及其客户占全球微处理器市场的份额已从2000年的9%升至39%，比一度称霸该市场的英特尔高三分之一。

这样的领先地位令人羡慕，但也并非不可动摇。由于技术决策上的失误，英特尔在过去两代芯片竞赛中落后，这说明即使是最优秀的制造商也会栽跟头。芯片制造也是出了名的周期性行业。市场繁荣导致产能过剩，进而转入萧条。疫情期间，人们纷纷提前购买用于居家工作和休闲娱乐的电子设备，待富裕世界走出疫情后，需求可能放缓。这将有损台积电的盈利，对其资产负债表造成压力。该公司拥有130亿美元的净现金，对于一家大型科技公司来说这笔应急资金不算多。为融资建设最尖端的晶圆厂，它在过去六个月发行了65亿美元的债券。

对台积电而言，最大的风险来自中美之间的摩擦。该公司在芯片业的地位为它应对地缘政治动荡提供了缓冲。业内知情人士表示，台湾地区政府鼓励包括台积电在内的所有本地芯片制造商把尖端制造留在岛内，作为防止外来干涉的一种保护。台湾的代工企业占到全球芯片销售的三分之二。

结果就是，台积电价值570亿美元的长期资产有97%在台湾（见图表3）。其中包括它所有最先进的晶圆厂。56,800名员工（一半拥有博士或硕士学位）约有90%常驻台湾。

台积电已向中美政府发出安抚信号，表示计划在两国的生产线上都加大投资。但很难不把这视作一种两头周旋的表演。台积电位于南京的工厂于2018年投产，生产的芯片比最先进的落后两三代。而到2024年它的第一家美国晶圆厂（比南京的工厂更先进）投产时，它将在台湾本土制造更先进的芯片。本刊根据已披露的投资计划估计，到2025年，台积电的晶圆厂和

相关设备的净值大概会翻一番，但86%仍将留在台湾岛上。

过去三年，美国政府开始打破这一微妙的平衡。它加强了出口管制，禁止任何外国公司使用美国设备为中国科技巨头华为制造芯片。该禁令适用于台积电，在2019年，华为是台积电的仅次于苹果的第二大客户。台积电给华为制造的大多是智能手机芯片，在华为（4月28日公布其季度收入连续第二次同比下降）被列为禁售对象后，Oppo等其他中国手机制造商欣然抢过华为空出的产能。

美国若试图进一步阻挠台积电与中国大陆的业务往来，可能会招致北京干预，中国政府一向不排除武力收复台湾的可能性。拜登政府还宣布了一项500亿美元的政府计划，以期重振美国本土的芯片制造业。政府补贴能否让英特尔重拾霸主地位尚有疑问，但此举可能包括对台积电进一步施压，让它把尖端生产放在美国，这一战略陷阱正是台积电一直强烈抵抗的。

到目前为止，中美两方都没直接干预台积电，也许是觉得这样做是实现自身技术目标最可靠的办法。假如这家芯片制造商的重要性继续提升，说不定其中一国就会认定它事关重大，不能再放任自由。■



Assuming the position

Joe Biden's government has not yet committed to a path on trade in technology with China

To understand which way it will jump, watch the hitherto obscure Bureau of Industry and Security

THE PROCESS of filling vacancies at the Bureau of Industry and Security (BIS) does not normally make the news. An agency of the Department of Commerce, BIS is tasked with running America's export-control regulations. These rules were originally designed to prevent the components of weapons of mass destruction from being shipped off to terrorists. The work of overseeing them was important public service, but carried out in the background, away from the public eye.

Donald Trump's presidency changed that. He and the China hawks in his administration repurposed BIS and its regulations as a weapon against China's technological ascendancy. They rewrote the rules several times between 2018 and 2020 in an escalating series of attempts to cut off Huawei, a Chinese technology giant, from global semiconductor supply chains. Huawei has reported declining revenue in its two most recent financial quarters as a result, proving that America can use export controls to disrupt Chinese technological development, at least in the short term.

This put BIS right in the middle of America's biggest foreign-policy challenge, containing China's rise. Speculation about its leadership began soon after Mr Biden took office. But the chaotic methods of Mr Trump's administration created a new political dynamic around the agency. The repurposing of regulations often left gaps between what the new rules actually said and what the Trump administration claimed they meant for China in speeches and press releases. Lawyers advised their clients to follow the rules to the letter, thereby allowing them to carry on doing business with

Chinese entities where it was still legal to do so.

The result is that many export-control experts were seen as “soft on China”. On May 4th a Republican congressman from Texas, Michael McCaul, called on the president to nominate a candidate that has “real national-security experience, deep knowledge of the CCP, and will not be conflicted by deep ties to industry”.

It is this sort of rhetoric that has driven the administration’s consideration of “outsider” candidates who do not carry the damaging expert label. The archetype is James Mulvenon, a defence analyst who became known in Washington last year for authorship of a report linking SMIC, China’s leading chipmaker, with the People’s Liberation Army. That Mr Mulvenon has even been under consideration demonstrates how far the role of BIS and the politics around it have shifted, as he is not a lawyer and has no experience administering or complying with export-control regulations. Barack Obama appointed a lawyer, George W. Bush a tech-company boss. The post was vacant for most of Mr Trump’s term; hence, in part, the chaos.

Political appointees do not determine policy, but rather implement what flows from the government, and from the National Security Council (NSC) in particular. Mr Biden’s NSC contains plenty of expertise on China and technology. Saif Khan, the council’s Director for Technology and National Security, published a paper in January which laid out a plan for curtailing Chinese semiconductor development. Its other members want to develop a tough new line, less for the industrial-competition reasons that motivated Mr Trump and his administration than because of the technology-enabled human-rights abuses that the Chinese government is perpetrating in Xinjiang and beyond. Yet the plan, at present, appears to be unfinished. People close to Mr Biden’s staff say that policy on China and technology remains undecided.

The choice of an under-secretary to run BIS, when it is made, will be a sign of whether the Biden administration has a real plan. If the president chooses someone with little to no experience with export-control law, but who has a hard line on China, that will indicate that domestic politics are dominating the administration's thinking and that it lacks the confidence to fend off critics like Mr McCaul. The appointment of someone who knows the law and can carry out the government's bidding quickly would suggest that Mr Biden does, indeed, have a plan for redrawing the lines of technological trade with China, and that he intends to use the most experienced people possible to do so. ■

For more coverage of Joe Biden's presidency, visit our dedicated hub ■



重要任命

拜登政府尚未确定与中国的技术贸易路线

要了解它会选择哪条路，可以关注一直以来人们所知不多的工业与安全局

工业与安全局（Bureau of Industry and Security，以下简称BIS）填补职位空缺的过程通常不会登上新闻版面。BIS是美国商务部的下属机构，其任务是执行美国的出口管制法规。这些法规最初是为了确保大规模杀伤性武器的零部件不会落到恐怖分子手中。监督这些法规的执行是重要的公共服务，但这项工作在幕后进行，远离公众视线。

特朗普的任期改变了这一点。他以及他政府中的对华鹰派把BIS及其监管改造成了对抗中国技术优势的武器。2018年至2020年间，他们多次修改这些法规，以不断升级的行动试图将中国科技巨头华为从全球半导体供应链中切除出去。华为最近连续两个财季报告营收随之下滑，证明至少在短期内，美国可以利用出口管制来扰乱中国的技术发展。

这就把BIS放在了遏制中国崛起这一美国最大外交政策挑战的中心。拜登 上台后不久，人们就开始猜测谁将出任BIS局长。但特朗普政府的混乱做法带来了围绕该局的一种新的政治动态。改变法规的用途后，在新法规的实际内容和特朗普政府在演讲和新闻稿中宣称它们对中国的影响之间往往存有差距。律师们建议其客户严格遵循实际规定，这样就能在仍然合法的领域里继续与中方实体开展业务。

结果是许多出口管制专家被视为“对中国手软”。5月4日，来自得克萨斯州的共和党众议员迈克尔·麦考尔（Michael McCaul）呼吁总统提名的候选人应具有“真正的国家安全经验，对中共有深刻了解，并且不会因为与产业界有密切联系而有利益冲突”。

正是这种论调促使拜登政府考虑任命“局外人”，他们不带有不利的专家标签。一个典型是国防分析师毛文杰（James Mulvenon），他去年撰写了一份报告，把中芯国际这家中国领先的芯片制造商与中国军方联系起来，

这让他开始在华盛顿出名。毛文杰既不是律师，也没有管理或遵守出口管制法规的经验，却在被考虑之列，这表明BIS的角色及其所处的政治环境已经转变。奥巴马当年任命的BIS局长是一名律师，小布什选择了一家科技公司的老板。在特朗普任内，这个职位在大部分时间里空缺，在一定程度上造成了混乱。

获政治任命的官员并不制定政策，而是执行美国政府、特别是国家安全委员会（National Security Council，下称国安会）的政策。拜登的国安会在中国和技术问题方面具有丰富的专业知识。国安会技术与国家安全主任赛义夫·汗（Saif Khan）在1月发表的文章中提出了限制中国半导体发展的计划。国安会的其他成员希望制定一条强硬的新路线，更多是因为他们认为中国政府正借助技术在新疆及其他地区侵犯人权，而不是像特朗普及其政府那样主要出于产业竞争方面的原因。不过这一计划目前似乎尚未制定完毕。与拜登下属关系密切的人士说，对华政策和技术政策仍然悬而未决。

最终选择谁来出任管理BIS的副部长，将是拜登政府是否真有切实计划的标志。如果拜登选择了某个缺少或者完全没有出口管制法律经验、但对中国态度强硬的人，那将表明国内政治在主导这届政府的思路，而且政府没有信心去抵挡麦考尔等人的批评。如果任命一个懂法律并可以迅速执行政府意图的人，就显示拜登确实有一项重新设计对华技术贸易路线的计划，并打算让最有经验的人担此重任。





The rise of e-money

The digital currencies that matter

Get ready for Fedcoin and the e-euro

TECHNOLOGICAL CHANGE is upending finance. Bitcoin has gone from being an obsession of anarchists to a \$1trn asset class that many fund managers insist belongs in any balanced portfolio. Swarms of digital day-traders have become a force on Wall Street. PayPal has 392m users, a sign that America is catching up with China's digital-payments giants. Yet the least noticed disruption on the frontier between technology and finance may end up as the most revolutionary: the creation of government digital currencies, which typically aim to let people deposit funds directly with a central bank, bypassing conventional lenders.

These "govcoins" are a new incarnation of money. They promise to make finance work better but also to shift power from individuals to the state, alter geopolitics and change how capital is allocated. They are to be treated with optimism, and humility.

A decade or so ago, amid the wreckage of Lehman Brothers, Paul Volcker, a former head of the Federal Reserve, grumbled that banking's last useful innovation was the ATM. Since the crisis, the industry has raised its game. Banks have modernised their creaking IT systems. Entrepreneurs have built an experimental world of "decentralised finance", of which bitcoin is the most famous part and which contains a riot of tokens, databases and conduits that interact to varying degrees with traditional finance. Meanwhile, financial "platform" firms now have over 3bn customers who use e-wallets and payments apps. Alongside PayPal are other specialists such as Ant Group, Grab and Mercado Pago, established firms such as Visa, and Silicon Valley wannabes such as Facebook.

Government or central-bank digital currencies are the next step but they come with a twist, because they would centralise power in the state rather than spread it through networks or give it to private monopolies. The idea behind them is simple. Instead of holding an account with a retail bank, you would do so direct with a central bank through an interface resembling apps such as Alipay or Venmo. Rather than writing cheques or paying online with a card, you could use the central bank's cheap plumbing. And your money would be guaranteed by the full faith of the state, not a fallible bank. Want to buy a pizza or help a broke sibling? No need to deal with Citigroup's call centre or pay Mastercard's fees: the Bank of England and the Fed are at your service.

This metamorphosis of central banks from the aristocrats of finance to its labourers sounds far-fetched, but it is under way. Over 50 monetary authorities, representing the bulk of global GDP, are exploring digital currencies. The Bahamas has issued digital money. China has rolled out its e-yuan pilot to over 500,000 people. The EU wants a virtual euro by 2025, Britain has launched a task-force, and America, the world's financial hegemon, is building a hypothetical e-dollar.

One motivation for governments and central banks is a fear of losing control. Today central banks harness the banking system to amplify monetary policy. If payments, deposits and loans migrate from banks into privately run digital realms, central banks will struggle to manage the economic cycle and inject funds into the system during a crisis. Unsupervised private networks could become a Wild West of fraud and privacy abuses.

The other motivation is the promise of a better financial system. Ideally money provides a reliable store of value, a stable unit of account and an efficient means of payment. Today's money gets mixed marks. Uninsured depositors can suffer if banks fail, bitcoin is not widely accepted and credit

cards are expensive. Government e-currencies would score highly, since they are state-guaranteed and use a cheap, central payments hub.

As a result, govcoins could cut the operating expenses of the global financial industry, which amount to over \$350 a year for every person on Earth. That could make finance accessible for the 1.7bn people who lack bank accounts. Government digital currencies could also expand governments' toolkits by letting them make instant payments to citizens and cut interest rates below zero. For ordinary users, the appeal of a free, safe, instant, universal means of payment is obvious.

It is this appeal, though, that creates dangers. Unconstrained, govcoins could fast become a dominant force in finance, particularly if network effects made it hard for people to opt out. They could destabilise banks, because if most people and firms stashed their cash at the central banks, lenders would have to find other sources of funding with which to back their loans.

If retail banks were sucked dry of funding, someone else would have to do the lending that fuels business creation. This raises the queasy prospect of bureaucrats influencing credit allocation. In a crisis, a digital stampede of savers to the central bank could cause bank runs.

Once ascendant, govcoins could become panopticons for the state to control citizens: think of instant e-fines for bad behaviour. They could alter geopolitics, too, by providing a conduit for cross-border payments and alternatives to the dollar, the world's reserve currency and a linchpin of American influence. The greenback's reign is based partly on America's open capital markets and property rights, which China cannot rival. But it also relies on old payments systems, invoicing conventions and inertia—making it ripe for disruption. Small countries fear that, instead of using local money, people might switch to foreign e-currencies, causing

chaos at home.

Such a vast spectrum of opportunities and dangers is daunting. It is revealing that China's autocrats, who value control above all else, are limiting the size of the e-yuan and clamping down on private platforms such as Ant. Open societies should also proceed cautiously by, say, capping digital-currency accounts.

Governments and financial firms need to prepare for a long-term shift in how money works, as momentous as the leap to metallic coins or payment cards. That means beefing up privacy laws, reforming how central banks are run and preparing retail banks for a more peripheral role. State digital currencies are the next great experiment in finance, and they promise to be a lot more consequential than the humble ATM. ■



电子货币兴起

重量级数字货币

准备迎接美联储币和电子欧元吧

技术变革正在颠覆金融业。让无政府主义者意乱情迷的比特币已经成为一个价值万亿美元的资产类别，许多基金经理坚称任何均衡的投资组合都应包含比特币。大批用数字化方式交易的短线投资者已成为冲击华尔街的力量。PayPal拥有3.92亿用户，显示美国正在赶上中国的数字支付巨头。然而，在科技和金融之间的前沿地带，最不起眼的颠覆却有可能带来最具革命性的变化：创建政府数字货币。一般来说，发行这种货币是为了让人们绕过传统的贷款机构，将资金直接存入央行。

这些“政府币”是货币的新形态。它们有望改进金融业的运作，同时还可能将权力从个人转移到政府手中，改变地缘政治，并且改变资本的配置方式。理应以乐观和谦逊的态度面对它们。

大约十年前，在雷曼兄弟破产后的一片狼藉之中，美联储前主席保罗·沃尔克（Paul Volcker）不满地指出，在ATM机之后，银行业就再没有诞生过什么有用的创新了。金融危机以来，银行业已经大大提升了自身的运作。银行对自己陈旧的IT系统进行了现代化改造。创业者们建立起了一个“去中心化金融”的试验田，其中最著名的就是比特币，同时也包含了各式各样的代币、数据库和通道，它们在不同程度上与传统金融对接互动。与此同时，金融“平台”公司已拥有超过30亿使用电子钱包和支付应用的客户。这些公司除了PayPal，还有蚂蚁集团、Grab和Mercado Pago这类专业公司、Visa这样的老牌企业，以及Facebook等来自硅谷的模仿者。

接下来就是由政府或央行发行的数字货币了。但这里发生了一种转折，因为这些货币会将权力集中在政府手里，而不是通过网络分散出去或是交给私营垄断机构。它们背后的逻辑很简单。你无需在零售银行开户，而是通过一个类似支付宝或Venmo等应用的界面直接在央行开户。你不再需要使

用支票或在网上刷卡支付，而是可以利用央行的低成本通道。你的资金将完全由国家信用担保，而不用交给一家可能并不可靠的银行。想买个披萨或者借钱给周转不灵的兄弟姐妹？不需要和花旗银行的呼叫中心打交道，也不需要支付万事达卡的手续费：英国央行和美联储随时为您效劳。

身为金融界贵族的央行成了雇工，这种转变听起来有点离奇，但确实正在发生。50多个国家和地区的货币管理机构正在探索数字货币，它们占了全球GDP的一大部分。巴哈马已经发行了数字货币。中国在50多万人当中试点了数字人民币。欧盟希望在2025年前推出虚拟欧元，英国已经启动了一个特别工作组，而全球金融霸主美国正在构建一种假想的电子美元。

促使政府和央行这么做的原因之一是担心失去控制权。目前央行利用银行体系来放大货币政策的效果。如果支付、存款和贷款从银行转移到私人运营的数字领域，央行将难以管理经济周期，也难以在危机时期向银行体系注入资金。无人监管的私营网络可能会成为欺诈泛滥和侵犯隐私的“狂野西部”。

它们的另一个动力是有望拥有更好的金融体系。在理想情况下，货币是可靠的储值工具、稳定的记账单位，也是高效的支付手段。当今的货币在这些方面的表现好坏参半。银行倒闭时，没有保险的储户可能蒙受损失，比特币尚未得到广泛接受，而信用卡又过于昂贵。政府发行的电子货币可能会有上佳表现，因为它们由政府担保，同时使用成本低廉的中央支付中心。

政府币可以由此削减全球金融业的运营费用，这项费用相当于地球上每人每年支出超过350美元。17亿没有银行账户的人也可以因此获得金融服务。政府数字货币还可以扩大政府的工具包，可以向公民即时发钱，还可以将利率降至零以下。对于一般用户来说，一种免费、安全、即时、通用的支付方式的吸引力是显而易见的。

不过，也正是这种吸引力会酝酿风险。如果不约束，政府币可能很快就会成为金融领域的主导力量；尤其是如果网络效应让人们不用它都不行，

就更是如此。银行的根基将被动摇，因为如果大多数人和公司都把现金存放在央行，银行就得为其贷款寻找新的资金来源。

如果零售银行的资金干涸，就得由其他人发放贷款来推动商业创造。这最终可能导致由官僚左右信贷分配的局面，这样的前景令人不安。发生危机时，储户在线上争相涌向央行也可能导致挤兑的局面。

一旦地位确立，政府币可能成为政府控制公民的“全景监狱”：想象一下不良行为瞬间就会招致电子罚款的情景。它们还可能改变地缘政治，比如通过提供跨境支付渠道，或美元的替代品——作为世界储备货币，美元是美国影响力的关键。美元的统治地位在一定程度上源于美国开放的资本市场和产权，这是中国无法匹敌的。但它同时也依赖老旧的支付系统、结算惯例和惰性——这让它已经构成绝佳的颠覆目标。小国也担心，国民可能放弃本币而转而使用数字外币，在国内造成混乱。

机会和危险都如此多样，令人生畏。将控制权看得重于一切的中国专制政府限制数字人民币的规模，并打压蚂蚁等私营平台，就很能说明问题。开放社会也应谨慎推进，例如对数字货币账户设置上限。

政府和金融公司需要做好准备迎接货币机制的长期转变，这种转变就如同向金属硬币或银行卡的飞跃一样意义重大。这意味着要加强隐私法律，改革央行的管理模式，让零售银行准备好退居外围。政府数字货币是金融领域的下一场伟大实验，其影响可能将远远超过不起眼的ATM机。 ■



Boom and gloom

The coming global economic boom could have a sting in the tail

Supply shortages are acute in America

THE GLOBAL economy is entering unfamiliar territory. After a decade of worries about inadequate demand and spending power in the aftermath of the global financial crisis, signs of insufficient supply are now emerging. A lack of goods, services and people means that red-hot demand is increasingly met slowly or not at all. There are already signs that supply bottlenecks may lead to nasty surprises which could upset the post-pandemic recovery. Nowhere are shortages more acute than in America, where a boom is under way. Consumer spending is growing by over 10% at an annual rate, as people put to work the \$2trn-plus of extra savings accumulated in the past year. More stimulus is still being doled out.

The boom is creating two kinds of bottleneck. The first relates to supply chains. There are shortages of everything from timber to semiconductors. The cost of shipping goods from China to America has tripled. Companies have not reported supplier delays this severe in decades. In the past year many firms have cut their investment in logistics. Lockdowns have left some container ships stranded. Companies are trying to go from 0 to 60 and it shows.

The second kind of bottleneck is in labour markets. In April America created only 266,000 jobs, many fewer than the 1m or more that had been expected. Yet job vacancies are at all-time highs, and so firms are struggling to fill positions. Economists argue over whether generous unemployment benefits are giving people a reason not to look for work. It also takes time for people to move from dying industries to growing ones.

As booming demand runs up against tight supply, inflation is in the spotlight. In April American consumer prices rose by 4.2% year on year, up from 2.6% in March. This partly reflects “base effects”: oil prices are only as high as they were in 2019, but 272% higher than in April 2020. It also reflects a genuine underlying rise in global prices. China’s factory-gate prices are rising at the fastest rate in over three years.

Central banks insist that their maximal stimulus must continue for fear of jeopardising the nascent recovery. Lael Brainard, a governor of the Federal Reserve, has said that the inflation spike as the economy reopens will be “largely transitory”. Jerome Powell, the chairman, sees little reason to worry. The Fed will tolerate somewhat above-target inflation for a bit, in part because it expects prices soon to fall back. So do many forecasters.

Yet this approach carries dangers. One is that inflation fades slowly. The supply bottlenecks of the early phase of the pandemic in 2020 cleared fast, but there is no guarantee this will happen now. Inflation expectations may also rise if people come to believe that central banks will act slowly and too late. Many companies are now discussing inflation with their investors. Bond-market traders think the Fed will be forced to act sooner than it wants. Bill Dudley, a former governor, worries that the Fed will have to raise interest rates to as high as 4.5% to cool the economy.

This points to the danger that sharp rate rises rock markets. So far the main event has been a sell-off in tech stocks, which is manageable. Banks are well capitalised. Yet the recent implosions of Archegos, a hedge fund, and Greensill Capital, a finance firm, are a reminder of the hidden leverage in a financial system that has come to depend on low interest rates. The post-pandemic boom may not always be exciting for the right reasons. ■



【首文】繁荣与灰暗

全球经济繁荣临近，结局或始料未及

供应短缺问题在美国突显

全球经济正踏入一个陌生地域。全球金融危机后的十年里，人们一直担忧需求和消费力不足，而如今，供应不足的迹象正在显现。商品、服务和人员的匮乏意味着，面对红火的需求，供应日益跟不上甚至完全满足不了。已有迹象表明供应瓶颈可能招致意想不到的糟糕局面，扰乱后疫情时代的经济复苏。美国经济渐现繁荣，短缺问题也最为严重。随着人们把过去一年额外积存的超过2万亿元美金拿出来消费，美国消费支出的年增长率目前已超过了10%。还有更多刺激福利正在陆续发放。

经济繁荣正在形成两类瓶颈。第一类与供应链有关。从木材到半导体的各种材料都出现短缺。从中国到美国的货运成本升至原来的三倍。企业在过去好几十年里都没有报告过如此严重的供应商延误。过去一年里许多公司削减了物流投资。封城措施导致一些集装箱船被困。企业试图迅速从静止状态恢复到正常运转，瓶颈就暴露了。

第二类瓶颈出现在劳动力市场。今年4月美国只创造了26.6万个职位，比预期的100万或以上要少得多。但职位空缺却处于历史最高水平，企业难以招募到人手。经济学家争论慷慨的失业救济是否是人们不找工作的原因之一。此外人们从濒死产业转移到成长产业也需要时间。

需求猛增遇上供给吃紧，通货膨胀随之显现。4月，美国消费价格同比增长4.2%，高于3月的2.6%。这在一定程度上是“基数效应”的体现：油价跟2019年的水平差不多，却是2020年4月的272%。但这也反映了全球价格真实存在的根本性上涨。中国产品的出厂价正以三年多来最快的速度上涨。

各国央行坚称必须继续保持最强力的刺激措施，以免刚起步的复苏受到影响。美联储理事莱尔·布雷纳德（Lael Brainard）表示，随经济重启出现的

通胀飙升将是“大体上暂时性的”。美联储主席鲍威尔认为没什么理由需要担心。美联储将容忍通胀多少高出目标一阵子，部分原因是它预计价格会很快回落。许多预测机构也这么认为。

但这种做法存在风险。一是通胀消退缓慢。在2020年疫情早期阶段出现的供应瓶颈得以迅速清除，但并不能保证当前的短缺也能快速缓解。如果人们开始相信央行会缓慢、过迟地做出反应，通胀预期也可能上升。许多公司正在与投资者讨论通胀问题。债券市场交易员认为美联储会被迫改变初衷，更早采取行动。前纽约联储主席比尔·杜德利（Bill Dudley）担心，美联储将不得不把利率提高到4.5%来给经济降温。

这又带出了利率急升可能冲击市场的风险。目前为止主要表现为一波科技股抛售潮，程度尚可控。银行资本充足。但是，最近对冲基金Archegos和金融公司Greensill Capital倒闭提醒人们，金融体系已变得依赖低利率，里头存在隐形杠杆。后疫情时代的繁荣让人兴奋，但可能不总是出于对的原因。 ■



Swapping notes

Will going digital transform the yuan's status at home and abroad?

Don't count on it: the new yuan will be a lot like the old yuan

WITH A FEW taps on her phone, Lu Qingqing, a 24-year-old office worker, leapt into the monetary future. She was one of 50,000 people in Shenzhen selected late last year for a trial of China's digital currency, called eCNY. She downloaded an app, received 200 yuan (\$30) from the government and went shopping for books. The app's display showed a traditional banknote. "It felt like real money," she says.

Legally, it is as real as hard cash. All the money in an eCNY app, offered by one of six commercial banks, is backed by an equivalent deposit at the People's Bank of China. Just as the central bank stands behind any paper yuan, so does it guarantee eCNY. If, say, the commercial bank that made Ms Lu's digital wallet went bust, her eCNY—linked to her personal-identity number—would be transferred to a new wallet.

Central banks worldwide are considering issuing digital versions of notes and coins. Although China will not be the first (that honour goes to the Bahamas), it is the most important launching ground. It is the world's leader in mobile payments (see chart 1). More than half a million people have already received eCNY in trials since last year. China's central bank is studying how to spread it abroad. Niall Ferguson, a historian, has called on America to wake up to the peril of letting China "mint the money of the future".

China's digital currency was first conceived as a way to curb the big mobile-money providers. Now three bold claims are being made about it: that it will dramatically enhance China's surveillance capabilities; that it will allow the

state to wield far more control over money; and that it will challenge the dollar for prominence.

Within China, however, many economists are far less bullish. The design of the eCNY, and the nature of China's economic system, mean that each of these claims is unlikely to be realised soon. "The digital yuan is not magic, so we don't expect magic from it," says Gary Liu of the China Financial Reform Institute in Shanghai.

Start with the first claim, that digitisation offers unmatched surveillance abilities, letting the state track all spending. It is not entirely wrong. But it is a limited gain compared with its existing powers.

Most mobile payments today involve a bank card, tethered to users' accounts on Alipay or WeChat. These must pass through NetsUnion, a central clearing platform. Similarly, foreign-exchange transactions take place on the China Foreign Exchange Trade System. In both cases regulators can see how people spend in real time. For mobile payments that do not touch banks, officials can demand a record and, says an industry insider, may soon require real-time reporting, too.

The upshot is that, even without eCNY, regulators have no real blind spots left, apart from old-fashioned cash. And so long as millions of older citizens do not much like paying for things with smartphones, the government will not phase out cash.

The second bold claim about eCNY is that it will reshape monetary policy in China. According to this view, the central bank will be able to program money to be used for specific purposes and at predefined times. This, however, both understates what the central bank can already do and overstates what the eCNY will let it do.

China already manages both the money supply and interest rates with

different sectors in mind. Since 2015, for instance, it has created hundreds of billions of yuan for the construction of affordable housing. More recently it has instructed banks to lower interest rates for small firms.

The eCNY, one might assume, will make targeting more precise. But its design will circumscribe its role. The central bank will replace only a small portion of base money, known as M₀, with eCNY, leaving the rest of the money supply undisturbed (see chart 2). It will distribute eCNY through commercial banks, which in turn will make it available to the public. It will not pay interest on eCNY. And it will probably place low ceilings on how much people can hold.

Granted, the central bank may in time expand the eCNY's role. But the limitations exist for a reason. The government is wary of undermining the financial system. It does not want savers to switch out of bank deposits en masse into eCNY, which would make it harder for banks to fund themselves. Moreover, few serious economists in Beijing like the idea of a 100% eCNY money supply, in which the government could directly control how banks lend. "We don't want to go back to central planning. That would be a mistake," says Yu Yongding, a former adviser to the central bank.

The final bold claim is that eCNY will catapult the yuan to global status. But that misunderstands why it accounts for just 2% of international payments today, about the same as the Canadian dollar. When deciding which currencies to use, companies and investors consider how easily they can make conversions to other currencies; how freely they can invest them; and whether they trust the issuing countries' legal systems. China's insistence on maintaining far tighter capital controls than any other major economy, as well as deep-seated doubts about its political system, blunt the yuan's appeal. The limiting factors are policy and politics, not technology.

Even the technological case for eCNY is far from clear-cut. When companies transfer money in and out of China, they already use currency in a digital format: electronic messages on the SWIFT payments network instruct banks to credit accounts in one country and debit them in another. What slows things down is complying with China's capital controls and with international regulations such as those aimed at stopping money-laundering.

The eCNY will not eliminate such checks, and the Belgium-headquartered SWIFT system, which connects more than 11,000 financial institutions, is likely to remain the most efficient conduit for sharing payment information across borders. "Even in the long term, SWIFT will remain indispensable," says Liu Dongmin of the Chinese Academy of Social Sciences.

The three more radical claims about it may not be realised, but will the eCNY fulfil the original aim, of giving the central bank a foothold in the digital-payments universe? Probably, but not a giant one. After the eCNY trial in Shenzhen, Ms Lu said that she would use it for some payments, but that Alipay and WeChat were far more convenient because of how they tie into commercial and social-messaging networks. Mr Liu of the China Financial Reform Institute expects others to concur. He predicts that in three years the eCNY will account for less than 5% of mobile payments.

Western governments and central bankers mulling digital currencies of their own may wonder if the outcome of the eCNY experiment will contain any lessons for them. But China is unusual in so many ways—from its sheltered financial system and intricate capital controls to the size of its mobile payments—that its experience could well prove to be unique. And other countries are sure to implement different designs for their digital currencies. Still, China's caution with the eCNY, if nothing else, hints at how disruptive the technology, if unconstrained, could be. ■



换掉纸币

数字化会改变人民币在国内外的地位吗？

别抱太大期望：数字人民币会和传统人民币很类似

点几下手机，24岁的上班族陆青青（音译）便迈入了未来货币时代。去年年底，中国的数字货币也就是数字人民币在深圳试点，陆女士是五万名入选的参与者之一。她下载了一个应用，收到了政府发的200元钱，然后去买书。显示在这款应用上的是一张传统的钞票。“感觉就像真钱一样。”她说。

从法律上说，它和纸钞一样真实。在由六家商业银行的任一提供的数字人民币应用中，所有资金都由它们在中国人民银行的等值存款作为担保。正如人为所有纸质人民币提供支持一样，它也为数字人民币提供担保。比如，如果创建了陆女士的数字钱包的商业银行破产了，与她的身份证号码相关联的数字货币就会被转移到新的钱包中。

世界各国的央行都在考虑发行数字版的纸币和硬币。虽然中国不会是第一个发行数字货币的国家（这份荣耀归于巴哈马），但它却是最重要的发行地。它是全球移动支付的领头羊（见图表1）。自去年以来已有超过50万人试用了数字人民币。人行正在研究如何将它推广到海外。历史学家尼尔·弗格森（Niall Ferguson）已呼吁美国认识到让中国“铸造未来货币”的危险。

中国发行数字货币的初衷是为了遏制大型移动支付供应商。现在，关于这种货币有了三个大胆的说法：它将极大提高中国的监控能力；它能让政府大大增强对货币的控制权；它还将挑战美元的显赫地位。

然而，中国国内的许多经济学家远没有那么乐观。数字人民币的设计以及中国经济体制的性质意味着这三种说法都不太可能很快成为现实。“数字人民币不是魔法，所以我们不指望它有什么奇效。”上海国是金融改革研

究院的刘胜军表示。

先来看第一个说法——数字货币提供了无与伦比的监控能力，让政府可以追踪每一笔开支。这种说法也不全错。但相比政府原本已有的监控能力，数字货币带来的提升有限。

如今，大部分移动支付都要用到与用户的支付宝或微信账号绑定的银行卡。这些支付必须通过网联清算这个中央清算平台。同样，外汇交易也要通过中国外汇交易系统。在这两种情况下，监管机构都可以实时监测人们的开支情况。对于不涉及银行的移动支付，官员们可以要求它们提供记录，而且据一位业内人士说，可能很快也会要求提供实时报告。

结果就是，即使没有数字人民币，除了传统的现金外，监管机构也没有真正的盲点了。而只要还有大批老年人不太喜欢用智能手机付款，政府就不会废除现金。

第二个关于数字人民币的大胆说法是它将重塑中国的货币政策。按照这种看法，人行将能够控制资金的使用，让它在指定时间用于指定用途。然而，这既低估了人行既有的能力，也高估了数字人民币将赋予该行的能力。

中国在管理货币供应和利率时已经考虑到了不同部门。例如，自2015年以来，中国为经济适用房建设提供了数千亿元的资金。最近，它向各银行下达了为小企业降息的指示。

有人可能认为数字人民币能更精准地定位。但它的设计会限制它的作用。人行只会用数字人民币替代一小部分基础货币也就是M0（流通中现金），其余的货币供应不受影响（见图表2）。它将通过商业银行分发数字人民币，从而让公众用上数字人民币。它不会为数字人民币支付利息。而且它规定的持有上限可能会比较低。

诚然，人行在日后可能会扩大数字人民币的角色。但目前设置这些限制是

有原因的。政府很小心地不要破坏金融体系。它不希望储户全部弃用银行存款而转向数字人民币，这会增加银行的融资难度。此外，政府中鲜有严肃的经济学家赞同百分之百供应数字人民币的想法，即使这样政府就可以直接控制银行的放贷。“我们不想回到中央计划。那会是个错误。”前央行顾问余永定表示。

最后一个大胆的说法是数字人民币将让人民币一跃成为全球货币。但这误解了为什么如今人民币只占国际支付总额的2%，与加元差不多。公司和投资者在决定使用哪种货币时，会考虑货币兑换的难易程度、投资该货币的自由度，以及他们对发行国的法律体系的信任度。中国坚持维持比其他主要经济体都严格得多的资本管制，加上人们对其政治体制根深蒂固的怀疑，都削弱了人民币的吸引力。制约人民币的因素是政策和政治，而不是技术。

就算是数字人民币的技术优势也远未明确。当公司把资金转入或转出中国时，它们已经在使用数字形式的货币了：银行根据SWIFT支付网络上的电子信息，在一个国家记入贷方账户，同时在另一个国家记入借方账户。转账流程慢是因为要遵守中国的资本管制以及防洗钱之类的国际法则。

数字人民币不会省掉这类核查，而且总部位于比利时的SWIFT系统连接了超过1.1万家金融机构，可能仍然是最高效的跨境支付信息共享的渠道。“即使从长期看，SWIFT仍将不可或缺。”中国社会科学院的刘东民表示。

关于数字人民币的这三个较为激进的说法可能不会变成现实，但数字人民币能否实现它最初的目标，让人行在数字支付领域占得一席之地？很可能，但占比不会太大。深圳数字人民币的试点结束后，陆女士说她会用数字人民币支付一些费用，但使用支付宝和微信要方便得多，因为它们与商业和社交通讯网络紧密相连。国是金融改革研究院的刘胜军认为其他人也是这样想的。他预计，三年内数字人民币占移动支付的比例将低于5%。

正在酝酿自己的数字货币的西方政府和央行官员可能会想知道，数字人民币试点的结果是否有任何可借鉴之处。但中国在太多方面都与众不同——

从它受保护的金融体系、错综复杂的资本管制，到它移动支付的规模——所以它的经验很可能也是独一无二的。其他国家肯定会为自己设计不同的数字货币。不过，中国对数字人民币的谨慎做法至少暗示了，如果不受限制，这项技术的颠覆力可能会非常之大。 ■



The Economist film

The future of shopping

Shopping is going through a radical shift now and the pandemic has sped it up. Retailers have been forced to adapt and innovate. Leading the way in this revolution is China.



经济学人视频

购物的未来

购物正在经历一场彻底的转变，而疫情加速了这一过程。零售商被迫适应和创新，引领这场零售革命的是中国。



Monetary sovereignty

Will the dollar stay dominant?

Digital money may pose a new threat to dollar hegemony

A MILE FROM the White House stands the Capital One Arena, a 20,000-seat stadium for basketball and ice-hockey games. The arena is in the Chinatown district of Washington, surrounded by Chinese restaurants and the “Friendship Archway”, built to celebrate the American and Chinese capitals becoming sister cities in 1984. One afternoon in March, this correspondent arrived at the arena and went to buy a Diet Coke from the Walgreens opposite. Once at the till she tapped on the azure blue Alipay app: up popped a QR code, scanned by the checkout worker to collect payment. The transaction took a second.

Had it been possible to enter the stadium it would have been just as easy to use Alipay, the payment platform started by Alibaba, to buy tickets or snacks. Nor is the Walgreens in Chinatown unique in accepting the app. Around 7,000 of them across America take it, as do shopping centres like Pier 39, in San Francisco, and several Chinese restaurants in New York and Boston.

These merchants want to make shopping easier for Chinese tourists, not to persuade Americans to use Alipay. The payment app is not easy for English-speakers (even in “English” mode most of the interface is in Chinese characters, so non-natives need screenshots reliant on Google translate). But its growing acceptance outside China, where Alipay and its rival WeChat Pay process 90% of mobile transactions, augurs a shift in financial power.

The dollar is pervasive because everyone uses it as their “unit of account”. Oil is invoiced in dollars. Most global trade is paid for in dollars. Most cross-

border financial contracts are in dollars. Global travellers keep \$100 bills in their socks. Financial markets and trade have grown faster than the global economy for decades, making the dollar ever more dominant. This gives America a clout it exploits through its use of sanctions, as well as unrivalled insight into global finance.

It is hard to see all this giving way to the yuan. But the way a transition could start, says Jean-Pierre Landau, formerly at the Banque de France, is with tourists. “If you have hundreds of millions of tourists moving around South-East Asia, asking to use their Alipay and attracting more attention to the app then, perhaps, progressively, they might want to denominate transactions in yuan.” First knick-knacks and museum tickets are sold in yuan. Then businesses start invoicing trade in the Chinese currency. Eventually they write financial contracts in it.

Digital money could thus threaten dollar hegemony. But the motive of many places, including China, for issuing their own digital currencies are mainly defensive. China is resisting the disappearance of public money as cash falls out of use. It is also fighting the concentration of power in the hands of data-savvy tech firms. Perhaps digital money will be used to promote a currency, says Mr Landau, but it can also be a defence against competition from a digital dollar.

A first reason to create a digital currency is “to protect or safeguard our monetary sovereignty,” said Mu Changchun, the Chinese central bank’s digital-currency boss, in March. He thinks most central banks are keen because they fear a digital dollar. “Digital currency supplied by one central bank should not impede another central bank’s ability to carry out its mandate for monetary and financial stability,” he said.

Indeed, if internationalisation were their goal, it is difficult to see how China’s tighter restrictions on Tencent and Ant would help to reach it. Since

2018 they have had to clear all mobile payments through a central clearing party, in effect overseen by regulators. The government has also demanded that they hand over data on their customers' transactions and borrowing. "You have to think twice before allowing a payments network with its headquarters in China, where privacy laws are different," comments Mr Landau.

"There are two possible rationales for the government to intervene in this way," says Markus Brunnermeier of Princeton. "The first is that big tech firms should not monopolise the data, and one way to do that is to have them give it to the government...the second is surveillance by the government." Another is to maintain capital controls. A third of economists polled by Mr Brunnermeier think capital controls are an insuperable obstacle to internationalisation of the yuan. Yet it is clear that the Chinese authorities are desperate to keep them, even at the expense of the currency's international role.

A bigger risk is what happens when other currencies go digital. Had Diem, the idea proposed by Facebook, been operating when Turkey's president sacked the head of its central bank in March, it would have been easy for millions of Turks to move their money into dollars or euros. It might also have been possible for businesses to start showing QR codes to accept dollars.

"It feels very significant that the countries which, apart from China, are most advanced, most active and most interested in CBDCs are the medium-sized emerging economies," says Mr Landau. "They are too big to accept the loss of monetary autonomy, and sufficiently small to be exposed to the risk of foreign-currency competition." They may feel they have no choice. ■



货币主权

美元会保持主导地位吗？

数字货币可能对美元霸权构成新的威胁

在距白宫一英里远的地方矗立着第一资本体育馆（Capital One Arena）。这个可容纳两万名观众的篮球和冰球赛事场馆位于华盛顿的唐人街区，周围中餐馆林立，还有为庆祝1984年中美两国首都缔结友好城市而建的“友谊牌楼”。3月的一个下午，笔者来到体育馆门口，在对面的沃尔格林（Walgreens）药房买了瓶健怡可乐，买单时点开蓝色的支付宝应用，弹出一个二维码，收银员扫码收款。一秒钟就完成了交易。

要是那天可以进入体育馆的话，同样可以用阿里巴巴创建的这个支付平台轻松购买门票或小吃。唐人街的这家沃尔格林也不是唯一接受支付宝付款的门店。全美大约有7000家沃尔格林可以使用支付宝，旧金山的39号码头（Pier 39）等购物中心以及纽约和波士顿的几家中餐馆也可以。

这些商家用支付宝是希望方便中国游客购物，而不是想说服美国人使用支付宝。对讲英语的人来说，支付宝并不简单好用（即使是在它的“英语”界面上，大部分内容也还是中文，因此不懂中文的人需要依赖谷歌翻译的拍照翻译功能）。但支付宝在中国以外的地区接受度日益增长（在中国国内，它和竞争对手微信支付处理了九成移动支付），预示着金融实力将发生转移。

美元之所以大行其道，是因为所有人都把它用作自己的“记账单位”。石油以美元计价。大多数全球贸易都以美元支付。大多数跨境金融合约也以美元结算。在世界各地行走的旅行者总会在袜子里塞点百元美钞。几十年来，金融市场和贸易的增长一直快过全球经济，让美元的主导地位愈发突显。这给美国带来了影响力——可以通过实施制裁来施展，也令它拥有了对全球金融无与伦比的洞察力。

很难想象所有这些都会让位给人民币。但游客有可能推动这种转变发生，曾在法国央行任职的让-皮埃尔·兰道（Jean-Pierre Landau）表示。“如果有上亿游客在东南亚各地旅行，要求使用支付宝，这个应用就会得到更多关注，也许一来二去，他们可能就会想用人民币计价交易。”先是小物品和博物馆门票以人民币出售。然后企业开始用人民币开出贸易账单。最终，金融合约也会用人民币计价。

如此，数字货币就可能威胁到美元霸权。但包括中国在内的许多国家发行自己的数字货币主要是出于防御。随着现金用得越来越少，中国正在阻止国家货币的消失。它也在极力防止支配力集中到精通数据的科技公司手中。数字货币也许将被用来提升一种货币的地位，兰道说，但也可以用来抵御数字美元的竞争。

创建数字货币的第一个原因是为了“保护或捍卫我们的货币主权”，中国人民银行负责数字货币研发的穆长春在3月表示。他认为大多数央行对数字货币都很积极，因为它们对数字美元心存忧虑。“一家央行提供的数字货币不应妨碍其他央行履行其货币和金融稳定职责的能力。”他说。

事实上，如果中国是以国际化为目标，很难看出加强对腾讯和蚂蚁集团的限制对实现这一目标有何帮助。自2018年起，这两家公司必须通过一个中央清算方来清算所有移动支付，实际上就是将它们置于监管机构的监督之下。政府还要求它们交出客户的交易和借款数据。“在开通使用一个总部在中国的支付网络之前，你得三思，那里的隐私法规可是不一样的。”兰道评论说。

“政府以这种方式做出干预，可能有两种依据，”普林斯顿大学的马库斯·布鲁纳迈尔（Markus Brunnermeier）说，“首先是大型科技公司不应该垄断数据，要避免这一点，一种方法就是要它们把数据交给政府……第二种方法是政府监控。”另一个是维持资本管制。布鲁纳迈尔访问的经济学家中，有三分之一认为资本管制是人民币国际化一个不可逾越的障碍。然而，中国政府显然还是竭力要保持这些管制，即使这会影响人民币的国际地位。

一个更大的风险是其他货币数字化后会发生什么。如果今年3月土耳其总统解雇其央行行长时，Facebook提出的Diem已经在运行，那么千百万土耳其人就能很容易地把资金转为美元或欧元。企业也可能可以开始提供二维码接受美元。

“除中国外，在央行数字货币上走得最远、表现最活跃、兴趣最浓的国家是中型新兴经济体，这一点让人感觉意义重大，”兰道说，“它们不是小国家，接受不了丧失货币自主权，同时又不够大，要承受外国货币竞争的风险。”它们可能觉得自己别无选择。 ■



Elon Musk's other company

SpaceX, a Tesla for the skies

Having revolutionised the rocket business, SpaceX takes aim at telecoms

WHAT GOES up must come down. That was certainly true of bitcoin, a cryptocurrency enthusiastically endorsed by Elon Musk which surged in value in February after Tesla added \$1.5bn-worth to its balance sheet. It plunged on May 12th after the carmaker stopped customers using bitcoin to buy its vehicles. Mr Musk worries about the use of fossil fuels to “mine” the cryptocurrency. More gracefully, on May 5th a prototype version of SpaceX’s massive “Starship” rocket—designed to be the biggest since the Saturn V that took the Apollo astronauts to the moon—rose 10km above Boca Chica in Texas, before flying itself back to its launchpad and landing gently on the ground. It was not Starship’s first high-altitude test flight. But it was the first that had ended without a fireball.

It was the latest piece of good news for SpaceX, a rocketry firm founded in 2002 by Mr Musk, who is perhaps better known as the founder of Tesla, an electric-car pioneer. Like Tesla, SpaceX has taken an unloved technology and made drastic improvements, shaking up a complacent industry. While Tesla’s mission—“accelerate the world’s transition to sustainable energy”—is grand, SpaceX’s is even grander. Mr Musk wants to use its cheap rockets to make humanity a “multi-planetary space-faring civilisation” by establishing a colony on Mars. And like Tesla, SpaceX’s valuation has soared. According to PitchBook, a data-analysis firm, SpaceX’s latest funding round, completed in April, valued it at \$74bn, up from \$46bn in August 2020. CB Insights, a firm of analysts, ranks SpaceX the third-most-valuable startup in the world (see chart).

It may seem odd to describe a 19-year-old firm as a “startup”. But most of

SpaceX's swelling valuation comes not from the business it already does but, again like Tesla, its investors' hopes for its future. To pay for its Martian ambitions, SpaceX plans to transform itself into a globe-straddling telecoms giant. It hopes to repeat Mr Musk's signature trick of making big improvements to existing technologies. Its Starlink service, currently open to testers in countries including America, Britain and Germany, is building the biggest satellite network ever, in order to beam fast internet access to every corner of the planet.

SpaceX's advances in rocketry provide the launchpad. Its craft are unusual in that they are reusable, rather than disposable. After launch, the first stage of its Falcon 9 can fly itself back to Earth; and after a refurbishment lasting a few weeks, it can fly again. Along with a focus on cost-cutting and a willingness to experiment and take risks, that has allowed SpaceX to undercut its competitors drastically.

As with Tesla, complacent incumbents have been trying to respond. United Launch Alliance, a joint venture between Boeing and Lockheed Martin, two aerospace giants, has cut jobs and trimmed costs. In November Tory Bruno, its boss, said prices for its Atlas V rocket were down from \$225m per launch to just over \$100m. Arianespace, a European firm, has also cut prices for its Ariane 5, which is thought to cost around €175m (\$213m) per flight. It hopes the Ariane 6, due to make its first flight next year, will be 40% cheaper than its predecessor. SpaceX charges \$62m for a fresh rocket, or \$50m for a used one.

Low prices, a focus on cost control, and a willingness to take risks and iterate rapidly (another signature Musk trait) have helped SpaceX win contracts with everyone from Iridium and Intelsat, established satellite firms, to startups such as Planet and governments, including those of America, Germany and South Korea. On April 16th NASA awarded SpaceX

\$2.9bn to develop a lunar lander as part of America's plan to return astronauts to the Moon by 2024 (though the contract was suspended on April 30th, while a government agency reviews rival firms' complaints). On September 15th it plans to fly four tourists on a three-day orbital jolly. Morgan Stanley, a bank, describes SpaceX as "mission control" for the fast-growing "emerging space" sector—which, estimates Seraphim Capital, a venture-capital company, attracted \$8.7bn of venture investment in the year to March, up by 95% from the year before.

And it is not standing still. Starship has a carrying capacity more than six times that of the Falcon 9. Despite its vast size, it is fully reusable, and is intended to be far cheaper than SpaceX's current rockets. Mr Musk hopes Starship could end up costing less than \$2m per launch.

However nifty SpaceX's technology gets, the launch market, at around \$6bn in 2019, is relatively small, says Simon Potter of BryceTech, a firm of analysts and engineers. Many players are shielded from full competition by governments worried about national security. That will limit SpaceX's market share. Instead, says Adam Jonas, an analyst at Morgan Stanley, SpaceX sees launch as an "enabling technology" for its other plans. The firm's next target is the telecoms business. Starlink aims to provide internet access worldwide, including places where other forms of connectivity are poor or non-existent.

This is a much bigger market, at least on paper. The International Telecommunication Union, a UN agency, reckons 48% of the world's population was offline in 2019. Gwynne Shotwell, SpaceX's chief operating officer, said in 2019 that the worldwide internet-access market was worth perhaps \$1trn a year. SpaceX, Mr Musk has said, might aim to capture around 3% of that. Even that sliver would have brought in \$30bn two years ago.

Satellite internet is not a new idea. But it is another technology that Mr Musk thinks he can improve. Existing internet satellites fly at high altitude, to maximise coverage. The drawback is that many customers must share a single satellite, limiting capacity. And the time taken for radio signals to travel to high-flying satellites adds unavoidable, and irritating, delays. At the moment satellite internet is usually a last-resort option when nothing better is available—in remote rural areas or on ships at sea, for instance.

Starlink hopes to fix those problems by using its cheap rockets to put thousands of small, cheap satellites in low orbits. In the first quarter of 2021, SpaceX launched more objects, measured by mass, into orbit than every other rocket operator combined, says Mr Potter. Starlink's 1,500-odd existing satellites already account for around a quarter of all those in orbit. SpaceX has firm plans for over 10,000 more, and has filed paperwork for up to 42,000—more than four times as many satellites as have been launched since the start of the space age.

The prototype service is undergoing testing by thousands of people. Most seem pleased, reporting fast and responsive connections. But the satellite-internet business has a poor record. Iridium went bankrupt in 1999, the year after its launch (it was eventually bailed out by the American government). Intelsat and Speedcast, two established companies, filed for bankruptcy last year, as did OneWeb, a startup with a similar business model to Starlink's. Intelsat is currently restructuring and Speedcast is doing business again under new owners. But the fragility of the business makes assigning a future value to SpaceX tricky. Morgan Stanley's attempt spans two orders of magnitude, from \$5bn to \$200bn, with different assumptions about the viability of Starlink accounting for almost all the difference.

Even with low launch costs, at least two big challenges remain, says Rasmus Flytkjaer of London Economics, a consultancy. One is that most of Starlink's potential customers are people ill-served by terrestrial internet firms. They

tend to live in relatively poor rural areas. Starlink's price of \$99 per month is not cheap even for rich-country users. The other is the cost of the high-tech satellite dishes needed to make the system work: 23-inch antennas that attach to roofs or walls. Since Starlink's satellites are in low orbits, they zip quickly across the sky. The aerials must be able to track satellites as they move, and switch seamlessly from one to the next as they disappear below the horizon.

Ms Shotwell said in April that the dishes, which SpaceX sells for \$499, cost around \$1,500 to produce, down from about \$3,000 two years ago. SpaceX hopes that economies of scale will eventually drive manufacturing costs down to "a few hundred dollars". Part of Iridium's problem, says Mr Flytkjaer, was meeting the capital cost of building up its network before it could attract paying customers. Mr Musk's deep pockets, he says, should mean SpaceX is less likely to run out of cash than its predecessor two decades ago.

Such challenges may explain Mr Musk's uncharacteristic lack of bombast when talking about Starlink. Tesla sells cars with features like "Ludicrous Mode" and "Bioweapon Defence Mode". Starlink, by contrast, calls its public-test programme the "Better Than Nothing Beta Test". At a space conference last year Mr Musk said Starlink's goal, for now, was simply not to go bankrupt. He has repeatedly tried to assure existing telecoms firms that Starlink is not a threat, pointing out that the service is ill-suited to serving large numbers of customers in densely populated cities.

Starlink's test programme is currently available in only a handful of rich countries. Yet the firm said on May 5th that it had collected half a million pre-orders. It has requested regulatory permission for up to 5m users in America alone. In December SpaceX won \$886m from America's government to provide broadband in rural areas; it is said to be in similar talks in Britain. Not all governments will be as accommodating, since the

internet access offered by Starlink could prove tricky for the authorities to censor.

In poorer countries, says Mr Flytkjaer, Starlink's satellites could connect rural mobile-phone masts to the internet, spreading the cost among many users. SpaceX is running tests with America's armed forces, which like the idea of having internet connectivity on any battlefield. In 2019 the firm showed its ability to provide high-speed, in-flight internet to a military jet.

Mr Musk is not the only billionaire who thinks satellite internet is an idea whose time has come, despite its unpromising history. After its bankruptcy OneWeb was rescued by the British government and Bharti Enterprises, an Indian conglomerate whose founder, Sunil Mittal, is one of India's wealthiest men. Jeff Bezos, Amazon's founder, is every bit as rich as Mr Musk—and just as much of a space cadet, bankrolling Blue Origin, his own private rocket firm. Amazon itself is planning a low-flying satellite-internet similar to Starlink, called Kuiper. The car industry increasingly dances to Mr Musk's tune. The space industry is going the same way. ■



马斯克的另一家公司

SpaceX——飞上天的特斯拉

在彻底改变了火箭发射业务后，SpaceX又瞄上了电信业【深度】

有起必有落。比特币无疑是这样。今年2月，特斯拉在其资产负债表上增加了15亿美元的比特币，这种受马斯克热捧的加密货币价值随之飙升。5月12日，特斯拉不再接受客户用比特币购车，比特币价格应声暴跌。马斯克对使用化石燃料“开采”比特币感到担忧。相比比特币，SpaceX公司的巨型“星舰”（Starship）火箭原型机最近的一次升降更优雅些。“星舰”意在成为自土星5号（Saturn V）将阿波罗计划的宇航员送上月球以来最大的火箭。5月5日，这艘原型机在得克萨斯州的博卡奇卡（Boca Chica）升空，飞到10公里的高度后，又自己飞回发射台，徐徐着陆。这不是星舰首次高空试飞，却是首次不以爆炸告终的试飞。

这是SpaceX最新的一则好消息。2002年，马斯克创立了这家火箭公司，而他更广为人知的身份或许还是电动汽车先驱特斯拉的创始人。和特斯拉一样，SpaceX选择对一种失宠的技术下手，对之做出激进的改进，撼动了一个安于现状的行业。尽管特斯拉“加速世界向可持续能源的转变”的使命已经很宏大了，但SpaceX的目标更是有过之而无不及。马斯克希望利用它的低成本火箭在火星上建立殖民地，让人类成为“跨行星的星际文明”。此外，与特斯拉一样，SpaceX的估值也在飙升。数据分析公司PitchBook称，SpaceX4月完成了最新一轮融资，估值从2020年8月的460亿美元升至740亿美元。分析公司CB Insights把SpaceX列为世界第三大最有价值的创业公司（见图表）。

把一家有着19年历史的公司说成“创业公司”似乎有些奇怪。但SpaceX不断上涨的估值中，大部分并非来自它已有的业务，而是投资者对它未来的希望。这一点又与特斯拉一样。为了给它雄心勃勃的火星计划买单，SpaceX计划把自己转型成一家覆盖全球的电信巨头。它希望再现马斯克对现有技术做出重大改进的标志性手法。它的“星链”服务项目正在建设有史以来最

大的卫星网络，以向地球的每个角落提供高速互联网接入。目前该项目已对美、英、德等国的测试者开放。

SpaceX在火箭技术上的进步为此奠定了基础。它的火箭非同寻常，因为可以重复使用，而不是一次性的。发射后，猎鹰9号的第一级火箭可以自行飞回地球；经过为期几周的翻新后，又能重新执飞。加上注重削减成本、勇于实验和冒险，SpaceX的发射价格远远低于竞争对手。

就和面对特斯拉一样，那些固步自封的同行老企业也在设法应对SpaceX带来的冲击。由波音和洛克希德·马丁这两家航空航天巨头合资的联合发射联盟（United Launch Alliance）已经削减了职位和成本。去年11月，它的老板托里·布鲁诺（Tory Bruno）表示，宇宙神-5（Atlas V）火箭的单次发射价格已从2.25亿美元降到1亿美元出头。欧洲的阿丽亚娜航天公司（Arianespace）也降低了阿丽亚娜5型（Ariane 5）火箭的发射价格，据信它每次的发射成本约为1.75亿欧元（2.13亿美元）。该公司希望，预定在明年首飞的阿丽亚娜6型（Ariane 6）火箭的发射成本将比5型低40%。而SpaceX对新火箭发射的收费是6200万美元，旧火箭是5000万美元。

低价格、注重成本控制、敢于冒险，以及快速迭代（马斯克的另一个标志性特征）帮助SpaceX赢得了各种合同，签订方包括铱星（Iridium）和Intelsat这样的老牌卫星公司、Planet等创业公司，以及美、德、韩等国政府。4月16日，美国国家航空航天局（NASA）向SpaceX拨款29亿美元，用于开发月球着陆器，这是美国在2024年让宇航员重返月球计划的一部分（尽管因为政府机构正在审查对手公司的投诉，该合同已在4月30日暂停）。SpaceX计划在9月15日将四名游客送上太空，开展为期三天的环绕地球之旅。摩根士丹利称SpaceX是快速增长的“新兴太空”部门的“指挥中心”——据风险投资公司Seraphim Capital估计，截至今年3月的一年里，该部门吸引了87亿美元的风险投资，比前一年增长了95%。

而且它不是原地踏步。星舰的运载能力是猎鹰9号的六倍多。尽管它体积巨大，却可以完全重复使用，而且意图比SpaceX现有的火箭便宜得多。马

斯克希望星舰的单次发射成本最终能低于200万美元。

分析与工程公司BryceTech的西蒙·波特（Simon Potter）表示，无论SpaceX的技术有多出色，火箭发射都是一个相对较小的市场，2019年规模约为60亿美元。政府出于对国家安全的担心，庇护许多企业免于全面竞争。这将限制SpaceX的市场份额。摩根士丹利的分析师亚当·乔纳斯（Adam Jonas）表示，SpaceX转而将发射视为助力自己其他计划的“使能技术”。它的下一个目标是电信业务。星链的目标是在全球提供互联网接入服务，包括在那些其他形式的网络连接不佳或匮乏的地方。

这个市场要大得多，至少理论上是这样。联合国下属机构国际电信联盟（International Telecommunication Union）估计，2019年全球有48%的人口无法上网。SpaceX的首席运营官格温·肖特韦尔（Gwynne Shotwell）在2019年表示，全球互联网接入市场可能为每年一萬亿美元。马斯克曾表示，SpaceX可能打算争取其中约3%的份额。即便是这区区一小块，在两年前也能带来300亿美元的收入。

卫星互联网并不是什么新想法。但它是马斯克认为他可以改进的又一项技术。现有的互联网卫星在高轨道飞行，以求让覆盖范围最大化。其缺点是许多客户必须共用一颗卫星，容量受到限制。而且无线电信号传送到在高空飞行的卫星需要一定时间，这就加大了不可避免的恼人的延迟。目前，卫星网络通常是在没有更好选择的情况下无奈之选——比如在偏远的农村或大海中的船只上。

星链希望用低成本火箭把成千上万颗廉价的小型卫星送入低轨道来解决这些问题。波特表示，2021年第一季度，以所含质量来衡量，SpaceX发射入轨的载荷比其他所有火箭运营商发射的总和还要多。星链现有的1500多颗卫星已经占所有在轨运行卫星数量的四分之一左右。SpaceX公司已为另外一万多颗卫星明确了发射计划，已提交书面发射申请的达4.2万颗——这是自太空时代开始以来发射卫星总数的四倍有余。

这一尚处于初始阶段的服务正在接受成千上万人的测试。大多数人似乎很

满意，表示它连接迅速，反应灵敏。但卫星互联网行业的历史比较惨淡。铱星在1999年也就是它创建后的第二年就破产了（它最终获得美国政府纾困）。Intelsat和Speedcast这两家老牌公司，以及与星链的商业模式类似的创业公司OneWeb，都在去年申请了破产。Intelsat目前正在重组，Speedcast也在新东家的领导下重新开展业务。但该行业如此脆弱，让人很难确定SpaceX未来的价值。摩根士丹利尝试给出的估值就跨越了两个数量级，从50亿美元到2000亿美元，其中的差异几乎都源自对星链可行性的不同假设。

咨询公司London Economics的拉斯马斯·弗莱特凯尔（Rasmus Flytkjaer）表示，即使发射成本很低，星链至少还面临两大挑战。一是它大部分的潜在客户使用的都是由地面互联网公司提供的性能很差的服务。他们往往生活在相对贫穷的农村地区。星链每月99美元的价格即使对富裕国家的用户来说也不便宜。另一个是让整个系统运作起来所需的高科技卫星天线的成本。这些天线直径23英寸，装在屋顶或墙壁上。在低轨道飞行的星链卫星会迅速划过天空，这些天线必须能够在卫星移动时追踪它们，并在一艘卫星消失在地平线之前无缝切换到下一颗卫星。

肖特韦尔在4月表示，SpaceX售价499美元的卫星天线的生产成本约为1500美元，两年前约为3000美元。SpaceX希望规模经济最终将把制造成本降到“几百美元”。弗莱特凯尔说，铱星的问题之一是要在吸引到付费用户之前拿出足够的资金建造网络。他表示，马斯克财力雄厚，应该不太可能让SpaceX像20年前的前辈那样耗尽资金。

这些挑战或许可以解释为什么马斯克在谈到星链时一反常态，没有夸夸其谈。特斯拉在卖车时会把“狂暴模式”和“生化武器防御模式”等功能作为卖点。而星链却将自己的公开测试项目命名为“聊胜于无的Beta测试”。在去年的一次太空会议上，马斯克表示，星链目前的目标仅仅是不破产。他一再试图向现有的电信公司保证星链不会对它们构成威胁，指出这项服务不适合提供给人口密集城市里的大批客户。

目前，星链的测试项目只在少数几个富裕国家进行。然而SpaceX在5月5日

表示自己已经收到了50万份预购订单。仅在美国，它就为多达500万用户申请了监管许可。去年12月，SpaceX从美国政府获得8.86亿美元的补贴，用于为农村地区提供宽带服务；据说它还在英国开展类似的谈判。并非所有国家都会如此接纳它，因为当局可能难以对星链提供的互联网接入进行审查。

弗莱特凯尔说，在较穷的国家，星链的卫星可以把农村的移动电话基站连接到互联网上，从而把成本分摊给大批用户。SpaceX正在与美国军方进行联合测试，后者对于让任何战场都获得互联网连接很感兴趣。2019年，SpaceX展示了为飞行中的军用飞机提供高速网络的能力。

马斯克并不是唯一一个认为卫星互联网时代已经到来的亿万富翁，尽管这个领域过去的表现令人沮丧。OneWeb破产后得到了英国政府和印度企业集团巴蒂集团（Bharti Enterprises）的救助。巴蒂的创始人苏尼尔·米塔尔（Sunil Mittal）是印度最富有的人之一。亚马逊的创始人贝索斯和马斯克一样有钱，也一样是太空迷，他出资创立了自己的私人火箭公司蓝色起源（Blue Origin）。亚马逊也在规划类似于星链的低轨道卫星互联网“柯伊伯”（Kuiper）。汽车行业越来越随马斯克起舞。太空行业也会一样。■



The holly and the ivy

David Swensen, an influential investor, died on May 5th

At Yale, Mr Swensen perfected the modern endowment model

STARTING IN THE 1980S, the endowments of a handful of big American universities began to divert their investments away from publicly traded equities and bonds towards “alternative” assets, such as venture capital and private equity. David Swensen, who died on May 5th aged 67, perfected the approach. Referred to variously as the endowment, Yale or Swensen model, it has since been copied—by family offices, sovereign-wealth funds and, more recently, by big pension funds.

In 1985 Mr Swensen was persuaded by James Tobin, a Nobel-prizewinning Yale economist, to give up a lucrative career on Wall Street to return to his former university to run its investment office. Yale’s endowment was then worth around \$1bn. By the middle of last year the figure had risen to \$31bn. Even this astonishing growth understates Mr Swensen’s influence. He was responsible for developing a stream of talented asset managers at Yale. And in two best-selling books, he set down his investment philosophy for a wider audience.

Three pillars of this thinking stand out. The first concerns time horizon. Because endowments have obligations stretching far into the future, they can take a long-term view. They can sacrifice the ease of trading in public markets for the better returns promised in private equity. By doing so, they can earn an illiquidity premium—a reward for giving up the ability to sell out easily.

The second pillar concerns information. It is hard to find mispriced stocks in the public markets, because news about listed companies travels fast and

is quickly incorporated into prices. But investors in private markets who do their homework are more likely to be rewarded. That is because reliable data and analysis are much harder to come by.

The third pillar is the importance of a contrarian mindset. Mr Swensen had a chance early on to demonstrate his. Following the stockmarket crash in October 1987, he had loaded up on company shares, which had become much cheaper, by selling bonds, which had risen in price. This rebalancing was in line with the fund's agreed policy. But set against the prevailing market gloom, it looked rash. His investment committee was worried. One member warned that there would be "hell to pay" if Yale got it wrong. But Mr Swensen stuck to his guns. The decision stood—and paid off handsomely.

These days, the Swensen model is often reduced to an asset-allocation decision: hold alternatives. But as money has flooded into private-equity funds, average returns have converged on the returns in public markets. There is no longer an obvious illiquidity premium. But Mr Swensen's point about information remains relevant. The dispersion of returns—the gap between the best and worst funds—is far higher in private than in public equity. Selecting the right private-equity manager takes expertise. Yale has some advantages: it can, say, tap into its alumni network for access to the better-run funds.

Mr Swensen is given too much credit in one regard. Endowments had a history of innovation before his return to Yale. Harvard's was already changing. And endowments had previously been pioneers in asset allocation: the Ivy League funds shifted markedly from bonds into equities from the 1930s. In other respects Mr Swensen gets too little credit. Star investors are generally not good at mentoring others. But Swensen alumni have regularly turned up in senior jobs at other endowments. "He was a smart player but also an incredibly good coach," says a colleague. In this, as in other matters of investment practice, David Swensen was a true outlier.





冬青树与常春藤

投资大师戴维·斯文森5月5日离世

在耶鲁大学，斯文森完善了现代捐赠基金模式

自上世纪八十年代开始，一小批美国大型高校的捐赠基金开始将它们的投资从公开交易的股票和债券转移到风险资本和私募股权等“另类”资产。于5月5日离世、享年67岁的戴维·斯文森（David Swensen）完善了这种方法。自那以后，这种被称为捐赠基金模式、耶鲁模式或斯文森模式的方法被家族办公室、主权财富基金，以及更近些年来被大型养老基金效仿。

1985年，耶鲁大学经济学家、诺奖得主詹姆斯·托宾（James Tobin）说服斯文森放弃了在华尔街的高薪职业，回到母校管理投资办公室。当时耶鲁的捐赠基金价值约10亿美元。到去年年中这一数字已增至310亿美元。即便这一惊人的增长也不能完全体现斯文森的影响力。他负责在耶鲁大学培养一大批才华出众的资产经理人。而在两本畅销书中，他向更广泛的读者群阐述了自己的投资理念。

这种投资思路有三个突出的支柱。第一个关乎时间跨度。由于捐赠基金背负着延伸至久远未来的责任，它们可以把眼光放长远。它们可以牺牲在公开市场上交易的便利度，来获得私募股权承诺的更好回报。这样一来，它们可以赚取非流动性溢价——放弃轻松卖出的选择而获得的一种奖赏。

第二大支柱关乎信息。在公开市场上难以找到定价错误的股票，因为有关上市公司的新闻迅速传播，并很快体现在价格中。但在私人市场上，做足了功课的投资者更有可能获得回报，因为在这个市场上拿到可靠的数据和分析要难得多。

第三大支柱是逆向思维的重要性。斯文森很早就有机会展现自己的这种思维方式。1987年10月股市崩盘后，他出售价格上涨的债券，大量买入价格大跌的公司股票。这种再平衡的操作符合耶鲁基金议定的政策。但是，鉴于当时市场普遍低迷的程度，这么做还是会显得很轻率。他领导的投资委

员会对此忧心忡忡。一位成员警告说，如果耶鲁决策错误，那可“有得受了”。但斯文森顶住了压力。这个决定维持不变——而且获得了丰厚的回报。

如今，斯文森模型常常都被简化为一种资产分配决策：持有另类投资。但是，由于资金已经大量涌入私募股权基金，这一块的平均回报率已经和公开市场趋于一致。明显的非流动性溢价已不复存在。但斯文森关于信息的观点仍具有现实意义。收益的差异——也就是最好的基金和最差的基金之间的差距——在私募股权中要比在公开上市股票中高得多。正确选择私募股权经理需要专业知识。耶鲁大学有一些优势，比如它可以利用其校友网络来买到经营更佳的基金。

人们在一个方面对斯文森的评价过高了。在他回到耶鲁之前，捐赠基金就有创新的记录。哈佛的捐赠基金已经在变化。而且捐赠基金在从前就是资产分配的先驱：自1930年代起，常春藤盟校的基金明显从债券转向股票。而在其他方面，斯文森获得的赞誉又太少了。明星投资者通常都不擅长指导他人。但斯文森的门徒经常在其他捐赠基金中出任高级职位。“他是一个聪明的玩家，但也是一位极其出色的教官。”一位同事说。在这方面，就和在投资实践的其他事务上一样，戴维·斯文森是名副其实的异类。■



Swamp in the heart of Europe

The power of lobbyists is growing in Brussels and Berlin

Europe's politics are getting more swampy

EUROPEANS HAVE long assumed that excessive lobbying is only an American problem. But over the past 15 years Brussels has become the world's second capital of the dark arts after Washington, DC, with Berlin not far behind. Both cities have become infested with new arrivals who are pushier and use more sophisticated techniques than old-fashioned associations such as the Federation of German Industry or BusinessEurope. Weak rules in both places are not designed to cope with the explosion of activity.

As international public-relations firms have moved in, big companies have also beefed up their in-house lobbying activities (see chart). Google and Facebook have opened offices in the government district of Berlin, near the Bundestag, Germany's parliament, and in the Quartier Léopold of Brussels, close to the European Commission, the executive body of the European Union.

That adds up to plenty of lobbyists' boots on the ground, according to Transparency International (TI), a watchdog. In Brussels 25,000 lobbyists with a combined annual budget conservatively estimated at more than €3bn (\$3.6bn) seek to influence EU policy. Approximately 7,500 of them are accredited with the European Parliament, which means they are regularly able to meet with parliamentarians. Berlin is now reckoned to host up to 7,000 lobbyists with over €1bn to throw around every year.

This does not necessarily translate into political clout. "Deep pockets do not equal effective lobbying," says Nick Aiossa of TI. Some companies throw

money at in-house lobbyists, consultancies and marketing campaigns without much result. But good lobbyists try to be part of the debate they wish to sway as early as possible, so they can try to shape the agenda. As power at the EU is diffuse and decisions are the result of deals at the commission, the council (made up of the 27 heads of government) and the parliament, good lobbyists who can navigate the decision cycle of these three institutions can be invaluable.

Though the effectiveness of lobbyists is still debatable, a series of scandals in Brussels and Berlin convinced policymakers to strengthen rules. In 2011 journalists from Britain's Sunday Times posing as lobbyists secretly filmed four members of the European Parliament (MEPS) negotiating a deal to propose amendments to legislation in exchange for €100,000 a year. The EU subsequently introduced a register for lobbyists, but it is voluntary. And since 2015 EU commissioners and their cabinet are required to make public their meetings with registered lobbyists, as are senior members of the parliament. That leaves half of 705 MEPs who do not reveal their dealings with lobbyists.

Germany remained a regulation laggard compared with other European countries until last year, when Der Spiegel, a weekly newspaper, revealed that Philipp Amthor, the youngest MP in the Bundestag and a rising star of Angela Merkel's Christian Democratic Union, was on the board of Augustus Intelligence, an American startup, and lobbied vigorously for the company at the ministry of economics. Mr Amthor initially denied receiving any compensation from the firm, but subsequently admitted getting share options that he did not disclose. The resulting furore reignited the debate about lobbying regulation.

A law passed in March will require members of the Bundestag to declare regular lobbying work. After further recent scandals involving MPs pocketing substantial commissions from companies making face masks, or

receiving money from lobbyists for Azerbaijan in return for voting in favour of pro-Azerbaijani motions, the government has also drafted a bill with stricter ethics rules for parliamentarians that is winding its way through the Bundestag. The bill bans MPs from any lobbying work, accepting cash donations or making paid speeches.

These are steps in the right direction but it is not enough. “The next scandal is just waiting to happen,” says Hans-Martin Tillack, author of “Die Lobby Republik”, a book sounding the alarm about the growth of corporate lobbying in Germany. “The payments are the problem,” he says. Corporate donations to political parties remain untouched by the new legislation. Fabio De Masi, a parliamentarian for the Left party, argues for a complete ban on corporate donations to political parties and an upper limit for party donations from private individuals. Timo Lange of LobbyControl, a watchdog in Berlin, also notes that lobbyists will not have to report meetings with members of the government who are not also MPs.

The EU should consider tightening its rules further, says Mr Aiossa. Policymakers in Brussels will play a bigger role than ever in European business when they come to disburse billions of euros in pandemic-recovery funds. Suggestions include requiring policymakers to meet only registered lobbyists, for example, and listing those meetings on a centralised platform rather than, as now, on 88 different websites. An independent ethics body should be set up to monitor potential conflicts of interests and the “revolving door” of EU officials who join the private sector.

Lobbyists making more of a mark in Europe’s capitals is not necessarily the route to a swamp. Most lobbying is a legitimate, even necessary, part of the democratic process of balancing competing interests in policymaking. But more transparency will do wonders to the reputation of a profession that is often in the mire. ■



欧洲心脏地带的沼泽

布鲁塞尔和柏林的说客势力日增

欧洲政治变得越来越沼泽化

长期以来，欧洲一直认为过度游说的问题是美国独有的。但在过去的15年中，布鲁塞尔已成为仅次于华盛顿特区的世界第二大黑魔法之都，柏林紧随其后。这两座城市已经充斥着新来者——比起像德国工业联合会或欧洲商业协会这样的老式协会，他们更能死缠烂打，手段也更老道。这两个地方薄弱的规则都无法应对游说活动的激增。

随着国际公关公司的介入，大公司也加强了自有的游说活动（见图）。谷歌和Facebook在柏林政府区的德国国会大厦附近，以及布鲁塞尔的利奥波德区靠近欧盟委员会（欧盟执行机构）的地方开设了办事处。

根据监察组织透明国际（TI）的说法，这加起来就带来了很多说客。在布鲁塞尔，有2.5万名说客试图影响欧盟的政策，保守估计其年度预算合计超过30亿欧元（36亿美元）。其中约有7500人获得了欧洲议会的认可，意味着他们能够定期与议院会晤。据估计，柏林现在每年要接待多达7000名说客，他们有超过10亿欧元可供调遣。

这并不一定会转化为政治影响力。TI的尼克·阿伊奥萨（Nick Aiossa）说：“财大气粗并不等于有效的游说。”一些公司在内部说客、咨询公司和市场营销活动上一掷千金，但收效不大。但是优秀的说客会尽早参与他们希望左右的那些辩论，以便设法塑造议程。由于欧盟的权力是分散的，而决策是由委员会、理事会（由27个政府首脑组成）和议会达成的各种协议的结果，因此能够游刃有余地在这三个机构的决策周期中进行游说的优秀说客可谓无价之宝。

尽管说客的效力尚不能定论，但布鲁塞尔和柏林爆出的一系列丑闻让政策制定者确信要强化规则了。2011年，英国《星期日泰晤士报》的记者假扮

说客，秘密拍摄了欧洲议会的四名议员（MEP）谈判一笔交易，用提出法律修正案换取每年10万欧元。欧盟随后设立了说客登记册，但这是自愿的。自2015年以来，和议会高级成员一样，欧盟委员及其内阁也被要求公开与已注册说客的会谈。目前，705名欧洲议会议员中尚有一半没有透露与说客的往来。

德国的游说监管一直落后于其他欧洲国家，事情在去年发生了变化。德国《明镜周刊》揭露德国联邦议院最年轻的议员、默克尔的基督教民主联盟的后起之秀菲利普·安托（Philipp Amthor）担任美国创业公司奥古斯都情报（Augustus Intelligence）的董事会成员，并在经济部积极为该公司游说。安托起初矢口否认从该公司获得任何报酬，但随后承认获得了他先前未披露的期权。由此产生的公愤重新点燃了有关游说监管的辩论。

今年3月通过的一项法律将要求德国联邦议院议员申报日常的游说工作。在最近爆出的更多丑闻中，国会议员从口罩生产商处收受大笔佣金，或收受亲阿塞拜疆说客的钱财而投票赞成有利于阿塞拜疆的动议。政府于是又起草了一项如今正在联邦议院讨论的法案，为议员设立更严格的道德准则，禁止国会议员进行任何游说工作、接受现金捐赠或发表有偿演讲。

这些步骤朝向正确的方向，但并不足够。“下一场丑闻早晚要发生。”汉斯-马丁·提拉克（Hans-Martin Tillack）说。他撰写的《游说共和国》（Die Lobby Republik）一书对公司游说活动在德国的增长拉响了警报。“问题在于付款。”他说。新法规并未涉及公司对政党的捐款。左派议员法比奥·德·马西（Fabio De Masi）主张完全禁止公司向政党捐款，个人捐款也要设立上限。柏林监察机构LobbyControl的蒂莫·兰格（Timo Lange）也指出，说客将不必报告与非国会议员的政府成员的会面。

阿伊奥萨说，欧盟应该考虑进一步收紧其规则。布鲁塞尔的决策者们负责分配数十亿欧元的疫情恢复资金，他们将在欧洲事务中发挥比以往更大的作用。相关建议包括要求决策者仅会见已注册说客，并在一个集中平台上公示，而不是像现在那样列在88个不同的网站上。应该建立一个独立的道德机构来监督潜在的利益冲突，以及欧盟官员加入私人部门的“旋转门”。

说客在欧洲各国首都的足迹大增，并不意味着这就会通往“沼泽”。在制定政策时平衡各种相互竞争的利益的民主过程中，大多数游说是合法乃至必要的一部分。但是，更高的透明度对这个声誉经常陷入泥潭的职业大有好处。 ■



Bartleby

Can human creativity prevent mass unemployment?

The market for artisan goods is likely to grow. But organised craft could lose its charm

IN “THE REPAIR SHOP”, a British television series, carpenters, textile workers and mechanics mend family heirlooms that viewers have brought to their workshop. The fascination comes from watching them apply their craft to restore these keepsakes and the emotional appeal from the tears that follow when the owner is presented with the beautifully rendered result.

Perhaps the idea of craftsmanship is not simply nostalgic. In a new paper in the Academy of Management Annals, five academics examine the idea of crafts as a way of remaking the organisation of work. They define craft as “a humanist approach to work that prioritises human engagement over machine control”. Crafts require distinct skills, an all-round approach to work that involves the whole product, rather than individual parts, and an attitude that necessitates devotion to the job and a focus on the communal interest. The concept of craft emphasises the human touch and individual judgment.

Essentially, the crafts concept seems to run against the preponderant ethos of management studies which, as the academics note, have long prioritised efficiency and consistency. Frederick Winslow Taylor, a pioneer of management studies, operated with a stopwatch and perceived human workers as inefficient, and potentially disobedient, machines. Craft skills were portrayed as being primitive and traditionalist.

The contrast between artisanship and efficiency first came to the fore in the 19th century when British manufacturers suddenly faced competition from across the Atlantic as firms developed the “American system” using

standardised parts. Initially these techniques were applied to arms manufacture but the worldwide success of the Singer sewing machine showed the potential of a mass-produced device. This process created its own reaction, first in the form of the Arts and Crafts movement of the late 19th century, and then again in the “small is beautiful” movement of the 1970s. A third crafts movement is emerging as people become aware of the environmental impact of conventional industry.

There are two potential markets for those who practise crafts. The first stems from the existence of consumers who are willing to pay a premium price for goods that are deemed to be of extra quality. This niche stretches all the way down from designer fashion through craft beers to bakeries offering “artisan” loaves. To the extent that automation takes over more sectors, this niche seems likely to become more lucrative; there is “snob value” in owning a good that is not mass produced. The second market lies in those consumers who wish to use their purchases to support local workers, or to reduce their environmental impact by taking goods to craftspeople to be mended, or recycled.

For workers, the appeal of craftsmanship is that it allows them the autonomy to make creative choices, and thus makes a job far more satisfying. In that sense, it could offer hope for the overall labour market. Let the machines automate dull and repetitive tasks and let workers focus purely on their skills, judgment and imagination. As a current example, the academics cite the “agile” manifesto in the software sector, an industry at the heart of technological change. The pioneers behind the original agile manifesto promised to prioritise “individuals and interactions over processes and tools”. By bringing together experts from different teams, agile working is designed to improve creativity.

But the broader question is whether crafts can create a lot more jobs than they do today. Demand for crafted products may rise but will it be easy to

retrain workers in sectors that might get automated (such as truck drivers) to take advantage? In a world where products and services often have to pass through regulatory hoops, large companies will usually have the advantage.

History also suggests that the link between crafts and creativity is not automatic. Medieval craft guilds were monopolies which resisted new entrants. They were also highly hierarchical with young men required to spend long periods as apprentices and journeymen before they could set up on their own; by that time the innovative spirit may have been knocked out of them. Craft workers can thrive in the modern era, but only if they don't get too organised. ■



巴托比

人的创造力能否防止大规模失业？

手工艺制品市场很可能增长。但有组织的劳动也许会使手工艺丧失魅力

在英国电视节目《修理店》（The Repair Shop）中，木匠、纺织工和机械师把观众送到工作室来的传家之物修好。节目令观众深深着迷，他们观赏手工艺人运用自己的技艺让这些纪念物起死回生，目睹物品主人收到精美的修复成果时喜极而泣的动人场面。

从事手工业的想法也许不仅仅是出于怀旧。在《美国管理学会年鉴》（Academy of Management Annals）收录的一篇新论文中，五位学者审视了通过手工艺重塑劳动组织形式的可能性。他们将手工艺定义为“一种以人为本的工作方式，重视人的参与超过机器的控制”。从事手工艺需要具备独特的技能，并掌握一种面面俱到的工作方法，着眼整个产品而不是单个部分。它还需要对这项工作全心投入的态度，对公共利益高度关切。手工艺这一概念强调人的温度和个人判断。

从本质上说，手工艺的概念似乎和管理学研究的主流观念背道而驰。正如学者们所指出的那样，管理学研究一直以效率和一致性为要务。管理学研究的先驱弗雷德里克·温斯洛·泰勒（Frederick Winslow Taylor）用码表来管理生产，认为工人就是低效的、有可能不服管教的机器。手工艺技能被描述为原始和囿于传统。

手艺和效率之间的对立最早在19世纪突显出来，当时英国制造商突然遭遇了来自大西洋彼岸的竞争——那里的企业开发出了“美国制度”（American System），开始使用标准化零件。这些技术最初被应用于武器制造，但辛格缝纫机在全世界的成功显示了批量生产的设备的潜力。这一工艺流程也遭遇了反击，先是19世纪晚期的艺术与工艺运动（Arts and Crafts Movement），然后是20世纪70年代的“小即是美”运动。随着人们意识到传统工业对环境的影响，第三次手工艺运动正在兴起。

从事手工业的人有两个潜在的市场。第一个源自有些消费者愿意花高价购买被认为质量上乘的商品。从设计师时装到精酿啤酒，再到卖“匠人”面包的烘焙店，各种利基市场不一而足。有鉴于自动化占领的行业越来越多，这样的利基市场看来很可能会变得更有利可图，毕竟拥有一件非批量生产的商品是件有“逼格”的事。第二个市场的存在是因为一些消费者希望以购买来支持本地工人，或是想通过请手艺人帮忙把东西修好或再利用来减少对环境的影响。

对于劳动者来说，手工艺的吸引力在于能让他们发挥自主性，做出有创造性的选择，从而大大提升工作带来的满足感。从这个意义上说，手工艺或许可以为整个劳动力市场带来希望。枯燥和重复性的任务就留给机器去实现自动化，让工人完全专注于他们的技能、判断和想象力。学者们列举了时下的一个例子：在软件行业这个处于技术变革中心的领域，一些人提出了“敏捷”宣言。发起最初的敏捷宣言的先行者承诺要践行“个人和互动高于流程和工具”。敏捷工作模式将不同团队的专家聚集在一起，为的就是提高创造力。

但一个更广阔的问题是，手工业创造的就业机会在未来是否能大幅增加。对手工产品的需求或许会上升，但重新培训可能被自动化取代的行业工人（如卡车司机），让他们抓住这个新机遇，会是件容易的事吗？在一个产品和服务往往必须通过重重监管关卡的世界里，大公司通常会占据优势。

历史还表明，手工艺和创造力之间并没有必然的联系。中世纪的手工业行会是阻挠新进入者的垄断组织。它们还存在严重的等级分化，年轻男子需要当很长时间的学徒和熟练工后才能自立门户，而到那时他们的创新精神说不定已经荡然无存。手工艺人在现代还是能大放光彩的，前提是他们不要太有组织性。 ■



Scrapyards of tomorrow

Old electric cars are a raw material of the future

But they need to be designed to make recycling them easier

CAR SALES have, generally speaking, plunged during the coronavirus epidemic. But there has been one bright spot. Electric vehicles (EVs) continue to grow in popularity. According to IHS Markit, a research firm, almost 2.5m battery-electric and plug-in-hybrid cars were sold around the world in 2020—and the company expects that number to grow by 70% this year. BloombergNEF, another researcher, reckons that by 2030 some 8% of the 1.4bn cars on the road will be electric, rising to more than 30% by 2040. It is not, moreover, just a matter of cars. There will also be electric lorries, buses, motorbikes, bicycles, scooters, ships and maybe even aircraft. And, when all of these machines come to the ends of their useful lives, they will need to be recycled.

This coming avalanche of e-waste will be hard to deal with. When a petrol or diesel car is dismantled and crushed, as much as 95% of it is likely to be used again. Ways to do that are well-developed, straightforward and helped by the fact that, on average, almost 70% of such a vehicle consists of readily recyclable ferrous metals. EVs, by contrast, contain a far greater variety of materials (see chart). Separating and sorting these is tricky, especially as many of them are locked up inside complex electrical components.

For those who can manage to do so, though, there is good business to be had here. EVs contain lots of valuable stuff. The magnets in their motors are full of rare-earth metals, and their batteries of lithium and cobalt. Rystad Energy, a Norwegian research company, forecasts that as the number of electric vehicles being made rises, lithium prices will triple by the end of the decade. Cobalt, meanwhile, comes mainly from Congo, a country that is

often war-torn and has a dreadful human-rights record.

Generally speaking, electrical waste is shredded in bulk before it is sorted and reprocessed. But lithium-ion batteries, the type used in EVs, are inflammable, so need careful handling. They are shredded separately in special machines filled with liquids or gases that suppress combustion. The result, called “black mass”, is then processed to extract its valuable components.

There are two ways of doing so. The more common at the moment is pyrometallurgy. This treats black mass as an ore, by smelting it in a furnace to liberate a metallic mixture from which pure metals, particularly the cobalt, can be separated. That, though, requires a lot of energy. It also destroys valuable non-metallic components such as the graphite in batteries’ anodes. And it fails to liberate the lithium, which ends up in compounds in the slag that is generated alongside the liquid metal, and must then be extracted separately.

The other approach, hydrometallurgy, works more subtly. It leaches metals, lithium included, out of the shredded material by dissolving them in acids or other solvents. That requires less energy and also permits the recovery of non-metallic materials such as graphite. Hydrometallurgy is more complex than pyrometallurgy, and comes with the added expense of treating the waste water it generates, to prevent pollution. But its overall advantages suggest it is the wave of the future.

Li-Cycle, a Canadian company founded in 2016 that is already the biggest recycler of lithium-ion batteries in North America, is one outfit betting on hydrometallurgy. To improve the gathering of its raw material Li-Cycle is testing what it calls spoke-and-hub systems. These collect incoming batteries of all sorts, not just those from EVs, at geographically dispersed receiving stations (the spokes), shred them, and then sort the debris, using

automatic separation and sieving systems, into three types of mixture: plastic, copper and aluminium, and black mass. The plastic and the copper-aluminium mix are sold to other recyclers. The black mass is sent to the system's hub, a hydrometallurgical processing plant that serves many spokes.

Kunal Phalper, Li-Cycle's chief commercial officer, says experience with a demonstration hub at the firm's base in Kingston, Ontario, suggests this approach can recover cobalt, lithium and also nickel (an important ingredient of some non-lithium-ion batteries) in a form pure enough for those metals to be used directly to make new batteries. In all, Mr Phalper claims, the process recycles 95% of a battery's materials. Li-Cycle will soon complete its first properly commercial hub, in Rochester, New York, and has plans for three more around the world by 2025.

Li-Cycle is not alone, though, in its hydrometallurgical ambitions. One rival is Redwood Materials of Carson City, Nevada, which was founded in 2017 by Jeffrey Straubel, formerly chief technology officer of Tesla, a big maker of EVs. Redwood uses a combination of pyro- and hydrometallurgy in its process, with some of the recovered materials providing energy to drive the pyro side of the equation. It already recycles rejects from the American EV-battery factories of two Japanese firms, Panasonic and Nissan, and is now setting up an operation that will take used batteries from general consumer goods.

Northvolt, another firm started by ex-Tesla-ites (Peter Carlsson, its chief executive, and Paolo Cerruti, its chief operating officer), makes lithium-ion batteries for European carmakers. It is adding a recycling plant to its factory in Sweden, to process the batteries it produces there when they reach the ends of their lives. Their steel and plastic casings, and copper wiring, are removed manually before they are crushed in an inert environment. Nickel, manganese, cobalt and lithium are then removed by hydrometallurgy.

Northvolt has also formed a partnership with Hydro, a Norwegian aluminium producer, to recover that metal as well. The firm hopes that, by 2030, half the materials it uses to make new batteries will have been recycled.

Similar “closed-loop” systems are being developed in other parts of the battery supply chain. For example, American Battery Technology, a firm in Nevada that mines and processes lithium, is adding a recycling plant intended to recover lithium and other metals from expired batteries. It will use the lithium in its own production processes and sell the other materials on.

The biggest battery-recycling operations of all, though, are not Western, but Chinese—not surprising, perhaps, given that China is the world’s largest market for EVs, and the country’s government has been promoting the recycling of lithium-ion batteries for some time. Brunn Recycling, a subsidiary of CATL, the world’s biggest EV-battery-maker, has half-a-dozen hydrometallurgical recycling operations around the country. Brunn says it can recycle 120,000 tonnes of old batteries a year, which it claims represents about half of China’s current annual battery-recycling capacity. Meanwhile, American Battery Technology’s approach of integrating recycling with primary production of lithium echoes that of Ganfeng Lithium, one of the world’s largest producers of lithium for batteries. Ganfeng, which has already installed a heavily automated recycling plant at its base in Jiangxi province, plans to build another as part of its mining operation in Sonora state, in Mexico.

Tesla itself also has trans-Pacific ambitions. It is setting up a battery-recycling facility at its EV factory in Shanghai, to complement one it is developing at its battery factory in Nevada. Nor is Tesla the only vehicle-maker involving itself in the industry. In January, Volkswagen opened a pilot battery-recycling plant in Salzgitter, near Hanover, to recover materials

from batteries used in EVs made by its various brands.

Salzgitter is close to the company's battery factory in Braunschweig, which is being expanded to produce more than 600,000 EV battery packs a year. The idea, says Frank Blome, head of batteries for Volkswagen Group Components, is that the firm's battery experts will work with its recyclers to make battery packs easier to dismantle. As Mr Blome observes, "anyone who takes something apart first needs to know how it was put together."

Designing recyclability in from the beginning will, in the long run, be crucial to the effective recycling of electric vehicles—and especially their batteries. Shredding lots of different types of e-waste at the same time inevitably results in contamination. Separating components before doing so would yield greater levels of purity. Some components, such as cathodes, might even be reused in their entirety.

Easing disassembly is also an important goal for Volkswagen's domestic rival, BMW. According to Frank Weber, a member of the firm's board, BMW will, from the start, be designing its electric vehicles with mass recycling in mind. This will include the handling of the solid-state lithium-ion batteries which BMW hopes to make in volume by the end of the decade. Solid-state batteries, which are able to store more charge than those using existing gel-based electrolytes, could double the range of EVs. They will also be safer to use for, unlike those containing gel electrolytes, they will not be inflammable.

While gel electrolytes continue to persist, however, it would be best if they too could be recycled. In the case of the most common of them, lithium hexafluorophosphate (known as PF6), that does not yet happen. Instead, this valuable chemical is destroyed during processing and has to be resynthesised from any lithium recovered. But a team led by Anand Bhatt and Thomas Ruether at CSIRO, Australia's national science organisation,

think they have come up with a way to recover PF6 intact. They use a special solvent to extract it from black mass before any further metallurgical process is applied to it. The PF6 obtained in this way is, they say, good enough to be used to make new batteries without further processing.

Also in Australia, a firm called EcoGraf has developed a process that can extract graphite from black mass with a purity that allows it be reused for making anodes. SungEel HiTech, a scrap-merchant that is South Korea's biggest battery recycler, is now setting up a plant at its factory in Gunsan to do just that.

Scrap merchants have to be flexible. SungEel's previous main business was recycling plasma-television screens, which have, these days, largely, been superseded by LED versions. Plasma televisions turned out to be a passing fad. EVs, though, are likely to run and run. ■



未来废料场

老旧电动汽车是未来的原材料

但它们需要在设计时就降低回收利用的难度

总体而言，新冠疫情期间汽车销售大幅下降。但其中有一个亮点。电动汽车车队持续扩张。据研究公司IHS Markit称，2020年全球共售出近250万辆纯电动汽车和插电式混合动力汽车，该公司预计今年这一数字将增长70%。另一家研究公司彭博新能源财经（BloombergNEF）估计，到2030年，在全球道路上行驶的14亿辆汽车中约有8%会是电动汽车，到2040年将增长到30%以上。而且，数量增长的将不仅仅是电动汽车，还会有电动卡车、电动公交车、电动摩托、电动自行车、电动踏板车、电动轮船，甚至可能还有电动飞机。而当所有这些机器到了使用寿命，就需要对它们回收利用。

这场即将到来的电子垃圾大雪崩会很难对付。汽油或柴油车被拆卸或压碎后，多达95%的部分很可能都会被回收再利用。所用的方法已经很完善，也很直截了当，这其中有一个有利因素：这类车辆中平均有近70%的部分由易于回收的铁类金属组成。相比之下，电动汽车包含的材料种类要多得多（见图表）。拆解和分拣这些材料是件棘手的事，特别是因为它们中有许多都被固定在复杂的电气组件中。

如果有企业能做好这件事，那这门生意值得一做。电动汽车里有很多有价值的材料。电机的磁铁里富含稀土金属，电池含锂和钴。挪威研究公司Rystad Energy预测，随着电动汽车产量的增加，到20年代末，锂的价格将增长两倍。而钴主要来自战乱频发、人权记录糟糕的刚果。

一般而言，电子垃圾在分拣和再生处理前先被成批压碎。但电动汽车使用的锂离子电池易燃，需要小心处理。它们要在装有阻燃液体或气体的特殊机器中单独粉碎。得到的“黑色物质”而后被处理以提取有价值的成分。

提取方法有两种。目前比较常见的是火法冶金。这种方法把黑色物质像铁矿石那样在炉中熔化以释放出一种金属混合物，再从中分离出纯金属，特别是钴。但这种方法很耗能，还会破坏电池阳极中的石墨等高价值非金属成分。它也无法释放出锂，锂会进入与液态金属一道生成的炉渣混合物中，之后必须单独提取。

另一种更精巧的方法是湿法冶金。它把压碎的金属在酸或其他溶液中溶解，过滤出包括锂在内的金属。这种方法耗能较低，还可以回收石墨等非金属材料。湿法冶金比火法冶金更复杂，并且因为需要处理生成的废水防止污染而有一笔额外费用。但从整体上的优势看，它会是未来的趋势。

加拿大公司Li-Cycle就押注湿法冶金。这家成立于2016年的公司已经是北美最大的锂离子电池回收公司。为了改善原材料的收集，Li-Cycle正在测试它称之为“轴辐”的系统。它在分散于各地的回收站（即“辐”）收集不局限于电动汽车电池的各类电池，将其压碎，然后用自动拆分和筛选系统将碎料分为三类混合物：塑料、铜和铝，以及黑色物质。塑料和铜铝混合物卖给其他回收公司。黑色物质送到系统的“轴”端，也就是一家连结众多“辐”的湿法冶金加工厂。

Li-Cycle的首席商务官库纳勒·法尔佛（Kunal Phalpher）说，公司在安大略省金斯顿（Kingston）总部的示范“轴”工厂的经验表明，用这种方式回收的钴、锂，以及镍（某些非锂离子电池的重要成分）的纯度足可以直接用于制造新电池。法尔佛称，这项工艺总共可以回收一个电池95%的材料。Li-Cycle即将在纽约州罗切斯特市（Rochester）建成第一座真正的商用“轴”工厂，并计划到2025年在全球再建三座。

不过，大力投资湿法冶金的公司不止Li-Cycle一家。其中一个竞争对手是内华达州卡森市（Carson City）的红杉材料（Redwood Materials），它由大型电动汽车制造商特斯拉的前首席技术官杰弗里·斯特劳贝尔（Jeffrey Straubel）于2017年创立。红杉材料的回收工艺是火法冶金和湿法冶金的结合，使用一些回收材料为火法冶金这一块提供能源。该公司已经在回收两家日本公司松下和日产在美国的电动汽车电池工厂的不合格品，现在正

在建设一家新工厂，回收一般消费品中的废旧电池。

诺斯伏特（Northvolt）是另一家由前特斯拉员工（首席执行官彼得·卡尔森[Peter Carlsson]）和首席运营官保罗·切鲁蒂[Paolo Cerruti]）创办的公司，为欧洲汽车制造商生产锂离子电池。该公司正在为它在瑞典的工厂增设一个回收厂房，处理它在此处生产的、走完了使用寿命的电池。先是由人工拆除电池的钢制和塑料外壳以及铜线，然后在惰性环境中将其粉碎，最后用湿法冶金分离出镍、锰、钴和锂。诺斯伏特还与挪威铝业公司海得鲁（Hydro）合作回收铝。它希望到2030年自己生产新电池所用的材料有一半已经被回收了。

电池供应链的其他环节也正在开发类似的“闭环”系统。例如，内华达州一家开采和加工锂的公司美国电池技术（American Battery Technology）正在增建一家工厂，从废旧电池中回收锂和其他金属。它将把回收的锂用于自己的生产流程，把其他金属出售。

但最大的电池回收企业不在西方，而在中国，这也许不足为奇，毕竟中国是世界上最大的电动汽车市场，而且中国政府推动锂离子电池的回收利用也已经有一段时间了。全球最大的电动汽车电池制造商宁德时代的子公司邦普循环在全国有六家湿法冶金回收厂。邦普说它每年可以回收12万吨旧电池，它称这占到中国目前电池回收能力的一半左右。与此同时，美国电池技术公司把回收利用与开采锂相结合的做法也是赣锋锂业正在采用的。这家全球最大的电池用锂生产商之一已经在其位于江西省的总部建成了一个高度自动化的回收厂，还计划在其墨西哥索诺拉州（Sonora）的锂矿再建一个。

特斯拉也有跨太平洋发展的雄心。它正在上海的电动汽车工厂里增设电池回收设施，作为其内华达州电池工厂中在建的回收设施的补充。特斯拉也不是唯一一家涉足回收行业的汽车制造商。1月，大众汽车在临近汉诺威的萨尔茨吉特（Salzgitter）开设了一个电池回收试点工厂，从大众旗下各品牌电动汽车所用的电池中回收材料。

萨尔茨吉特距离大众位于布伦瑞克（Braunschweig）的电池工厂很近，这座电池工厂正在扩建，以后每年将可生产超过60万个电动汽车电池组。大众集团零部件公司（Volkswagen Group Components）的电池部门负责人弗兰克·布洛姆（Frank Blome）表示，这一步的思路是让公司的电池专家与回收人员合作，让电池组更容易拆解。正如布洛姆所言，“要拆一样东西，先得知道它是怎么组装起来的。”

从长远来看，一开始就做好可回收设计对于电动汽车的有效回收至关重要，对其中的电池更是如此。同时压碎许多不同类型的电子垃圾会不可避免地导致污染。在压碎前将不同的部件拆分，回收材料的纯度会更高。有些部件，例如阴极，甚至可能被整个拿来直接重复使用。

对于大众的本国竞争对手宝马来说，简化拆解同样是一个重要的目标。据宝马董事弗兰克·韦伯（Frank Weber）称，宝马将在电动汽车设计之初就开始考虑批量回收的问题。这将包括对固态锂离子电池的回收处理，宝马希望到本十年末将批量生产这种电池。与目前使用凝胶电解质的电池相比，固态电池能够存储更多的电量，可能将电动汽车的行驶里程增加一倍。固态电池不易燃，所以使用起来也比含凝胶电解质的电池更安全。

不过在凝胶电解质电池没有被淘汰之前，最好也可以回收利用它们。最常见的凝胶电解质六氟磷酸锂（即PF6）还不能回收。这种有价值的化学物质在回收过程中被破坏，必须用回收的锂重新合成。但是由澳大利亚的国家级科研机构澳大利亚联邦科学与工业研究组织（CSIRO）的安南德·巴特（Anand Bhatt）和托马斯·鲁特尔（Thomas Ruether）领导的团队认为他们已经想出了一种完整回收PF6的方法。在做进一步冶金加工之前，他们先用一种特殊的溶剂将它从黑色物质中提取出来。他们说以这种方式回收的PF6无需进一步处理，直接就可以用来生产新电池。

另一家澳大利亚公司EcoGraf开发了一种可以从黑色物质中提取石墨的工艺，回收的石墨纯度足以重新用于生产电池阳极。废料回收商、韩国最大的电池回收企业SungEel HiTech目前正在其位于群山市（Gunsan）的工厂内设立回收车间来采用这种工艺。

废料商必须灵活应变。SungEel以前的主要业务是回收等离子电视屏幕，如今这种屏幕基本上已被LED屏取代。等离子电视只是昙花一现，而电动汽车应该会在路上奔驰不息。 ■



Bitter pills

Patrick Radden Keefe traces the roots of America's opioid epidemic

Introduced in 1996, OxyContin generated vast sales—and led to enormous suffering

Empire of Pain. By Patrick Radden Keefe. Doubleday; 560 pages; \$32.50. Picador; £20

AT 50,000 OVERDOSE deaths a year and rising, America's opioid crisis has never been worse. What began in the late 1990s as an epidemic of prescription pain-pill abuse morphed into a worse one of illicit heroin and, later, fentanyl. Prosecutors and the public have zeroed in on Purdue Pharma, which introduced the blockbuster drug OxyContin in 1996. Of the colossal revenues it generated, some \$13bn was paid to the company's previously low-profile owners, members of the Sackler family, who have recently sunk from honoured arts patrons to society pariahs.

Patrick Radden Keefe's excellent new book tells the story of this now-infamous clan. He traces the empire of the title to Brooklyn in 1920, and a trio of brothers born to Jewish immigrants: Arthur (the eldest and, in Mr Keefe's telling, the "patriarch"), Raymond and Mortimer. Arthur Sackler's business acumen and questionable ethical judgment proved lucrative. He in effect invented the field of medical advertising, creating the first family fortune after aggressively marketing the sedatives Librium and Valium to doctors, without a serious study of the addiction risks. A fascination with Chinese artefacts led him to bequeath huge sums to prestigious museums. For decades the Sackler name would primarily be associated with that largesse.

Arthur died in 1987, almost a decade before Purdue, which the brothers had acquired in 1952, began selling OxyContin. By the time that happened, his

branch of the family no longer held a stake—facts that its members hope will exonerate them from the taint of the “OxySacklers”. But after a gripping if lengthy account of the patriarch’s career in the first third of his book, Mr Keefe’s view is less forgiving. “So many of the antecedents of the saga of OxyContin could be found in the life of Arthur Sackler,” he concludes.

For the other two brothers and their descendants, Purdue yielded money beyond even Arthur’s imaginings. “The prescription blizzard will be so deep, dense and white,” Richard Sackler, son of Raymond, promised at the launch party for OxyContin. His words proved all too prophetic. The plan for mass-market opioids was abetted by misleading advertising, which claimed that less than 1% of patients would become addicted, and a vast salesforce incentivised by lucrative commissions.

The company peddled theories of “pseudo-addiction” (for which the cure was said to be more opioids) and of “opiophobia” among sceptical doctors. The guardrails against harm buckled in the face of Purdue’s wealth and the lawyers and lobbyists it could buy. Regulators endorsed ludicrous claims about the drug’s safety. A serious case brought by federal prosecutors in Virginia in the early 2000s was watered down by the Department of Justice. Thousands of doctors were given all-expenses-paid trips. Altogether, OxyContin took in \$35bn in sales.

The results were brutal. Other drug manufacturers soon followed Purdue’s lead. When OxyContin was reformulated in 2010 to make it more difficult to abuse, many Americans who were already addicted switched to heroin and, eventually, fentanyl. In 2019 a team of economists rigorously evaluating OxyContin’s impact concluded that its introduction and marketing “explain a substantial share of overdose deaths” over 20 years.

Purdue is now the subject of many lawsuits brought by state and city governments. Sifting through the reams of evidence unearthed by court

proceedings, Mr Keefe shows how callous some of the remaining Sacklers have been over the destruction wrought around them—blaming the problem on immoral addicts rather than the drug, and regarding themselves as victims of a media witch-hunt. Shiftless third-generation types are rendered with evident loathing, skilfully skewered by their own words in court or by Mr Keefe's (anonymous) sources. One aspiring fashionista wishes an obstreperous journalist would focus less on her last name and more on the hoodies she designs.

The company pleaded guilty to assorted federal charges over its handling of OxyContin in November 2020. No Sacklers, and no executives, were obliged to acknowledge guilt personally, however, “as if the corporation had acted autonomously, like a driverless car”, Mr Keefe observes. Still, the Sackler name is mud. Museums and universities refuse their money. The Sackler wing of the Metropolitan Museum of Art, which houses an ancient Egyptian temple, was targeted by protesters chanting “Temple of greed! Temple of Oxy!” Purdue is bankrupt (and may not pay the retirement benefits of its salespeople).

Yet ongoing legal efforts to claw back the fortunes extracted by the owners appear unlikely to succeed. The implosion of the empire of pain, it seems, comes with a golden parachute. ■



苦药

追溯美国阿片类药物泛滥的根源

1996年上市的奥施康定销量巨大——也带来了巨大的痛苦【《疼痛帝国》书评】

《疼痛帝国》。帕特里克·拉德登·基夫著。道布尔戴出版社；560页；32.50美元。斗牛士出版社；20英镑

美国的阿片类药物危机前所未有地严峻：每年有五万例用药过量死亡的案例，并且数量还在上升。始于上世纪90年代末的大规模滥用处方止痛药演变成了更严重的滥用非法海洛因，后来又演变成滥用芬太尼。检方和公众将炮火对准了普渡制药（Purdue Pharma），这家公司于1996年推出了畅销药物奥施康定（OxyContin）。这种药创造的巨额收入中约有130亿美元都进了萨克勒（Sackler）家族成员的口袋。这些从前不怎么引人注目的公司所有者近年已从尊贵的艺术赞助人沦为了社会弃儿。

帕特里克·拉德登·基夫（Patrick Radden Keefe）这本出色的新著讲述了这个如今声名狼藉的家族的故事。他将书名中的“疼痛帝国”的历史回溯至1920年的布鲁克林和出身犹太移民家庭的三兄弟——亚瑟（Arthur，长兄，故事中的“大家长”）、雷蒙德（Raymond）和莫蒂默（Mortimer）。亚瑟·萨克勒的商业头脑和成问题的道德判断带来了丰厚的利润。医疗广告根本就是他的发明，他在没有认真研究成瘾风险的情况下就向医生大力推销镇静剂利眠宁和安定，为家族赚到了第一桶金。出于对中国艺术品的迷恋，他向著名博物馆遗赠了巨额资金。接下来的几十年里，萨克勒这个名字主要都是和这样的慷慨联系在一起。

三兄弟于1952年收购了普渡制药。亚瑟于1987年去世。再过了将近十年，普渡开始售卖奥施康定。此时亚瑟和他的子嗣已不再持有这家公司的股份——这些子女希望这些事实会让他们免受“奥施萨克勒家族”（OxySacklers）恶名的拖累。但是，在用了该书前三分之一的篇幅扣人心弦（却也冗长）地记述了这位家长的商业生涯后，基夫的看法却没

那么宽容。“奥施康定事件的许多前情都可以在亚瑟·萨克勒的一生中找到。”他总结道。

而普渡带给两个弟弟及其后代的财富之巨是连亚瑟也想象不到的。雷蒙德的儿子理查德·萨克勒（Richard Sackler）在奥施康定的发布会上承诺：“雪白的处方单将会像暴风雪般漫天飞舞，遮天蔽日。”这番预言全然应验。将阿片类药物推向大众市场的计划受到误导公众的广告推动——它们声称会上瘾的患者不到1%。受丰厚佣金驱使的销售大军也为推波助澜。

普渡在心存疑虑的医生中兜售“伪成瘾”（据说治疗方法就是服用更多阿片类药物）和“阿片恐惧症”的理论。面对普渡的财力和它能够收买的律师和说客的冲击，抵御伤害的防护栏已经弯曲变形。监管机构认可了关于奥施康定安全性的荒唐声明。本世纪初，弗吉尼亚州的联邦检察官提起的一宗严重案件被司法部大事化小。成千上万名医生获得了费用全包的旅行机会。奥施康定的总销售额达到350亿美元。

后果很惨痛。其他制药商很快跟风而行。当普渡在2010年重新设计了奥施康定以抑制滥用时，许多已经上瘾的美国人转向了海洛因，并最终转向了芬太尼。2019年，一组经济学家严谨地评估了奥施康定的影响，得出结论称它的推出和营销可能是20年来“相当一部分用药过量死亡案例的原因”。

普渡现在成了州政府和市政府提起的多宗诉讼的对象。基夫仔细查看了法庭诉讼程序中发掘出的大量证据，向读者展示了萨克勒家族其他一些成员对周遭受到的危害有多麻木不仁——他们将问题归咎于不道德的瘾君子而不是药物，并自认为是媒体猎巫运动的受害者。作者对不求上进的家族富三代的厌恶渗出了字里行间，他巧妙地用他们自己在法庭上的话或基夫自己的匿名消息源的话揭露了这些人的嘴脸。一名颇有志向的时尚达人希望一位不依不饶的记者不要太关注她的姓氏，多关注下她设计的连帽衫。

去年11月，普渡对有关它制售奥施康定的各项联邦指控认罪。然而，不管是萨克勒家族成员还是公司高管，没有哪个人被要求认罪，“就好像公司

自己会行动，像无人驾驶汽车一样”，基夫写道。不过萨克勒这个名字还是臭了。博物馆和大学拒绝了他们的资助。大都会艺术博物馆的萨克勒侧厅内收藏的一座古埃及神庙成了抗议者的靶子，他们高呼“贪婪之庙！奥施之庙！”普渡破产了（而且可能无法支付其销售人员的退休福利）。

一些仍在推进中的法律行动试图追回被该公司所有者攫取的财富，但看起来胜算不大。疼痛帝国已在高空爆炸解体，其王侯将相却似乎有一顶黄金降落伞护体。 ■



Film-making

Go small

The new economics of blockbusters

BEFORE COVID-19 Hollywood was alight with franchise fever. All ten of 2019's top-grossing films globally came from big studios and featured characters returning to the big screen. Directors such as Martin Scorsese fretted that Marvel's superheroes would be the death of cinema. Cinema-owners would beg to differ. On March 10th AMC, the world's biggest chain, which has recently become a darling of retail investors, reported a 77% fall in revenues last year, and a net loss of \$4.6bn, in large part because Marvel and others have postponed releases until audiences come back.

The dearth of blockbusters is reshaping box-office economics. Six of last year's top-ten money-makers worldwide were not in English. Five were Chinese and one was Japanese. This reflects Asian countries' ability to contain outbreaks more successfully than most of the West. It also points to another twist. As big productions have retreated, smaller ones have stepped in.

At least five of the ten highest-grossing films of 2020 had budgets under \$100m, compared with one in 2019. Many of those lower down the charts did much better than their producers had hoped. In December IFC Films, an independent American studio, predicted that last year would be its most profitable ever. Its films, including "The Rental", a horror flick, had longer theatrical runs in more cinemas than they would have had they been competing for screens with the Avengers. "After We Collided", a romance distributed by Open Road Films, another indie studio, made \$5m in Britain, ten times its expected haul (and nearly \$50m worldwide).

The economics are changing for big studios, too. The handful of blockbusters released in the pandemic busted few blocks. Warner Bros’ “Wonder Woman 1984” had the best opening weekend in America last year, taking \$17m, compared with the \$103m that the earlier “Wonder Woman” earned in a comparable period four years ago. Warner’s parent firm, WarnerMedia (part of the AT&T telecoms group) plugged some of the gap with revenues from streaming the superheroine’s antics. According to Antenna, an analytics firm, WarnerMedia’s newish HBO Max platform gained more subscribers in the film’s first three days than any other streaming service gained in any three days of 2020.

Going straight to streaming could increase profits by cutting out cinema owners, who typically receive half the price of a ticket. It may also trim costs. With a quicker turnaround from big screen to small, studios save on marketing. Explosions and other special effects, a big reason why tentpole films cost between \$100m and \$200m to produce these days, lose some appeal when viewed in the living room. Sadly for Mr Scorsese, franchises are here to stay. Disney is planning more spin-offs for its Marvel and Star Wars characters—even if many never grace the silver screen. ■



电影制作

变小

大片的新经济学

新冠疫情之前，好莱坞的系列影片热潮如火如荼。2019年全球票房收入最高的十部影片都是大制片厂出品的回归系列。马丁·斯科塞斯等导演担心漫威的超级英雄们会把电影艺术推向末路。但影院老板们应该不会应和。今年3月10日，新进成为散户投资者宠儿的全球最大连锁院线AMC报告称，它去年的收入下降了77%，净亏损46亿美元，这很大程度上是因为漫威等公司推迟了新片上映，等待观众回归。

大片稀缺正在重塑票房经济学。去年全球最卖座的十部电影中有六部是非英语影片。其中五部是中国电影，一部日本电影。这反映出亚洲国家对疫情的控制比大多数西方国家更成功。它也指向了另一种转折：随着大制作撤退，较小些的制作登上大舞台。

2020年票房最高的十部电影中至少有五部的预算低于1亿美元，而2019年只有一部。排行榜再往下走，许多影片的票房都远超过制片方的预期。去年12月，美国独立电影公司IFC Films预测，2020年将是它有史以来最赚钱的一年。它出品的恐怖片《租房惊魂》（The Rental）等电影得以在更多影院放映更久，无需和《复仇者联盟》竞争排片。由另一家独立电影公司开路影业（Open Road Films）发行的爱情片《之后2》（After We Collided）在英国取得了500万美元的票房，是预期的十倍（全球票房近5000万美元）。

大制片厂的经济运作也在发生变化。在疫情期间发行的少数几部大片都没有激起多大的水花。华纳兄弟的《神奇女侠1984》是去年美国首周末票房最高影片，为1700万美元，而四年前《神奇女侠》上映时这个数字是1.03亿。华纳兄弟的母公司华纳传媒（WarnerMedia，属于电信集团AT&T）在流媒体上同步播放了这位超级女英雄的怪招奇技，填补了部分收入缺

口。根据分析公司Antenna的数据，华纳传媒新推出的HBO Max平台在该片上映的前三天里的新增订户数超过了其他任何流媒体服务在2020年数字最高的三天里的订户增量。

直接通过流媒体播放可能会增加利润，因为绕开了影院老板，他们通常会拿走票价的一半。这么做还可能削减成本。更快地从大银幕转向小屏幕让制片公司得以节省营销费用。爆炸等特效是如今主力大片的制作成本高达一两亿美元的一大原因，但如果是在客厅里观看，这些特效就没那么吸引了。会让斯科塞斯难过的是，系列片还会继续下去。迪士尼正计划为它的漫威电影和《星球大战》中的角色制作更多衍生作品，即便其中很多角色可能永远不会登上大银幕。 ■



Own goal

China's football troubles reflect broader issues within the economy

Slow growth and politics take their toll

IT WAS A hot and sticky night for football. Because of covid-19 restrictions, the match was played at a neutral site, nearly three hours from Shanghai by car. Adding to the inconvenience, kick-off was at 6pm on a Monday. Yet a few thousand supporters still made the trek on May 10th to watch their beloved local side, Shenhua, battle the club from Hebei, a northern province. “It’s a kind of faith for us,” said A.G. Wan, a middle-aged businessman.

Cries of *sha bi*, a phrase not translatable in a family newspaper, rang out whenever the referee missed fouls that, for the fans, were plain to see. Cheers erupted when a Shenhua midfielder scored the equaliser with a perfectly struck last-minute penalty kick. The crowd’s passion would have been familiar to football fans anywhere. But the canvas on which it was painted—a league beset by financial chicanery and political meddling—was unmistakably Chinese.

China can seem like an economic juggernaut. Leaders set lofty targets and funnel money to favoured industries, a potent recipe when combined with talented, driven people. Football shows a less flattering side of its system: how the top-down approach that has worked well to build bullet trains can fail in less predictable domains.

The government has high ambitions for football, encapsulated by President Xi Jinping’s stated dream for China to win the World Cup some day. That day remains distant. The national team is ranked 77th in the world, behind tiny Curaçao. And domestic leagues, a crucial building block, are mired in mediocrity.

To understand what has gone wrong, look at the Chinese Super League (CSL), the country's main football contest. Three months after winning its first-ever CSL title, Jiangsu Suning disbanded in February, tripped up by slowing growth and a more conservative political environment. The team's owner, Suning, an electronics retailer, has been trying to pay down its debts, like other overstretched Chinese firms. Not long ago a football champion would have attracted buyers, even if bleeding cash. These days, though, few tycoons dare to acquire trophy assets. In all, more than 20 teams have left China's professional leagues in the past two years.

The economics of football in China are atrocious. Average annual salaries for players of \$1.2m in 2019 put the CSL roughly in line with Ligue 1, France's top division. But revenues in China are piddling, with tickets regularly costing as little as 50 yuan (\$8). Guangzhou Evergrande, a club renowned for its profligacy, took in only a third of the 2.9bn yuan (\$450m) that it spent in 2019.

Moreover, most wages go to a few extremely expensive players, often imported from abroad, sometimes well past their prime. Carlos Tevez, a faded Argentinian star, described his spell with Shenhua in 2017 as a "vacation for seven months", despite reportedly earning \$40m. In the 1990s foreign clubs rarely gave their Chinese counterparts the time of day, says Joseph Lee, a powerful agent. Now, he says, they view China as "stupid" money.

Why have teams burnt cash with such gusto? Partly it is about branding. Xu Jiayin, the billionaire behind Evergrande, a property developer, once said that owning a football club ensured that his company made the evening news at a fraction of the cost of advertisements. But China's tycoons are not just targeting consumers. They see Mr Xi's professed love for football as a way to connect with him. After he rose to power in 2012, Chinese money poured into starry European clubs, from Inter Milan to Manchester City.

The past year has made clear that, far from appreciating their investments in football, Mr Xi and his advisers see them as a red flag. Companies including Fosun, Wanda, CEFC, TEDA and Guangzhou R&F were among the big spenders, and all have had their finances come under scrutiny. There is talk that some entrepreneurs overpaid for players or for clubs in order to skirt China's stringent capital controls (the suggestion was that they had kickbacks paid into their accounts abroad).

So the government has introduced tough new rules, a crackdown that parallels Mr Xi's efforts to reassert control over the broader economy. Politically, there has been a push to induct more footballers into the Communist Party, much as private companies are pressed to set up party branches. And the Chinese Football Association has capped salaries at 5m yuan for Chinese players and €3m for foreigners. It also ordered clubs to drop corporate titles from their names. Guangzhou Evergrande has become Guangzhou.

Ma Dexing, a football columnist, sees the restraints as progress. "Over the past 30 years professional football in China has been chaotic," he says. Mr Lee thinks the changes have been rash. "It's like half the building was good and the other half rotten, but they demolished it all," he says.

The new rules also display officials' penchant for micro-management. In 2017, to boost youth development, the football association required clubs to field an under-23 player for every match. Managers gamed that rule, substituting youngsters after as little as a minute. So the football tsars mandated that they must play for the whole match. "The narrative every year ends up being 'How have the rules changed?'" sighs Cameron Wilson, founder of Wild East Football, a website devoted to the Chinese game.

For China's national football team, the fundamental problem is not at the elite level but at the grassroots. In big cities there is little space for children

to kick a ball around. A hyper-competitive education system, in any case, leaves them little time for play. Officials had hoped that glittering football academies would help. The world's largest was opened by Evergrande in 2012 with 50 full-sized pitches. So far, though, none of its thousands of graduates has made the senior national team.

The football association has also tried to identify promising players early in life, placing them in development programmes—an approach that works for table tennis and diving but does not translate so well to team sports. "You don't need an under-15 national team. You need thousands of under-15s playing," says Joan Oliver, former boss of Barcelona, who now owns Beijing Institute of Technology Football Club in China's second tier.

With qualifying matches for the 2022 World Cup coming up, the government wants short cuts. Over the past three years China has started naturalising foreign footballers. On May 10th it named five, including three Brazilian-born forwards, to its squad. Mr Xi has called for greater self-reliance in China's quest for global power. Football is a stark reminder that it still needs foreign imports. ■



自摆乌龙

中国足球的烦恼是更广泛经济问题的写照

增长放缓与政治干预的影响显现

对足球比赛来说，那是一个闷热潮湿的夜晚。由于新冠肺炎的防疫要求，比赛在距离上海近三小时车程的一个第三方场地举行。更添不便的是，开球时间是周一下午6点。不过，仍有数千名球迷长途跋涉前去观看5月10日的这场比赛——他们热爱的本地俱乐部申花对阵河北俱乐部。“这对我们来说差不多是一种信仰。”中年商人A.G.万说。

每当场上出现球迷认为显而易见的犯规而裁判没有判罚时，球迷们就会狂呼“傻逼”。比赛最后一分钟，申花的一名中场球员以一记完美的点球将比分扳平，现场一片欢腾。世界上任何地方的球迷对于这样的群情激昂都不会陌生。但它所处的背景环境——一个受困于财务伎俩和政治干预的联赛——却明明白白是中国特色的。

中国看起来可能像一台势不可挡的巨型经济机器。领导者设定宏伟的目标，将资金输送到要重点发展的行业，再加上奋发努力的人才，就形成了一种强有效的运作模式。足球暴露了这套系统叫人不那么感觉良好的一面：这种自上而下的方法可以成功地建造高速列车，在那些更难预测的领域却可能遭遇失败。

政府对足球有很高的期许：国家主席习近平曾说，希望国足有朝一日能夺得世界杯。距离那一天仍然遥远。中国国家队的世界排名是第77位，排在弹丸之地库拉索岛（Curaçao）之后。而为国家队输送人才的重要的国内联赛也始终没有起色。

想知道是哪里出了问题，看看中国最主要的足球赛事中超联赛。江苏苏宁队在第一次夺得中超冠军的三个月后，受增长放缓和政治环境趋于保守的影响，于今年2月宣布解散。球队的东家苏宁是一家电子产品零售商，与其他过度扩张的中国公司一样，一直在努力偿还债务。前几年，一支冠军

球队哪怕严重亏损也能吸引来买家。但如今很少有大亨敢去收购炫耀性资产。过去两年里已有20多支球队退出了中国各级职业联赛。

中国足球的经济状况惨不忍睹。2019年，中超球员的平均年薪为120万美元，与法国顶级的甲级联赛大致相当。但中国球队的收入却微不足道，票价通常只有50元。以出手阔绰闻名的广州恒大在2019年支出29亿元，而收入只有支出的三分之一。

此外，大部分工资都付给了少数天价球员，这些球员往往从国外引进，有些早已过了巅峰期。过气的阿根廷球星卡洛斯·特维斯（Carlos Tevez）在2017年加盟申花，他把自己这段经历形容为“休假七个月”，尽管据报道赚了4000万美元。大名鼎鼎的经纪人李誉鸿表示，在上世纪90年代，外国俱乐部基本上懒得理睬中国俱乐部，现在他们把中国视为“人傻钱多”之地。

为什么球队如此热衷烧钱？一定程度上与品牌推广有关。房地产开发商恒大地产的亿万富翁老板许家印曾表示，拥有一家足球俱乐部可以让公司登上晚间新闻，花费只是广告费的零头。但中国的大亨们盯上的并不仅仅是消费者。他们把足球视为与公开表达热爱足球的习近平建立连结的一种方式。习近平于2012年掌权后，中国资金大举涌入星光熠熠的欧洲俱乐部，包括国际米兰和曼城等。

过去一年有一件事情已经很明确：习近平和他的幕僚非但不欣赏这种足球投资，还视之为一种危险信号。大手笔投资的公司包括复星、万达、华信能源、泰达和广州富力，它们全都受到了严格的财务审查。有传言称，一些企业家为球员或俱乐部支付过高的价钱是为了规避中国严格的资本管制（言下之意是他们用自己的海外账户收受了回扣）。

政府因此推出了严厉的新规，与习近平重申对整体经济的控制的做法一致。在政治上，推动吸收更多球员加入共产党，正如要求私营企业设立党支部一样。此外，中国足协规定中国球员的薪资上限为500万元人民币，外籍球员为300万欧元。另外还要求俱乐部除去公司冠名。广州恒大队已

更名为广州队。

足球专栏记者马德兴将这些限制视为进步。他说：“过去30年，中国的职业足球一直很混乱。”李眷鸿则认为这些改变过于草率。“就好像一栋楼一半是好的一半是烂的，但他们把整栋楼拆了。”他说。

新规也显现出官员们对微观管理的嗜好。2017年，为促进年轻球员成长，足协要求俱乐部每场比赛都要派出一名23岁以下的球员。教练们钻规则的空子，让年轻球员上场一分钟后就换下来。于是官员们又规定他们必须踢满整场比赛。“每年对足球的讨论到了最后都是‘规则又变什么样了？’”专门介绍中国足球的网站狂野东方足球（Wild East Football）的创始人韦侃伦（Cameron Wilson）叹息道。

对于中国国家足球队来说，根本问题不在精英层面，而在基层。大城市的的孩子没有什么地方踢球。而且无论如何，在一个竞争白热化的教育体系里，他们也没什么时间踢球。官员曾希望那些光鲜亮丽的足球学校会有用。2012年，恒大开设了世界最大的足球学校，里面有50个标准球场。但到目前为止，几千名毕业生当中还无人入选国足。

足协也试图早早发掘有潜力的小球员，让他们参加培养计划——这种方法对乒乓球和跳水奏效，但不太适合团体运动。“中国不需要一支15岁以下的国家队。真正需要的是成千上万15岁以下的孩子踢球。”巴萨前CEO、目前是中甲球队（中甲是仅次于中超的职业足球联赛）北京理工足球俱乐部大股东的琼·奥利弗（Joan Oliver）表示。

随着2022年世界杯预选赛临近，政府打算走捷径。过去三年里中国开始归化外籍球员。5月10日，五名归化球员入选国家队，包括三名巴西出生的前锋。习近平呼吁在中国追求全球影响力的过程中要更多依靠自力更生。而足球是一个扎眼的提醒——它仍需要外国进口。■



Tier-two tech

How to thrive in the shadow of giants

Smaller companies are snapping at the heels of the tech titans

A COUPLE OF years ago Snap, the company behind Snapchat, a social-media app, came close to imitating the feature for which it was then famous: digital photos that self-destruct ten seconds after the recipient views them. Shortly after a headline-grabbing initial public offering in 2017, the firm faced a user revolt triggered by an unpopular redesign, falling rates after it started automatically auctioning ad space and an exodus of executives. Its shares dropped precipitously in value, at one point in late 2018 sinking below \$5, less than a fifth of the price they fetched when the firm started trading.

Snap has since staged one of the greatest turnarounds in tech history. When it reported its latest quarterly results in April, it pleasantly surprised analysts again, just as it has for the past few quarters. Revenue grew by 66% from a year earlier, to \$770m. The number of daily users reached 280m, an addition of more than 50m over the same period. The firm's share price has surged by 208% in the past 12 months, to \$54. "The pandemic exposed the resilience of the changes we have made," says Evan Spiegel, Snap's boss.

The comeback reveals a broader trend. While the largest Western tech companies have had a blowout first quarter, firms that fall in the category below—call them “tier-two tech”—are growing briskly, too. And it is not just the extra digital demand generated by the pandemic that is making all boats rise, or the fact that it is easier for smaller firms to grow. Some second-tier companies are confounding sceptics who claimed it was impossible to thrive in the shadow of the industry's titans.

By any reasonable definition, the universe of biggish listed tech companies is large. In America it includes hundreds of firms. We have defined as “tier-two” those with a market value of no less than \$20bn that were incorporated in 2000 or later. That leaves 42 firms worth a combined \$2.4trn. They range from e-commerce sites and streaming services to travel firms and vendors of corporate applications.

Even before the pandemic this group had added some weight relative to “GAFAM”, as some now call America’s five tech behemoths (Google and its parent company Alphabet, Apple, Facebook, Amazon and Microsoft). In February 2020 its joint market capitalisation amounted to 22% of GAFAM’s, up from 14% three years earlier (see chart).

One reason for the increase in relative size in America is technological progress, especially the rise of cloud computing. This has allowed firms to specialise and created big markets even for seemingly obscure products and services, which can now be tailored for narrow purposes and offered globally. “The investments we made back in 2017 are now paying off,” says Mr Spiegel.

A good example is Twilio. The firm is largely unknown to consumers, but used by most. It provides services for text, voice and video communication to more than 200,000 other firms, from Airbnb, a home-sharing site, to Zendesk, a help-desk service. After a few years of fast growth, its annual revenue is approaching \$2bn and its market capitalisation exceeds \$50bn. “If you are a developer, you don’t have to spend a year to understand all the details. You can just plug into our systems,” explains Jeff Lawson, Twilio’s boss, “that’s the idea of infrastructure-as-a-service.”

The pandemic has given the second tier a further boost. At its peak it was worth 35% of the big five (although that has fallen to 29%, as investors have cooled on newish tech stocks). This pattern in America of a weightier

second tier has parallels in China, where a new generation of tech darlings, including Meituan and Pinduoduo, has come of age to take on the duopoly of Alibaba and Tencent. “Covid has been the great digital accelerator,” says Mr Lawson.

Demand for Twilio’s services, for instance enabling salespeople to communicate electronically with customers, shot up when physical retailers had to move online. Many other second-tier tech firms benefited, too. Zoom, a now near-ubiquitous videoconferencing service, saw its revenue surge to \$882m in the latest quarter, nearly a five-fold increase on a year earlier. Revenues of Shopify, an e-commerce platform, more than doubled. Most of the other 40 firms in our sample grew by double digits or more. Besides Snap, these include Pinterest, another social-media firm (78%), and PayPal, a provider of online payments (29%).

The techlash has helped, too. Under scrutiny from critics and regulators, GAFAM mostly shied away from big takeovers (with the notable exception of Microsoft, which recently bought Nuance, which makes speech-recognition and other software, for \$16bn and was rumoured to be in talks with Pinterest). This in turn has pushed more tier-two firms to go public. Of the 42, no fewer than 13 did so in 2019 and 2020, adding about \$600bn to the group’s current collective market capitalisation.

The second tier have succeeded mainly by getting better at creating protected space for themselves to grow, says Mark Mahaney of Evercore ISI, an investment bank. They not only offer compelling products but have built, in geek speak, “platforms”, complete with an “ecosystem” of users and corporate partners on top.

Platforms are best thought of as a marketplace, where the operator provides some basic services that enable buyers and sellers to transact. They often exhibit strong “network effects”: more buyers attract more merchants,

which attract more buyers and so on. Such setups also make it harder for one of the giants to ape rival products, as Microsoft has done with Slack or Apple with Spotify.

Take Snap. It was straightforward for Facebook to copy Snapchat's hallmark feature, called "Stories". These were just collections of pictures and videos captured within the past 24 hours. So the firm has instead recast "Stories" as a platform on which curated partners, such as big media companies, can offer original content. Snapchat's four other main offerings are conceived as platforms, too. For example, users of "Map" can locate their friends and local hotspots, and "Camera" lets tens of thousands of developers offer digital filters for users' cameras.

Several more tier-two firms have also erected robust platforms. "Shopify does not compete with Amazon. We are not a retailer. We are a piece of software that powers other brands," explains Harley Finkelstein, the company's president. Instead of selling stuff for other firms, in other words, the site provides them with tools to set up their own virtual stores, from web hosting to payment, and allows third-party companies to offer additional services, including design and delivery.

Similarly, the more users and merchants PayPal and other payments firms like Square and Stripe attract, the more useful they become to everyone. Twilio's corporate customers and developers of more specialised communication applications, such as call-centre software and group texting, likewise feed off each other.

Others are trying to spin up their own "flywheels", as the digital virtuous circles are known. Spotify and Twitter want to fulfil this function for anyone producing digital works. The first now sees itself as a home for all sorts of audio content, from songs to podcasts. The second mainly aims to distribute all manner of written content, including tweets and newsletters.

Zoom, for its part, in October introduced “Zapps” (later renamed “Zoom Apps”). These, much like the lenses on Snapchat and the applications on Twilio, are supposed to form a moat that both keeps rivals at a safe distance and creates additional demand.

Not all this platform-building will succeed. But where it does, the builders could yet catch up with GAFAM, at least if tech history is a guide.

In China Meituan and Pinduoduo, two e-commerce platforms, have overtaken Baidu to become the third- and fourth-largest internet firms in China. Only a few years ago Adobe and Salesforce, two providers of corporate applications (which are both too old to be included in our sample), were still much smaller than Oracle and SAP, leaders in business software, let alone Microsoft. Adobe and Salesforce still have lower revenues than Oracle and SAP. But they are growing faster and are now in the same league in terms of market capitalisation, currently worth \$229bn and \$204bn, respectively, compared with \$227bn for Oracle and \$168bn for SAP.

“S” is the most likely letter to be added to the GAFAM acronym. In its new incarnation, Snap may yet become a serious rival to Facebook. Snapchat is now arguably the closest the West has to a “super-app” (the model is WeChat, Tencent’s flagship platform). If it keeps buying biggish companies, meanwhile, Salesforce could one day pull even with Microsoft. And if it continues on its current trajectory long enough, more wares may one day be sold on Shopify than on Amazon.

Much has to go right for this to happen. One risk is that the tech sell-off of the past few weeks makes it harder for loss-making firms to raise capital, or maintain the enthusiasm of shareholders for heavy losses in the pursuit of growth. Over three-fifths of the second tier lose money. The titans will have to become less innovative, the reason Oracle and SAP have seen their lead eroded. Many of the second-tier tech firms will need to be willing to

merge. And trustbusters will have to tackle GAFAM's dominance. "Unless the regulatory environment really changes, this is going to be the status quo for the foreseeable future," argues Dan Ives of Wedbush Securities, an investment firm.

Instead of waiting for a second-tier firm to grow into a GAFAM-sized beast, it may be more realistic to expect an ecosystem like the biological one, in which species of all sizes find their niche. Dinosaurs occasionally die out. But that happens rarely, and mostly through outside intervention. ■



二线科技公司

如何在巨头的阴影下茁壮成长

次一级规模的公司正紧追在科技巨头身后

社交媒体应用Snapchat有一个曾让它大出风头的功能，数码照片会在接收者打开查看10秒钟后自动销毁。几年前，推出这款应用的Snap公司自己差点也上演了一次阅后即焚。2017年，Snap的IPO登上各大媒体头条，之后不久该公司就因为新设计不受欢迎遭到用户抵制，当它开始自动拍卖广告位后广告收费降低，高管又接连出走。公司股价大幅下跌，2018年底一度跌破五美元，不到公司上市发行价的五分之一。

从那之后，Snap上演了科技业历史上最了不起的逆转之一。在今年4月公布的最新季报中，它延续前几个季度的增长势头，再次令分析师感到惊喜。公司收入同比增长66%，达到7.7亿美元。日活跃用户数达到2.8亿，比去年同期增长了五千多万人。公司股价在过去12个月里飙升了208%，达到每股54美元。“我们所做的改变在疫情中显现了韧性。”老板埃文·斯皮格尔（Evan Spiegel）说。

Snap的成功翻盘揭示出一个更大的趋势。在西方最大的科技公司于今年第一季度纷纷实现井喷式增长的同时，规模次一级的公司，即“第二梯队科技公司”，也在迅速发展。这不仅仅是因为疫情带来的额外数字化需求让所有公司都水涨船高，抑或是较小的公司更容易增长。一些第二梯队公司的表现驳斥了怀疑论者称它们在行业巨头的阴影下不可能成功的说法。

无论按何种合理定义，“较大”上市科技公司的群体都会很大。在美国就有成百上千家。我们对“第二梯队”的定义是2000年及以后成立、市值不低于200亿美元。美国符合这一定义的公司有42家，市值合计2.4万亿美元，业务涉及电商网站、流媒体、旅游和企业软件等。

即使在疫情之前，第二梯队公司相对于五大科技股“GAFAM”（包括谷歌、谷歌母公司Alphabet、苹果、Facebook、亚马逊和微软）的体量就已经有

所增加。2020年2月，这些公司的总市值为五大巨头的22%，而三年前是14%。

美国第二梯队公司的体量相对提升的原因之一是技术进步，尤其是云计算的兴起。这让公司得以发展出专门化的业务，为哪怕是看似冷门的产品和服务也创造出了大市场——如今这些产品和服务可以针对窄小范围的用途量身定制，并向全球供应。“我们在2017年所做的投资正在得到回报。”斯皮格尔说。

Twilio就是一个很好的例子。很少有消费者知道这家公司，但大多数人都在使用它的服务。该公司向从民宿应用爱彼迎到客服软件公司Zendesk的20多万家企业提供文本、语音和视频交流服务。经过几年的快速增长，Twilio的年收入已接近20亿美元，市值超过500亿美元。“如果您是开发者，不用花一年的时间来了解所有细节，直接接入我们的系统就行了，”Twilio的老板杰夫·劳森（Jeff Lawson）解释说，“这就是‘基础架构即服务’的理念。”

疫情也推动了第二梯队的发展。它们的总市值一度升至相当于五大巨头的35%（尽管由于投资者对较新的科技股的热情降温，这一比例目前已跌至29%）。美国这种第二梯队增强的趋势在中国同样存在。包括美团和拼多多在内的新一代科技宠儿已经成熟，可以挑战阿里巴巴和腾讯的双头垄断。“新冠疫情成了数字化的大加速器。”劳森说。

在实体零售商不得不转战线上之时，对Twilio的服务（例如让销售人员能通过电子设备与客户交流）的需求激增。第二梯队的许多其他公司也同样受益。如今几乎无人不用的视频会议服务Zoom最新一季度的收入飙升至8.82亿美元，比去年同期增长了近四倍。电子商务平台Shopify的收入翻了一番多。这一梯队里的其他40家公司大多数也都实现了两位数或更高的增长。除Snap之外，其中还包括另一家社交媒体公司Pinterest（增长78%）和在线支付供应商PayPal（增长29%）。

对科技巨头的抵制也帮了忙。在被批评人士和监管机构盯牢之际，五大巨头

大多避免进行大型收购（明显的例外是微软，它最近以160亿美元的价格收购了语音识别等软件的供应商Nuance，据传还在与Pinterest洽谈）。这继而又促使更多的第二梯队公司上市。在这42家公司中，有多达13家在2019年和2020年上市，为这一梯队目前的总市值添加了约6000亿美元。

投资银行Evercore ISI的马克·马哈尼（Mark Mahaney）说，第二梯队取得成功主要是因为它们越来越擅长为自身增长创造受保护的空间。它们不仅提供吸引人的产品，还构建了极客们所说的“平台”，平台之上是用户和企业合作伙伴组成的“生态系统”。

最好把平台看成市场，运营方在其中提供一些让买卖双方得以开展交易的基本服务。平台通常会显现出强大的“网络效应”：更多买家吸引来更多卖家，继而吸引更多买家，循环往复。这样的模式也让巨头更难模仿打造出具有竞争力的产品，就像微软和苹果分别面对Slack和Spotify那样。

以Snap为例。Facebook轻易就复制了Snapchat的标志性功能“故事”（Stories），也就是过去24小时内拍摄的图片和视频合集。Snap就把“故事”功能改成了一个平台，大型媒体公司等精选合作伙伴可以在该平台上发布原创内容。Snapchat其他四个主要功能也都做成了平台。例如，“地图”的用户可以定位朋友和本地热门场所，而“相机”让数万名开发者可以为用户的相机提供数字滤镜。

还有另外几个第二梯队公司也建立了强大的平台。“Shopify不和亚马逊竞争。我们不是零售公司。我们是赋能其他品牌的软件。”Shopify的总裁哈里·芬克尔斯坦（Harley Finkelstein）解释说。也就是说，Shopify不是帮其他公司销售产品，而是为它们提供建立自己的虚拟商店所需的虚拟主机和支付等工具，并让第三方公司可以提供包括设计和送货在内的更多服务。

同样，PayPal以及Square和Stripe等其他支付公司吸引的用户和商家越多，它们对各方的用处就越大。Twilio的企业客户和更专门化的通信应用（比如呼叫中心软件和群发短信等）的开发者之间同样也是互相增强。

其他公司也在尝试转动起自己的“飞轮”，也就是数字化的良性循环。Spotify和推特希望为数字作品的生产者发挥这样的功能。如今Spotify自视为一个涵盖从歌曲到播客的各种音频内容的平台。推特则主要是发布包括推文和简讯等各类文字内容。Zoom在10月推出了“Zapps”（后更名为“Zoom Apps”）。这些产品和Snapchat的镜头及Twilio的应用类似，希望打造出护城河，把竞争对手挡在安全距离之外，同时创造出更多需求。

这些构建平台的努力并非都能成功。但成功的那些公司仍有机会赶上五巨头，至少从科技业的历史来看是这样。

在中国，电商平台美团和拼多多已经赶超百度，成为中国的第三和第四大互联网公司。仅在几年前，企业软件供应商Adobe和Salesforce（两家公司创立时间都比较长，没有包含在我们列出的第二梯队中）的规模还比商业软件领头羊甲骨文和SAP小得多，更不用说微软了。它们两家现在的收入仍低于甲骨文和SAP，但增速更快，而按市值看已经处于同一行列。Adobe和Salesforce目前的市值分别为2290亿美元和2040亿美元，甲骨文和SAP分别为2270亿美元和1680亿美元。

GAFAM这个缩写最有可能增加“S”这个字母。经历了凤凰涅槃的Snap可能会成为真正能威胁到Facebook的竞争对手。Snapchat目前可说是西方最接近于“超级应用”（以腾讯的旗舰平台微信为典范）的软件。如果Saleforce继续收购较大的公司，那它某天可能与微软并驾齐驱。如果Shopify能长久保持当前的发展轨迹，那么有朝一日它平台上销售的商品可能比亚马逊还多。

这些要成为现实，还需要多方因素配合。一个风险是过去几周的科技股抛售潮让亏损的公司更难融资，或者更难维持股东们愿意为了追求增长而承受严重亏损的热情。第二梯队公司中超过五分之三都在赔钱。巨头们的创新能力必须得是减退的，这正是甲骨文和SAP丧失领先地位的原因。许多第二梯队公司得愿意接受合并。此外还需要反垄断机构解决五巨头主宰市场的问题。“除非监管环境发生实质性改变，否则在可预见的未来，现状还是会持续下去。”投资公司Wedbush Securities的丹·艾夫斯（Dan Ives）

表示。

与其坐等某家第二梯队公司长成五巨头般的猛兽，更现实的选择可能是期待出现一个类似自然生态环境的产业生态系统，大小各异的物种都将在其中找到自己的生存空间。恐龙有时会灭绝，但这发生的几率很低，而且主要是由于受到了外部干预。■



Controlling agricultural pests

RNA, good for vaccines, can also be used as a pesticide

A new approach to debugging

RIBONUCLEIC ACID (RNA), once little-known outside biological circles, has recently become the molecule de nos jours. The reason is its role in covid-19 vaccines. The RNA molecules in these encode spike, a coronavirus protein. So, when the protein-making machinery of a body cell encounters such RNA, spike is what it makes. That lets a vaccine-recipient's immune system learn to recognise a crucial part of the enemy before the real thing turns up.

Helping to make proteins is not, however, RNA's only job. Among many other things it is central to a process called RNA interference, which prevents, rather than facilitates, the manufacture of specific proteins. RNAi, as this activity is called for short, has also been investigated medically. It has been approved for use against four genetic diseases and is under investigation for the treatment of more than a dozen others. That is good. Some biologists, though, think RNAi may have an important non-medical use as well, as a precisely targeted, environmentally friendly pesticide.

The theory is simple. Identify a protein crucial to the survival of the pest in question. Tailor a specific interfering RNA molecule to sabotage production of that protein. Deliver it into the bodies of the pests. Then wait for them all to die. In practice, of course, things are more complicated. Delivery mechanisms have to be designed and regulatory hoops jumped through. But until recently, the biggest obstacle was cost. Life-saving medicines can be expensive. Pesticides must be cheap. One effect of all the medical RNA work, however, has been to bring down the cost of making the stuff. As Michael Helmstetter, the boss of RNAissance Ag, a firm in Kansas which is developing RNA-based pesticides, observes, "a gram of RNA cost \$100,000

when we started. By 2014 it was \$100 a gram. Now it's a dollar a gram."

Top of the list of potential beneficiaries are honeybees. These semi-domesticated insects, important not only for their eponymous product, but also as pollinators, are plagued by Varroa destructor, a mite a couple of millimetres across (pictured above, on the head of a pupating bee). Varroa mites live by attaching themselves to, and feeding on, bees. This weakens or kills the hosts and also spreads viruses around a hive. Some suspect Varroa plays a role in colony-collapse disorder, a mysterious phenomenon in which most of a hive's workers desert for no apparent reason.

Beekeepers have tried all sorts of ways of attacking Varroa mites. Some place plastic strips laced with amitraz, a pesticide reckoned particularly effective against mites, at the entrances to hives. Others vaporise oxalic acid, which has a similar reputation, and pump it into the hive. Others still run breeding programmes, selecting for bees that resist infestation. None has succeeded in solving the Varroa problem. At best, these approaches keep the mites' numbers just below the threshold of crisis.

GreenLight Biosciences, a company in Boston, wants to help. It has bought from Bayer, a German pharmaceutical and life-science firm, the rights to an experimental Varroa pesticide based on RNAi. Andrey Zarur, GreenLight's boss, hopes this will succeed where other methods fail because it attacks the mite in a way mere chemical interventions cannot.

Varroa's lifecycle starts when a pregnant female mite crawls alongside a bee larva developing inside one of the nursery cells in a hive's honeycomb. While the larva is growing, this mite just sits there. But once it turns into a pupa she springs into action and lays her eggs on it. Mites and bee then mature in unison over the next few days, and when the adult bee emerges from the cell, the mites attached to it spread around the hive to repeat their trick with future generations.

That the mites spend so much time hidden in the honeycomb makes them hard to attack. And this is where GreenLight hopes its RNA will win through. In field trials in the state of Georgia the firm's operatives are feeding Varroa-destroying RNA to the bees themselves—mixing it in sugar water which the workers drink and make honey from. This lays a biotechnological trap for the mites by lacing any honey in their birthplace with the stuff. By lowering the cost of RNA production and so allowing much more of it to be used, Mr Zarur thinks he can deliver more RNA to the mites, succeeding where Bayer and others did not.

Varroa mites are not, though, the only pests in GreenLight's crosshairs. It also has its sights trained on Colorado potato beetles, which can devastate crops if not controlled. In their case the RNA is simply sprayed onto an infested field and the beetles munch it up. And, though it is cagey about the details, the firm says it has 13 other hostile organisms under investigation, too. These include the fall armyworm, a moth caterpillar that chomps through everything from tobacco to oranges, and the caterpillars of the diamondback moth, the world's worst pest of brassicas, a group which includes cabbages, cauliflowers, broccoli, Brussels sprouts and oilseed rape. Nor is the RNAi approach limited to attacking animals. In principle, any organism is susceptible to it. GreenLight's target list therefore also includes crop-damaging fungi such as Botrytis, Fusarium and powdery mildew.

Not surprisingly, GreenLight has rivals in its quest to develop RNA pesticides. At least two other American companies are working on them as well. RNAissance Ag, Dr Helmstetter's firm, is gunning for the potato beetle and the fall armyworm. AgroSpheres, in Charlottesville, Virginia, is going after Diamondback moths. All three enterprises think they can make RNA cheaply enough for it to be sprayed onto fields. But they do so in different ways.

GreenLight employs a process called cell-free biology, which is more akin to

chemistry than conventional biotechnology. Eliminating the need to coddle fussy micro-organisms, says Mr Zarur, simplifies and cheapens things dramatically. But the more traditional approach taken by RNAissance and AgroSpheres, of growing their RNA molecules inside modified bacteria, offers advantages, too. Packaging the RNA in bacterial cells in this way protects the molecules. It also allows the companies' biotechnologists to add features to the cell walls, such as stickiness that stops them slipping off the leaves of plants.

Spraying RNA onto crops is not, however, the only way to get it into pests. Though it has abandoned its honeybee technology, Bayer is developing a genetically modified maize which produces RNA that kills beetle larvae called corn rootworms. A group at the University of Florida is taking a similar approach to the insects known as psyllids that spread a bacterium which causes citrus-greening disease, a serious threat to orange groves.

RNA spraying has advantages, though. A farmer can use it on existing crops, rather than having to replant with transgenic versions. The regulations are less onerous than for the creation of transgenic organisms. And in Europe, where transgenic crops are banned in many places, governments seem open to RNA-based pesticides.

Andreas Vilcinskas, an entomologist at the Fraunhofer Institute's campus in Giessen, Germany, who is working with GreenLight, says the German government now supports their development. It has good reason to. In 2018 the European Union banned the outdoor use of three types of neonicotinoids, a popular class of pesticides. Since then, Germany, France and Poland have all had to reverse this ban on an emergency basis after aphids spread like wildfire. Ironically, neonicotinoids were banned to help bees. Promoting RNA as a pesticide might thus, as it were, kill many bugs with one stone. ■



控制农业虫害

用于疫苗的RNA也可用作杀虫剂

除虫有新招

核糖核酸（RNA）过去在生物圈之外鲜为人知，近来却成了“这个时代的分子”。这是因为它在新冠疫苗中扮演的角色。新冠疫苗中的RNA分子会编码一种冠状病毒刺突蛋白，因此当人体细胞的蛋白合成机制遇到这样的RNA，就会制造刺突。这让疫苗受种者的免疫系统在真正的敌人出现之前，学会识别它的关键特征。

然而，帮助合成蛋白质并不是RNA唯一的工作。它的许多其他工作之一是在一个叫作RNA干扰的过程中起到的核心作用。RNA干扰是阻止、而不是帮助特定蛋白质的生成。这一过程简称为RNAi。人们也对它进行了医学上的研究。它已经被批准用来治疗四种遗传病，还有其他十多种疾病的治疗也在研究中。这是件好事。不过，一些生物学家认为，RNAi可能还有一个重要的非医学用途，即用作一种精准靶向、对环境无害的杀虫剂。

它的原理很简单。找到对相关害虫的存活至关重要的一种蛋白质。制作专门的RNA干扰分子来破坏这种蛋白质的生成。把它送入害虫体内。然后等待害虫通通死掉。当然，实际操作起来会更复杂。必须设计好药物输送机制，还要通过重重监管。但直到最近，最大的障碍还是成本。救命药可以昂贵，而杀虫剂必须便宜。但RNA的医学研究带来的好处之一是降低了这种物质的生产成本。堪萨斯州的RNAissance Ag公司正在研发基于RNA的杀虫剂，其老板迈克尔·海姆斯泰特（Michael Helmstetter）说：“公司刚启动时RNA的价格是10万美元一克。到2014年是100美元一克。现在是一美元一克。”

蜜蜂可能是最大的受益者。这些半驯养的昆虫之所以重要，不仅是因为它们生产蜂蜜，还因为它们传播花粉。但它们常常受到狄斯瓦螨（以下简称瓦螨）的侵扰。瓦螨是一种只有几毫米大的螨虫（如上图所示，贴附在一

只正在化蛹的蜜蜂头上）。瓦螨靠附着在蜜蜂身上并吸食蜜蜂体液为生。这会让蜜蜂衰弱或者死亡，并且在蜂房周围传播病毒。一些人怀疑瓦螨与蜂群崩溃综合症有关，这是一种导致大部分工蜂原因不明地弃巢而去的神秘现象。

养蜂人尝试了各种办法来对付瓦螨。一些人在蜂房入口处放置加有双甲脒的塑料条，双甲脒是公认的高效杀螨剂。一些人把同样被认为有很好杀螨效果的草酸汽化后注入蜂房。另一些人仍在开展育种项目，选育抗螨蜂种。但他们都没能成功解决瓦螨问题。这些方法充其量也只是把瓦螨的数量刚刚控制在危机爆发的临界值以下。

波士顿一家名为GreenLight Biosciences的公司想出份力。它从德国制药和生命科学公司拜耳那里买下了一种基于RNAi的试验性瓦螨杀虫剂的所有权。GreenLight的老板安德烈·扎鲁（Andrey Zarur）希望它会在其他方法都挫败之时取得成功，因为它对付瓦螨的方法是单凭化学干预无法做到的。

当待产卵的雌螨和在蜂房的巢室里成长的蜜蜂幼虫一起爬行时，瓦螨的生命周期便开始了。在蜜蜂幼虫生长的过程中，雌螨只是静待在那里。但一旦蜜蜂幼虫变成蛹，雌螨就开始行动起来，在蜂蛹上产卵。在接下来的几天里，瓦螨会和蜜蜂一起发育成熟，当蜜蜂成虫从巢室里出来时，附着在它身上的瓦螨就会在蜂房周围四散开来，以后一代接一代地重复这种伎俩。

瓦螨在巢房里蛰伏的时间很长，这让它们很难对付。这也是GreenLight希望自己的RNA能取得突破的地方。在乔治亚州的田野试验中，GreenLight的技术人员把能杀灭瓦螨的RNA掺在工蜂食用以及酿造蜂蜜用的糖水中喂给蜜蜂。如此这般在瓦螨出生地的所有蜂蜜中加入这种RNA，就为瓦螨设下了一个生物技术陷阱。扎鲁认为，如果能降低RNA的生产成本，并由此大幅提高RNA的用量，他就能更多地给瓦螨投喂RNA，从而做成拜耳和其他公司没有做成的事。

不过，瓦螨并不是GreenLight瞄上的唯一害虫。它还盯上了科罗拉多马铃薯甲虫，这种甲虫如果不加以控制，会对庄稼造成毁灭性破坏。他们的做法是直接把RNA喷洒到受甲虫入侵的田地里，让甲虫吃掉。尽管对细节讳莫如深，但GreenLight表示，它还在对其他13种有害生物开展研究，其中包括草地贪夜蛾的幼虫，它从烟草到柑橘无所不吃；还有小菜蛾的毛虫，这是世界上对包括卷心菜、花椰菜、西兰花、抱子甘蓝和油菜在内的芥属植物危害最大的害虫。另外，RNAi方法也不是只能用来对付动物。原则上，所有生物体都容易受到它的影响。因此，GreenLight的目标清单里还包括葡萄孢菌、镰刀菌和白粉菌等对作物有害的真菌。

毫不出奇，GreenLight在研发RNA杀虫剂的过程中遇到了竞争对手。至少还有两家美国公司也在致力于研发这种杀虫剂。海姆斯泰特的公司RNAissance Ag正在竭力对付马铃薯甲虫和草地贪夜蛾。位于弗吉尼亚州的夏洛茨维尔市（Charlottesville）的AgroSpheres正在想办法消灭小菜蛾。这三家企业都认为自己能生产足够便宜的RNA，用于田间喷洒灭虫。但它们的方法有所不同。

GreenLight采用的方法叫作无细胞生物学，它更类似于化学而不是传统的生物技术。扎鲁说，无需悉心培养娇贵的微生物这一点极大地简化了过程并降低了成本。而RNAissance和AgroSpheres采用了更传统的方法——在经基因改造的细菌中培育RNA分子。这也自有优势。这种方法将RNA包裹进菌细胞，可以起到保护RNA分子的作用。它还可以让这两家公司的生物技术专家在细胞壁上做文章，比如增加粘性，防止它们从植物叶片上滑落。

然而，在作物上喷洒RNA并不是让它进入害虫体内的唯一方法。虽然拜耳已经放弃了蜜蜂技术，但它正在研发一种转基因玉米，这种玉米产生的RNA可以杀死一种叫作玉米根虫的甲虫幼虫。佛罗里达大学的一个研究团队正在尝试采用类似的方法对付一种叫作木虱的昆虫。木虱传播的细菌会引发柑橘黄龙病，对柑橘园是严重的威胁。

不过，RNA喷洒有其优势。农民可以在现有作物上喷洒RNA，而不必改种

转基因作物。且与创造转基因生物相比，相关法规也没那么繁琐。欧洲很多地方都禁止转基因作物，各国政府似乎对基于RNA的杀虫剂持开放态度。

德国弗劳恩霍夫应用研究促进协会（Fraunhofer Institute）吉森（Giessen）园区的昆虫学家安德里亚斯·维尔钦斯卡斯（Andreas Vilcinskas）正在与GreenLight合作，他说他们的研究现在得到了德国政府的支持。德国政府有充分的理由这么做。2018年，欧盟禁止在户外使用当时被广泛应用的三种新烟碱类杀虫剂。从那以后，蚜虫如野火般迅速蔓延，德国、法国和波兰不得不又紧急撤销了这道禁令。讽刺的是，禁止新烟碱类杀虫剂的初衷是为了保护蜜蜂。因此，将RNA作为杀虫剂来推广，可说是一箭双雕。 ■



Green steel

Plentiful renewable energy is opening up a new industrial frontier

Competitors are alarmed

NORRLAND IS THE largest of Sweden's three historical "lands". It spans the top half of the country and is sparsely populated, the more so the farther north you go. The few people who live there have long relied for work on mining, the army and forestry. Most of Sweden's industry is far to the south. But Norrland abounds in hydropower. Power that is cheap and—crucially—green, along with bargain land and proximity to iron ore, is sparking an improbable industrial revolution, based on hydrogen, "green" steel and batteries.

SSAB, a steelmaker, is poised to deliver its first consignment of "eco-steel" from a hydrogen-fuelled pilot plant in Lulea, a northern city. Volvo, an industrial-vehicle firm these days, will use the steel to build lorries. Of the six or seven tonnes that its typical lorry weighs, around five consist of steel. And for each tonne of steel produced using fossil fuels, around two tonnes of planet-cooking carbon dioxide get belched into the atmosphere.

To make steel, iron ore must be melted at high temperatures and reduced from iron oxide to iron, a process that typically involves burning fossil fuels, releasing huge amounts of carbon dioxide. Replacing them with hydrogen as a reducing agent eliminates more than 98% of the carbon dioxide normally released. The hydrogen is made by electrolysing water, using electricity produced by hydro-power. This approach involves almost no carbon-dioxide emissions at all.

Scania, another automotive firm, is also hoping to exploit Norrland's cheap hydro-power. It plans to make 15,000 battery-powered trucks a year by 2025,

around 15% of its annual production. To that end it has invested in Northvolt, a new battery-making enterprise powered by Norrland's hydro-electricity. Northvolt's main facility is in Skellefteå, 130km south-west of Luleå. It is also building a battery-recycling plant there. By the end of 2021 the company hopes to have churned out enough batteries to store 16 gigawatt-hours. Carl-Erik Lagercrantz, Northvolt's chairman, wants to scale that up eventually to 150 gigawatt-hours a year. If he does so by 2030, he will be supplying a sizeable amount of the European Union's expected annual demand of some 450 gigawatt-hours of electric-vehicle battery capacity by 2030.

Mr Lagercrantz also wants to get into the green-steel business. Taking inspiration from SSAB's pilot project, he decided to have a go at hydrogen-based steelmaking too, and founded H2 Green Steel. Production will be based in Boden, an old army town 30km north-west of Luleå. The new plant will make 5m tonnes of flat steel a year by 2030, a small but meaningful percentage of the 90m tonnes that is currently consumed annually in the EU.

Northern Sweden's steelmaking leaps are being emulated elsewhere in Europe, in response to similar environmental pressures which will only increase if, as looks very likely, Germany's Greens enter government after the election in September. Europe produces a still significant 16% of the world's steel. Big producers in Germany and Poland, where the industry is mostly coal-based and very dirty, are nervy. Even neighbouring Norway is in danger of losing out. It too has the gift of rich renewable-energy resources, but underinvestment means there may soon not be enough of this green electricity to meet the demands of both households and industry.

Meanwhile, all the green-tinged investments have knock-on effects for the rest of the economy of northern Sweden. Claes Nordmark, the mayor of Boden, says house prices are rising and contractors are queuing up to build

apartment blocks in anticipation of H2 Green Steel's new facility. Other companies are vying to supply the steelmaker, or to take advantage of its products. Expecting a jump in population, Mr Nordmark and his colleagues in the region are building schools and sporting facilities. Your correspondent encouraged him to abandon Swedish reticence and brag. "Those in the south think there is nothing here. But now we can offer the green jobs that people dream of—and an amazing lifestyle," he beams. ■



绿色钢铁

丰富的可再生能源正在开辟工业新前沿

竞争对手惶惶不安

瑞典在传统上划分为三个地区，诺尔兰是其中最大的一个。它横跨瑞典版图的上半部，人口稀少，越往北越是如此。长期以来，当地为数不多的居民要靠采矿业、军队和林业提供工作机会。瑞典的大部分工业都远在南方。但诺尔兰有充沛的水电资源。这种电力价格低廉，而且更重要的是环保，加上这里地价便宜，靠近铁矿，这一切正在引发一场超乎想象的工业革命，它基于氢能、“绿色”钢铁和电池。

钢铁制造商SSAB已准备好要交付第一批“生态钢材”，产自它在北部城市吕勒奥（Lulea）的一家氢燃料试点工厂。如今已是工业车辆厂商的沃尔沃将使用这些钢材来制造卡车。一般重六七吨的沃尔沃卡车会用到五吨钢。每用化石燃料生产一吨钢材，就有约两吨令地球升温的二氧化碳排放到大气中。

要制造钢铁，必须在高温下熔化铁矿石，从氧化铁中还原出铁。这个过程通常要燃烧化石燃料，释放大量二氧化碳。如果改用氢气作为还原剂，可以把通常情况下的二氧化碳排放减少98%以上。所用的氢气是用水电解水生产的。这种方法几乎完全不排放二氧化碳。

另一家卡车公司斯堪尼亚（Scania）也希望利用诺尔兰的廉价水电。该公司计划到2025年每年生产15000辆电动卡车，约占其年产量的15%。为此，它投资了使用诺尔兰水电的电池制造新企业Northvolt。Northvolt的主要工厂位于吕勒奥西南向130公里的谢莱夫特奥（Skelleftea），并正在那里建造一家电池回收厂。该公司希望其电池产能到2021年底可达到16吉瓦时。Northvolt的董事长卡尔-埃里克·拉格克兰茨（Carl-Erik Lagercrantz）希望最终把产能提升至每年150吉瓦时。到2030年，欧盟对电动汽车电池的年需求预计将达到约450吉瓦时，如果拉格克兰茨能在那

时实现目标，将会在其中占有相当的份额。

拉格克兰茨还有意涉足绿色钢材业务。受到SSAB公司试点项目的启发，他也决定一试氢能炼钢，成立了H2 Green Steel公司。生产基地将设在吕勒奥西北向30公里的古老军事小镇布登。到2030年，新工厂将年产500万吨扁钢，在目前欧盟每年9000万吨的扁钢消耗量中占比虽小，但意义重大。

瑞典北部地区的炼钢业取得飞跃发展，欧洲各地纷纷效仿，以应对类似的环境保护压力——假如德国绿党赢得9月的大选上台执政（看起来非常有可能），这种压力只会有增无减。欧洲钢铁产量仍占世界总量的16%，比例不小。德国和波兰的大型钢铁生产商紧张不安，因为他们主要以煤为燃料，污染严重。就连瑞典的邻国挪威也面临败下阵来的风险。挪威也拥有丰富的可再生能源，但在这方面投资不足，所生产的绿色电力很快将难以满足民用和工业需求。

同时，所有这些绿色能源投资都对瑞典北部的其他经济部门产生了连锁推动效应。布登的市长克莱斯·诺德马克（Claes Nordmark）表示，H2 Green Steel公司将在当地建造新厂房的消息传出后，房价上涨，承包商正在竞相建造公寓楼。其他公司也展开竞逐，争取成为这家钢铁公司的供应商或能利用其产品。预计当地人口将激增，诺德马克和他当地的同事正忙于筹建学校和体育设施。笔者鼓励诺德马克放下瑞典人的内敛，来点豪言壮语。他笑逐颜开地说：“南方人以为我们这里一无所有。但现在我们可以提供人们梦寐以求的‘绿色’职位和超赞的生活方式啦。”■



Engineering

Knitting a road with stones and string

Greener road-building

SINCE THE Romans began doing it with great panache more than 2,000 years ago, road-building has been a sweaty, grubby business, involving heaving great quantities of rocks and stones into place and, in more recent times, covering the surface with asphalt or concrete. Now a group of Swiss researchers think they have come up with a more elegant solution. Strange as it may seem, this involves knitting.

Martin Arraigada and Saeed Abbasion of the Swiss Federal Laboratories for Materials Science and Technology use a robotic arm to lay out string in a series of elaborate patterns. As the knitting takes shape, layers of stones are added and tamped down. The string entangles the stones, keeping them in place. The result is a structure that is surprisingly stable and strong. In one experiment a section of pavement put together in this way withstood a load of half a tonne. The encapsulated stones hardly moved at all.

Roads and pavements are usually made from layers of different grades of sand, gravel and stones. Once these are in place the surface is treated with an aggregate that is sealed and bound together with cement to form concrete, or mixed with bitumen to make asphalt. Neither method is environmentally friendly. Making cement produces huge amounts of carbon dioxide, while bitumen, a sticky tar-like substance, is obtained from oil.

Knitting roads creates fewer emissions. And the stones and string are easily recyclable, says Dr Arraigada. The group tried various materials for the string, settling eventually on recycled textiles reinforced with polyester, a type of plastic. Polyester resists rotting and can also be recycled, although

the group hope to find biological materials which can do the same job.

They got the idea of knitting roads from work carried out by the Gramazio Kohler architectural research group at ETH, a university in Zurich. In one of this group's projects, led by Gergana Ruseanova, now at Swinburne University of Technology, in Australia, a Stonehenge-like structure with 11 columns was built in a similar way. A mobile robot, which moved on caterpillar tracks, laid down 120km of string in geometric patterns while 30 tonnes of crushed stones were added. The resulting three-metre-high columns comfortably supported a nine-tonne capping stone.

There is, though, some way to go before knitted roads become a commercial proposition, cautions Dr Arraigada. He and his colleagues are testing various set-ups and modelling on a computer how different patterns of string can be used to hold the stones. They will then carry out more tests—including ones that apply the sorts of rolling pressure generated by the wheels of moving vehicles.

Concrete and asphalt road surfaces are usually impervious to water, and are shaped so that rain flows off them into gutters running alongside. If water gets caught in surface cracks, it can cause potholes—especially if it freezes and thereby expands, opening up more cracks. Binding aggregates with string would produce a permeable road surface, which might result in fewer potholes. It might have other advantages, too. The researchers think, for example, that a porous road could help water reach the subsoil below, reducing the impact that covering so much land with roads has on local hydrology. Just like knitting a nice cardigan, success will depend on starting with a good pattern. ■



工程学

用石头和绳子编一条路

更环保的筑路法

自从两千多年前罗马人开始气势恢宏地修建“条条大路”以来，筑路就一直是一项叫人汗流浃背、灰头土脸的工作，得要让大量的岩石和石块就位。到了近代，还要用沥青或混凝土覆盖路面。现在，一组瑞士研究人员认为他们找到了一个更优雅的解决方案。不过看起来可能很奇怪，因为用的是编织技术。

瑞士联邦材料科学与技术实验室（Swiss Federal Laboratories for Materials Science and Technology）的马丁·阿拉依噶达（Martin Arraigada）和赛义德·阿贝申（Saeed Abbasion）用一个机械臂把细绳编成一系列精心设计的形状，编织成形的过程中添加一层层石块并夯实。绳子缠绕住石块，把它们的位置固定下来。最终形成的结构坚固稳定得惊人。在一次实验中，用这种方法建造的一段路面承受了半吨的负荷。细绳缠绕着的石块几乎纹丝不动。

公路和人行道通常是由多层不同等级的沙子、碎石和石块筑成。这些材料铺好之后，再在表层铺上骨料，用水泥密封并粘合形成混凝土，或者与沥青混合制成柏油路。这两种方法对环境都有害。制造水泥的过程产生大量二氧化碳，而沥青这种类似焦油的粘性物质是从石油中提炼出来的。

编织筑路产生的排放较少。而且阿拉依噶达称用到的石块和细绳很容易回收。这个团队试过用各种材料制作细绳，最终选择了一种用聚酯（一种塑料）增强的再生纤维纱。聚酯不容易腐烂，也可以回收利用，不过团队还是希望能找到有同样功效的生物材料。

他们这种编织筑路法的灵感来自苏黎世联邦理工学院（ETH）的格拉玛奇奥·科勒（Gramazio Kohler）建筑研究小组的成果。在乔治纳·卢塞诺娃（Gergana Ruseanova，如今在澳大利亚的斯威本科技大学）的带领下，那

个团队的一个项目曾以类似的方式建造了一个有11根柱子的类似巨石阵的结构。一个履带式机器人按几何图案布下120公里的细绳，再放上30吨碎石。最后建成的3米高的石柱堆稳稳地撑起了9吨重的盖顶石。

不过，阿拉依噶达提醒道，在编织筑路法能用作商业方案之前，还有一段路要走。他和同事们正在测试各种装置，并在电脑上模拟用不同的编绳图案来固定石头。之后他们会做更多测试，包括测试行进中车辆的车轮产生的滚动压力。

混凝土和沥青路面通常都不透水，并被铺成能让雨水流向路边排水沟的形状。如果水留在路面的裂缝中，就会形成坑洼，尤其是当水结冰时还会膨胀，就会撑开路面产生更多的裂缝。用细绳捆绑骨料能形成可渗水的路面，可能会减少坑洼。这么做可能还有其他好处。比如研究人员认为，多孔的道路可以让水更容易下渗到路面下的底土，减少道路大面积覆盖土地对当地水文的影响。就和织一件漂亮的羊毛开衫一样，成功将从设计一个好花样开始。■



Bartleby

Abolishing executive offices

The costs of office-less executives outweigh the benefits

IT IS A tradition of corporate architecture. A company's top executives get offices on the top floor, often dubbed the C-suite after the "chiefs" who occupy it. The CEO resides in the "corner office", with the biggest windows and best views. Junior staff suffer a few moments of trepidation when summoned upstairs.

Some heterodox bosses shun this tradition. Reed Hastings of Netflix has no office, corner or otherwise, and huddles at random desks, for example. Now more staid firms are following suit. Executives in the London offices of HSBC, a banking giant, will no longer be based on the 42nd floor of the group's Canary Wharf tower. Instead the floor will be converted into meeting rooms. Senior executives will "hot-desk" with everyone else.

A plausible argument for such a shift can be made. Staff morale would suffer if the rank-and-file are crammed in open-plan offices while the executives cling to cushy digs with panoramic vistas. When the top brass sit alongside their teams, they will be more in touch with how projects are going, and how staff are feeling. In theory, if the executives are visible, employees are more likely to approach them with problems.

But lingering bosses may equally hurt morale. One of the joys of office life is the freedom to enjoy a bit of banter with colleagues. This may include the odd crack about the management. In the presence of their boss staff will be constrained in what they talk about and the tone of their comments. They may feel the need to sound serious at all times, lest the quality of their commitment to their work come into doubt—after all, the manager may be

right behind them.

You also have to wonder whether executives will really spend every morning searching for a place to sit. Some hot desks will be a lot hotter than others. Once the chief financial officer has picked a desk on day one, deferential underlings will steer clear of that particular spot on subsequent days. In contrast, anyone who works closely with a particular executive will be tempted to pick a desk close by. The risk is of a “beach towels on sunbeds” syndrome where employees compete to get the desks nearest to (or farthest from) particular managers.

Of course, the executive may be absent from the open floor for extended periods. Any meeting that involves confidential information, such as a future business plan or a career review, will have to be held in private. So the meeting rooms that HSBC is creating on the executive floor may end up being block-booked by the managers for much of the day.

Even so, the lingering boss presents other problems. Anyone who has worked in an open-plan office will acknowledge that the babble of others talking can make it hard to concentrate at times. Managers may find themselves constantly being approached by team members with questions or problems for them to solve. Many people resort to headphones to shut out the background noise (and to signal their unavailability). But if managers do that, they run the risk of seeming shut off from their colleagues.

Studies of open-plan offices have shown that they do not create the hoped-for collaborative effects. One study found that at firms that switched to open-plan design face-to-face interactions fell by 70%. Like an animal caught on open ground without cover, many people do not like being constantly observed. In the absence of a physical barrier, they create a “fourth wall”, indicating their desire for solitude by facial expressions or curt replies to questions.

Where people do need to communicate, it is usually with members of their own team. So using a hot-desking system to mix up different teams, in the hope of creating collaboration, is unlikely to work either. People will avoid contact with their immediate neighbours and will message their other team members electronically.

In practice, the main benefit for companies of adopting an open-plan design is to save money by cramming more employees in the same space. This explains the willingness of some companies to allow working from home. Recently, HSBC revealed that more than 1,200 staff, mainly in call centres, would be doing so permanently. Indeed, the HSBC executive-office shift is part of a plan that aims to save 40% of head-office costs. As Noel Quinn, the bank's chief executive, told the Financial Times, the executive offices were empty half the time because the managers were travelling. As reporters are often told, the best way to understand what is really going on is to "follow the money". ■



巴托比

拆掉高管办公室

取消高管办公室会得不偿失

公司架构里有一个传统。高管的办公室要安排在顶楼，通常叫做“C-suite”，因为在这里办公的高管头衔里都有Chief这个词。为CEO安排的是“转角办公室”，窗户最大，视野最佳。下级员工被召上楼去见老板时，心里会有点打鼓。

一些喜欢打破常规的老板没有遵循这种传统。比如奈飞（Netflix）的里德·黑斯廷斯（Reed Hastings）就没有办公室，不只是没有转角办公室，连一般的办公室都没有，他总是随便找张桌子办公。现在，更多循规蹈矩的公司也纷纷效仿。银行业巨头汇丰在伦敦的管理层原本在位于金丝雀码头的大厦的42楼办公。该楼层将改造成多间会议室。高管们将和其他所有人一样，使用“公用办公桌”办公。

这种转变有一个看似合理的依据。如果普通员工都挤在大开间的办公室里，高管却占据全景视野的舒适单间，员工士气会受打击。如果领导层与他们的团队一起办公，就会更了解项目的进展和员工的想法。从理论上讲，在能看到高管时，员工更有可能会带着问题去找他们。

但是，老板总在附近可能同样会打击士气。办公室生活的乐趣之一就是可以和同事们打趣说笑，偶尔可能也会挖苦一下管理层。当老板在场时，员工就得注意谈话的内容和评论的语气。他们可能会觉得时时刻刻都得一本正经地说话，以免被怀疑自己工作不够投入。毕竟，上司可能就在身后。

你也一定会想，高管是否真的会每天早上花时间找位置。有些公用办公桌会比其他办公桌抢手得多。一旦首席财务官在上任头一天选了某张桌子，毕恭毕敬的下属在接下来的日子里就不会再去坐那个位置。相反，任何与某个高管合作密切的人都会想要选择领导边上的位置。这样可能就会出现类似于“用大毛巾占沙滩椅”的现象，也就是员工会争相抢占离某位主管最

近（或最远）的桌子。

当然，高管们可能很长时间都不会出现在开放式办公室里。像未来商业计划或员工评核等任何涉及机密信息的会议都必须保密进行。因此，最后可能出现的情形就是，汇丰银行在高管办公楼层改建的会议室大部分时间都被高管预订了。

即便如此，老板可能会时不时出现在身后还带来了其他问题。在开放式办公室工作过的人都会认同，其他人说话的嗡嗡声有时会让人难以集中注意力。高管可能会发现不断有团队成员来找他们请示或解决问题。很多人会戴上耳机来屏蔽背景噪音（同时也是发出不想被打扰的信号）。但如果高管这样做，可能就会给人拒同事于千里之外的感觉。

对开放式办公室的研究表明，它们并不会产生人们想要达到的协作效果。一项研究发现，在改为开放式办公的公司中，面对面的互动交流减少了70%。就像被困在没有遮盖物的空地上的动物一样，许多人都不喜欢总在别人眼皮底下的感觉。在没有任何实体隔离的情况下，他们砌起了“第四堵墙”，通过面部表情或简短生硬地回答问题来表明自己想要独处。

当员工真的需要沟通时，对象往往是自己团队的成员。因此，用公用办公桌来让不同团队混坐一起以期创造协作也不太可能奏效。人们会避免与坐在旁边的人打交道，并用电子设备向自己团队的成员发信息。

在实践中，在办公空间不变的情况下塞进更多员工能省钱，这是采用开放式办公的公司得到的主要好处。这也解释了为什么一些公司愿意让员工居家工作。汇丰最近透露将有1200多名员工（主要在呼叫中心工作）长期居家工作。事实上，汇丰计划将总部成本削减40%，改造高管办公室是该计划的一部分。首席执行官祈耀年（Noel Quinn）在接受《金融时报》采访时说，高管经常出差，他们的办公室一半时间都空着。正如记者们常听到的那样，了解真相的最好方法就是“从钱上着手”。■



Bit by bit

As bitcoin lurches, Wall Street plots its way into cryptoland

To work out the fate of crypto-investing, watch what the banks do next

CRYPTO BUFFS have had a punishing week. On May 13th Tether, which issues a “stablecoin” widely used to facilitate bitcoin trading, said that just 2.9% of its \$58bn-worth of coins is backed by cash reserves, feeding doubts about its dollar peg. Elon Musk, Tesla’s boss, tweeted that the electric-car maker would not after all accept payments in bitcoin. Then on May 18th China warned financial firms against servicing cryptocurrencies. The price of bitcoin tumbled to \$30,000, less than half its record high in April, before stabilising at around \$39,000.

As it cratered, bitcoin dragged most other cryptocurrencies with it. Several big crypto exchanges, including Coinbase, experienced lengthy outages. Investors unable to liquidate positions felt trapped; those willing to “buy the dip” felt cheated. The latest swing might raise doubts about whether crypto markets are liquid or even reliable enough to welcome institutional investors en masse. That is why it is worth looking to Wall Street.

America’s big banks have been venturing into cryptoland. In March Morgan Stanley became the first to offer wealthy customers access to bitcoin funds. Last month Goldman Sachs revived the crypto desk it had mothballed in 2017; Citigroup said it may offer crypto services. BNY Mellon and State Street are vying to administer bitcoin exchange-traded funds, currently under regulatory review in America. JPMorgan Chase, once adamant that it would steer clear unless cryptocurrencies began to be regulated, has hinted that it might start trading operations if the market expands.

Why are highly regulated banks wandering into the unregulated wilderness

of crypto? It helps that watchdogs in America have been setting out what services banks can provide. Last year the Office of the Comptroller of the Currency said they could offer custodial services for crypto assets. The Commodity Futures Trading Commission regards bitcoin and other digital currencies as commodities, enabling banks to trade derivatives linked to them.

The main reason for banks' enthusiasm, though, is obsessive interest from some customers. A year ago Itay Tuchman, Citigroup's foreign-exchange chief, hardly ever fielded calls on crypto from institutional clients. Now he receives them several times a week, he says. Roman Regelman of BNY Mellon deems the craze "an opportunity, but also an imperative". Wealthy clients are pulling money out of private banks, and retail punters out of current accounts, to bet on digital currencies through fintech firms and startups. Many would rather do everything with their banks, which, in turn, hope to reap the rewards in customer fees and data.

Perhaps the easiest service to offer is derivatives trading, as Goldman now does, providing clients with exposure to the assets without having to buy them. Then comes custody: the storage, and related book-keeping, of assets on behalf of big investors. This requires investing in technology; the few banks already selling custody subcontract tasks to specialist firms.

But it is the next level of services, where banks hold digital assets on their balance-sheets, either as collateral or by trading in spot markets, that is currently beyond reach. After a day like May 19th, when bitcoin lost nearly a third of its value in a few hours, regulators may ensure it stays that way. Even if banks do not trade directly, says Chris Zuehlke of Cumberland, a Chicago-based firm that helped Goldman execute its first big "block" trade of crypto futures on May 6th, they could still connect clients to large spot traders, acting as the shopfront but relying on the infrastructure, and balance-sheets, of others.

Banks insist that most clients expect a rollercoaster ride. But a prolonged rout could still scare off prospective converts and trigger a regulatory crackdown. Wall Street has an unrivalled ability to bring liquidity and distribution muscle to new assets. Anyone wanting to work out the fate of crypto-investing might do well to see what the banks do next. ■



步步为营

比特币暴跌之际，华尔街探入加密地域

欲知投资加密货币命运如何，且看银行后续动作

加密货币发烧友度过了被暴击的一周。5月13日，发行一种广泛用于促进比特币交易的“稳定币”的Tether公司表示，它持有的价值580亿美元的稳定币中只有2.9%有现金储备支持，这让人们怀疑它的稳定币能否盯住美元。电动汽车制造商特斯拉的老板马斯克在推特上表示，特斯拉将不再接受比特币付款。之后在5月18日，中国警告金融公司不要提供加密货币相关服务。比特币价格一度暴跌至3万美元，不到4月历史高位的一半，之后保持在约3.9万美元。

比特币崩盘，其他大多数加密货币也随之崩溃。包括Coinbase在内的几家大型加密货币交易平台都经历了长时间的交易中断。无法平仓的投资者感到被套住了；那些乐于“逢低买入”的人觉得自己受骗了。最近的波动可能会让人怀疑加密货币市场是否具有足够的流动性，甚至是否足够可靠，能让机构投资者集体入场。因此就值得来看一看华尔街的动向。

美国的大银行已经在探入加密货币领域。今年3月，摩根士丹利率先向富裕客户提供比特币基金。5月，高盛重启了在2017年搁置的加密货币交易团队；花旗集团表示可能会提供加密货币服务。纽约梅隆银行（BNY Mellon）和道富银行（State Street）正在竞相管理比特币的交易所交易基金（ETF），目前这类基金正在美国接受监管审查。摩根大通曾坚定地表示，除非加密货币开始受到监管，否则不会涉足这一块，但现在它已经暗示，如果市场扩大，它可能会开设交易业务。

为什么被高度监管的银行会踏入尚未受监管的加密货币狂野西部？美国的监管机构一直在明确规定银行能够提供的服务，这是一个有利因素。去年，美国货币监理署（Office of the Comptroller of the Currency）表示，银行可以为加密货币资产提供托管服务。美国商品期货交易委员会

(Commodity Futures Trading Commission) 将比特币和其他数字货币视为大宗商品，允许银行交易与之挂钩的衍生品。

不过，银行如此热情主要是因为有些客户对加密货币兴趣高涨。一年前，花旗集团的外汇业务主管伊塔伊·塔奇曼 (Itay Tuchman) 几乎从未接到过机构客户来电询问加密货币事宜。现在，他说他每周都会接到几通这样的电话。纽约梅隆银行的罗曼·瑞格尔曼 (Roman Regelman) 认为，这一热潮“是机遇，也是急务”。富有的客户正从私人银行撤资，散户取出活期账户里的存款，通过金融科技公司和创业公司押注数字货币。许多人宁愿在银行办理所有业务，反过来，银行也希望从客户服务费和数据中获利。

最方便提供的服务可能是衍生品交易，就像高盛正在做的，它让客户能有机会投资这种资产而又无需购买它们。然后是托管：代表大投资者保管资产并做相关簿记。这需要对技术投资，所以这一小批银行已经将托管分包任务出售给了专业公司。

但是，下一个级别的服务，也就是银行在自己的资产负债表上持有数字资产，无论是作为抵押品还是通过在现货市场上交易，目前还无法企及。5月19日比特币在几小时内贬值了近三分之一，在经过了这样的一天后，监管机构可能会确保银行业务不超越现状。芝加哥公司Cumberland的克里斯·齐尔克 (Chris Zuehlke) 说，即便银行不直接交易，它们还是可以帮助客户与大型现货交易商对接，充当一站式店面，但依靠其他机构的基础设施和资产负债表。Cumberland在5月6日帮助高盛执行了首笔“大宗”加密货币期货交易。

银行坚称大多数客户预期会有过山车式的行情。但长久的溃败还是有可能吓跑潜在的客户，并引发监管机构的打压。在为新资产带来流动性和分销实力方面，华尔街无可匹敌。任何人要想知道加密货币投资的命运，不妨看看银行下一步会怎么做。 ■



Forest bump

The wood-products industry is undergoing root-and-branch change

Ever more money grows on trees

IN THE BUCOLIC low-rise surroundings of Norway's biggest lake, Mjostarnet stands out. At 85 metres tall, this building of flats, offices and a hotel, completed in 2019, is Norway's third-tallest. It is the highest in the world built of wood. Similar structures have sprung up in other countries. So, in many more places, have wooden additions to existing buildings, which weigh around a fifth of what an equivalent steel-and-concrete one would, and therefore risk less damage to the building below.

Mjostarnet stands as a proud example of wood's comeback after a century of steel, concrete and plastic. Global exports of forest products, including sawn wood, pulp and paper, grew by 68% between 2000 and 2019, to \$244bn. Demand is reaching redwood-like heights, fertilised by a pandemic DIY boom. Having ranged between \$200 and \$400 for much of the past decade, the price of 1,000 square feet of one-inch-thick timber has exceeded \$1,400—and hoisted the share prices of wood producers up with it. The stockmarket value of many big ones such as Weyerhaeuser has roughly doubled in the past year; the American giant is now worth \$30bn.

Mark Wilde of the Bank of Montreal expects more saw mills to come online in response. They will be different to those of the past, for the industry is also undergoing root-and-branch changes.

The first is the collapse in demand for commercial printing over the past 15-20 years. This has led to consolidation in paper production. Many paper mills have been converted to manufacture packaging, preferred by consumers who worry about plastic's environmental impact. Some big

European wood firms, such as Metsa of Finland, have abandoned print paper (it still makes cardboard and tissues). After shutting two mills this year, Stora Enso, which is also Finnish, will derive 10% of revenue from print paper, down from 70% a decade ago. The rest will come mainly from pulp, packaging and fibre products.

The second, related change is technology-enabled diversification. Most mills already manufacture wood products on top of selling lumber. In modern ones, saws slice three-quarters of a tree into planks, and chop the rest into chips that can be turned into wood-based composites. Because the forest business reflects the decades-long sylvan lifecycle, this 40-year-old “chip-n-saw” technique is only now enjoying widespread adoption. It works best on trees with a diameter of 25cm, compared with 40cm for traditional bandsaws, and so lets forest owners sell or, if they are vertically integrated with mills, use their trees 20-30 years earlier than in the past.

Greater harvesting efficiency is now combining with newer techniques to expand the range of wood products. Metsa is turning waste lignin, a natural polymer which gives trees their rigidity, into textiles for clothing and furnishings. UPM, another Finnish company, has worked out how to turn “black liquor”, a gloop left over from paper manufacturing, into biofuels and other chemicals. It will open a refinery in Germany—the first of its kind anywhere—next year. It is already making wound dressings and a cell-culture medium from wood nanofibres to rival agar jelly. There is talk of climbing higher up the value chain to planning and design. All this will prove a handy scaffold when lumber prices come back down to earth. ■



万木争荣

木制品行业正在发生根本性的变化

树上生钱，更胜以往

在挪威最大的湖区，建筑低矮，一片田园风光，米约萨塔（Mjostarnet）在其中如鹤立鸡群。这座2019年完工的建筑高85米，内有公寓、写字楼和酒店，是挪威第三高的大楼。它是世界上最高的木结构建筑。类似的木结构建筑在其他国家也不断涌现。而在更多地方，人们是在现有建筑上添加了木结构部分，这种结构的重量约是钢筋混凝土对等结构的五分之一，因此损坏下方建筑的风险更小。

在钢铁、混凝土和塑料风行了一个世纪后，米约萨塔成为木材卷土重来的傲人范例。从2000年至2019年，全球林产品（包括锯木、纸浆和纸张）出口增长了68%，达到2440亿美元。受到DIY大行其道的推动，对木材的需求像参天大树一样直冲云霄。在过去10年的大部分时间里，1英寸厚1000平方英尺的板材价格一直在200美元到400美元之间波动，而现在已经超过1400美元，木材生产商的股价也随之拉高。许多像惠好（Weyerhaeuser）这样的大型木材生产商的股票市值过去一年几乎翻了一番；惠好这家美国巨头的市值现在达到300亿美元。

蒙特利尔银行（Bank of Montreal）的马克·王尔德（Mark Wilde）预计将有更多企业顺势加入这个行业。它们将不同于传统的木材生产商，因为这个行业也在经历根本性的变化。

首先是过去15年到20年间对商业印刷的需求崩塌。这导致了造纸业的整合。许多造纸厂已转而生产包装材料——消费者因为担心塑料对环境的影响，变得更偏好纸质包装。一些欧洲大型木材公司，比如芬兰的Metsa，已不再生产印刷纸张（它仍在生产硬纸板和纸巾）。在今年关闭了两家工厂后，同样来自芬兰的斯道拉恩索公司（Stora Enso）从生产印刷纸张获得的收入将占10%，远低于十年前的70%。剩下的收入将主要来自纸浆、

包装和纤维制品。

第二个相关的变化是因技术发展而出现的多样化。除了销售板材，大多数工厂已经在生产木制品。在现代化工厂里，锯木设备把一棵树的四分之三锯成板材，剩下的切成薄片，可以用来制作木质复合材料。因为林业要顺应森林数十年的生命周期，所以这种面世已有40年的“削片锯木联合”技术到现在才得以广泛应用。它在直径25厘米的树木上效果最好，而传统的带锯机适用于直径40厘米的树木。这样一来，林场主就能比过去提前20年到30年出售林木，或者加工它们——如果他们和木材厂垂直整合了的话。

采伐效率提高了，再加上现在有了更先进的技术，木制品的范围得以扩大。Metsa正在将废弃的木质素——一种决定树木刚性的天然聚合物——转化为做服装和装饰材料用的纺织品。芬兰另一家公司芬欧汇川（UPM）已经找到了将“黑液”（造纸过程中留下的黏液）转化为生物燃料和其他化学品的方法。该公司明年将在德国开设一家全球前所未见的精炼厂。它已经在用木质纳米纤维生产伤口敷料和细胞培养基，和琼脂凝胶竞争。业内还有人在谈论要攀爬到价值链的上端，介入规划和设计。等到木材价格大幅回落时，所有这些就会构成一个好用的脚手架。■



Monster merger

The Warner-Discovery deal and the future of streaming

To survive online, media firms are combining

ONE OF THE biggest hits of recent years on Discovery's cable television network is "90 Day Fiancé", a reality show that follows the fortunes of couples in America on K-1 visas. A condition of the visa is that the pair must marry within three months, or else leave the country. Many of the show's romances are rocky. But the couples—and riveted viewers—realise that, unless they tie the knot in time, deportation awaits.

On May 17th Discovery announced that it was to form a marriage of necessity of its own, joining forces with WarnerMedia, which is to be spun off from its owner, AT&T, a telecoms giant. Combined, the two companies will form the world's second-largest media group by revenue, behind only Disney. Their hope is that this scale will allow them to survive an existential battle for viewers that makes "Godzilla vs. Kong" look like cautious cuddling.

The announcement is a Hollywood plot twist for show business. It has already caused speculation about further mergers, as panicked media companies seek their own partners before it is too late. Some may already have missed their moment.

At first sight Warner and Discovery make an odd couple. The first specialises in high-quality TV series and films, such as "Game of Thrones" or the Godzilla-Kong saga, whereas the second serves up cheap factual fare. Yet their different programming, and the sheer quantity of it, ought to help them appeal to a wider audience. The \$19bn that the two spent on content last year was more than either Disney or Netflix (see chart). The new firm

will also have the biggest share of American cable viewers. Its channels accounted for 29% of viewing time last year, according to MoffettNathanson, a research firm, which expects it to use its heft to negotiate better affiliate fees and ad rates. The merged firm expects to save \$3bn a year in costs.

For AT&T, the deal represents an admission that its expensive foray into entertainment has flopped. It bought Time Warner in 2016 at an enterprise value of \$110bn, later changing its name to WarnerMedia. The previous year it had purchased DirecTV, a satellite-television firm, at an enterprise value of \$67bn. The idea was to vertically integrate the businesses of content creation and distribution. But the liaison proved an unhappy one. And while regulators delayed the Time Warner acquisition by two years, Disney and other rivals gained ground.

In February AT&T began to unwind its position, spinning out DirecTV in a deal that valued the division at just \$16bn. By hiving off WarnerMedia it will receive the equivalent of \$43bn upfront, in a mix of cash, securities and transferred debt. As well as this, AT&T shareholders will own 71% of the new company, with Discovery's shareholders getting the rest. The deal values WarnerMedia at about \$100bn, meaning that under AT&T its value has stagnated even as other media giants grew fast.

The new company is to be run by Discovery's boss, David Zaslav, leaving no place for Jason Kilar, who was hired a year ago to run WarnerMedia. Mr Kilar, whose background is in technology, had gone all out to push HBO Max, Warner's streaming service. In December he said that all of this year's releases from the Warner Bros studio would be available for streaming at the same time that they entered cinemas. Hollywood traditionalists were scandalised; many now feel some satisfaction. "AT&T backstabs its own hatchet man" ran a headline in Variety, an industry magazine.

The shotgun wedding may be awkward, but it is necessary. Competition in streaming, already brutal, is about to become more so. The lockdowns of 2020 provided a captive audience. Total media-consumption time increased by 12% between the second and fourth quarters of last year, according to a nine-country survey by MIDiA Research, a firm of analysts. The average American household subscribed to four streaming services. As the world opens up people will spend less time in front of the box. Consumer spending on video media shrank by 2% year on year in the first quarter, according to GroupM, a giant in the business of placing adverts on behalf of clients. In recent weeks Netflix and Disney, the leading streamers, have both missed forecasts for subscriber growth.

To compete in this environment, says Michael Nathanson of MoffettNathanson, a streaming service needs four things: scale at home, high-quality content, a flexible balance-sheet to pay for it and, to help spread the costs, the ability to expand globally. With a compelling catalogue and a solid presence in America, HBO Max ticks the first two boxes. But AT&T's sickly balance-sheet has made it hard to keep up with the likes of Netflix in spending on shows. And having chosen to license content to distributors in other countries, such as Sky in Britain, rather than set up shop abroad, its international footprint is puny.

The Discovery deal helps to tackle both of these problems. Warner will no longer be beholden to AT&T's balance-sheet, although the new firm will start life with hefty debts of its own. And Discovery+ is already up and running in Europe and India. This earns the combined company a place in the top tier of streamers, alongside Netflix, Disney and Amazon, says Mr Nathanson. Amazon is looking to shore up its position, and is reportedly in talks to buy Metro-Goldwyn-Mayer (MGM), the studio behind the James Bond films, for \$9bn. Last year it spent \$11bn on video and music content, 40% more than in 2019. With 175m viewers it is not far behind Netflix's tally of 208m—though many rarely watch, subscribing instead for shopping

discounts and other benefits.

Where does that leave the rest? Some are scrambling to form mergers of their own. On the same day that the Warner-Discovery deal was announced, two big French broadcasters, TF1 and M6, said they would join forces, arguing that together they could provide an “ambitious French response” to competition from international streamers. The deal must first satisfy regulators; the two firms control three-quarters of the French TV-advertising market. Brian Wieser of GroupM expects more consolidation in Europe. He highlights BritBox, owned by Britain’s BBC and ITV, and TVNow, owned by RTL, a European group, as services that will require considerably bigger investments if they are to be truly competitive.

Of the larger American firms, Apple TV+ has yet to take off, despite giving away subscriptions left, right and centre (more than 60% of its 40m or so users are reckoned to be on free trials). It has not registered any big hits so far, but it has oodles of cash with which to buy some if it chooses; Apple executives reportedly looked at MGM before Amazon swooped in.

NBCUniversal, which is owned by Comcast, a cable giant, and last year launched its Peacock streaming service, and ViacomCBS, which recently unveiled its own equivalent, Paramount+, are in a sticky position. Their competing television interests would make it difficult for them to merge. They could buy other media properties that have not already been snapped up, such as AMC Networks, which owns several entertainment channels, or Lionsgate, the studio behind films like “The Hunger Games” and TV shows like “Mad Men”. But none of these assets alone would help a company to leap to global scale. Those that have not already arranged their nuptials may face the corporate equivalent of unceremonious deportation. ■



巨兽联合

华纳与探索合并以及流媒体的未来

为在线上存活下来，媒体公司纷纷联姻

在探索公司（Discovery）的有线电视网络上，近年最受欢迎的节目之一是《90天未婚夫》（90 Day Fiancé），这档真人秀追踪在美国持K-1签证的情侣的命运。K-1签证的条件之一是他们必须在三个月内结婚，否则必须离开美国。节目中许多情侣的恋情发展都不怎么顺利。但他们和看得入迷的观众都明白，除非及时完婚，否则等着他们的就是驱逐出境。

5月17日，探索宣布它自己必须要成婚了。它将与华纳媒体（WarnerMedia）合并，后者会先从母公司、电信巨头AT&T里分拆出来。两家合并后将形成全球收入第二高的媒体集团，仅次于迪士尼。它们希望这样的规模能让自己在攸关生死的观众争夺战中活下来——这场大战的激烈程度让《哥斯拉大战金刚》也显得只是小打小闹。

对影视行业而言，这个消息就像好莱坞影片中的剧情转折点。它已引发了将出现更多并购的猜测，因为惊慌失措的媒体公司争相寻求自己的合作伙伴，生怕为时已晚。一些公司可能已经错失良机。

乍看之下，华纳和探索的联姻有点奇怪。前者擅长制作《权力的游戏》或《哥斯拉大战金刚》这类高质量的电视剧和电影，后者则是制作低成本的纪实节目。然而，它们风格不同而数量庞大的节目应该有助于吸引到更多观众。去年，这两家公司在内容上的支出合计190亿美元，高过迪士尼或奈飞（见图表）。合并后的新公司将拥有最多的美国有线电视观众。据研究公司莫菲特内森（MoffettNathanson）估计，它们旗下的电视频道占据了去年29%的收视时间，它还预计新公司将利用它的规模谈判更高的联署营销费和广告费。合并后的新公司预计每年可节省30亿美元的成本。

这次合并意味着AT&T承认自己花费高昂的娱乐业探险已告失败。AT&T在

2016年以1100亿美元的企业价值收购了时代华纳，后来将其更名为华纳媒体。此前一年，它以670亿美元的企业价值收购了卫星电视公司DirecTV。这么做是为了垂直整合内容创作和发行。但事实证明这段联姻并不美满。而且对时代华纳的收购因等待监管机构批准而延迟了两年，在此期间迪士尼和其他竞争对手趁机抢占了市场。

2月，AT&T开始“割肉”，以仅160亿美元的估值剥离了DirecTV。通过剥离华纳媒体，AT&T将获得包括现金、证券和转让债务在内总值430亿美元的付款。除此以外，AT&T的股东将拥有新公司71%的股份，探索的股东将获得其余股份。在这次交易中，华纳媒体的估值约为1000亿美元，也就是说在其他媒体巨头快速增长之时，在AT&T旗下的华纳媒体的价值却停滞不前。

新公司将由探索的老板大卫·扎斯拉夫（David Zaslav）掌管，而没有交给一年前受聘职掌华纳媒体的杰森·基拉尔（Jason Kilar）。技术出身的基拉尔此前不遗余力地推动华纳的流媒体服务HBO Max。他在去年12月表示，华纳兄弟影业2021年发行的所有影片将在电影院和自家流媒体上同步上映。这让好莱坞的传统派深感震惊，现在他们中的许多人多少感到满意了。行业杂志《综艺》（Variety）打出大标题“AT&T摆了它的前台打手一道”。

仓促成婚或许叫人尴尬，但也着实必要。在流媒体这一块的竞争目前已经很残酷，而且还会加剧。2020年的封城措施催生了一批坐困家中的忠实观众。分析公司MIDiA Research一项对九个国家的调查显示，去年第二季度到第四季度之间媒体消费总时长上升了12%。美国家庭平均订阅四个流媒体服务。随着全球逐步解封，人们坐在屏幕前的时间将减少。广告业巨头群邑（GroupM）的数据显示，消费者的视频媒体支出在第一季度同比缩减了2%。最近几周，流媒体巨头奈飞和迪士尼的订户增长均未达到预期。

莫菲特内桑森的迈克尔·内桑森（Michael Nathanson）指出，要在这种环境里竞争，一款流媒体服务需要四样东西：本土规模、高质量内容、能为

内容买单的灵活的资产负债表，以及能帮助摊薄成本的全球扩展能力。凭借精彩丰富的节目库和在美国市场的稳固占有率，HBO Max满足了前两样。但AT&T羸弱的资产负债表让它在节目投入方面难以跟上奈飞等公司。由于它选择把节目授权给其他国家的发行商，如英国的天空电视台，而不是在海外设立分公司，其国际业务相当薄弱。

与探索合并有助于解决这两个问题。华纳将不再受制于AT&T的资产负债表，尽管新公司一成立就会背上巨债。而探索的流媒体服务Discovery+已经在欧洲和印度运作，这使合并后的公司得以跻身顶级流媒体公司，与奈飞、迪士尼和亚马逊处在同一梯队，内桑森表示。亚马逊希望巩固自己其中的位子，据说正在谈判以90亿美元的价格收购曾打造詹姆斯·邦德系列电影的电影公司米高梅。去年亚马逊在视频和音乐内容上花费了110亿美元，比2019年多40%。亚马逊拥有1.75亿订阅观众，与奈飞的2.08亿相差不远，不过其中很多人并不怎么收看节目，订阅是为了购物折扣和其他好处。

那么剩下的媒体公司要怎么办？有些正急着找人联手。在华纳媒体和探索宣布合并的同一天，TF1和M6这两家大型法国广播公司表示将联合起来，这样就能以“宏大的法国对策”抗衡来自国际流媒体的竞争。这一合并首先必须满足监管机构的要求，毕竟这两家公司控制着法国电视广告市场四分之三的份额。群邑的布莱恩·威泽（Brian Wieser）预计欧洲会出现更多整合。他特别提到由英国广播公司和独立电视台（ITV）联合推出的BritBox，以及欧洲企业集团RTL旗下的TVNow，因为这些平台将需要大大加大投资才可能真正具备竞争力。

而在规模更大的美国公司中，苹果的流媒体服务Apple TV+尽管在到处赠送订阅（据信约4000万用户中超过60%是在免费试用），但其业务尚未起飞。它至今没推出过什么大热之作，但它有大量资金，如果愿意的话可以买一些来——据称在亚马逊突然出手之前，苹果高管曾考虑收购米高梅。

有线电视巨头康卡斯特（Comcast）旗下的NBC环球（NBCUniversal）去

年推出了流媒体服务Peacock，维亚康姆CBS（ViacomCBS）最近也推出了自家的同类服务Paramount+。但两者处境尴尬。这两家公司在电视业务上是竞争对手，因而难以合并。它们可以收购其他尚未被哄抢的媒体资产，比如拥有多个娱乐频道的AMC Networks，或制作过《饥饿游戏》（The Hunger Games）等电影和《广告狂人》（Mad Men）等剧集的狮门影业（Lionsgate）。但仅凭这些资产并不能让一家公司一举具备全球规模。那些尚未安排联姻的公司可能将面临粗鲁的驱逐。■



Every last drop

How to get all the toothpaste out of the tube

With a super-slippery surface

A GNARLED TOOTHPASTE tube, squeezed and twisted out of shape in a vain attempt to extract its remaining contents, haunts many a bathroom. But not, perhaps, for much longer. Colgate-Palmolive, an American consumer-goods giant, has taken up an invention by a pair of experts in super-slippery surfaces to produce toothpaste tubes that promise to deliver every last scrap of their contents.

In 2012 Kripa Varanasi, a professor at the Massachusetts Institute of Technology, and Dave Smith, his PhD student, set up a company called LiquiGlide to commercialise their work on making liquids flow more easily through pipes and out of containers. What caught many people's imaginations at the time was a demonstration of how this could be used to empty a ketchup bottle without shaking it vigorously.

So far, ketchup-makers have not embraced the idea. But the health and beauty industry, where products tend to be pricier than ketchup, is interested. Mibelle Group, a Swiss producer of health-care and beauty products, employs the technology to lessen the amount of material left stuck to the insides of pipes and vessels in its factories when it is time for a clean-up. LiquiGlide's deal with Colgate is, though, the firm's first big break into a consumer business.

The new toothpaste, called Elixir, comes in three varieties: a formula for whitening teeth, one for gum and enamel care and a "detox" version which, it is claimed, removes impurities from the mouth. All are packaged in plastic tubes that can be emptied with ease. Elixir has gone on sale in

Europe, though no decision has yet been made about whether it will be sold elsewhere.

To produce their slippery pipes and containers, Dr Varanasi and Dr Smith first impose a microscopically textured pattern on them and then apply a suitably formulated liquid. This fills the gaps in the texture, creating a surface across which gooey substances slide easily. Any risk of contamination can be eliminated by making the liquid in question from materials also employed in the product.

Besides pleasing customers who like to get their money's worth, the new, slippery toothpaste tubes should help with recycling. Existing tubes are rarely recycled, not only because they have residue left inside them but also because they are usually made from a laminate of plastic and aluminium foil. Mixed materials of this sort are hard to recycle, and therefore end up being dumped in landfill, or incinerated.

Despite their success with toothpaste, Dr Varanasi and Dr Smith have not given up on food producers. Besides ketchup, their slippery surfaces also aid the dispensing of products such as mayonnaise, and may help, too, with things like hummus and soured cream that have a thicker consistency and which usually come in tubs. They have, for instance, carried out a trial putting cream cheese into a squeezy bottle with a slot-shaped dispenser. "You get this perfect strip of cream cheese right on your bagel," enthuses Dr Smith. ■



一滴不剩

如何把牙膏挤干净？

用一种超光滑的表面

皱巴巴的牙膏管是许多浴室里挥之不去的难题。就算挤到扭曲变形，也别想把里面的残留物都弄出来。不过，这一幕可能很快将不复存在了。美国消费品巨头高露洁棕榄采纳了两位研究超光滑表面的专家的发明，生产出的牙膏管承诺能把牙膏挤得一滴不剩。

麻省理工学院教授克里帕·瓦拉纳西（Kripa Varanasi）和他指导的博士生戴夫·史密斯（Dave Smith）研究如何让液体更容易通过管道和流出容器。他们在2012年成立了一家名为LiquiGlide的公司，寻求把研究成果商业化。当时他们的展示令许多人大感兴趣：使用了他们的技术后，无需用力摇晃就能把瓶子里的番茄酱倒空。

到目前为止，还没有哪家番茄酱制造商欣然接受了这个创意。健康和美容行业倒是很感兴趣，因为这两个行业的产品往往比番茄酱更贵。瑞士保健和美容产品生产商米百乐集团（Mibelle Group）采用了这项技术，以减少在做清理时粘附在工厂管道和容器内部的物质。不过，与高露洁达成为交易是LiquiGlide进军消费业务的首个重大突破。

高露洁的新款牙膏名叫Elixir，配方有三种类型，一种用于美白牙齿，一种用于牙龈和牙釉质的护理，还有一种是“排毒”版，号称可以去除口腔污物。它们所用的包装都是可以轻松挤干净的塑料管。Elixir已经在欧洲上市，不过高露洁还没决定是否也会在其他地方上架。

为了制造出超顺滑的管道和容器，瓦拉纳西和史密斯首先在它们的内壁打造出极其细微的凹凸纹理，然后再加入一种配方得当的液体。这种液体会填补纹理间的空隙，从而形成一个能让粘稠物质轻松滑过的表面。这种液体可以用容器内装载的产品用到的原料来制造，这样就可以完全消除污染的风险。

这种新型超顺滑牙膏管除了能让那些不喜欢白白浪费钱的顾客开心，应该还有助于废物利用。现有的牙膏管很少被回收，不仅是因为里面有残余物，还因为它们通常是由一层塑料和铝箔制成。这种混合材料很难回收，因此最终会被扔到垃圾填埋场或者焚烧。

尽管已经把牙膏拿下，但两人并没有放弃食品生产商。除了番茄酱，他们的光滑表面还能帮人们更畅快地涂抹蛋黄酱等产品。还有鹰嘴豆泥和奶油油之类更粘稠和通常用盒子装的产品或许也用得着。例如，他们做了一次试验，把奶油芝士装进一个可以挤的、带有槽状挤出口的瓶子里。“你可以在百吉饼上挤出完美的一圈奶油芝士。”史密斯兴奋地说。 ■



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The global chip shortage is here for some time

Microchips were a boom-and-bust industry even before covid-19

FOR WANT of a chip, the factory was lost. On May 18th Toyota became the latest carmaker forced to cut production amid a global shortage of microchips, announcing it would suspend work at two of its plants in Japan. Firms including Ford, General Motors and Jaguar Land Rover have also had to send workers home.

The pain is not confined to the car industry, for the shortage spans all sorts of chips, from the expensive, high-tech devices that power smartphones and data centres to the simple sensors and microcontrollers that have become a vital commodity, scattered across everything from cars to washing machines, and often costing just a few cents each. In the past few weeks companies including Foxconn, Nintendo and Samsung have warned of hits to production, affecting everything from smartphones and games consoles to televisions and home broadband routers.

Governments are worried. America's called a summit in April; another is due on May 20th. Germany's finance minister has written to the government of Taiwan, where many chipmakers are based, lobbying for priority for carmakers. A report from Gavekal Research, a consultancy, published on May 4th, said the shortage might soon hit export performance in several East Asian economies. But there is little that ministers can do. The chip drought is the result of the covid-19 pandemic interacting with an industry that is notoriously prone to cycles of boom and bust. It is likely to persist for months, if not years.

“The most important thing [to recognise]”, says Malcolm Penn, who runs

Future Horizons, a chip-industry consultancy, “is that shortages are a natural part of the industry.” Chipmaking, he says, is a good example of what economists call a “pork-cycle” business, named for the regular swings between under- and over-supply first analysed in American pork markets in the 1920s. As with pigs, the supply of chips cannot quickly react to changes in demand. Capacity was tight even before the pandemic, says Mr Penn, pointing out that investment by chipmakers in factory equipment has been below its long-term average for many years (see chart).

The pandemic thus arrived at the worst possible time. After an early crash, demand in several segments boomed, says Alan Priestley of Gartner, another consultancy. Locked-down consumers bought laptops and other gadgets. Cloud-computing operators, which are big consumers of high-end chips, scrambled to add servers to deal with the wave of home-workers. The car industry was particularly badly hit by a decision to cut orders early in the pandemic. Demand for cars has since recovered. But the complexities of the production process means it takes three to four months to turn a blank silicon wafer into a usable batch of chips. “I can cancel my orders in an afternoon,” says Mr Penn. “If I want to start them up again, that takes months—and anyway, that capacity is now busy serving other customers.”

The impact of the pandemic, in turn, has been made worse by industry-specific problems. In March a chip plant owned by Renesas, a Japanese firm, caught fire, piling pain on the car industry. Some chipmakers, meanwhile, face shortages of their own. Many cheap, workaday parts are made in older factories designed to process silicon wafers that are 200mm in diameter, or even smaller. (These days 300mm is the standard.) Efforts to boost capacity are stymied by the fact that few toolmakers still make the old-style machines, says Mr Priestley. The market for second-hand 200mm tools, meanwhile, has been stripped bare.

But the pork cycle is turning once again. Taiwan Semiconductor Manufacturing Company, the world's biggest contract chipmaker, plans to spend \$30bn on new capacity this year alone. Samsung Electronics and Intel, two other giants, have pencilled in \$28bn and \$20bn respectively; second-tier chipmakers are ramping up spending too. That will bring relief to the wider economy, says Mr Priestley, but not immediately. On May 14th Jim Whitehurst, the boss of IBM, a computer-maker, said he thought the shortages might last for two years. And, says Mr Penn, when the drought eventually ends, chipmakers may find they face a familiar problem, but on a bigger scale: a capacity splurge in response to serious shortages today could well mean a sizeable glut tomorrow. ■



加载中，请稍等

全球芯片短缺将持续一段时间

早在疫情之前，微芯片就是个盛衰交替的周期性行业

芯片不够了，工厂一筹莫展。5月18日，在全球微芯片短缺之际，丰田成为最新一家被迫减产的汽车制造商，宣布将让日本的两家工厂停工。福特、通用汽车和捷豹路虎等公司此前也已不得不先让工人回家。

头痛的不止汽车产业，因为这次短缺涉及各类芯片，从驱动智能手机和数据中心的昂贵高科技设备，到已成为重要日常用品的简单传感器和微控制器。后者广泛应用于汽车和洗衣机等各种产品，单个成本往往仅需几美分。过去几周，包括富士康、任天堂和三星在内的公司都发出了生产受到冲击的警告，从智能手机、游戏机，到电视和家庭宽带路由器的各种商品都会受影响。

各国政府感到担忧。美国在4月召开了一场峰会，5月20日又举行了一场。德国财政部长已向众多芯片制造商所在的台湾地区的政府致函，游说其优先为汽车制造商供应芯片。咨询公司龙洲经讯（Gavekal Research）在5月4日发布的一份报告称，芯片短缺可能很快会影响几个东亚经济体的出口表现。但部长们对此也束手无策。这次芯片短缺是新冠疫情和一个以兴衰周期闻名的行业相互作用的结果。它很可能会持续数月，甚至数年。

芯片业咨询公司Future Horizons的老板马尔科姆·佩恩（Malcolm Penn）说，“[需要认识到的]最重要的一点是，短缺是这个行业的一个自然组成部分。”他说，芯片制造是经济学家称之为“猪周期”生意的一个很好的例子。上世纪20年代，经济学家首度分析了美国猪肉市场供应不足与供应过剩之间的规律性波动，这个名词由此而来。和猪肉的供应一样，芯片供应无法对需求的变化迅速作出反应。佩恩说，即使在疫情之前，产能也很紧张。他指出，芯片制造商对工厂设备的投资多年来一直低于其长期平均水平（见图表）。

这么说来，疫情发生的时间不能更糟了。另一家咨询公司高德纳（Gartner）的艾伦·普里斯特利（Alan Priestley）表示，在经历了一开始的崩盘后，有几个领域需求激增。被疫情封锁在家的消费者纷纷购置笔记本电脑和其他电子小设备。作为高端芯片的消费大户，云计算运营商忙不迭地添置服务器以应对居家工作者激增。汽车行业在疫情初期决定削减芯片订单，这让它受到的冲击尤其严重。自那以后对汽车的需求已经逐渐恢复，但生产过程的复杂性意味着将一张空白硅片变为一组可用的芯片需要三到四个月的时间。“我取消订单只需一个下午，”佩恩说，“如果我想恢复它们，得花几个月——再说了，这些产能这会儿正忙着服务其他客户呢。”

疫情的影响反过来又因为行业特有的一些问题而加剧。3月，日本公司瑞萨科技（Renesas）旗下的一家芯片厂失火，令汽车行业雪上加霜。与此同时，一些芯片制造商自身也面临短缺问题。许多廉价的普通零部件都产自老式工厂，当初建这些工厂就是为了加工直径200毫米或以下的硅片。

（现在的标准是300毫米。）普里斯特利说，现在还在生产这类老式机器的工具制造商已经寥寥无几，所以芯片工厂也没办法提高产能。同时，二手市场上生产200毫米硅片的机器早已断货。

但猪周期正再度转向。全世界最大的芯片代工厂台积电仅今年就计划在新产能上投入300亿美元。另外两家巨头三星电子和英特尔分别计划投入280亿美元和200亿美元。二线芯片制造商也在加大投入力度。普里斯特利说，这将为更广泛的经济缓解压力，但不会立竿见影。5月14日，计算机制造商IBM的老板吉姆·怀特赫斯特（Jim Whitehurst）说他认为短缺可能会持续两年。而且，佩恩表示，等到短缺最终结束时，芯片制造商可能会发现自己面对一个熟悉的问题，只不过规模会更大：今天为严重短缺而大幅增加产能，很可能会导致明天严重过剩。■



Formula races

Alibaba v Tencent: the battle for China's e-commerce deliveries

When it comes to logistics, Chinese tech giants take divergent routes

IN 2019 RICHARD LIU told couriers working for JD.com that the Chinese e-commerce giant he founded would cancel their base pay after a 2.8bn yuan (\$438m) loss the previous year, its 12th consecutive one in the red. Riders would make only a commission on deliveries. If the company did not cut back on spending, Mr Liu warned, it would go bust in two years.

Far from collapsing, two years on JD Logistics, JD.com's delivery division, is on a roll, fuelled by a boom in Chinese e-commerce (see chart). Its parent company's revenues jumped by 39%, year on year, in the first quarter, to 203bn yuan. On May 26th Pinduoduo, an upstart rival that also offers customers delivery by JD Logistics couriers, reported quarterly sales of 22bn yuan, 239% higher than a year ago.

The State Post Bureau expects logistics companies to deliver more than 100bn parcels this year, twice as many as in 2018. Overall spending on logistics in China is projected to hit 16trn yuan in 2021 and surpass 19trn yuan by 2025. That would make it the world's largest market. The logistics business has also avoided the worst of the crackdown against Chinese big tech, which has seen firms such as Alibaba and Tencent (which owns a large stake in JD.com) taken to task by the Communist authorities over their growing power.

Domestic and foreign investors have been pouring money into the industry, say lawyers working on deals involving such businesses. JD Logistics has attracted investments from big private-equity groups such as Sequoia China and Hillhouse Capital. The market buzz around the firm is as frenetic as

the pace at which its 190,000 workers fulfil and ferry orders. On May 21st it raised \$3.2bn in Hong Kong's second-largest initial public offering this year. Its shares are scheduled to begin trading on May 28th. The company's backers are betting that its Amazon-like approach of creating a fully integrated delivery network has more mileage than a similar offering from SF Express, a stodgier incumbent similar to FedEx, or a rival model championed by Alibaba, which has plumped for a more distributed system.

JD Logistics is the only large Chinese delivery service to grow out of an e-commerce parent. It became a separate entity from JD.com in 2017, in part so that it could take orders from other online retailers. It still delivers the bulk of JD.com's packages but a large chunk of its revenues now comes from orders outside the group. By owning much of its technology, lorries and warehouses, and directly employing staff, the firm has been able to ensure faster delivery times while monitoring quality. It operates China's largest integrated logistics system, covering a good's entire journey and including a fully autonomous fulfilment centre in Shanghai and driverless vehicles. The system can also flip into reverse, sending customer feedback to product designers that, JD Logistics claims, helps it produce better products and bolster brands.

Contrast that with Cainiao, in which Alibaba has a controlling stake. It does not own many of the logistics assets in its network. Instead it allows around 3,000 logistics companies employing some 3m couriers to plug into its platform. Its aim is to integrate and streamline the vast delivery resources that already exist across China, rather than build its own. The company has teamed up with most large logistics services—and taken investments from them as well. Alibaba, for its part, has bought minority stakes in several large operators as a means of exerting more influence over the industry. Cainiao is not publicly listed and does not disclose many operational details or, for that matter, how exactly it makes money.

In terms of revenues, both JD Logistics and Cainiao trail SF Express. Similarly to JD Logistics, that firm operates its own network. It still leads the market in “time-definite” delivery, a service that requires couriers to pick up and drop off parcels on a rapid, predetermined timetable. Like FedEx in America but unlike JD and Cainiao, it did not emerge from the tech industry, so lacks its rivals’ technological chops.

Which model emerges victorious will ultimately depend on which best controls costs, thinks Eric Lin of UBS, a bank. JD Logistics may have to lower prices further as it tries to get more business beyond JD.com. Analysts predict it could lose a combined 12bn yuan over the next three years, and turn a profit only in 2024. SF Express is spending heavily to try to match JD’s and Cainiao’s tech prowess. Its share price has fallen by around half since it issued a profit warning in April; it is expected to record a net loss of at least 900m yuan in the first quarter. Jefferies, an investment bank, points to SF Express’s troubles as a clear sign of an ongoing price war.

In the long run Cainiao’s asset-light model may enable it to keep spending in check. But for the time being it, too, is thought to be having trouble containing costs. Like its rivals it must fend off new specialist competitors offering cut-price services in areas like cold-chain and last-mile delivery. Average delivery prices in America have increased by about 5% annually in recent years, according to Bernstein, a broker. In China they have been falling at an average rate of 10% for the past decade. As China’s online shoppers get their goods ever more quickly, investors may need to brace for longer waiting times before their logistics returns finally arrive. ■



方程式赛车

阿里巴巴对阵腾讯：中国电商配送之战

中国科技巨头在物流上各行其道

电商巨头京东的创始人刘强东在2019年宣布取消快递员的底薪，这是在前一年京东物流亏损28亿元、且连续第12年亏损后做出的决定。骑手们从此只能挣揽件提成。刘强东警告称，如果不削减开支，京东物流两年内就会倒闭。

两年过去了，在中国电商市场迅猛增长的推动下，京东物流非但没有倒闭，还一路凯歌（见图表）。其母公司今年第一季度收入同比增长39%，达到2030亿元。5月26日，采用京东物流为客户提供配送服务的新贵对手拼多多公布季度销售额达220亿元，比一年前增长239%。

国家邮政局预计，今年物流公司递送的包裹数量将超过1000亿件，是2018年的两倍。中国2021年的物流总支出预计将达到16万亿元，到2025年将超过19万亿元。这将使中国成为世界最大的物流市场。阿里巴巴和腾讯（为京东大股东）等中国科技巨头因为影响力日增而被政府训诫，但物流业务避过了风头。

参与物流投资交易的律师们说，近期国内外投资者对物流业大举注资。京东物流已经吸引到红杉中国和高瓴资本等大型私募股权投资集团的投资。市场追捧京东物流的热度堪比该公司19万快递员高速接单送货的疯狂劲头。5月21日，京东物流在香港融资32亿美元，成为香港今年第二大IPO。公司股票于5月28日开始交易。投资者押注京东物流打造完全一体化配送网络的做法（类似亚马逊）会胜过顺丰速运（更传统的老牌快递企业，类似联邦快递）的同类服务或是阿里巴巴选择的那种更分散的系统。

京东物流是中国唯一脱胎自电商母公司的大型快递公司。它在2017年从京东剥离成为独立实体，原因之一是这样就能接受其他线上零售商的配送订

单。该公司仍然负责配送京东的大部分包裹，但现在它很大一部分收入来自京东以外的订单。京东物流的大部分技术、货车和仓库都是自有的，并直接雇用员工，这样就可以确保在加快配送速度的同时还能监控质量。京东物流运营着中国最大的综合物流系统，覆盖一件商品的整个运输旅程，包括一个位于上海的全自动化履单中心和无人配送车。该系统还可以逆向传递信息，把客户反馈发送给产品设计者。京东物流表示，这有助于它打造出更好的产品和提升品牌。

阿里巴巴控股的菜鸟与之不同。它并不拥有其配送网络内的许多物流资产，而是让雇有约300万名快递员的约3000家物流公司接入菜鸟平台。它的目标是整合和精简中国各地已有的大量快递资源，而非打造自家资源。菜鸟已与多数大型物流公司建立了合作，并接受了它们的投资。阿里巴巴则已购入几家大型物流公司的少数股权，以加大对行业的影响力。菜鸟不是上市公司，没有披露太多运营细节，同样也没有披露详细的盈利情况。

在收入方面，京东物流和菜鸟都落后于顺丰。与京东物流类似，顺丰经营自己的网络。它在“限时”快递业务上依然保持领先，这类服务要求快递员按指定时间快速完成取件和配送。有别于京东和菜鸟，顺丰与美国联邦快递一样不是科技行业出身，因而缺乏对手的技术优势。

瑞银的连沛堃认为，哪种模式能胜出最终将取决于谁能更好地控制成本。京东物流为赢得京东以外的更多业务可能不得不进一步降低价格。分析师预测，未来三年京东物流可能总共亏损120亿元，要到2024年才能盈利。顺丰则正投入巨资以在技术上追赶京东和菜鸟。自4月发布盈利警告以来，顺丰的股价已下跌了约一半，预计第一季度将录得至少9亿元的净亏损。投行杰富瑞指出，顺丰出现的问题是价格战持续的一个明显迹象。

从长远来看，菜鸟的轻资产模式可能有利于它控制支出。但在目前，它也被认为存在成本控制问题。与竞争对手一样，它必须抵御在冷链配送和末端配送等领域提供低价专门服务的新对手。据券商盛博的数据，近年来，美国的平均快递价格每年增长约5%。而在中国，过去十年里快递价格平

均每年下跌10%。随着中国的网购买家越来越快地收到货物，物流投资者可能要准备好等待更久才能收到回报。 ■



Schumpeter

Amazon's future beyond Jeff Bezos

Could an MGM deal be the CEO's parting shot?

IN THE EARLY days of Amazon, its founder, Jeff Bezos, insisted there was some advertising the e-commerce giant wouldn't touch, such as guns. That extended to James Bond's Walther PPK. When producers of "Skyfall", a Bond film released in 2012, sought to run an ad on the site, Amazon at first informed them that it violated the company's weapons policy. "The studio was like 'screw you!'" an Amazon executive later recalled. "Who is James Bond in silhouette without a gun? Literally, he's just a random dude."

This anecdote, one of innumerable gems in Brad Stone's latest book, "Amazon Unbound", springs to mind amid reports that Amazon is in talks to acquire Metro-Goldwyn-Mayer (MGM), part-owner of the Bond franchise, for \$9bn. The book, by one of the company's most astute observers, helps answer a question many are pondering as arguably the world's most accomplished businessman prepares to surrender his role as CEO this summer. Will the Seattle-based e-commerce and cloud-computing juggernaut, whose revenues have grown at a compound annual rate of over 40% for more than two decades, lose momentum without its dome-headed, maths-geek mastermind? Or will it, like the Bond franchise itself, continue to thrive even with newcomers in the starring role?

One of Amazon's bigger investors reckons it already knows the answer. Baillie Gifford, an Edinburgh-based asset manager, is cutting its stake. To explain why its enthusiasm has waned after 15 years as a shareholder, it borrows Mr Bezos's mantra that it should always be "Day One" at Amazon—infused with a spirit of long-term focus, customer obsession and bold innovation. "Amazon is now seen as good value, safe and acceptable,"

Baillie Gifford recently told its own investors. “It no longer has a founder CEO. We fear that in his inimitable terms it is no longer Day One in Seattle though the road ahead is still long and profitable.”

There is plenty in Mr Stone’s book to lend weight to such a characterisation. Central to it is Mr Bezos’s omnipotence within the firm. His business acumen is already legendary. Less well known is his role as a master of in-house invention on everything from Alexa, a voice-operated digital assistant, to Amazon’s own-label “single-cow burger”, his obsession with high standards, his tolerance of failure when in service to big ideas, his laser-like focus on financial nitty gritty and his (often exasperating) attention to detail. However much his successor, Andy Jassy, was schooled at his boss’s hip, he may lack the inventive streak that unites the likes of Mr Bezos and Apple’s late founder, Steve Jobs.

Yet how much mileage was there left in it anyway? Despite a period last year when Mr Bezos took back day-to-day control during the pandemic, his relationship with Amazon has already become semi-detached. Mr Stone portrays a chief executive who, once he had become the world’s richest man, metamorphosed into a master of the universe. From a focus on Amazon’s self-perpetuating “flywheel” of endless choice, relentless innovation and customer-centricity, his horizons expanded: to space, for which he is building rockets; to newspaper publishing, as owner of the Washington Post; and to Hollywood, where he met Lauren Sanchez, for whom he left his wife. He moved into what Mr Stone calls an “alternate dimension of wealth, glamour and international intrigue”. The geek muscled up. He hung out with A-list celebrities. In short, he appeared to have outgrown his terrestrial creation.

Mr Jassy shares some of Mr Bezos’s virtues, such as what Mr Stone describes as “almost inhuman levels of discipline”. On his watch, Amazon Web Services, the cloud business that is Amazon’s biggest source of profits, has

exhibited the parent company's culture of high standards and unrelenting competitiveness. Since joining the firm in 1997, he has been steeped in Amazon values like frugality. In addition, as Mr Stone writes, Mr Jassy may also be somewhat humbler than Mr Bezos in confronting Amazon's problems: a marketplace business accused by dissatisfied merchants of fraud and unfair competition (baselessly in Amazon's eyes), warehouse staff seeking higher pay and better working conditions, and regulatory probes in America and Europe. The company is already splurging on employee health and welfare programmes.

Mr Jassy's toughest task may simply be confronting the law of large numbers. With revenues of \$386bn last year and a market value of \$1.6trn, it is ever harder for Amazon to keep the flywheel going, especially with potential accelerators, such as India, underperforming. Last year the firm had capital expenditures of \$40bn. How does it allocate so much money without frittering a lot away?

Such questions make the potential acquisition of MGM to bolster Amazon's Prime subscription services intriguing. Even at a pricey \$9bn, it is easily affordable for Amazon. Last year it spent \$11bn on TV series, films and music for Prime. The reports come days after Mr Jassy announced the return of Jeff Blackburn, a veteran Amazon executive who left the firm recently. He will oversee a media and entertainment business that includes sports rights, such as the National Football League's "Thursday Night Football", Twitch, Amazon's gaming platform, and Amazon Studios, which recently won two Oscars. First he will report to Mr Bezos, then to Mr Jassy.

This could suggest that the post-Bezos era will be marked by the quest for a new source of rapid growth—a flywheel in which blockbuster entertainment, advertising and shopping reinforce each other. Or it could be the departing CEO's final vanity project. If it is a flywheel, it may form part of a new era of competition among America's tech giants. As one observer

puts it, Amazon is trying to crack mass entertainment before Facebook and Google crack shopping. If it is a sign of hubris, it would be more worrying, suggesting that Mr Bezos will use his new role as executive chairman to drive Amazon from the leather-clad luxury of the back seat. Perhaps stroking a white cat as he does so. ■



熊彼特

亚马逊的“后贝索斯”未来

收购美高梅是贝索斯的临别大招吗？

电商巨头亚马逊成立之初，创始人贝索斯曾坚称该平台绝不会碰某些类型的广告，例如枪支。即使是007用的瓦尔特PPK手枪也不能例外。2012年上映的邦德电影《007：大破天幕杀机》的制片人当时想在该网站投放广告，但亚马逊起先告知他们这违反了公司的武器政策。“电影公司听到后的反应差不多是‘去你的吧！’”一名亚马逊高管后来回忆道，“没了枪，谁认得出这剪影是詹姆斯·邦德？那简直就是个路人甲嘛。”

这只是布拉德·斯通（Brad Stone）的最新著作《解缚亚马逊》（Amazon Unbound）中记述的无数趣闻轶事之一。近来有报道称亚马逊正在谈判以90亿美元收购007系列电影的共同所有人美高梅（MGM），这让人不禁想起了这段故事。斯通是最敏锐的亚马逊观察家之一，在堪称全球最成功商人的贝索斯准备在今夏辞任CEO之时，他的这本书有助于回答许多人脑中的一个疑问。这家总部位于西雅图的电商和云计算巨头在过去20多年里营收以超过40%的复合年增长率扩增，一旦失去它聪明“绝顶”、精通数学的主脑，会不会就此失势？还是会像007电影一样，哪怕起用新人出演，也能继续火爆？

亚马逊的一个大投资方认为自己已经有了答案。总部位于爱丁堡的资产管理公司百利（Baillie Gifford）正在减持亚马逊的股份。在解释为何在持股15年后热情消退时，百利借用了贝索斯的口号。贝索斯说在亚马逊每天都要像创业“第一天”，也就是秉持目标长远、顾客至上和大胆创新的精神。“亚马逊现在被视为一家价值好、安全、可接受的公司，”百利最近对自己的投资者表示，“它不再由创始人担任CEO。虽然这家公司未来的路仍很长而且能盈利，但我们担心——借用他的独家用语来说——在西雅图已经不是创业‘第一天’了。”

斯通书中的大量内容也支持了这样的看法。最核心的一点是贝索斯在公司内近乎全能的角色。他的商业头脑已被广为称颂。而不太为人所知的是，他还是从语音数字助手Alexa到亚马逊自有品牌“单牛汉堡”（single-cow burger）等众多内部发明的幕后大师。他痴迷高标准，容忍追求伟大创意时的失败，精准聚焦核心财务问题，而且（时常令人恼火地）高度注重细节。无论继任者安迪·贾西（Andy Jassy）在他老板身边学到了多少，他恐怕还是缺乏贝索斯和苹果已故创始人乔布斯这类人的创造力。

但是，亚马逊到底还能走多远？虽然去年疫情期间贝索斯重新执掌公司的日常运营，但他与亚马逊的关系已经变得若即若离。斯通描绘了一位首席执行官在晋升世界首富之后变身宇宙之王。他原来专注于亚马逊那无所不有、不懈创新和顾客至上的永不止息的“飞轮”，现在，他的视野更宽广了：走向太空，开始建造火箭；走向新闻出版，买下《华盛顿邮报》；走向好莱坞，在那里遇上劳伦·桑切斯（Lauren Sanchez），并为了她与妻子离婚。他进入了斯通所说的“财富、风光和国际谋划的另一维度”。这位极客练出了一身肌肉。他和一线明星打成一片。简而言之，他似乎已经超脱了原来的肉体凡胎。

贾西继承了贝索斯的部分优点，比如斯通所说的“近乎非人的自律”。在他的领导下，作为亚马逊最大利润来源的云服务AWS展现出了母公司坚持高标准和不懈竞争力的文化。自1997年加入公司以来，他一直在践行亚马逊价值观，例如节俭。此外，斯通写道，贾西在应对亚马逊的各种问题时或许还会比贝索斯稍谦卑些。这些问题包括不满的商户指控平台存在欺诈和不公平竞争（在亚马逊看来毫无根据）；仓库工人要求提高工资和改善工作条件；欧美监管机构开始对它展开调查。亚马逊现在已经开始在员工健康和福利项目上大把撒钱。

贾西最艰巨的任务可能只是面对大数定律。亚马逊去年营收3860亿美元，市值1.6万亿美元，这让飞轮越发难保持转动，特别是在印度等潜在加速市场表现不佳的情况下。去年公司资本支出达到400亿美元。怎样才能做到在分配如此巨额资金时不造成大量浪费呢？

鉴于这些问题，计划收购美高梅以支撑亚马逊的Prime订阅服务就耐人寻味了。即使收购价高达90亿美元，对亚马逊来说也不算什么。去年公司在Prime的影视剧集和音乐上就花费了110亿美元。收购报道传出的几天前，贾西刚刚宣布了杰夫·布莱克本（Jeff Blackburn）的回归。布莱克本是亚马逊的资深高管，刚离开公司几个月。回归后他将负责媒体和娱乐业务，包括体育转播权，例如美国职业橄榄球大联盟（NFL）的《周四橄榄球之夜》、亚马逊的游戏平台Twitch，以及今年捧走两个奥斯卡奖项的亚马逊影业（Amazon Studios）。他将首先向贝索斯汇报，然后向贾西汇报。

这可能意味着后贝索斯时代的特征将是寻求新的快速增长源：一个让热门娱乐、广告和购物彼此增强的飞轮。或者，这也可能是即将离任的CEO最后的面子工程。如果这是个飞轮，它可能成为美国科技巨头竞争新时代的一部分。正如一位观察家所言，亚马逊正试图在Facebook和谷歌攻破购物市场之前抢先攻破大众娱乐市场。如果这只是狂妄自大之举，那将更叫人担忧，因为这表明贝索斯将利用自己执行董事长的新角色，坐在后排的豪华真皮座椅上操控大局，兴许还一边抚摸着腿上的一只白猫。 ■



The Economist film

Body Builders - part 1

Bionics is moving from sci-fi fantasy to the commercial market. In BODY BUILDERS we reveal the groundbreaking technology driving the new bionic industry.



经济学人视频

身体构建者 #1

仿生学正从科幻创意变为一个商业化的市场。在《身体构建者》中，一起看看驱动仿生产业的突破性技术。



The little Engine that could

ExxonMobil loses a proxy fight with green investors

An activist hedge fund succeeds in nominating at least two climate-friendly directors to the energy giant's board

“THE STONE AGE did not end for lack of stone, and the oil age will end long before the world runs out of petroleum.” That battle cry animates critics of Big Oil, who dream of phasing out hydrocarbons in favour of cleaner fuels and technologies. Their bête noire is ExxonMobil, long the richest and mightiest of Western oil supermajors—and the most unrepentant in its defence of crude. Lee Raymond, a formidable former boss of the Texan titan, once told your correspondent to get out of his office after being challenged over his flagrant denial of climate science.

Darren Woods, who currently does Mr Raymond’s old job, does not deny that climate change is real. And he must now contend with the biggest rebuke to the firm’s management in living memory. At his company’s shareholder meeting on May 26th a coalition of activist investors led by Engine No.1, a small hedge fund, managed to put at least two green-tinged directors on the board to promote a lower-carbon strategy of the sort espoused by European supermajors such as BP, Royal Dutch Shell and Total. As The Economist went to press the fate of a third activist nominee had yet to be determined.

Engine No.1 didn’t quite get its way: it had put forward four candidates. But as David Larcker of Stanford’s Graduate School of Business observes, it is “extremely rare” for a company the size of ExxonMobil to elect even one dissident director, let alone two or three. Even one dissenting voice can make a big difference, says Charles Elson, a corporate-governance expert at the University of Delaware who has served as a courteous rebel on various boards. The result is thus an unprecedented attack on ExxonMobil’s carbon-

addiction, which is greater than any other supermajor's (see chart 1).

The campaign succeeded thanks to the backing of powerful allies. CalPERS and CalSTRS, pension funds representing, respectively, California's public employees and its teachers, have between them over \$700bn in assets under management. Two giant funds representing New York's state and city employees, with another \$300bn or so in assets, joined them in supporting Engine No.1's effort. Together they hold less than 1% of ExxonMobil's shares. But as large asset managers, their actions sent a strong signal to the broader market.

The market received it. Institutional Shareholder Services (ISS) and Glass Lewis, a proxy-advisory duopoly which counsels investors on such matters, recommended the election of three and two of Engine No.1's directors, respectively. In a report published on May 14th ISS declared that the hedge fund "made a compelling case that additional board change is needed to provide shareholders with sufficient confidence" in ExxonMobil's prospects. The majority of shareholders agreed, almost certainly including some big asset managers.

The vote itself was as odd as the result. ExxonMobil's management refused to announce the results, which should already have been tabulated, at the scheduled hour, instead declaring a recess "to ensure all of our shareholders have the opportunity to express their views". This unusual move fuelled rumours that the firm was trying to persuade large institutional investors to reverse votes cast for the dissident directors, especially those with the greenest profiles. If true, that would be a departure from ExxonMobil's habitually strong corporate governance.

Whatever actually went on during the unscheduled break, the result was still a bombshell. When the meeting resumed, the firm announced that two

of Engine No.1 candidates, Gregory Goff and Kaisa Hietala, had been elected. It said it needed more time to determine whether a third, Alexander Karsner, would join them.

ExxonMobil's proxy defeat is the latest sign that outside pressure for the oil business to embrace the transition to a low-carbon future is mounting. On May 18th the International Energy Agency (IEA), an international forecaster not known for alarmism, warned that investments in all new fossil-fuel projects must stop now if the global energy sector is to achieve carbon neutrality by 2050. President Joe Biden wants America's power sector to stop adding greenhouse gases to the atmosphere 15 years earlier than that.

So far it has been Europe's oil giants that were pushed harder to go greener—by activists, consumers, regulators, investors and courts. Last year BP vowed to slash the carbon intensity of the products it sells by 50% in the next 30 years. Last month Shell won shareholder approval for its plan to create a carbon-neutral business by mid-century, including emissions from the fuel burned by end-users. Though ambitious by industry standards, this was not enough for a judge in the Netherlands, who on May 26th ordered the Anglo-Dutch giant to cut emissions between 2019 and 2030 by 45%, in keeping with global climate accords; Shell is expected to appeal.

Now carbon-bashing is spreading beyond tree-hugging Europe. Earlier this year activist badgering had already prompted ExxonMobil to unveil plans for a new “low carbon solutions” division, which will develop technologies to capture carbon and store it underground. It has also pledged to cut the carbon intensity of its own exploration and production operations by 15-20% by 2025. The same day as the ExxonMobil vote, shareholders of Chevron, its American rival similarly bullish on oil, voted for a proposal to reduce emissions from the end use of its products.

ExxonMobil's new directors will now push for more aggressive emissions

cuts. Engine No.1 points to the firm's plans to spend merely \$3bn or so in total over the next five years on its low-carbon effort, compared with around \$20bn a year on dirtier traditional investments. Unlike Shell, the company has promised only to reduce emissions from its own operations, not the vastly greater ones produced when its products are used by consumers.

The big reason such arguments no longer fall on deaf ears is ExxonMobil's once mighty reputation for being tightly run has slipped. Indiscipline has replaced historically prudent capital spending. The firm has torched billions in shareholder value in the past few years. The most eye-popping chart in Engine No.1's 80-page manifesto shows its return on capital languishing at or well below its weighted-average cost of capital since 2015 (see chart 2).

Whereas Chevron spent less than \$70bn on capital expenditure in total over the past five years, ExxonMobil splurged nearly \$100bn, even as oil prices swooned. Its net debt has nearly doubled since 2015 to over \$60bn. A mistimed and overpriced acquisition of XTO Energy, a gas firm, led it in November to write off \$17bn-20bn—and S&P Global, a rating agency, to entitle a scathing analysis of the incident “How not to do M&A”. “Board refreshment is necessary due to the long-term financial underperformance at ExxonMobil,” says Anne Simpson of CalPERS.

Last summer, as ExxonMobil's share price headed to a two-decade low and the company was knocked out of the Dow Jones Industrial Average after nearly a century in the blue-chip index, Ms Simpson's argument would have sounded incontrovertible. To many it remains compelling. But deep down many investors may still worry that the green shift will destroy shareholder value. Thanks to dearer oil ExxonMobil has clawed back \$110bn in market capitalisation since October, handily besting the European giants whose promised wind and solar projects are years away from profitability and

could meanwhile eat into their dividends.

Crude prices are, of course, cyclical by nature. They will fall again at some point, in contrast to the carbon dioxide relentlessly accumulating in the air as more oil is burned. Mainstream investors now view climate risk as “a core component of long-term value”, notes Timothy Youmans of EOS, which offers stewardship services to owners of \$1.5trn in assets and supports Engine No.1. Last week’s shareholder battle is proof of that. Mr Woods and his successors should brace for more such fights. ■



小“引擎”做到了

代理权之争，埃克森美孚输给环保投资者

一支维权对冲基金成功提名至少两名重视气候问题的候选人加入了这家能源巨头的董事会

“石器时代的终结不是因为石头不够了，石油时代的终结也远不用等到世界上石油耗尽的那一天。”这句口号鼓舞着石油巨头的批评者，他们梦想着逐步淘汰碳氢化合物，转而采用更清洁的燃料和技术。埃克森美孚（ExxonMobil）是他们的眼中钉。长期以来，这家公司在西方石油巨头中最有钱有势，同时也最执迷不悟地为原油辩护。笔者曾采访过这家得克萨斯巨头凶悍的前老板李·雷蒙德（Lee Raymond），在质疑他对气候科学的公然否定后，被他赶出了办公室。

达伦·伍兹（Darren Woods）如今坐在雷蒙德昔日的位置上，他并不否认气候变化确实存在。而他现在必须应对这家公司的管理层所遭遇的抨击——人们记忆中最严重的一次。在5月26日的公司股东大会上，由小型对冲基金“1号引擎”（Engine No.1）领导的维权投资者联盟成功让至少两名倾向于环保的人士进入董事会，以推行BP、荷兰皇家壳牌（Royal Dutch Shell）和道达尔（Total）等欧洲石油巨头都在支持的低碳战略。在本刊付印之际，他们提名的第三个人是否当选尚未揭晓。

1号引擎也不算大获全胜：它推举了四名候选人。但正如斯坦福大学商学院的戴维·拉克尔（David Larcker）所说，像埃克森美孚这样规模的公司能选出一名持异议的董事都“极其罕见”，更别说两名或三名了。特拉华大学的公司治理专家查尔斯·埃尔森（Charles Elson）也担任过多家公司的董事，总是在董事会上礼貌地提出反对意见。他说，即便只有一个人反对，也会产生重大影响。结果就是埃克森美孚比其他所有石油巨头都更严重的“碳瘾”遭到了前所未有的打击（见图表1）。

这次行动能成功有赖强大盟友的支持。分别代表加州公职人员和教师的加

州公务员退休基金（CalPERS）和加州教师退休基金（CalSTRS）管理的资产共计超过7000亿美元。分别代表纽约州和纽约市雇员的另外两家大型基金管理着大约3000亿美元的总资产。它们都加入了支持1号引擎的行列。尽管这四家基金持有的埃克森美孚股份加起来不到1%，但作为大型资产管理公司，它们的行动向更广泛的市场发出了一个强烈的信号。

市场收到了信号。为投资者提供持股公司投票建议的股东投票顾问双寡头——机构股东服务公司（Institutional Shareholder Services，简称ISS）和Glass Lewis——分别建议选出三名和两名由1号引擎提名的候选人。ISS在5月14日发布的一份报告中宣称，1号引擎“提出了令人信服的理由，认为董事会需要更进一步重组，好让股东有足够的信心”相信埃克森美孚的前景。对此大多数股东都表示赞成，几乎可以肯定其中包括一些大型资产管理公司。

投票过程和投票结果一样不同寻常。获选名单本已出炉，但埃克森美孚的管理层拒绝在预定时间公布结果，而是宣布休会，“以确保我们所有的股东都有机会表达自己的观点”。这一异常举动导致传言四起，称埃克森美孚正试图说服大型机构投资者撤销之前给异见董事们的投票，尤其是那些环保立场最鲜明的董事。如果真是这样，那就有违埃克森美孚一贯强大的公司治理了。

无论在这段计划外休会期间到底发生了什么，结果仍然令人震惊。当会议重新开始时，埃克森美孚宣布，1号引擎提名的两位候选人格雷戈里·戈夫（Gregory Goff）和凯萨·希塔拉（Kaisa Hietala）已经当选。它表示还需要更多时间来决定第三位候选人亚历山大·卡斯纳（Alexander Karsner）是否进入董事会。

埃克森美孚在代理权上的失利是一个最新的迹象，显示要求石油业向低碳未来转型的外部压力正在加大。5月18日，并不惯于危言耸听的国际预测机构国际能源署（IEA）警告称，如果全球能源行业要在2050年前实现碳中和，那么现在就必须停止对化石燃料项目的所有新投资。美国总统拜登希望美国电力行业能提前在2035年就停止向大气排放温室气体。

迄今为止，欧洲石油巨头受到的压力更大——维权人士、消费者、监管机构、投资者和法院都逼迫它们加大环保力度。去年，BP誓言在未来30年内将所销售产品的碳强度削减50%。壳牌计划在本世纪中叶实现碳中和——这将把终端用户使用其燃料产生的排放也计算在内，该计划在5月获股东通过。虽然从行业标准来看这一目标已经够雄心勃勃了，但在荷兰的一个法官看来还不够，他在5月26日责令这家英荷巨头到2030年将碳排放降至较2019年减少45%，以符合全球气候协议。预期壳牌将会上诉。

现在，打击排放的行动正从拥抱树木的欧洲向其他地方蔓延。在维权人士锲而不舍的推动下，今年早些时候埃克森美孚宣布了成立“低碳解决方案”新部门的计划，将开发碳捕集和地下封存技术。它还承诺到2025年把自己勘探和生产经营的碳强度降低15%至20%。就在埃克森美孚投票的当天，它的美国竞争对手、同样力挺石油的雪佛龙（Chevron）的股东投票支持了一项提案，要求减少其产品在最终使用时产生的碳排放。

埃克森美孚的新任董事们接下来将推动更大幅度的减排。1号引擎指出，埃克森美孚在未来五年对低碳业务的总计划支出只有30亿美元左右，而它每年在重污染的传统投资上的支出大约在200亿美元。与壳牌不同的是，埃克森美孚只承诺减少自身运营带来的排放，而不包括消费者使用其产品时产生的排放——这一部分要大得多。

这样的反对声音不再被置若罔闻的一个重要原因是，埃克森美孚原本管理严格的盛名已经不再。过去在资本支出上的审慎已被无纪律取代。过去几年里，埃克森美孚已经烧掉了数十亿美元的股东价值。在1号引擎80页的声明中，一张最令人瞠目的图表显示，自2015年以来，埃克森美孚的资本回报率只是勉强跟上或远低于其加权平均资本成本（见图表2）。

雪佛龙过去五年的资本支出总额不到700亿美元，而埃克森美孚在油价低迷的情况下还挥霍了近1000亿美元。自2015年以来，它的净债务几乎翻了一番，达到600多亿美元。对天然气公司XTO Energy不合时宜且价格过高的收购让埃克森美孚在去年11月做了170亿至200亿美元的减计。评级机构

标普全球（S&P Global）就此事做了一番犀利的分析，题为《如此并购要不得》（How not to do M&A）。 “鉴于埃克森美孚的财务业绩表现长期不佳，重组董事会很有必要。”CalPERS的安妮·辛普森（Anne Simpson）表示。

去年夏天，埃克森美孚的股价跌至20年来的低点，公司也在入选道琼斯工业平均指数成分股近一个世纪后被剔除出这一蓝筹股指数，辛普森发表的观点在那时听起来应该无可争议。对许多人来说它现在也仍然令人信服。但在内心深处，许多投资者可能仍然担心向绿色能源的转型将损害股东价值。油价回升后，埃克森美孚自去年10月以来已经挽回了1100亿美元的市值，轻松击败了欧洲各大石油巨头，后者承诺的风能和太阳能项目要盈利还要等待多年，同时可能损耗它们的股息。

当然，原油价格本身具有周期性，到了某个时刻又会再次下跌。与之形成对照的是，随着更多石油被燃烧，二氧化碳则是源源不断地在大气中累积。主流投资者现在将气候风险视为“长期价值的核心组成部分”，EOS的蒂莫西·尤曼斯（Timothy Youmans）指出。同样支持1号引擎的EOS目前为总共1.5万亿美元资产的所有者们提供管理服务。埃克森美孚的股东之争证明了尤曼斯的观点。伍兹和他的继任者应该准备好迎接更多这样的争斗。 ■



Capex carnival

An investment bonanza is coming

Firms across the world are spending big. We analyse their capital-expenditure plans

AS LOCKDOWNS LIFT across the rich world, people are going out and spending. Australia's restaurants have been crammed for months. America's shopping malls are filled with people splurging stimulus cheques. Cinemas in Britain, which were allowed to reopen in mid-May, are packed once again. Yet behind the scenes another, potentially more significant, spending bonanza is just beginning.

Businesses are starting to invest in huge numbers. In America capital spending (or capex) by companies is rising at an annual rate of 15%, both on the hard stuff, such as machines and factories, and intangibles, like software. Firms in other parts of the world are also ramping up spending. Forecasts for business investment have never looked so rosy. Analysts at Morgan Stanley, a bank, predict a "red-hot capex cycle". Overall global investment, they reckon, will soar to 121% of pre-recession levels by the end of 2022 (see chart 1). Oxford Economics, a consultancy, argues that "the time looks right for a boom in capex", while IHS Markit, a research firm, forecasts that global real fixed investment will rise by more than 6% this year.

Today's optimism marks quite a change from the pre-pandemic norm. In America gross domestic business investment, as a share of GDP, had been sluggish since the early 1980s. After the financial crisis of 2007-09 it took more than two years for global investment, in real terms, to regain its previous peak. By contrast, although investment fell more steeply at the start of the pandemic, it has been quicker to bounce back this time. The prospect of surging capex holds out promise that the global economy will not face a repeat of the 2010s, when growth in productivity and GDP stayed

stubbornly below pre-crisis trends. Investment in new products, technologies and business practices is, after all, the foundation for higher incomes and a better quality of life. So what is behind the capex cheer—and could it last?

To understand why analysts are so upbeat, consider the firms included in the S&P 500, America's main stockmarket index. Together they account for about one dollar in seven of total rich-world corporate capital formation. In a recent report Bank of America analyses these companies' earnings calls since 2006, and concludes that executives are at their most bullish about capex. The Economist has looked at the biggest 25 non-financial firms in the S&P 500 and found that analysts' expectations for capex in 2021 have risen by 10% in the past year.

For now the investment recovery is concentrated in a few industries. We find that global tech firms are expected to boost capex by 42% this year, relative to 2019. Apple will invest \$430bn in America over a five-year period, an upgrade of 20% on previous plans. Taiwan's TSMC, the world's largest semiconductor-maker, recently announced that it would invest \$100bn over the next three years in manufacturing. Analysts reckon that Samsung's capex will rise by 13% this year, having gone up by 45% in 2020.

Tech companies are spending so freely in part because the pandemic has created new demands. More shopping happens online. Remote work is on the rise. New equipment and software is needed for these to run smoothly. Recent research by Nicholas Bloom of Stanford University and Steven Davis and Yulia Zhestkova of the University of Chicago finds a big rise in the share of patent filings for work-from-home technologies. UBS, another bank, reckons that shipments of computers for commercial use will rise by nearly 10% this year, an acceleration even over the last.

Tech firms are not the only enthusiastic spenders. Firms in the S&P 500

that focus on discretionary consumer spending boosted capex by 36% year-on-year in the first quarter. Companies such as Target and Walmart, two retailers, are trying to keep up with the online giants that are eating their lunch. Marks & Spencer, an august British retailer, recently announced that it had launched 46 new websites in overseas markets from Iceland to Uzbekistan.

Other retailers are spending frantically to expand capacity, having been caught out by the surge in household spending. Everything from sofas to hot tubs is in short supply. Earlier this year Peloton announced “substantial incremental investments” in expediting the transport of its exercise bikes from Taiwan. Maersk, a shipping firm, recently said it would buy more containers to ease bottlenecks. The global order-book for enormous container ships has risen from 9% of the existing fleet, in October, to over 15% in April.

The big question is whether the emerging capex boom augurs a broad and lasting shift away from the weakness of the 2010s, or is simply an enthusiastic but temporary response to reopening. Not everyone is boosting capex: our analysis suggests that about half of the companies in the S&P 500 are not expected to invest more in 2021 than they did in 2019. Global oil-and-gas firms are cutting back by a tenth relative to pre-pandemic levels, possibly in response to lower expected demand for their planet-warming fare. Airline operators are also dialling down spending, perhaps because they expect it to be a while before people can travel freely again. Many executives, including those from raw-materials and industrial-goods firms, continue to preach capital discipline. It may be quite a leap for them to go from a decade of austerity to boom time.

Another worry is the trend towards greater consolidation in industries from hotels to mining, which seems unlikely to have been reversed by covid-19. Research by the IMF suggests that companies with market power may be

less keen on investing. In the five years before the pandemic, for instance, American business investment in hotels was barely higher than it was in the five years before the financial crisis, even though demand was far higher.

Set against that, though, economic conditions today could convince reluctant companies to loosen the purse-strings. In contrast to the post-financial-crisis period, households have a lot of savings to spend. A more decisive fiscal and monetary response this time has also allowed firms to load up on cash (see chart 2). Bond issuance by investment-grade-rated American companies jumped to a record \$1.7trn in 2020, up from \$1.1trn in 2019, according to S&P Global Market Intelligence, a research outfit.

Moreover, the economic reallocation provoked by covid-19, and its investment implications, will be felt for some time. Managers in certain industries, especially semiconductors, already accept that they went into the pandemic with too little spare capacity, and are promising multi-year projects to make up for it. Perhaps most important, the pandemic is leading to an era of greater technological optimism. The rapid deployment of entirely new business models when covid-19 struck, not to mention vaccine discovery, may have reminded bosses of the payoff to investing. All that might explain why the expectations for capex by S&P 500 firms in 2022 are even more ambitious than those for this year. The investment boom may only be getting started. ■



资本支出盛宴

投资狂潮来袭

世界各地的公司都在大举投资。我们分析了它们的资本支出计划

随着发达国家纷纷解除封锁，人们开始外出消费。澳大利亚的餐馆过去几个月里熙来攘往。美国的购物中心里挤满了要把领到的经济刺激支票花出去的民众。英国在5月中旬获准重开的电影院再次人头济济。不过在幕后，另一场意义可能更为深远的撒钱大潮才刚刚掀起。

企业开始大手笔投资。美国公司的资本支出正以每年15%的速度增加——不论是投向机器和工厂等有形资产还是软件等无形资产。世界其他地区的公司也在扩大支出。对商业投资前景的预测从未如此乐观。摩根士丹利的分析师预测将出现“白热化的资本支出周期”。他们认为，到2022年底全球整体投资将飙升至经济衰退前水平的121%（见图表1）。咨询机构牛津经济研究院认为，“目前看起来是资本支出激增的恰当时机”。而研究公司埃信华迈（IHS Markit）预测，全球实际固定资产投资今年将增长6%以上。

当前的乐观情绪相比疫情前常态显现出一种相当大的变化。自上世纪80年代初以来，美国国内商业投资占GDP的比重持续低迷。2007到2009年金融危机后，全球投资实值用了两年多的时间才重回之前的峰值。相比之下，尽管这次疫情爆发之初投资下挫更猛，但反弹的速度也更快。资本支出激增的前景让人有理由预期全球经济将不会重演2010年代的情形——当时生产率和GDP的增速始终低于危机前水平。毕竟，对新产品、技术和商业活动的投资是增加收入和提高生活质量的基础。那么，这轮资本支出热潮的驱动力是什么？它能否持续下去？

要理解分析师为何如此乐观，不妨看看美国主要股指标普500所包含的公司，它们合计约占到发达国家公司资本形成总额的七分之一。美国银行（Bank of America）最近的一份报告分析了这些公司自2006年以来的财报电话会议，得出结论称，眼下公司管理层对资本支出的热情攀升到了最高

峰。本刊研究了标普500指数中最大的25家非金融公司，发现分析师对2021年资本支出的预期在过去一年上升了10%。

目前，投资复苏主要集中在少数几个行业。我们发现，全球科技公司今年的资本支出预计将比2019年增加42%。苹果未来五年将在美国投资4300亿美元，比之前的计划加码20%。全球最大的半导体制造商台积电最近宣布，未来三年将在制造上投资1000亿美元。分析师预计，三星的资本支出在2020年增长45%的基础上，今年将再增加13%。

科技公司如此大把撒钱，原因之一是疫情创造了新的需求。更多购物转移到了线上。远程工作正在兴起。这些要流畅运行都需要新的设备和软件。斯坦福大学的尼古拉斯·布鲁姆（Nicholas Bloom）和芝加哥大学的史蒂文·戴维斯（Steven Davis）以及尤利娅·热斯特科瓦（Yulia Zhestkova）最近的研究发现，居家办公技术在专利申请中的占比大幅上升。另一家银行瑞银估计，商用电脑的出货量今年将增长近10%，增速甚至高于去年。

热衷花钱的不只是科技公司。标普500指数中的非必需消费品公司第一季度的资本支出同比增加了36%。零售商塔吉特（Target）和沃尔玛等企业正在努力追赶那些抢夺了自己的市场份额的网络巨头。英国老牌零售商玛莎百货（Marks & Spencer）最近宣布已在从冰岛到乌兹别克斯坦的海外市场开设了46个新网站。

被家庭支出激增杀了个措手不及的其他零售商正在疯狂投资扩大产能。从沙发到浴缸，一切都供不应求。今年早些时候，Peloton宣布“实质性的增量投资”以加快从台湾进口健身自行车。航运公司马士基（Maersk）最近表示将购买更多集装箱来缓解瓶颈。全球巨型集装箱船的订单在去年10月占现有运力的9%，到今年4月已上升至超过15%。

一个关键问题是，正在冒头的这轮资本支出热潮是预示着世界将从之前疲软的十年广泛而长久的转向，还是仅仅是对经济重启热烈却短暂的反应？并非所有公司都在扩大资本支出：我们的分析显示标普500指数公司当中约有一半预计2021年的投资不会超过2019年的水平。全球油气公司的投资

较疫情前削减了十分之一，可能是因为预见到它们那些让地球变暖的产品将面临需求减少。航空公司也在削减开支，也许是因为预计人们还需要一段时间才能再次自由出行。原材料和工业品等企业的许多高管仍在大谈投资纪律性。对他们来说，可能很难一下子从紧缩的十年转向繁荣的时代。

另一个担忧是，从酒店到采矿的诸多行业进一步整合的趋势看起来不太可能因为疫情而逆转。国际货币基金组织的研究表明，拥有市场支配地位的公司可能没那么热衷于投资。以酒店业为例，尽管疫情之前五年里的需求远高于金融危机之前的五年，但美国对酒店的商业投资却几乎没有变化。

但与之不同的是，当前的经济状况可能会说服那些不大情愿的企业也打开钱袋子。与金融危机过后的那段时期相比，现在美国家庭有大量储蓄可供消费。这次更果断的财政和货币政策也让企业积累了大量现金（见图表2）。研究机构标普全球市场财智（S&P Global Market Intelligence）的数据显示，2020年美国公司投资级债券发行量创下新高，从2019年的1.1万亿美元跃升至1.7万亿美元。

此外，疫情引发的经济再分配及其对投资的影响还会再持续一段时间。某些行业的经营者，尤其是半导体行业，已经承认自己在进入疫情年代时备用产能严重不足，并许诺投资多年期的项目来弥补缺口。也许最重要的是，这次疫情开启了一个对技术更加乐观的时代。疫情爆发后，全新的商业模式迅速普及，更不用说疫苗的研发，这些或许都让老板们再度意识到了投资的回报潜力。这一切或许可以解释为何标普500指数公司对2022年资本支出的预期甚至比今年还要高。投资热潮可能才刚刚开始。■



Banyan

The impulse behind Japan's decision to go on with the Olympic games

Nationalism explains what rationality cannot

FEWER THAN 50 days remain before the apparently unstoppable opening of the 2020 summer Olympic games in Tokyo. The pandemic led to their postponement last year. Today the clock is ticking down against a backdrop of resurgent infections of covid-19 in Japan, a state of emergency in Tokyo and nine other prefectures, hospitals filling up and widespread opposition to the games from the public, businessfolk and medical experts.

All this counts for little in the eyes of the government and the International Olympic Committee (IOC). The games are a go “barring Armageddon”, as one IOC member unhelpfully put it. Yet Armageddon is the real fear. The pace of vaccination in Japan has been snail-slow. Many foreign athletes will arrive unjabbed. The games risk going down in history as a massive superspreader event.

One reason for Japan’s obduracy lies in its contractual obligations to the IOC. Another is the personal concern of the prime minister, Suga Yoshihide, not to lose face—and possibly support within the ruling party. But the establishment’s sense of the Olympic games as serving a patriotic purpose should not be underestimated. Tokyo’s Olympics were intended to banish a sense of being overtaken—“Japan passing”, in the anglicised phrase—by a rising China and others following years of stagnation and the Fukushima nuclear disaster. Bad enough was 2020 passing. The games’ total abandonment, in the herd thinking of the establishment, does not count as a blow for common sense. Rather, it could shatter the very notion that, as Mr Suga’s predecessor put it, “Japan is back.”

The country has been somewhere near here before. In the 1930s Japan lobbied hard to host the 1940 Olympic games in Tokyo. It was to be Japan's moment to establish itself as a first-rate power. But like the pandemic today, war—Japan's own invasion of China in 1937 and a looming global conflict—overshadowed everything. The games were cancelled.

Japan's military adventurism contributed to the cancellation. Yet seeking to put a gloss on things, Kido Koichi, an adviser to Emperor Hirohito, declared that when peace reigned again, Tokyo would be ready to host the games and show the people of the world "the true Japanese spirit". After the war, Kido was condemned as a war criminal, but Tokyo was true to his word. In 1964 it put on a splendid games, which served as a modern, democratic coming-out party for Japan.

Ever since, Asia's hostings of the summer games have carried a broader significance for the host nation and even its neighbours. The 1988 games in Seoul, the South Korean capital, were a catalyst for democracy, helping to end decades of authoritarian rule. China's communist leaders represented the Beijing games in 2008 as a return to historical greatness. In 2022 Beijing hosts the winter Olympics, as the Japanese government is all too aware. As Jeff Kingston of Temple University in Tokyo points out, not holding the games would hand a propaganda coup to China.

Yet such grand narratives, coupled with the region's brittle nationalisms, can rub up against each other. Some South Koreans, led by two former prime ministers, are calling for their country to boycott the Tokyo games. At issue is a speck that appears on the official online map of Japan's Olympic torch relay. It represents the rocky islets of Dokdo, controlled by South Korea but claimed by Japan, which calls them Takeshima. Last week South Korea "strongly" urged Japan to amend the map.

Japan's Olympic organisers appear to have tweaked the Dokdo dot to make it

harder to spot. You now have to zoom in to see it. It has also been shaded, implying territorial ambiguity.

Yet regardless of how the dot got onto the Olympic map, or of the modifications made to it, Alexis Dudden of the University of Connecticut argues that it serves as “the ultimate dog whistle” to revanchist Japanese, many in the ruling Liberal Democratic Party, who think that nothing their country did during its militarist phase, including the occupation of Korea, warrants an apology. Whoever put in the dot knew it would get a rise out of easy-to-offend South Koreans. Again, Ms Dudden concludes, Japan’s far right shores up an unhealthy form of Japanese nationalism that is of no help in improving the rocky relationship between the two countries. And that is to say nothing about the want of sportsmanship in Japan’s riling its neighbour. But then nobody ever said the games are only about sport. ■



榕树

日本坚持举办奥运会背后的动力

理性解释不了的事，民族主义可以

距2020东京夏季奥运会开幕已不到50天，这一赛事似乎铁定了要办。去年新冠疫情爆发令奥运会推迟举行。如今会期临近，日本疫情却再次告急，东京和其他九个县进入紧急状态，医院爆满，公众、商界和医学专家普遍反对举行奥运会。

在日本政府和国际奥委会眼中，这些都不算什么。“除非发生末日大战”，否则奥运会还是要办的——一位奥委会委员的说法可谓火上浇油。然而，就怕真会出现末日大战。日本的疫苗接种以龟速推进。许多外国运动员将在没有接种疫苗的情况下抵达日本。这届奥运会可能成为一次大规模超级传播事件而被载入史册。

日本此番顽固坚持的一个原因是它对国际奥委会负有合同义务。另外也有首相菅义伟的个人考虑，他不想丢面子——可能还会丢掉执政党内部的支持。但不可低估的是当权派如何视奥运会为服务爱国主义目标的机会。在经历了多年经济停滞和福岛核灾难后，举办东京奥运会意在消除一种日本被崛起的中国和其他国家超越的感觉——在英语中表达为“Japan passing”亦即“忽略日本”或“跳过日本”。跳过2020年已经够糟了。在当权派的群体思维中，完全放弃举办奥运会不是一次一般意义上的打击，而是会粉碎菅义伟的前任安倍晋三所说的“日本回来了”的理念。

日本过去已经发生过差不多的事。上世纪30年代，日本大力游说在东京举办1940年奥运会，那本来会是日本确立自己一流强国地位的时刻。但就像今天的疫情一样，战争（日本自己在1937年发动了侵华战争，加之世界大战逼近）给一切蒙上了阴影。那一届奥运会被取消了。

日本的军事冒险主义导致了那年奥运会的取消。但为挽回颜面，裕仁天皇的顾问木户幸一宣称东京将准备就绪，等和平重现便可举办奥运会，向世

界展示“真正的日本精神”。战后，木户幸一被列为战犯，但东京兑现了他的话。1964年，东京举办了一届盛大的奥运会，成为日本跻身现代化民主国家的亮相派对。

自那以后，在亚洲，主办夏季奥运会对东道国甚至邻国都带有了更宏大的重要性。1988年在韩国首都首尔举行的奥运会成为民主催化剂，推动了数十年威权统治的终结。中国的共产党领导人把2008年北京奥运会呈现为中国的大复兴。北京将在2022年举办冬奥会，日本政府不会忘记这件事。正如天普大学（Temple University）东京校区的杰夫·金斯顿（Jeff Kingston）指出的，日本这次不办奥运会，就是把大好的政治宣传机会让给了中国。

然而，这类宏大叙事，加上该区域内敏感的民族主义情绪，让国家之间容易产生摩擦。以两位前总理为首的一些韩国人正在呼吁韩国抵制东京奥运会。引起争议的是日本奥运火炬传递的官方电子地图上的一个小圆点。这个小点代表的是韩国控制并命名为独岛的岩石小岛，但日本也声称对其拥有主权，并称之为竹岛。上周，韩国“强烈”敦促日本修订该地图。

日本的奥运组织者似乎已经对这个小圆点做了微调，让它更难辨别。现在必须放大地图才能看到它，还给它加上了阴影，暗示领土归属模糊不清。

然而，不管这个小点是如何上了奥运地图，也不管对它作何修改，康涅狄格大学的阿列克斯·杜丹（Alexis Dudden）都认为它是日本复仇主义者的“终极狗哨”，其中许多是执政的自民党人，他们认为自己国家在军国主义时期所做的一切都不值得道歉，包括对韩国的入侵。在地图上添上这个点的人肯定知道这会触怒一点就着的韩国人。杜丹总结道，日本的极右翼再度煽起一股不健康的日本民族主义，对改善两国间不稳定的关系毫无帮助。更勿庸说日本这种激怒邻国的做派缺乏体育精神了。但话说回来，谁说奥运会只关乎体育呢。 ■



Infrastructure year

How to build back under budget (maybe)

Lessons from the construction of the James Wilson line

“THIS IS A unique opportunity,” says Bent Flyvbjerg, an economic geographer who studies infrastructure projects. “There hasn’t been anything like it in the history of the United States.” He is referring to the Biden administration’s \$1.7trn infrastructure plan. A group of Senate Republicans have countered with a \$1trn offer. Whatever the final number, how can lawmakers make sure the money goes as far as possible?

The need to build new projects and repair old ones is not in dispute. Poor infrastructure costs trillions in foregone growth. A third of America’s bridges are structurally deficient. New structures, such as seawalls and storm barriers, are needed to help mitigate the effects of climate change. But productivity in public-sector construction has stagnated for decades and high costs abound, particularly where transport is concerned. The money needed to construct a mile of interstate highway rose threefold in real terms between the 1960s and the 1980s. American subway lines often cost between two and four times as much as typical projects in Europe or Asia.

Consider the James Wilson line, a hypothetical rail project named after The Economist’s founder and paid for with an influx of Biden bucks. Even before ground is broken, the cost forecasts are wildly inaccurate and prospective benefits dramatically inflated. A cost-benefit analysis is done, but elected officials discard its results in favour of political considerations. Mr Flyvbjerg argues that this all leads to the projects that look best on paper being implemented, “and the projects that look best on paper are the projects with the largest cost underestimates and benefit overestimates, other things being equal”.

Soon, a press release goes out announcing the construction of the Wilson line. Immediately vocal pressure groups demand expensive changes. By insisting on additional features like walls to contain noise and paths for pedestrians, this stirring display of participatory democracy adds new costs. Spooked by the response, the government takes expensive, pre-emptive steps to reduce the likelihood of litigation. A recent paper argues that such exercises of “citizen voice”—and governments’ fear of them—are a big cause of soaring highway-construction costs.

Leah Brooks, one of the paper’s authors, argues that legal and social changes in the 1970s set the stage for this situation. That decade saw the rise of homeowners’ associations, as well the introduction of legislation requiring more consideration of citizens’ concerns. New judicial doctrines increased the ability of citizens to sue executive agencies. The National Environmental Policy Act (NEPA), a landmark piece of legislation passed in 1969, delivered valuable environmental protections. Combined with a Supreme Court decision that enhanced citizens’ ability to sue the government, NEPA provided a “judicial toehold” from which to oppose new construction—whether or not the challengers’ concerns are genuinely motivated by a desire to protect the environment.

It is now time for a contract to be awarded for construction of the Wilson line. Best practice is to give out contracts on the basis of cost, speed, and a technical score determined by an in-house oversight team. But unfortunately the agency drawing up the contract does not have enough qualified staff to conduct a full review of construction proposals. The lowest bidder wins the job, as is typically the case in America. After winning, however, the contractor quickly tacks on additional costs, and the government is again in over its head. Unable to manage such a big project, it ends up relying on contractors and consultants who botch key segments of the Wilson line, requiring expensive do-overs. Inter-agency turf battles and co-ordination problems worsen the situation.

For the Wilson line's underground sections, its builders choose to do things the hard way. Its stations, like those of New York City's recently built Second Avenue subway, are unnecessarily large. And instead of digging the stations out from street level in a so-called "cut-and-cover" approach, which is the (cheaper) norm in sensible places like Denmark , the Wilson line's builders choose to mine them from within a tunnel. Alon Levy, who studies transit infrastructure costs, says such mystifying choices come about because America has failed to copy other countries. Mr Flyvbjerg goes further: America has such an "island mentality", he claims, that it doesn't even consider outside ideas for long enough to reject them.

What can be done so that projects like the imaginary Wilson line do not go off the rails? State and federal agencies can ensure that teams have enough capacity to review multiple projects and to manage contractors. Being too punctilious can backfire, though: New York's exacting requirements are partly responsible for the astronomical costs of subway construction there.

More advanced construction practices can also help. Standardisation of components like railway cars and subway stations can reduce variation, thereby shortening timelines and lowering costs. Transparency and accountability are vital as well. The Army Corps of Engineers, which is responsible for maintaining more than \$300bn-worth of dams and levees, records cost data but does not make them public. Ms Brooks says it should. To mitigate the effects of citizen voice, she also suggests a statute of limitations on litigation for some infrastructure projects.

Donald Trump implemented NEPA reforms which he said would speed construction, but which also did away with some valuable environmental protections. The Biden administration is considering rolling back these changes. NEPA has been used to challenge not just polluting industrial facilities but renewable energy projects as well, and the threat of environmental lawsuits adds to infrastructure costs. Mr Biden is free to roll

back Mr Trump's changes— but he should consider making some of his own. ■



基建年

如何（也许）能在预算内重建

詹姆斯·威尔逊线建设的经验教训

“这是一个独一无二的机会，”研究基础设施项目的经济地理学家傅以斌（Bent Flyvbjerg）说，“美国历史上前所未见。”他指的是拜登政府1.7万亿美元的基础设施计划。一群参议院共和党人“还价”1万亿美元。无论最终数字是多少，立法者如何确保这笔资金发挥最大的效力呢？

建设新项目和修复旧项目的必要性是没有争议的。糟糕的基础设施造成数万亿美元的增长损失。美国三分之一的桥梁存在结构缺陷。还需要像海堤和拦洪屏这样的新建筑来帮助减轻气候变化的影响。但几十年来，公共部门建设的生产率一直停滞不前，成本居高不下，在交通项目上尤为明显。从1960年代到1980年代，建造一英里的州际公路所需资金的实际价值增长了三倍。美国地铁线路的成本通常是欧洲或亚洲典型项目的两到四倍。

以詹姆斯·威尔逊线（James Wilson line）为例——这是一个假想的铁路项目，以《经济学人》创始人的名字命名，成本用拜登提供的海量资金支付。甚至在破土动工之前，成本预测就十分离谱，预期收益被大幅拉高。成本效益分析是做了，但民选官员出于政治考虑无视了分析结果。傅以斌认为，这一切都会导致实施的是那些在纸面上看起来最好的项目，“而在其他条件相当的情况下，在纸面上看起来最好的项目就是那些成本被低估最多、收益被高估最多的项目”。

很快就出了新闻稿宣布威尔逊线将投建。声音响亮的各种施压团体立即要求做出昂贵的修改。它们坚持要求加上控制噪音的墙壁以及人行通道等附加设施，参与式民主的这种激情澎湃的展示增加了新的成本。这种反应吓坏了政府，于是它先发制人地采取昂贵的措施来减少诉讼的可能性。最近的一篇论文认为，这种对“公民发声”的践行——以及政府对此的恐惧——是导致高速公路建设成本飙升的一个重要原因。

该论文的作者之一莉亚·布鲁克斯（Leah Brooks）认为，1970年代的法律和社会变化为今天这种状况奠定了基础。那十年见证了房主协会的兴起，还推出了新的立法要求更多地考虑公民关切的问题。新的司法原则提高了公民起诉行政机构的能力。1969年通过的具里程碑意义的《国家环境政策法》（NEPA）带来了宝贵的环境保护举措。再加上最高法院的一项判决提高了公民起诉政府的能力，NEPA提供了一个“司法立足点”来反对新建筑——无论质疑者的担忧是否真正出于保护环境的愿望。

到了签合同建造威尔逊线的时候了。最佳做法是根据成本、速度和由内部监督团队打出的技术评分来分配合同。但不幸的是，起草合同的机构没有足够多有资质的人员来对施工方案做全面审查。出价最低者赢得了工作，这在美国是最普遍的情况。然而在胜出后，承包商很快添上了更多的成本，政府再度力不从心。由于无法管理如此大的项目，它最终只能依赖承包商和顾问，而这帮人把威尔逊线的关键部分搞砸了，需要花大价钱返工。机构间争夺势力范围的战争和协调上的问题使得局面更加恶化。

对于威尔逊线的地下部分，建造商选择的方法简直是自讨苦吃。它的车站，就像纽约市最近建成的第二大道地铁站一样，都太大了。而且，威尔逊线的建造商并没有采用所谓的“明挖回填”的方法在街上挖出车站——这是丹麦等脚踏实地的地方（更便宜）的规范做法。他们选择从隧道内开挖。研究交通基础设施成本的阿龙·李维（Alon Levy）表示，之所以会做出这种叫人看不懂的选择，是因为美国未能效仿其他国家。傅以斌的评论更不留情，他说美国的“孤岛心态”如此严重，连花时间琢磨一下外来想法再拒绝掉都不肯。

怎样做才能让像想象中的威尔逊线这样的项目不偏离轨道呢？州和联邦机构可以确保团队有足够的能力来审查多个项目和管理承包商。然而，过于谨慎又可能适得其反：纽约的地铁建设成本之所以会飙到天文数字，严苛的要求是原因之一。

更先进的施工操作也有帮助。铁路车厢和地铁站等部件的标准化可以减少差异，从而缩短时间并降低成本。透明度和问责制也很重要。负责维护价

值超过3000亿美元的水坝和堤坝的陆军工程兵团记录了成本数据却不公开。布鲁克斯说它们应该被公布。为了减轻公民发声的影响，她还建议立法就一些基础设施项目设立诉讼限制。

特朗普实施了对NEPA的改革，他说这将加速建设，但也去掉了一些有价值的环境保护。拜登政府正在考虑撤销这些变化。NEPA不仅被用来质疑造成污染的工业设施，还被用来质疑可再生能源项目，而且环境诉讼的威胁提高了基础设施成本。拜登大可以撤销特朗普的改革——但他应该考虑做出一些自己的改革。 ■



Covid transmission

Improving ventilation will help curb SARS-CoV-2

There has been a misunderstanding about how the virus spreads

ON JANUARY 24TH 2020 three families, together numbering 21 people, came independently to eat lunch at a restaurant in Guangzhou. It was the eve of the Chinese New Year. Extra seating had been squeezed in to accommodate more patrons than usual, and these families were crowded onto neighbouring tables along one wall of the windowless room (see plan). The largest of them—a party of ten who had arrived the day before from Wuhan—sat around the middle table. Later that day, one of their number developed fever and a cough and, at a hospital, was diagnosed with covid-19. Within two weeks, ten of the 21 were confirmed as being infected with SARS-CoV-2.

The families involved had never met and video footage showed they had no close contact during the lunch. An initial analysis by the Guangzhou Centre for Disease Control and Prevention proposed that the infection had spread via respiratory “droplets”. But medical lore has it that such droplets—defined as particles expelled while breathing that are more than five microns across—cannot travel more than a couple of metres after they have been exhaled. And some of those who became infected during the lunch were farther than that from the “index” patient.

It made no sense. How could a single infected person transmit the virus to nine others in just an hour when there had been no direct contact between them?

The outbreak at the Guangzhou restaurant was the first recorded “superspreading” event of the pandemic. Superspreading is loosely defined

as being when a single person infects many others in a short space of time. More than 2,000 cases of it have now been recorded—in places as varied as slaughterhouses, megachurches, fitness centres and nightclubs—and many scientists argue that it is the main means by which covid-19 is transmitted.

In cracking the puzzle of superspreading, researchers have had to re-evaluate their understanding of SARS-CoV-2's transmission. Most documented superspreadings have happened indoors and involved large groups gathered in poorly ventilated spaces. That points to SARS-CoV-2 being a virus which travels easily through the air, in contradistinction to the early belief that short-range encounters and infected surfaces were the main risks. This, in turn, suggests that paying attention to the need for good ventilation will be important in managing the next phase of the pandemic, as people return to mixing with each other inside homes, offices, gyms, restaurants and other enclosed spaces.

It has taken a long time for public-health experts to acknowledge that covid-19 routinely spreads through the air in this way. Social distancing and mask-wearing were recommended with the intention of cutting direct, close-range transmission by virus-carrying droplets of mucus or saliva breathed out by infected individuals. The main risk of spreading the illness indirectly was thought to come not from these droplets being carried long distances by air currents, but rather by their landing on nearby surfaces, on which viruses they were harbouring might survive for hours, or even days. Anyone who touched such an infected surface could then transfer those viruses, via their fingers, to their mouth, eyes or nose. This makes sense if SARS-CoV-2 spreads in the same way as influenza—which was indeed the hypothesis in March 2020, when the World Health Organisation (WHO) declared the start of the covid-19 pandemic. Hence the advice to disinfect surfaces and wash hands frequently.

Doctors did know at the time that not all respiratory particles fall fast. Those

smaller than five microns can become aerosols, staying aloft for hours and potentially travelling much farther than droplets, or simply accumulating in the air within a closed room. Anyone inhaling these aerosols could then become infected. But this was assumed not to matter, because aerosols were thought to be relevant only in specialist medical settings, such as when patients are attached to a ventilator in an intensive-care unit. Intubation, as this process is known, does indeed create aerosols, as the breathing tube is forced down a patient's trachea. But a wider risk was not perceived. The WHO therefore played down the risks of aerosols, issuing guidance via its Twitter and Facebook pages at the end of March 2020 that the general public need not worry. "FACT: #COVID19 is NOT airborne," it said, adding that any claims to the contrary were "misinformation".

Researchers outside the medical world, however—especially those who study the physics of particles in the air—felt the evidence pointed in a different direction. The Guangzhou restaurant outbreak was an early warning. Around the same time, 1,300km across the country in Ningbo, 23 of 68 passengers on a bus fitted with an air-recycling system had been infected during a one-and-a-half-hour journey. But the worst known case of superspreading early in the pandemic was American. This happened at a choir practice in Skagit Valley, Washington State, in March 2020. Of the 61 people present during a two-and-a-half-hour meeting, 53 became infected. In all these cases, investigation showed that those infected were not necessarily the people closest to the index patients, as might be expected if transmission had been by droplet or surface contact.

None of this surprised Lidia Morawska, a physicist at the Queensland University of Technology, in Brisbane, Australia. She had spent much of her career studying how pollution caused by so-called particulate matter, such as dust and smog, affects air quality. After the original SARS outbreak, which happened in 2003, she began experiments to show how respiratory particles are generated in people's throats and then transported through the air.

She demonstrated that received medical wisdom is wrong. Because exhaled breath is a moist, hot, turbulent cloud of air, a five-micron-wide droplet released at a height of one and a half metres (about the distance above ground of the average mouth or nose) can easily be carried dozens of metres before settling. Also, the generation of respiratory particles is not restricted to medical settings. Liquid drops of all sizes—including those defined as aerosols—are continuously shed while people are breathing, talking, sneezing or singing (see chart).

In July 2020 Dr Morawska wanted to bring this work to the attention of public-health agencies. She assembled a group of 36 experts on aerosols and air quality to write an open letter outlining their evidence for infection by smaller liquid drops and calling on the WHO to change its tune on airborne transmission. “We appeal to the medical community and to the relevant national and international bodies to recognise the potential for airborne spread of coronavirus disease 2019 (covid-19),” they wrote in Clinical Infectious Diseases. “There is significant potential for inhalation exposure to viruses in microscopic respiratory droplets (microdroplets) at short to medium distances (up to several metres, or room scale), and we are advocating for the use of preventive measures to mitigate this route of airborne transmission.” More than 200 other researchers from 32 countries also signed the letter.

One signatory was Jose-Luis Jimenez, an atmospheric chemist at the University of Colorado, Boulder. He says that the confusion in health circles over whether or not airborne transmission of SARS-CoV-2 is important can be traced back to medical textbooks that still contain outdated descriptions of how respiratory particles are produced and move.

But the widespread assertion, still stubbornly promulgated by the WHO, that droplets above five microns in diameter do not stay airborne, but rather

settle close to their source, is a dodgy foundation on which to build public-health advice. According to Dr Jimenez, physicists have shown that any particle less than 100 microns across can become airborne in the right circumstances. All of this matters because hand-washing and social distancing, though they remain important, are not enough to stop an airborne virus spreading, especially indoors. Masks will help, by slowing down and partially filtering an infectious person's exhalations. But to keep offices, schools, hospitals, care homes and so on safe also requires improvements in their ventilation.

Under pressure from physicists, the WHO recently acknowledged that better ventilation should be used to help prevent covid-19's spread—and in March it published a “roadmap” to that effect. But the document fell far short of properly recognising the hazard of airborne transmission and, therefore, the need to control it. Despite overwhelming evidence that it happens, the agency still maintained that SARS-CoV-2 “mainly spreads between people when an infected person is in close contact with another person”.

Others, though, are acting on the new knowledge. Martin Bazant, a chemical engineer, and John Bush, a mathematician, both at the Massachusetts Institute of Technology, have devised a way to calculate how long it would be safe to stay within a room that contains an infected person. The pair described their model in a paper in a recent issue of the Proceedings of the National Academy of Sciences.

Applied to a typical American school class of 19 pupils and a teacher, the safe time after an infected individual enters a classroom that is naturally ventilated (that is, how long before the risk of infection is unacceptably high) is 72 minutes. This period can, though, be extended in two ways. One is by mechanical ventilation of the room, which increases the safe time to 7.2 hours. The other is by everyone wearing masks. In the absence of mechanical ventilation, mask-wearing increases the safe time to eight

hours. But the real benefit comes from combining these approaches. That pushes the safe time up to 80 hours—almost 14 days if a school day is six hours long. Add in intervening weekends and a class wearing masks in a school room with adequate ventilation would thereby be safe for longer than the time it takes to recover from covid-19, which is typically between one and two weeks. School transmissions would thus be rare.

A caveat is that the modelling assumed a classroom with minimal talking, physical activity or singing by the pupils. But games lessons would usually be outdoors and singing lessons could be. As to too much talking, teachers might welcome an unimpeachable reason to tell pupils to keep quiet in class.

Infection risk will not always be distributed evenly around a room. Jiarong Hong, a mechanical engineer at the University of Minnesota, Minneapolis, therefore used computer models to study how aerosols would spread in a classroom, according to the location of an infected individual and the position of nearby fans or air filters. Assuming the teacher was infected, and so was releasing virus-laden aerosols at the front of the class, Dr Hong's modelling shows that placing an air cleaner or extractor fan at the front of the room sets up an airflow which prevents the movement of such aerosols towards the pupils. An even better aerosol-cleansing effect is achieved when the fans and filters are elevated above the people in the room. This takes advantage of the rising air plumes created by body heat, which mean that exhaled aerosols tend to float upwards. Dr Hong's modelling shows that even small, cheap box fans mounted in this way would do a good job of keeping classrooms safe and preventing aerosols from building up to dangerous levels.

Dr Hong has also modelled the air flow in the Guangzhou restaurant outbreak of January 2020. As the plan shows, he found that the movements of virus-laden aerosols around the three affected families of diners matched

the seating positions of the people who eventually became sick. The outbreak occurred because there was no source of external fresh air and a nearby recirculating air conditioner redistributed aerosols from the infected person to the other tables, creating a contaminated bubble of air that was increasingly burdened with viruses over the course of the lunch.

The risk, then, is real. But how can the occupants of a room know whether it is well-ventilated? Just because a room feels spacious and an air conditioner is operating does not mean the air inside it is clean.

Here, Dr Morawska has a suggestion. In a (non-scientific) experiment last year, she took a carbon-dioxide meter into a large, high-ceilinged, air-conditioned restaurant near her home. CO₂ concentrations can be a useful proxy for clean air. Outdoor air contains around 400 parts per million (ppm) of the gas, and people's exhaled breath contains around 40,000ppm. Exhaling into a room therefore gradually raises its CO₂ concentration unless the ventilation is good enough to remove the excess.

According to experts on air quality, anything below 500ppm in a room means the ventilation is good. At 800ppm, 1% of the air someone is breathing has already been exhaled recently by someone else. At 4,400ppm, this rises to 10%, and would be classed as dangerous. These sorts of levels are seen only in crowded spaces with poor airflow. To keep the risk of covid-19 low, CO₂ levels should be well below 700ppm.

When Dr Morawska conducted her experiment, the restaurant had ten people in it—far fewer than would normally be allowed—and the CO₂ concentration was already 1,000ppm when she arrived. Within an hour it had jumped to 2,000ppm. “We continued sitting during the dinner for another hour or so,” she says. “So if there was someone infected there, well this could have been a problem.”

Though anecdotal, that tale indicates a serious risk—and one which resonates beyond covid-19. All sorts of symptoms, from headaches, fatigue and shortness of breath to skin-irritation, dizziness and nausea, are linked to poor ventilation. It has also been connected with more absences from work and lower productivity.

The ventilation measures needed to deal with all this are not difficult, but existing regulations and design standards often have different objectives—particularly, these days, conserving heat and thus reducing energy consumption. That often means recirculating air, rather than exchanging it with fresh air from the outside world. (An exception is passenger aircraft, which refresh cabin air frequently.)

In situations where it is not possible to reduce health risks by ventilation alone—for example, places like nightclubs, where there are lots of people crowded together, or gyms, where they are breathing heavily—air filtration could easily be incorporated into ventilation systems. Air could also be disinfected, using germicidal ultraviolet lamps placed within air-conditioning systems or near ceilings in rooms.

And then there is public awareness. “Before this pandemic it was completely socially acceptable to come to the office coughing, sneezing, spreading viruses around,” says Dr Morawska. “No one would say anything—even people educated to understand how infections are transmitted.”

That insouciance must be corrected, she says. The WHO must acknowledge the need to control airborne pathogens and governments must agree and enforce comprehensive standards for indoor air quality that keeps people healthy. One way to ensure compliance might be to issue ventilation certificates for buildings, similar to the food-hygiene certificates which already exist for restaurants. Occupants should also be given information about air quality routinely, she adds, through the use of monitors and

sensors that can display a room's carbon-dioxide levels or other relevant measures.

For new buildings this should not cost much extra, though replacing exiting ventilation systems might be costly. But not as costly as covid-19 has been. And if improvements in indoor air quality also reduced absenteeism and improved productivity, those gains might cover that cost. "Although detailed economic analyses remain to be done," wrote Dr Morawska in a recent edition of *Science*, "the existing evidence suggests that controlling airborne infections can cost society less than it would to bear them." ■



新冠传播

改善通风将有助于抑制新冠病毒

对这种病毒的传播方式一直存在误解【深度】

去年1月24日，三个家庭共21人分头来到广州同一家餐厅吃午饭。当天是除夕。为接待比平日更多的食客，餐厅增设了桌椅，这三个家庭在一个无窗隔间里挤在三张靠墙相邻的餐桌上用餐（见平面图）。人数最多的一家共十人，前一天刚从武汉来到广州，围坐在居中的桌子边。当天晚上，其中一人出现发烧和咳嗽的症状，在医院确诊为新冠肺炎。接下来两周内，21人中有10人确诊感染。

这三个家庭之前从未有过交集，视频监控显示他们在午餐期间也没有过密切接触。广州市疾病预防控制中心初步分析后认为，感染是通过呼吸道“飞沫”传播的。但医学界一般认为，这种飞沫（即呼吸时排出的直径大于5微米的颗粒）在呼出后的飞行距离只有两三米。而当天午餐期间被感染的一些人和这个群组中的零号病人之间的距离要更远。

这就没道理了。在没有直接接触的情况下，一个受感染者怎么可能在一小时内就感染了九个人呢？

广州餐厅的聚集性爆发是新冠疫情第一次有记录的“超级传播”事件。对超级传播的粗略定义是在短时间内一人感染许多人的情况。现在，已记录的超级传播事件达2000多例，发生的场所林林总总，有屠宰场、大型教堂、健身中心和夜总会等。许多科学家认为，超级传播是新冠肺炎传播的主要途径。

在破解超级传播谜题的过程中，研究人员不得不重新评估他们对新冠病毒传播方式的认识。大多数有记录的超级传播事件都发生在通风不良、人群聚集的室内空间。这表明新冠病毒很容易经空气传播，这与之前认为近距离接触和受污染的物体表面是主要风险源的观点相左。这继而又表明，注

意保持良好通风对下一阶段的疫情防控很重要，因为人们又将在家中、办公室、健身房、餐厅和其他封闭空间内彼此密切接触。

公共卫生专家经过了很长时间才承认，新冠肺炎经常在这种情况下通过空气传播。他们之前建议人们保持社交距离和戴口罩，目的是要切断受感染者呼出的带病毒的粘液或唾液飞沫导致的近距离直接传播。专家们过去认为间接传播病毒的主要风险不在于这些飞沫随气流长距离传播，而在于它们落在附近的物体表面上后，所携带的病毒可能在那里存活数小时甚至数天，任何触摸了这种受污染表面的人都可能将病毒通过手指转移到自己的口、眼或鼻部。如果新冠病毒与流感的传播方式相同（2020年3月世卫组织宣布将新冠疫情定性为全球性大流行病时确实是这么假定的），那么这种想法就有其道理。他们因此建议人们勤消毒物体表面和勤洗手。

医生们当时确实知道并非呼吸道呼出的所有颗粒物都会快速沉降。那些直径小于5微米的颗粒可能会变成气溶胶，在空气中停留数小时，有可能比飞沫传播得远得多，或者在封闭房间内的空气里积聚。吸入这些气溶胶的人都可能被感染。但当时假定不需要担心这种情形，因为人们认为只有在专业的医疗环境下气溶胶才值得重视，例如患者在重症监护病房中连接呼吸机时。连接呼吸机的过程就是通常所说的“插管”，由于气管导管是被强行插入患者的气管，这个过程确实会产生气溶胶。但人们没有意识到一个更广泛存在的风险。因此，世卫组织淡化了气溶胶的风险，在2020年3月底通过其官方推特和Facebook主页发布的指南中告知公众无需担心。“事实：#新冠不经空气传播。”指南如是说，并补充说任何相反的说法都是“错误信息”。

然而，医学界以外的研究人员、尤其是那些研究空气中颗粒物的物理学现象的人员认为证据指向了不同的方向。广州餐厅的聚集性感染是一次预警。大约在同一时间，在距广州1300公里的宁波，在一辆装有空气循环系统的大巴上，68名乘客中有23人在一个半小时的车程中被感染。但已知晓的疫情初期最严重的超级传播案例发生在美国。2020年3月，在华盛顿州斯卡吉特谷（Skagit Valley）的一次两个半小时的合唱团排练中，在场的61人中有53人被感染。在所有这些案例中，调查表明被感染者不都是与群

组中的零号病人距离最近的人。如果病毒是通过飞沫或表面接触传播的话，那就应该是离得最近的人最易被感染。

澳大利亚布里斯班的昆士兰科技大学（Queensland University of Technology）的物理学家莉迪亚·莫拉夫斯卡（Lidia Morawska）对上述种种都毫不意外。她职业生涯的大部分时间都在研究灰尘和雾霾等所谓的颗粒物造成的污染对空气质量的影响。2003年的SARS疫情爆发之后，她开始通过实验来说明呼吸道颗粒物在人们的喉咙中产生继而经空气传播的过程。

她的实验证明公认的医学观点是错误的。由于人呼出的是潮热、涌动的气团，在一米半高度（也就是一般人的嘴或鼻子离地的距离）喷出的直径5微米的飞沫能很容易地飘散到几十米开外才落地。此外，不只是医疗环境下会产生呼吸道颗粒物。人们在呼吸、说话、打喷嚏或唱歌的过程中会不断产生各种尺寸的液滴，包括被定义为气溶胶的那些（见图表）。

2020年7月，莫拉夫斯卡希望让公共卫生机构注意到她的这项研究。她召集了36名气溶胶和空气质量专家共同撰写了一封公开信，概述了他们发现的较小液滴也能传播病毒的证据，并呼吁世卫组织改变对空气传播的说法。“我们恳请医学界及相关国家和国际机构认识到新冠病毒通过空气传播的可能性。”他们在《临床传染病》（Clinical Infectious Diseases）杂志上写道。“在短距离到中等距离（远至数米，或在房间范围内）吸入微小呼吸道飞沫（微飞沫）而感染病毒的可能性很大，我们呼吁采取预防措施来抑制这种空气传播。”来自32个国家的另外200多名研究人员也在这封信上署了名。

科罗拉多大学博尔德分校的大气化学家何塞-路易斯·希门尼斯（Jose-Luis Jimenez）是署名人之一。他说公共卫生界对空气传播是否是新冠病毒的重要传播途径意见不一，其原因可以追溯至医学教科书中仍然收录着对呼吸道颗粒物产生和运动过程的过时的说明。

广泛传播的论断称，直径大于5微米的飞沫不会在空气中悬浮，而是会在

靠近源头处沉降。世卫组织也仍在固执地宣传这一点。但以此为基础来制定公共卫生建议并不可靠。据希门尼斯说，物理学家已经证明，任何直径小于100微米的颗粒在适当条件下都可以在空气中悬浮。这一点意义重大，因为尽管勤洗手和保持社交距离仍然很重要，却并不足以阻止病毒经由空气传播，尤其是在室内。口罩会有帮助，它能减缓感染者呼出气体的流动速度，并能起到一定的过滤作用。但要保证办公室、学校、医院、护理院等地的安全，还需要改善室内通风。

在受到来自物理学家的压力后，世卫组织于近期承认应该通过改善通风来帮助防止新冠肺炎的传播，并在今年3月发布了改善通风的“路线图”。但这份文件远未充分认识到空气传播的危害，因而也就没有认识到防控空气传播的必要性。尽管有大量空气传播的证据，但世卫仍坚持认为新冠病毒“主要是通过感染者与他人密切接触而实现人际传播”。

不过，其他人正在根据新知识采取行动。麻省理工学院的化学工程师马丁·巴赞特（Martin Bazant）和数学家约翰·布什（John Bush）设计出了一种方法，可以计算出在一个有一名感染者的房间里待多久是安全的。两人在近期发表于《美国国家科学院院刊》的一篇论文中介绍了他们的模型。

将此模型应用于美国的学校里一个典型的班级——包含19名学生和一名教师，得出的结果是在一名感染者进入这样一个自然通风的教室后，安全时间（即感染风险高出可接受水平之前的时间）为72分钟。不过有两种方式可以延长这一时间。一种是机械通风，可将安全时间延长到7.2小时。另一种是人人戴口罩。在没有机械通风的情况下，戴口罩可将安全时间延长到8小时。但把这两种方式相结合才会取得真正可观的效果。这种方式把安全时间延长到了至多80个小时——如果每天上学6小时，就相当于近14天。加上穿插其间的周末，也就是说，对于在通风良好的教室里戴着口罩的师生来说，他们的安全时间超过了新冠肺炎患者康复的耗时（一般是一到两周）。结果是，校内传播将会变得很少见。

需要注意的是，这个模型假设学生在教室里尽量少说话、活动或唱歌。但体育活动类的课通常就是在户外的，而音乐课也可以改到户外。至于少说

话，老师可能巴不得有一个无懈可击的理由要求学生们在课堂上闭上嘴巴。

感染风险在室内并不总是均匀分布的。因此，位于明尼阿波利斯市的明尼苏达大学的机械工程师洪家荣运用计算机模型，根据感染者的位置以及附近风扇或空气过滤器的位置研究气溶胶在教室里的传播情况。假设老师是感染者，因而会在教室前面释放载有病毒的气溶胶，模型显示，在教室前面放置空气净化器或排风扇会产生气流，阻止这些气溶胶朝学生的方向移动。当风扇和净化器的位置高于房间内的人员时，还可实现更好的气溶胶净化效果。这是因为人体体温产生的上升气流会使得呼出的气溶胶倾向于向上漂浮。洪家荣的模型表明，即使是安装在高处的小型廉价转页扇也能发挥很好的作用，保持教室安全和防止气溶胶积聚到危险水平。

洪家荣还模拟了2020年1月出现聚集性感染的广州餐厅里的空气流动。如餐厅平面图所示，他发现携带病毒的气溶胶围绕三个受影响的用餐家庭的运动轨迹与那些最终被感染的人的座位契合。出现这一聚集性感染是因为没有外部新鲜空气补充进来，而附近的一台再循环式空调将感染者呼出的气溶胶又吹到了另外两个餐桌，在那里形成了一个被污染的密闭“大气泡”，在午餐过程中那里头的病毒越积越多。

这样看来，空气传播的风险是真实存在的。但是，房间里的人如何知道通风是否良好呢？仅仅因为房间给人感觉很宽敞、空调也一直开着，并不等同于室内空气就是洁净的。

对此莫拉夫斯卡给出了一个参考。在去年的一项（非科学）实验中，她带着一个二氧化碳测量仪去了她家附近一家面积大、层高高且装有空调的餐厅。二氧化碳浓度可用作衡量空气清洁程度的有用指标。室外空气中的二氧化碳浓度约为400ppm（1ppm为百万分之一），在人体呼出气体中的浓度约为40,000ppm。因此，在房间里呼气会逐渐提高二氧化碳浓度，除非有足够的通风移除过量的二氧化碳。

根据空气质量专家的说法，房间内二氧化碳浓度低于500ppm表明通风良

好。浓度达到800ppm时，一个人吸入的空气中有1%是他人呼出没多久的。浓度达到4400ppm时，这个比例会上升到10%，就会被列为危险水平。这么高的浓度只有在通风不佳的拥挤空间中才会出现。为了将感染新冠肺炎的风险保持在较低水平，二氧化碳浓度应远低于700ppm。

莫拉夫斯卡做这项实验时，餐厅里有10个人，远少于正常情况下餐厅的接客量。她刚到餐厅时二氧化碳浓度就已经达到1000ppm，一小时内就已飙升至2000ppm。“我们在晚餐期间又多坐了一个小时左右，”她说，“所以，如果餐厅里有受感染者，那可能就要出问题了。”

虽然这个实验只是观察性的，但仍指出了一个严重的风险，而且不仅限于新冠肺炎的传播。从头痛、疲劳和呼吸急促，到皮肤刺激、头晕和恶心，种种症状都与通风不良有关。通风不良还与缺勤率升高和生产率下降有关。

解决所有这些问题所需的通风措施并不麻烦，但现有的法规和设计标准往往有不同的目标。目前更多强调的是保存热量，这样就能节能。这往往意味着让空气再循环流动，而不是与外界交换新鲜空气。（频繁更新机舱空气的客机是个例外。）

在人多拥挤的夜总会，或人们大口喘气的健身房等场所，仅靠通风无法降低健康风险，这时在通风系统中加入空气过滤功能是个简便易行的方法。也可以在空调系统中或房间天花板附近安装杀菌紫外线灯，给空气消毒。

公众意识也需要转变。“在这次疫情之前，大家完全可以接受有人在办公室里咳嗽、打喷嚏、传播病毒，”莫拉夫斯卡说，“谁也不会说什么——即使是那些了解病毒是怎么传播的人。”

这种满不在乎的态度必须纠正，她说。世卫组织必须承认需要控制空气传播的病原体，各国政府必须同意并实施全面的室内空气质量标准，保证人们的健康。确保合规的一种方法可能是为建筑物颁发通风合格证书，类似于现在发给餐厅的卫生许可证。她补充说，还应该通过监视器和传感器来

显示室内二氧化碳浓度或其他相关指标，定时向住户提供有关空气质量的信息。

对于新建筑来说，这应该不会增加太多成本，不过更换现有通风系统可能代价不菲。但也不会高过新冠肺炎的代价。如果室内空气质量改善还能降低缺勤率、提高生产率，那么这些收益可能会弥补改造的成本。“尽管详细的经济分析尚待完成，”莫拉夫斯卡在近期的《科学》杂志上写道，“现有证据表明，防控空气传播感染的社会成本要低于不加防控的代价。”■



Bartleby

How executive mothers cope

Women still face barriers to progress at work

BETSY HOLDEN was vice-president of strategy and new products at Kraft, a giant food company, when she became pregnant for the second time. “No one has ever done the job with two children,” her male boss worried. “How many children do you have?” Ms Holden asked. “Two,” he replied.

This double standard is only one of the barriers that female executives face, as recounted in “Power Moms”, a new book by Joann Lublin, a former Wall Street Journal columnist. The author focuses on two waves of female leaders. The first group were the baby-boomers, born between 1946 and 1964. These were often the only women in upper management at their firms. They faced a lot of pressure to be hands-on mothers, had little support from their husbands and were reluctant to ask for reduced schedules for fear of not seeming committed to their jobs. The stress for these women was immense, especially as they felt unable to discuss their parenting problems with male colleagues.

The second wave of women, born between 1974 and 1985, had female colleagues in upper management, expected (and usually received) support from their spouses, and benefited from employer perks, such as maternity leave and flexible working. They were able to be more open with colleagues about their parental duties. This later generation has mastered the “work-life sway” in which they move back and forth between their personal and professional lives in the course of a day, conducting a meeting before taking their children for a check-up and then returning to the office.

The earlier generation, by blazing the trail, made it easier for those behind

them. A Harvard Business School study shows that adult daughters of employed mothers are more likely to hold supervisory responsibility and earn higher incomes while sons are likely to spend more time caring for family members. And companies are now much more willing to promote women, who make up more than a fifth of senior executive positions in American firms, compared with just 10% in 1996. A few are exceptionally accommodating, for example providing rooms where mothers can express milk, sinks to wash the breast pump and even courier services to deliver the milk when they are away on a business trip.

But there is still a long way to go. Only 27% of American employers offered paid parental leave in 2019. That may be up from 17% in 2016, but still leaves a lot of mothers uncovered. Even where leave is available, many women don't take full advantage. A survey of female tech-industry employees in 2018 found that 44% of women who had taken maternity leave had taken off less time than their entitlement because they thought a longer break would damage their careers.

Working mothers are still overloaded. Mothers who are employed full-time spend nearly two-thirds more of their day feeding, bathing and caring for their children (under six) than their employed husbands do. They still struggle with guilt. One executive was on the phone with an important client in her locked office, only for an impatient toddler to bang on the door and repeatedly scream, "You don't love me." Unsurprisingly, a study found that chronic stress levels are 40% higher in women who are employed and bringing up two children than in childless working women. Worse still, female employees routinely toiling more than 60 hours a week were more than three times as likely to develop heart disease, cancer or diabetes than those on a conventional 40-hour schedule.

Despite the advances made by female executives, things are even more difficult for the vast majority of working mothers. Many work in smaller

businesses, where maternity benefits and flexible hours are less likely to be available. Many are in low-paid jobs, or in sectors like health care and retailing, where it has been impossible to work remotely during the pandemic. The author writes that “nothing is more essential to an employed mother’s professional success than reliable high-quality child care”, and for many women who are not executives, this is a constant headache.

It is good news that many more women have climbed the corporate ladder, not just in terms of fairness, but because an economy should take advantage of all its potential talent. There needs to be a lot more progress made in helping the vast majority of women to juggle their home and work lives, not least by providing affordable child care. There are many more cleaners, cooks and carers than there are chief executives. ■



巴托比

高管妈妈们日子如何

女性职场发展仍然障碍重重

贝琪·霍顿（Betsy Holden）在食品巨头卡夫公司（Kraft）担任战略和新产品副总裁时怀上了二胎。“从来没有人在这个职位上养着两个小孩。”她的男老板很担心。“那你有几个孩子？”霍顿问他。“两个。”他答道。

正如前《华尔街日报》专栏作家乔安·卢布林（Joann Lublin）在其新著《神力妈妈》（Power Moms）中所述，这种双标只是女性高管面临的种种障碍之一。卢布林聚焦了两代女性领导者。首先是1946到1964年出生的婴儿潮一代。她们通常是所在企业中唯一的女高管。她们本身是事必躬亲的母亲，面对诸多压力，而丈夫给予的支持极少。她们不愿请求减少工作安排，怕显得自己不够忠于职守。这些女性背负着巨大的压力，尤其是在发觉无法与男同事讨论育儿问题时。

第二代女性高管生于1974到1985年间，她们在高管层中有其他女同事，期望（通常也能获得）配偶的支持，还能享受到如产假和弹性工作制等雇主福利。她们能够更开诚布公地和同事交流为人父母的责任。这代女性已经掌握了“工作与生活的平衡之道”，每天在个人生活和职场之间自如切换——先开个会，再带孩子去做检查，随后再回到办公室。

作为开路先锋的前一代女性让后来者的路更好走。哈佛商学院的一项研究表明，在职妈妈们的成年女儿更有可能承担管理职责，收入也会更高，而她们的儿子很可能会花更多时间照顾家庭成员。而企业提拔女性的意愿已大幅提高，在美国企业的高管职位中，女性占比超过五分之一，而1996年时仅为10%。有些企业为女性提供极大便利，例如为母亲们提供挤奶室和清洗吸奶器的水池，甚至在她们出差时提供母乳配送的快递服务。

但仍有很长的路要走。2019年，只有27%的美国企业提供了带薪产假。这虽然要比2016年的17%要高，但仍有众多母亲未获得这种保障。即便有假

期，很多女性也没能充分利用它。2018年一项对科技行业女性员工的调查发现，44%休过产假的女性的休息时间少于应享有的时间，因为她们认为休假更久会损害自己的职业生涯。

在职妈妈们仍然超负荷运转。孩子六岁之前，全职工作的母亲每天要比上班的丈夫多花近三分之二的时间喂孩子、给孩子洗澡和照顾孩子。她们却仍然在愧疚中挣扎。一位高管锁上办公室的门和一名重要客户通电话，她蹒跚学步的孩子在外头等得不耐烦，拍着门不断尖叫：“你根本不爱我。”毫不奇怪，一项研究显示，育有两个孩子的职业女性的长期压力水平要比没孩子的职业女性高40%。更糟糕的是，相比每周工作40小时常规时长的女性，那些经常性地每周辛苦工作超过60小时的女性员工患心脏病、癌症或糖尿病的几率要高三倍多。

尽管女性高管的境况有所改善，但绝大多数在职妈妈的处境却更艰难了。许多人在较小型的企业工作，这些地方提供产假福利和灵活工时的可能性更低。很多人从事低薪工作，或身处疫情期间无法远程工作的医疗保健和零售行业。作者写道，“没什么比可靠的、高质量的托儿服务更关系到一位职业母亲的事业成就了”，而对于众多非高管女性来说，这一直都是个令人头疼的问题。

越来越多的女性在职场上获得了晋升，这是好消息。这不只是为了实现公平，更是因为一个经济体应该充分利用其所有的潜在人才。仍然有待大幅进步的环节是帮助绝大多数女性平衡好家庭与工作，尤其是在提供经济实惠的育儿服务方面。毕竟比起首席执行官，清洁工、厨师和护工的人数要多多了。■



The Economist film

Body Builders - Future Works

As our elderly population grows, so will the global bionics industry extending the life of aging limbs and restoring the function of damaged ones.



经济学人视频

身体构建者 #未来工作系列

老龄人口不断增加，能够延长肢体使用年限、修复人体受损功能的全球仿生业也在迅速发展。



The world economy

The new geopolitics of global business

China and America dominate like never before

TWENTY YEARS ago this week the share price of a startup run by an obsessive called Jeff Bezos had slumped by 71% over 12 months. Amazon's near-death experience was part of the dotcom crash that exposed Silicon Valley's hubris and, along with the \$14bn fraud at Enron, shattered confidence in American business. China, meanwhile, was struggling to privatise its creaking state-owned firms, and there was little sign that it could create a culture of entrepreneurship. Instead the bright hope was in Europe, where a new single currency promised to catalyse a giant business-friendly integrated market.

Creative destruction often makes predictions look silly, but even by these standards the post-pandemic business world is dramatically different from what you might have expected two decades ago. Tech firms comprise a quarter of the global stockmarket and the geographic mix has become strikingly lopsided. America and, increasingly, China are ascendant, accounting for 76 of the world's 100 most valuable firms. Europe's tally has fallen from 41 in 2000 to 15 today.

This imbalance in large part reflects American and Chinese skill, and complacency in Europe and elsewhere. It raises two giant questions: why has it come about? And can it last?

In themselves, big companies are no better than small ones. Japan Inc's status soared in the 1980s only to collapse. Big firms can be a sign of success but also of sloth. Saudi Aramco, the world's second-most-valuable firm, is not so much a \$2trn symbol of vigour as of a desert kingdom's dangerous

dependency on fossil fuels. Even so, the right sort of giant company is a sign of a healthy business ecology in which big, efficient firms are created and constantly swept away by competition. It is the secret to raising long-run living standards.

One way of capturing the dominance of America and China is to compare their share of world output with their share of business activity (defined as the average of their share of global stockmarket capitalisation, public-offering proceeds, venture-capital funding, “unicorns”—or larger private startups, and the world’s biggest 100 firms). By this yardstick America accounts for 24% of global GDP, but 48% of business activity. China accounts for 18% of GDP, and 20% of business. Other countries, with 77% of the world’s people, punch well below their weight.

Part of the explanation is Europe’s squandered opportunity. Political meddling and the debt crisis in 2010-12 have stalled the continent’s economic integration. Firms there largely failed to anticipate the shift towards the intangible economy. Europe has no startups to rival Amazon or Google. But other countries have struggled, too. A decade ago Brazil, Mexico and India were poised to create a large cohort of global firms. Few have emerged.

Instead, only America and China have been able to marshal the process of creative destruction. Of the 19 firms created in the past 25 years that are now worth over \$100bn, nine are in America and eight in China. Europe has none. Even as mature tech giants like Apple and Alibaba try to entrench their dominance, a new set of tech firms including Snap, PayPal, Meituan and Pinduoduo are reaching critical mass. The pandemic has seen a burst of energy in America and China and a boom in fundraising. Firms from the two countries dominate the frontier of new technologies such as fintech and electric cars.

The magic formula has many ingredients. A vast home market helps firms achieve scale quickly. Deep capital markets, networks of venture capitalists and top universities keep the startup pipeline full. There is a culture that exalts entrepreneurs. China's tycoons boast of their "996" work ethic: 9am to 9pm, six days a week. Elon Musk sleeps on Tesla's factory floor. Above all politics supports creative destruction. America has long tolerated more disruption than cosy Europe. After 2000, China's rulers let entrepreneurs run riot and laid off 8m workers at state firms.

The recent erosion of this political consensus in both countries is one reason this dominance could prove unsustainable. Americans are worried about national decline, as well as low wages and monopolies (roughly a quarter of the S&P 500 index merits antitrust scrutiny, we estimated in 2018). The Economist supports the Biden administration's aim to promote competition and expand the social safety-net to protect workers hurt by disruption. But the danger is that America continues to drift towards protectionism, industrial policy and, on the left, punitive taxes on capital, that dampen its business vim.

In China President Xi Jinping sees big private firms as a threat to the Communist Party's power and social stability. The cowing of tycoons began last year with Jack Ma, the co-founder of Alibaba, and has since spread to the bosses of three other big tech firms. As party officials seek to "guide" incumbent private firms in order to achieve policy goals, such as national self-sufficiency in some technologies, they are also more likely to protect them from freewheeling competitors.

The more America and China intervene, the more the rest of the world should worry about the lopsided geography of global business. In theory the nationality of profit-seeking firms does not matter: as long as they sell competitive products and create jobs, who cares? But if firms are swayed by governments at home, the calculus changes.

As globalisation unwinds, rows are already erupting over where multinational firms produce vaccines, set digital rules and pay taxes. European hopes of being a regulatory superpower may become a figleaf for protectionism. Others with less clout may erect barriers. To assert its sovereignty, India has banned Chinese social media and hobbled American e-commerce firms. That is the worst of both worlds, depriving local consumers of global innovations and creating barriers that make it even harder for local firms to achieve scale.

It would be a tragedy if only two countries in the world proved capable of sustaining a process of creative destruction at scale. But it would be even worse if they turned away from it, and other places admitted defeat and put up barricades. The best gauge of success will be if in 20 years' time the list of the world's biggest companies looks absolutely nothing like today's. ■



【首文】世界经济

全球商业的地缘政治新格局

中国和美国占据了前所未有的支配地位

二十年前的这一周，一家创业公司的股价同比下跌了71%。这家公司的掌门人是一个叫贝索斯的偏执狂。亚马逊的这一濒死体验是互联网泡沫破裂的一部分，这场泡沫暴露了硅谷的狂妄自大，连同安然公司（Enron）140亿美元的欺诈案一起粉碎了人们对美国企业的信心。同一时间，中国正在痛苦推进把风雨飘摇的国有企业私有化，丝毫看不出它能打造创业文化的迹象。相反，欧洲才是光明希望的所在，新的统一货币有望促成一个有利于商业的庞大的一体化市场。

创造性破坏常常都让预测显得很可笑，但即便考虑到这一点，疫情后的商业世界与人们在20年前可能的预期相比仍可谓天差地别。如今科技公司占到全球股市市值的四分之一，而地域分布已变得极不平衡。美国的优势一路上升，中国也在日益崛起，在全球市值最高的100家公司中这两国占了76家。而欧洲则从2000年的41家下滑到如今的15家。

这种不平衡在很大程度上反映了美国和中国的本事，以及欧洲和其他地区的安于现状。这引出了两个巨大的问号：为何会走到这个局面？它会持续下去吗？

就公司本身而言，大企业并不优于小公司。上世纪80年代日本企业地位飙升，最终却还是一落千丈。大公司可以是成功的标志，也可能只是怠惰的象征。沙特阿美石油公司（Aramco）市值2万亿美元，居全球第二，但它不是什么活力的象征，而是更多地体现了这个沙漠王国对化石燃料的危险的依赖。即便如此，恰当的巨型公司仍然反映出一种健康的商业生态——大型、高效的公司在其中诞生，又不断在竞争中被淘汰。这就是提高长期生活水平的秘诀。

要了解美国和中国的支配地位，一个方法是拿它们在全球经济产出中的占

比和在商业活动的占比作比较。商业活动占比的定义是一国在全球股市市值、公开融资、风险投资、较大规模的私营创业公司即“独角兽”，以及世界百强公司中的平均占比。按照这个标准，美国贡献了全球GDP的24%，却占到商业活动的48%。中国贡献了全球GDP的18%，商业活动占20%。其他国家的人口占全球的77%，但经济产出和商业活动占比却小得多。

一个解释是欧洲浪费了大好时机。政治干预以及2010至2012年的债务危机阻碍了欧洲大陆的经济一体化进程。欧洲企业大都没能预见到向虚拟经济的转变。欧洲没有出现可匹敌亚马逊或谷歌的创业公司。但是，其他地区的国家同样裹足不前。十年前，巴西、墨西哥和印度摆开架势要打造一大批全球企业，但迄今没什么大突破。

相反，只有美国和中国成功驾驭了创造性破坏的过程。在过去25年里成立、目前市值超过1000亿美元的19家公司中，九家在美国，八家在中国。欧洲一家都没有。而就在苹果和阿里巴巴等成熟的科技巨头力图巩固自己的支配地位之时，Snap、PayPal、美团和拼多多等新一批科技公司也即将达到临界规模。这次疫情在美国和中国激发了创业热情，融资激增。在金融科技和电动汽车等新技术前沿，两国企业已经占据了主导。

成功的秘诀包含了很多要素。广阔的国内市场有助于企业迅速扩大规模。深厚的资本市场、风险投资家网络以及顶尖大学带来了充足的创业公司后备力量。社会上盛行赞美企业家的文化。中国的巨头们宣扬自己的“996”工作理念：每天早上9点到晚上9点，每周工作6天。马斯克睡在特斯拉工厂的车间里。最重要的是，政治环境也支持创造性破坏。相比安稳舒适的欧洲，美国一直更包容颠覆的冲击。2000年之后，中国的统治者对企业家放任自流，并让800万国企工人下岗。

两国的这种支配地位或许不能持续，其中一个原因是上述政治共识在近年已流失。美国人担心国家的衰落，还有低工资和垄断（本刊在2018年估计约四分之一的标普500指数公司应该接受反垄断审查）。本刊支持拜登政府的目标——促进竞争，同时扩大社会安全网，保护工人免受颠覆的伤害。但危险在于美国继续滑向保护主义、产业政策并实施左翼的惩罚性资

本税，这会抑制它的商业活力。

在中国，国家主席习近平将大型民营企业视为对党的权力和社会稳定的威胁。对大亨们的打压始于去年，阿里巴巴的联合创始人马云首当其冲，此后波及其他三家大型科技公司的老板。随着共产党官员试图“指导”现有私企来实现政策目标，例如让中国在某些技术上自给自足，他们也更有可能保护这些企业免于直面不受约束的竞争。

美国和中国干预得越多，其他国家就越会担忧全球商业的地域失衡。从理论上讲，逐利的公司来自哪国并不重要：只要它们销售有竞争力的产品并创造就业机会，谁会在乎这一点呢？但如果公司受到本国政府的左右，这里头的计算就不一样了。

随着全球化进程的倒退，跨国公司该在哪里生产疫苗、制定数字规则和纳税的争论已经爆发。欧洲希望成为超级监管者，这可能成为保护主义的遮羞布。其他影响力更弱的国家可能会建立壁垒。为了宣示主权，印度已经对中国社交媒体颁布禁令，并对美国电商公司施加障碍。这是最糟糕的两败俱伤之举，一方面剥夺了国内消费者享受全球创新成果的机会，另一方面又制造了障碍，使本地企业更难扩大规模。

如果世界上只有两个国家有能力保持大规模的创造性破坏，那将是一场悲剧。但如果它们自己也改弦易辙，而其他国家又甘认失败、竖起路障，结果还会更加糟糕。20年后，全球最大企业的名单是否会与今天截然不同，这才是检验成功的最佳标准。 ■



Political science

Congress is set to make a down-payment on innovation in America

Federal spending on research is about to get a boost

SENATOR HARLEY KILGORE, a West Virginia oil prospector's son who carried around a horse chestnut for good luck, had a vision for American science. It was too dominated, he thought, by big business and by the university system: the country's practical needs were an afterthought. In 1942 Kilgore proposed creating a federal bureaucracy, responsive to the public, that would guide scientific research for the good of the country and distribute its benefits geographically.

Kilgore was opposed by Vannevar Bush (pictured above), who led American R&D during the second world war. Bush felt that scientific research should be directed by the scientists themselves. In a report for the president called "Science: The Endless Frontier", Bush summarised his ideas. Government, he said, should fund research. But rather than direct this research towards meeting social needs, it should instead seek to advance science for its own sake: basic, not applied, science was to be the primary objective. Bush won the day. The National Science Foundation (NSF), born in 1950, has largely followed the principles he laid out.

Kilgore is about to get his revenge. The Senate will probably soon pass the US Innovation and Competition Act, known until recently as the Endless Frontier Act. Though the bill is named after Bush's report, it will take American science policy in a more Kilgorian direction. It lays out ten "key technology focus areas," such as artificial intelligence, biotechnology and advanced materials science, to which new research funding will be directed. It allocates funding for regional tech hubs spread across the country. And its objectives are clear: the goal, in true Kilgorian fashion, is to "enhance

the competitive advantage and leadership of the United States in the global economy".

When it was first introduced in May 2020, the Endless Frontier Act planned to set aside \$100bn for a new Directorate for Technology and Innovation within the NSF. This would have borrowed characteristics from the Defence Advanced Research Projects Agency (DARPA), the military-research office responsible for spearheading research that led to the internet, the computer mouse and mRNA vaccines.

The act's ambitions have since narrowed. Instead of the full \$100bn, the NSF's new tech directorate will get \$4bn. Some of the money has gone to pork. A significant portion has been diverted to the Department of Energy's national labs. Though more than \$50bn of funding will go to NSF, much of it either replaces existing funding or is earmarked for causes other than R&D, such as STEM education.

Innovation experts advise against looking a gift horse in the mouth, however. Federal spending on research has fallen from more than 1.2% of GDP in 1976 to less than 0.8% today. As a portion of the federal budget, it has dropped from 12% at its 1960s peak to 3%. The money set aside for R&D in the new bill will not reverse this slide. But the law will still deliver substantial additional funding to the NSF: Its budget for 2022 will be 27% higher than in 2021 and will double over the next five years. Jonathan Gruber of the Massachusetts Institute of Technology, whose work helped to spur the legislation, views the act as a "down payment" towards future innovation.

Others view it as a missed opportunity. Samuel Hammond of the Niskanen Centre, a think-tank, acknowledges that the influx of cash is valuable, but pines for what might have been. Science, he says, needs not just new funding but new institutions as well. Some researchers spend more than

40% of their time on administrative tasks such as grant-writing. Studies have found grant evaluations inconsistent and subjective. Since the number of grant applications has increased faster than available funding, high-quality work may languish unfunded. And though scientists tend to do their best work in their younger years, the recipients of research grants have been getting steadily older.

Mr Hammond believes that government agencies that fund research have become sclerotic: he sees a “compliance culture” resulting from a risk-averse leadership wary of heavy-handed congressional oversight. That is a problem, says Benjamin Reinhardt, an independent researcher who has studied DARPA, because big wins come from taking risks. “All the value,” he says, “is in the long tail.”

One reason to create new research-funding institutions is to turn the scientific process on itself. Some economists have suggested prizes for big breakthroughs. New Zealand has experimented with lotteries for grant funding. Two researchers, Adam Marblestone and Sam Rodriques, have proposed Focused Research Organisations, stand-alone research efforts concentrated on solving single, well-defined science or technology problems.

Mr Gruber agrees that existing funding agencies are too conservative, and wishes the bill were bigger. But he believes it is a good start. The promotion of regional tech hubs, he says, could result in a virtuous cycle: once science and technology are no longer concentrated on the coasts, Americans may become more receptive to increases in R&D funding in the future. And, in the selection of ten key technology areas to focus on, he sees the beginnings of a less tentative approach to innovation. “You can call it picking winners,” he avers. “I call it taking risks.” ■



政治型科学

国会将为美国创新支付“首付”

联邦科研支出将加码

参议员哈里·基尔戈（Harley M. Kilgore）是西弗吉尼亚州一名石油勘探员的儿子，随身带着一颗图吉利的马栗。他对美国的科学发展有自己的展望。他认为科学界太过被大企业和高校系统主导，使得国家的实际需求沦为次要考量。1942年，基尔戈提议设立一个联邦机构，回应公众的需求，根据国家利益引导科学研究，并按地域分配研究收益。

二战期间领导美国科研工作的范内瓦·布什（Vannevar Bush，见上图）反对基尔戈的提议。布什认为，科研工作应由科学家自己主导。在向总统提交的一份名为《科学：无尽前沿》（Science: The Endless Frontier）的报告中，布什总结了自己的想法。他说，政府应该资助科研，但不应以满足社会需求为导向，而应寻求推动科学自身的进步，所以首要目标应是发展基础科学，而非应用科学。布什的看法占了上风。在1950年成立的国家科学基金会（National Science Foundation，以下简称NSF）一直以来大致遵循了他提出的原则。

现在，基尔戈即将翻盘。参议院可能很快会通过《美国创新与竞争法》（US Innovation and Competition Act），此前一直被称为《无尽前沿法》。虽然该法案以布什的报告命名，却将使美国的科学政策更倾向于基尔戈倡导的方向。其中列出十个“关键技术领域”，如人工智能、生物技术和先进材料科学等，将获得新的科研拨款。法案同时给分布在美国各地的区域技术中心拨款。其目标很明确：“加强美国在全球经济中的竞争优势和领导地位”——这完全就是基尔戈的理念。

《无尽前沿法》草案在2020年5月首次提出，计划为NSF内部新成立的技术和创新学部（Directorate for Technology and Innovation）拨款1000亿美元。这是要借鉴美国国防部高级研究计划局（DARPA）的特色——这个军

事研究机构牵头的前沿研究最终带来了互联网、电脑鼠标和mRNA疫苗等成果。

但此后，该法案的规模有所缩减。NSF新设的这个技术学部将获得40亿美元拨款，而非原定的1000亿。其中一些资金已被用于政治利益，很大部分被转拨给了能源部下属的国家实验室。尽管将有500多亿美元划拨给NSF，但其中大部分是取代现有拨款或指定用于研发以外的事务，如STEM教育（科学、技术、工程及数学教育）。

但创新专家们建议大家不要吹毛求疵了。联邦政府的科研支出已从1976年占GDP的1.2%以上降到如今的不足0.8%；占联邦预算的比例也从上世纪60年代高峰期的12%下降到3%。新法案对研发的拨款不会扭转这种下滑趋势，但仍将为NSF输送大量新资金：其2022年预算将比2021年高27%，未来五年内还将翻一番。麻省理工学院教授乔纳森·格鲁伯（Jonathan Gruber）的研究帮助推动了这项立法，他认为该法案是对未来创新投入的“首付”。

也有人觉得这是错失良机。智库组织尼斯卡宁中心（Niskanen Center）的萨缪尔·哈蒙德（Samuel Hammond）承认这些投入的资金很宝贵，但还是遗憾本来或许可以有更大的规模。他说，科研不仅需要新资金，还需要新机构。一些研究人员把超过40%的时间都花在撰写拨款申请这类行政工作上。有研究发现，拨款评估的标准不一，太过主观。由于可用资金跟不上拨款申请的增长，高质量的科研工作可能会因资金不足而搁浅。此外，科学家往往在较年轻时最能出成果，但科研拨款获得者的年龄却在逐渐上升。

哈蒙德认为，负责科研拨款的政府机构已变得僵化保守：其领导层警惕国会的严厉监管，只想规避风险，形成了一种“合规文化”。曾研究DARPA的独立研究员本杰明·莱因哈特（Benjamin Reinhardt）表示，这是个问题，毕竟最重大的成果都源自敢于冒险。“所有价值，”他说，“都在长尾上。”

创建新的科研拨款机构的原因之一是让科学进程能独立自主地运转起来。

一些经济学家建议对重大突破予以奖励。新西兰已经在实验采用抽签的方式划拨科研经费。两位研究人员亚当·马布莱斯通（Adam Marblestone）和山姆·罗德里格斯（Sam Rodriques）提议建立“重点研究组织”，由这些独立的研究组织集中解决单个明确界定的科学或技术问题。

格鲁伯也认同现有拨款机构过于保守，且新法案的规模未如理想。但他认为这总算是起了个好头。他说，推动发展区域科技中心可能带来良性循环：一旦科学与技术不再集中在东西海岸，美国人未来可能更能接受增加科研拨款。而且，法案选择聚焦十个关键技术领域，他觉得是政府在创新上开始不再犹豫不决。“你可以说这是在挑选赢家，”他断言，“不过我会说这是敢冒风险。”■



Inventing the future

A growing number of governments hope to clone America's DARPA

They will not succeed unless they adopt the spirit which motivates it

USING MESSENGER RNA to make vaccines was an unproven idea. But if it worked, the technique would revolutionise medicine, not least by providing protection against infectious diseases and biological weapons. So in 2013 America's Defence Advanced Research Projects Agency (DARPA) gambled. It awarded a small, new firm called Moderna \$25m to develop the idea. Eight years, and more than 175m doses later, Moderna's covid-19 vaccine sits alongside weather satellites, GPS, drones, stealth technology, voice interfaces, the personal computer and the internet on the list of innovations for which DARPA can claim at least partial credit.

It is the agency that shaped the modern world, and this success has spurred imitators. In America there are ARPAs for homeland security, intelligence and energy, as well as the original defence one. President Joe Biden has asked Congress for \$6.5bn to set up a health version, which will, the president vows, "end cancer as we know it". His administration also has plans for another, to tackle climate change. Germany has recently established two such agencies: one civilian (the Federal Agency for Disruptive Innovation, or SPRIN-D) and another military (the Cybersecurity Innovation Agency). Japan's interpretation is called Moonshot R&D. In Britain a bill for an Advanced Research and Invention Agency—often referred to as UK ARPA—is making its way through Parliament.

As governments across the rich world begin, after a four-decade lull, to spend more on research and development, the idea of an agency to invent the future (and, in so doing, generate vast industries) is alluring and, the success of DARPA suggests, no mere fantasy. In many countries there is

displeasure with the web of bureaucracy that entangles funding systems, and hope that the DARPA model can provide a way of getting around it. But as some have discovered, and others soon will, copying DARPA requires more than just copying the name. It also needs commitment to the principles which made the original agency so successful—principles that are often uncomfortable for politicians.

On paper, the approach is straightforward. Take enormous, reckless gambles on things so beneficial that only a handful need work to make the whole venture a success. As Arun Majumdar, founding director of ARPA-E, America's energy agency, puts it: "If every project is succeeding, you're not trying hard enough." Current (unclassified) DARPA projects include mimicking insects' nervous systems in order to reduce the computation required for artificial intelligence and working out how to protect soldiers from the enemy's use of genome-editing technologies.

The result is a mirror image of normal R&D agencies. Whereas most focus on basic research, DARPA builds things. Whereas most use peer review and carefully selected measurements of progress, DARPA strips bureaucracy to the bones (the conversation in 1965 which led the agency to give out \$1m for the first cross-country computer network, a forerunner to the internet, took just 15 minutes). All work is contracted out. DARPA has a boss, a small number of office directors and fewer than 100 programme managers, hired on fixed short-term contracts, who act in a manner akin to venture capitalists, albeit with the aim of generating specific outcomes rather than private returns.

The first challenge for the new ARPAs is to secure the breathing space required for such experimentation. SPRIN-D illustrates how difficult this can be. The concept was approved by Germany's cabinet—"and then the Federal Court of Auditors came along," sighs Barbara Diehl, SPRIN-D's chief partnership officer. After the auditors issued their recommendations, the

agency lost its exemption from standard public-sector procurement rules and pay scales, restricting who it could hire and the sorts of risks it could take. Existing government ministries exert influence through the agency's board, stymying radicalism, says Ms Diehl. Dominic Cummings, a former aide to Boris Johnson, Britain's prime minister, who demanded a British agency as a condition of his employment, has said he is concerned by the provisions for ministerial oversight in the legislation creating it.

Without freedom from political interference, the risk-taking instincts of those at the cutting edge are curbed. The administrative and research directors of Germany's Cybersecurity Innovation Agency recently quit, frustrated by political interference. In America the homeland-security ARPA was established in 2002, but has been hamstrung by power struggles in the department that gave it its name. "It has never been allowed to make independent decisions, it has never been allowed an independent budget," says an observer. There is a debate about whether the Biden administration's health ARPA (ARPA-H) ought to stand alone, or be part of the National Institutes of Health (NIH). The latter would be less of a legislative challenge, but may infringe its independence.

DARPA's budget in 2020 was \$3.6bn, equivalent to just 8% of the NIH's. If all goes to plan, ARPA-H will be on a similar scale, but none of the others receives such funding (ARPA-E got \$425m last year, roughly as much as one of DARPA's six offices). Since the model works by making lots of bets in the hope that a few will come off, stingier funding means fewer wagers, which reduces the chance of success and thus of continued political support. This is especially true given the difficulty of measuring progress. As a paper by Pierre Azoulay of the Massachusetts Institute of Technology (MIT) and his colleagues notes: "It is impossible to accurately measure the incidence of one-in-a-thousand ideas, much less one-in-a-million ideas, on a timescale relevant to political decision-making."

The new agencies must also work out how to get their innovations out of the lab. There is a close relationship between DARPA and the Department of Defence, which is a customer for its work. But other agencies lack such a pipeline. Research by Anna Goldstein at the University of Massachusetts, Amherst, and her colleagues finds that, although new “cleantech” companies sponsored by ARPA-E produce more patents than others, they are not more likely to raise venture capital, be acquired by larger firms or list on public markets. So far, at least, the agency’s innovations have struggled to leap into the real world.

When ARPA-E began in 2009 the hope was that venture capitalists would pick up innovations emerging from it. They have proved reluctant. Energy technologies take far longer to reach the market than venture capital’s favourite investment, software. ARPA-E has thus tweaked the DARPA model to add a “tech-to-market” team, to guide projects through the industrial jungle. Last year it began handing out grants of up to \$150,000 to promising previous award-winners seeking to grow. William Bonvillian, a science-policy expert at MIT, suspects one missing ingredient is simply time: “We created the internet in ’69. It didn’t scale up until ’91 or ’92. So we’ve just got to get used to it taking a while.”

ARPA-H may face similar difficulties. It is based on the idea that the NIH is too conservative, focusing on biology at a time when many life-science breakthroughs happen where biology, chemistry and computer science meet. Mikko Packalen and Jay Bhattacharya, of Waterloo and Stanford universities respectively, provide supportive evidence, finding that the NIH’s funding of work building on new advances has declined. ARPA-H’s other goal, though, is to pump money into treatments for rare diseases, eschewed by the private sector because of limited moneymaking opportunities. As with ARPA-E, this lack of commercial interest may make the transition from innovation to the real world tricky.

Michael Stebbins, who was an official in Barack Obama's administration, and is an advocate for ARPA-H, hopes that someone from DARPA can be recruited to lead the new agency. Replicating DARPA's freewheeling culture is such a challenging task that there have been times when DARPA itself has failed. It went through a fallow period in the late 1960s and early 1970s, and many feel its ambitions have been trimmed back in recent decades—minimising failures, but also successes.

The defence focus also has an inbuilt advantage. By failing to build a terrible weapon, American leaders can reassure themselves that their adversaries won't either. There is no such reassurance in failing to cure cancer. But that has not been enough to dissuade politicians in America, Britain, Germany and Japan. The lesson many have learnt from DARPA is that mere difficulty is no reason to avoid something. It may even be a reason to do it. ■



创造未来

越来越多的政府希望克隆美国的DARPA

除非它们秉承DARPA的精神内核，否则不会成功

用信使RNA制造疫苗的想法未经验证。但如果有效，这种方法会革新医学，尤其是因为它可以保护人们免受传染病和生物武器的威胁。所以在2013年，美国国防部高级研究计划局（Defence Advanced Research Projects Agency，以下简称DARPA）赌了一把。它向一家新成立的小公司莫德纳（Moderna）拨款2500万美元来做相关研发。八年过去了，莫德纳的mRNA新冠疫苗如今已生产了超过1.75亿剂，在DARPA至少有部分功劳的创新名单上又添了一项——这个名单上已经有气象卫星、GPS、无人机、隐形技术、语音接口、个人计算机和互联网。

DARPA这个机构塑造了现代世界，它的成功引发了各种效仿。在美国，在这一国防部门的高级研究计划局（ARPA）最先成立之后，国土安全、情报和能源部门的ARPA也相继成立。总统拜登已要求国会拨款65亿美元成立医疗卫生部门的ARPA，他誓言这将“如我们预期的那样终结癌症”。拜登政府还计划成立应对气候变化的ARPA。德国近年来设立了两个这样的机构：一个是民用领域的联邦颠覆性创新局（Federal Agency for Disruptive Innovation，SPRIN-D），另一个是军事领域的网络安全创新局（Cybersecurity Innovation Agency）。日本的同类机构名为探月类研发项目（Moonshot R&D）。在英国，有关设立高级研究和发明局（Advanced Research and Invention Agency，通常认为是英国版的ARPA）的法案正在议会审议。

在经过40年的停顿期后，发达国家的政府现在纷纷开始在研发上投入更多资金。设立一个机构来创造未来（并由此催生出大量新产业）的想法显得很诱人，而且DARPA的成功表明这并非幻想。在许多国家，拨款体系受困于官僚网络，人们对此深感不满，希望使用DARPA模式可以避开这种情况。但正如一些人已经发现的那样（其他人很快也会发现），复制DARPA

模式不是照搬名字就行了，还需要致力于遵循让原版DARPA大获成功的原则，而这些原则往往会让政客们不安。

从表面上看，DARPA的做法直截了当，那就是对大有益处的项目大胆押下重注，只要有少数取得成功，整体上就是成功的。正如美国能源部下属ARPA（ARPA-E）的首任局长阿伦·玛尊达（Arun Majumdar）所说：“如果每个项目都挺成功，那说明你还不够努力。”当前（非机密的）DARPA的项目包括模仿昆虫的神经系统以减少人工智能所需的计算，以及在敌人用基因编辑技术发动攻击时保护士兵。

结果是DARPA与一般的研究机构迥乎不同。其他机构大多注重基础研究，而DARPA要造出实物。其他机构大多要做同行评审，并使用精心挑选的标准来衡量进展，但DARPA彻底摆脱了官僚主义（1965年的一次谈话促使该机构为第一个跨国计算机网络提供了100万美元，那便是互联网的前身，而那次谈话只花了15分钟）。DARPA外包了所有工作。它只有一个老板、一小批部门主管和不到100名项目经理。这些经理签的都是短期的固定期限合同，工作方式类似于风险投资家，只不过他们的目标是取得具体成果，而不是个人收益。

新成立的各家ARPA面临的第一项挑战是为这类实验争取到所需的自主空间。SPRIN-D的历程显示了这有多难。成立这个机构的设想得到了德国内阁的批准，“结果联邦审计署（Federal Court of Auditors）来了。”SPRIN-D的首席合作官芭芭拉·迪尔（Barbara Diehl）叹息道。审计官员提出建议后，该机构就丧失了在公共部门采购规定和薪酬标准上的豁免权，限制了它能聘用谁以及可以承担什么风险。迪尔说，现有政府各部通过SPRIN-D的董事会施加影响，不让它大刀阔斧地行事。英国首相约翰逊的前顾问多米尼克·卡明斯（Dominic Cummings）当初出任顾问时提出的一个条件是设立一个英国版的ARPA。他曾表示，创建这个机构的相关立法中包含了由政府部委施加监督的规定，这令他感到担忧。

如果不能免于政治干预，前沿科研人员的冒险本能就会被抑制。德国网络安全创新局的行政和研究主管最近就因为对政治干预忍无可忍而辞职。美

国国土安全部的ARPA于2002年成立，但一直受该部内部的权力斗争牵制而难有作为。“它从来没有独立决策权，从来没有独立预算。”一位观察人士说。拜登政府的医疗ARPA（ARPA-H）是应该自成一体还是隶属于美国国立卫生研究院（NIH）仍存在争议。后一种方案在立法上难度较小，但可能会损害ARPA-H的独立性。

DARPA在2020年的预算为36亿美元，仅相当于NIH预算的8%。如果一切按计划进行，ARPA-H将会有类似的预算，但其他ARPA都不会获得这么多资金（ARPA-E去年得到的拨款为4.25亿美元，大致相当于DARPA下属六个部门中一个的水平）。由于DARPA模式的成功在于广撒网、多下注，希望总有几个项目能成功，资金少自然意味着能下注的项目也少了，这就降低了成功的机会，从而减少了在政治上持续获得支持的机会。在很难衡量进展的情况下尤其如此。正如麻省理工学院的皮埃尔·阿祖莱（Pierre Azoulay）及其同事在一篇论文中指出的那样：“不可能用政治决策的时间框架准确衡量千里挑一的创意的进展，更不用说那些百万里挑一的。”

这些新设立的ARPA还必须研究出如何让它们的创新成果走出实验室。DARPA与国防部关系密切，国防部是其研究成果的客户。但其他机构缺乏这样的渠道。马萨诸塞大学阿默斯特分校（University of Massachusetts, Amherst）的安娜·戈德斯坦（Anna Goldstein）及其同事的研究发现，尽管由ARPA-E资助的新“清洁技术”公司取得的专利比其他公司多，但它们并没有因此而更可能获得风险投资、被大公司收购或在公开市场上上市。至少到目前为止，该机构的创新成果一直难以转化为现实应用。

ARPA-E于2009年成立时，对它寄予的希望是风险投资家会选中它的创新成果。事实证明他们不太感兴趣。与软件这种最受风投青睐的投资对象相比，能源技术推向市场所需的时间要长得多。因此，ARPA-E对DARPA模式做了微调，增加了一个“技术到市场”团队，指引研发项目穿越产业丛林。去年，ARPA-E开始对那些曾经赢得其资助、寻求进一步发展的潜力股公司提供最高15万美元的科研资金。麻省理工学院的科学政策专家威廉·邦维利安（William Bonvillian）认为这其中缺少的一个要素就是时间：“我们在1969年发明了互联网，直到91、92年才大规模应用它。我们得习惯这中

间需要一些时间。”

ARPA-H可能面临类似的困难。成立该机构是因为人们认为NIH过于保守：如今生命科学的众多突破来自生物学、化学和计算机科学的交叉，NIH却仅专注于生物学研究。滑铁卢大学的米科·帕克艾伦（Mikko Packalen）和斯坦福大学的杰伊·巴特查里亚（Jay Bhattacharya）给出的证据支持了这一点，他们发现NIH对基于新技术进步的研究的资助减少了。不过，ARPA-H的另一个目标是资助罕见病疗法的研究，由于这方面的研究盈利机会有限，私营部门一直敬而远之。与ARPA-E一样，缺乏商业回报可能会让创新难以转化为实际应用。

曾在奥巴马政府任职的迈克尔·斯特宾斯（Michael Stebbins）是ARPA-H的支持者，他希望可以请到DARPA的人来领导这个新机构。复制DARPA自由行事的文化挑战巨大——它自己在这件事上也曾多次失败。它在上世纪60年代末到70年代初期间无所作为，而许多人认为近几十年来它当年的雄心已被削弱，这大大减少了失败，但同样减少了成功。

DARPA专注于国防也有一种天然优势。就算造不出可怕的武器，美国领导人可以自我安慰说对手也造不出来。找不到治愈癌症的办法就没法这么安心了。但这不足以让美国、英国、德国和日本的政客作罢。许多人从DARPA学到的经验是，困难本身不是逃避的理由。它甚至可能正是行动的原因。■



Paid in China

Soaring factory prices in China add to global inflation fears

Long a source of cheap goods, is China now exporting higher prices?

ERIC ZHU, an international sales manager at a Chinese forklift-maker, has just sent his second letter of the year to customers, explaining that prices are going up once again. “We need to share some of the price increases with our partners. We cannot absorb them all ourselves,” he says. “The world is crazy now.” Although not standard economics terminology, crazy is a good description for the price movements now coursing through global markets. Inflation in America is running at its fastest since 2008. Energy and commodity prices have soared. And as Mr Zhu can attest, investors and company bosses are worried that China, the world’s workshop, is itself starting to export inflation.

It is easy to see why people are concerned. On June 9th China reported that factory-gate prices rose at an annual rate of 9% in May, the highest in more than a decade. That, along with soaring shipping costs and a stronger yuan, will probably push up the prices of made-in-China goods, from phones to futons. America’s imports from China already cost 2.1% more in April than they did a year ago, the fastest rise since 2012 (see chart).

Yet the danger of China-exported inflation can be overplayed. Only part of the rise in China’s producer prices reflects domestic causes. Its strong economic recovery was led by investment in homes and infrastructure, which pushed up the price of steel. In order to meet green targets, the government has reined in both coal and steel production. Officials have also vowed to crack down on “excessive speculation” in domestic commodity futures, suggesting that this helped the run-up in prices.

Most of the price pressures instead reflect the peculiarities of the covid-clouded world. The global demand for consumer goods—things you can buy online while confined at home—has soared. Chinese exports are about 20% higher than their pre-pandemic trend, and factories have struggled to keep up with orders. Disruptions to global commodity supplies, such as lockdowns that limited copper mining in Chile and Peru, have also pushed up prices.

Rather than transmit the shock, Chinese companies have absorbed much of it. Compared with the end of 2019, before covid-19 upended the world, factory-gate prices in China have risen by nearly 6%. But an index measuring the cost of manufactured consumer goods in China went up by just 0.6%. Companies have had to get by with thinner margins. No wonder Mr Zhu wants to share the pain with customers.

Moreover, the policy environments in China and America are very different. Whereas the Federal Reserve eased monetary policy dramatically, the People's Bank of China was much more conservative. It has cautiously begun tapering its support. This may help explain the divergence between the two countries' inflation trajectories. In America, the Fed's preferred measure of "core" consumer prices, excluding food and energy, rose by 3.1% year-on-year in April, the most since 1992. In China, the core index rose by just 0.9% year-on-year in May. (China's farmers have also helped quell inflation. A recovery in pig stocks after an outbreak of African swine fever has brought pork prices down by nearly a quarter compared with last year.)

Taking a longer view, some analysts think that China's ageing population will transform it into an inflationary force. In the early 2000s, China's low wages helped make consumer goods cheap around the world. That suggests that shrinking labour supply and rising wages should have the opposite effect. Yet this is not so clear-cut. Low-end manufacturing is already moving to cheaper places like Vietnam and Bangladesh, while a rapid increase in

automation in China has also helped restrain prices.

Now, though, the pressing question is whether China's input-price inflation will be transitory or more enduring. The answer lies outside China. As the vaccine roll-out gains traction and something closer to normal life resumes in America and Europe, people are likely to spend more on services such as tourism and eating out, not just on goods bought online. That would ease the pressure on commodities and, by extension, on China's factories. ■



中国内部承担

中国出厂价飙升加剧全球通胀忧虑

一直是廉价商品来源的中国如今在输出高价？

中国一家叉车制造商的国际销售经理埃里克·朱（音译）刚刚给客户发出了今年第二封信，对再一次涨价做解释。“我们需要合作伙伴分担一部分价格涨幅。我们没法全部自己承担，”他说，“目前的市道太疯狂了。”虽然不是一个标准经济学术语，但“疯狂”的确很好地描述了眼下全球市场上的价格趋势。美国的通胀增速为2008年以来最高。能源和大宗商品价格飙升。而就像朱先生可以证明的那样，投资者和公司老板们都担心中国这个世界工厂本身开始输出通胀。

不难看出人们为何担忧。6月9日，中国公布的数据显示5月工业生产者出厂价格同比增长9%，为十几年来最高。再加上运输成本飙升和人民币汇率走高，从手机到沙发床的中国制造商品的价格都很可能被推高。美国从中国进口的商品在4月已同比涨价2.1%，是自2012年以来最快的增幅（见图表）。

但是，中国输出通胀的风险有可能被高估。中国生产商价格上升只有一部分是源于国内因素。中国强劲的经济复苏是由房地产和基建投资带动的，这推高了钢材的价格。为实现环保目标，中国政府已经在限制煤炭和钢铁生产。官员们还誓言要打击国内大宗商品期货市场的“过度投机”，暗示这也是推动价格上涨的因素之一。

实际上，这波价格压力主要反映了全球在疫情阴影下的特殊现状。全球对消费品（人们困居家中之时仍可从网上买到的物品）的需求飙升。中国出口量比疫情前高约20%，工厂产能难以跟上订单。全球大宗商品供应受到疫情干扰，例如智利和秘鲁的铜矿开采因封城而受限，也推高了价格。

中国的公司没有传输这种冲击，而是自己吸收掉了大部分。相比2019年

底，也就是疫情还没有让世界天翻地覆的时候，中国的出厂价已经上涨了近6%。但一个衡量中国产消费品成本的指数仅上升了0.6%。企业不得不靠着缩水的利润撑下去。难怪朱先生希望客户能分担一些痛苦。

另外，中美两国的政策环境大相径庭。美联储大幅放宽货币政策，而中国人民银行则保守得多。后者已开始谨慎地缩减支持。这可能有助于解释两国通胀走势的差异。在美国，美联储惯用的“核心”消费价格（不包括食品和能源）指数在4月同比上升3.1%，是1992年以来最大的增幅。在中国，5月的核心价格指数仅同比上升0.9%。中国农民也对平抑通胀起了一定作用。生猪生产已从非洲猪瘟的影响中恢复，令猪肉价格比去年下降了近四分之一。

更长远来看，一些分析师认为人口老龄化将使中国成为推高通胀的力量。在21世纪初，中国的低工资帮助全世界用上了廉价消费品。这么说起来，劳动力供应萎缩和工资上涨应该会令消费品价格上涨。然而事情并不是这么绝对的。低端制造业已逐渐向越南和孟加拉国等成本更低的地方转移，而中国自动化程度的迅速提高也帮助抑制了价格上升。

而眼下紧迫的问题是，中国的投入价格上涨是暂时的还是会更持久。答案取决于中国之外的因素。随着疫苗接种的铺开，欧美在一些方面逐渐接近恢复正常生活，人们很可能在旅游和外出就餐等服务上消费更多，而不仅仅是在网上买东西。这将缓解对大宗商品的压力，进而缓解中国工厂承受的压力。■



Electric shock of the new

How to be the next Tesla

A traffic jam of upstarts is vying to follow in Elon Musk's tyre tracks. Does any stand a chance?

CARMAKING IS LITTERED with defunct marques, from Diatto and Hupmobile to Mercer and Whitlock. America spawned around 250 firms by the 1910s. As the 20th century wound to a close it had three that mattered: Ford, General Motors (GM) and Chrysler. In the past few years an electric version of the early American automobile boom is unfolding on a global scale.

Chinese startups like Aiways, Li Auto, Nio, WM Motor and Xpeng are already making electric vehicles (EVs) in their thousands. In Europe, Croatia's Rimac and Spain's Hispano Suiza are building hypercars, while Britain's Arrival is manufacturing electric vans. American companies such as Canoo, Fisker, Lordstown, Lucid and Rivian hope to start full-scale production soon. Foxconn, a Taiwanese contract manufacturer better known for making Apple's iPhones, may soon also be assembling electric cars for others. As for Apple, its next gadget could be an iCar.

Most of the insurgents are loss-making. Some have yet to earn any revenue. But all see a chance to grab a slice of an industry that has turned decisively in the direction of battery power (see chart 1). Everyone wants to be the next Tesla, which has successfully used batteries and clever software to take on the internal combustion engine. In the process Elon Musk's firm has become the world's most valuable car company, worth more than the next three biggest carmakers combined.

Tesla's \$600bn valuation serves as a "torch at the front", says Engelbert

Wimmer of e&Co, a consultancy. Now investors are looking for the next beacon. Nio listed in New York in 2018. Xpeng and Li followed suit last year. All are worth as much or more than many established carmakers. Arrival and several of the American firms have used mergers with special-purpose acquisition companies, or SPACs, as a shortcut to public markets—and to valuations in the billions. Patrick von Herz of Lincoln International, an investment bank, calls it a “global feeding frenzy”. He Xiaopeng, Xpeng’s boss, has said he expects the market to swell to 300 or so firms before settling at around ten. How do the challengers avoid the fate of the forgotten?

The basic blueprint for survival involves three elements. The upstarts must first find a starting niche from which they can expand. They then need actually to produce cars at scale. Finally, they have to create a sales-and-distribution network. Most will fail at one or more of these steps. Ironically, those with the best odds of emulating Tesla’s success may be the ones that look least like it.

Start with picking your battlefield. That could be geographic. Philippe Houchois of Jefferies, another investment bank, reckons that the next Tesla will come from China. Consumers hungry for new tech and a government keen to support electrification have given China’s insurgents a head-start. Nio, the largest of the lot, made 44,000 cars in 2020. It is valued at \$69bn. The market capitalisations of Xpeng and Li, respectively \$28bn and \$22bn, are also juicy. Rich access to capital helps fund expansion at home and abroad. Xpeng has already started selling cars in Norway, home to Europe’s most enthusiastic EV buyers. Nio is about to join it.

Even more important than geography is choosing the right market segment. Tesla was not the first to make EVs but it was the first to make big and pricey premium ones where the high cost of the battery could be absorbed. Many new firms are also aiming at premium SUVs and saloons where profit

margins are fattest. But competition is hotting up from established carmakers such as Volkswagen's Audi and Porsche brands, as well as Mercedes. In April Geely, a Chinese firm with global ambitions, launched a premium electric marque called Zeekr. The mass market, meanwhile, is likewise busy, with GM and Ford the latest to announce a big electric push.

Other segments may therefore be a better bet. One is light commercial vehicles, demand for which has been boosted by the pandemic e-commerce boom. Alastair Hayfield of Interact Analysis, a consultancy, sees "no Tesla yet" for delivery vans. Carmakers are merely popping EV power trains into existing products—an unhappy compromise that affects performance. That leaves opportunities for firms like Arrival and Rivian. Another potentially lucrative niche is the hypercar. Wealthy petrol-heads seem willing to fork out \$2m or so to add to their stables. Rimac and Pininfarina of Italy also see these cars as test-beds for EV technology to sell to other car firms. China's Silk-FAW considers its Hongqi S9 hybrid as a gateway to the mass market.

Identifying the right segment may not be enough, however. Brian Gu, president of Xpeng, admits that the new firms must offer something truly different. For years the industry's technologically stodgier incumbents "didn't realise it was a tech race", says Peter Rawlinson, who runs Lucid. As cars become more like personal electronic devices, being tech firms first and carmakers second may confer an advantage. Foxconn's boss, Young Liu, has argued that the driving experience of the future will be "software-driven and software-defined".

Novel intellectual property is a "good visiting card" for investors, says Pedro Pacheco of Gartner, a consultancy. But it is not enough to stick big touchscreens onto a standard electric power train, as many of the Chinese Tesla copycats are doing. The over-the-air software updates, proprietary charging networks and online direct sales pioneered by the American firm are now seen as table stakes.

So the newcomers are trying to stamp their own technological mark on the industry. Lucid's techies have extracted range of up to 517 miles (832km) from its batteries. Nio offers a three-minute battery-swap service, to reassure Chinese buyers without access to home charging. Xpeng claims that its voice-activation system is the best in the business. Fisker and Canoo offer subscriptions that give motorists access to car use rather than ownership.

Ultimately, buyers will decide which of these are desirable features and which are gimmicks. But not before the new models are produced and sold. Making a few thousand cars a year is hard enough (though losing money doing so is easy). Actually selling hundreds of thousands at a profit is another matter entirely. "Production hell" nearly sent Tesla under. A lead on flashy software must be backed up with giant presses, paint shops and assembly lines. As such, manufacturing an EV is in many ways not much different to making a petrol car, according to Bernstein, a broker—and no less expensive. A new purpose-built car factory that can churn out 100,000 or so vehicles a year costs at least \$1bn.

To get around this problem some of the challengers are instead repurposing existing factories, as Tesla did by acquiring a disused one in Fremont, California, for a song. Rivian has moved into an old Mitsubishi factory in Illinois. Other newcomers are teaming up with the old guard, with experience of maintaining long and complex supply chains. Baidu has entered into a partnership with Geely and Huawei with its domestic rivals, BAIC, Changan and GAC. Fisker and Nio are taking an asset-light route by using contract manufacturers of the sort used by big carmakers to make small runs of cars or those with finicky features such as folding roofs.

Arrival's approach may be the most innovative. Where Tesla and others are going "giga", the British firm says "micro". Commercial vehicles do not require the styling or customisation of passenger cars, so it is eschewing

production lines for “cell” assembly of composite panels. This can be done in small industrial units that cost just \$40m-50m to buy and retool. These can produce 10,000 vehicles a year close to markets, adding scale with less risk.

The final hurdle is flogging the vehicles to consumers. The new EV-makers are mostly dispensing with traditional dealer networks in favour of Tesla’s model of online sales backed up with shops to show off their wares. That still leaves the challenge of creating a servicing network if anything goes wrong. Such networks, which car buyers have come to expect, can be as expensive and tricky to scale up as manufacturing is. Mr Pacheco of Gartner notes that even Tesla’s is still a work in progress. In America the big three Detroit carmakers have nearly 10,000 dealerships that will service cars; Tesla has around 135.

Many new firms won’t get that far. Several have already suffered setbacks. Dyson, a British firm better known for vacuum-cleaners, sank £500m (\$640m) into an EV effort only to conclude in 2019 that it would never make money. The same year Nio teetered on the brink of bankruptcy until the local government in its home city of Hefei bailed it out. A bloodbath awaits China’s myriad smaller EV firms as they run out of ideas and money. Fisker is a reborn version of a firm that went bankrupt in 2013.

As the complicated reality of carmaking sets in, the hype is wearing off among investors (see chart 2). Lordstown’s value has fallen by 65% since peaking in February, after it lowered forecast production for its pickup truck and said it needed fresh funds. Canoo’s shares are worth less than half what they were when it went public in December, owing to growing doubts about its business plan.

In short, notes Aakash Arora of BCG, a consultancy, the new firms need to

establish brands. So far, he says, only Tesla has done so. It can take years to gain a reputation for reliable products, while capital burns like petrol put to a spark. A new entrant needs a trusted name, deep pockets and a proven ability to come up with clever tech. One company that has all those in spades is Apple. The iPhone-maker has been working on an EV for several years. The latest chatter is that it will have one in production by the middle of the decade. Some of its potential competitors will by then be well on the way to oblivion. ■



新势力触电

如何成为下一个特斯拉

蜂拥而至的造车新势力争相跟随马斯克。有谁能突围吗？

在汽车制造业里已经有大量品牌不复存在，比如迪亚托（Diatto）、Hupmobile、美世（Mercer）和惠特洛克（Whitlock），等等。美国到1910年代已经诞生了大约250家汽车制造商。到了20世纪末，其中三家变得举足轻重：福特、通用汽车和克莱斯勒。过去几年里，电动汽车在全球范围的蓬勃发展再现了当年美国汽车产业的繁荣景象。

爱驰、理想、蔚来、威马和小鹏等中国创业公司已经在以数万台的年产量制造电动汽车。在欧洲，克罗地亚的Rimac和西班牙的Hispano Suiza正在打造电动超级跑车，而英国的Arrival正在制造电动货车。Canoo、Fisker、Lordstown、Lucid和Rivian等美国公司希望很快开始全面投产。台湾代工厂富士康更出名的业务是为苹果生产iPhone，它可能很快也会为其他公司组装电动汽车。至于苹果，它的下一个产品可能就是iCar。

目前，大多数新崛起的电动车制造商都在亏损。有些还没挣到一分钱。但在这个已经确定向电力驱动转型的行业（见图表1），所有这些公司都看到了从中分得一杯羹的机会。每一家都想成为下一个特斯拉。特斯拉已经使用电池和智能软件成功向内燃机发起宣战。在此过程中，马斯克的公司成为了世界上最有价值的车厂，市值超过了排在它之后的三大汽车制造商的总和。

咨询公司e&Co的恩格尔贝特·维默尔（Engelbert Wimmer）表示，特斯拉高达6000亿美元的估值就像“领头的火炬”。现在，投资者正在寻找下一个灯塔。2018年，蔚来在纽约上市。小鹏和理想也在去年跟上。这些公司的市值都与许多老牌汽车制造商相当，甚至更高。Arrival和几家美国公司已经通过与特殊目的收购公司（SPAC）合并这条捷径成功上市，市值以几十亿美元计。投资银行林肯国际（Lincoln International）的帕特里克·冯·赫

兹（Patrick von Herz）称这是“全球性的疯狂竞争”。小鹏的老板何晓鹏表示，他预计电动车厂商会增加到300家左右，然后稳定在十来家。这些挑战者该如何避免被遗忘的命运？

要想存活下来需要具备三个基本要素。首先，新势力必须找到一个能作为扩张起点的利基市场。然后，它们需要真正地量产汽车。最后，它们必须创建一个销售和分销网络。大多数公司会在这其中的一步或多步上失利。讽刺的是，最有可能像特斯拉一样成功的可能是那些看起来最不像特斯拉的公司。

首先是选择战场。它可能是地理意义上的。另一家投资银行杰富瑞（Jefferies）的菲利普·霍乔斯（Philippe Houchois）认为，下一个特斯拉将诞生于中国。消费者对新技术的渴望以及政府对电气化的大力支持让中国的造车新势力抢占了先机。蔚来是其中最大的一家，它在2020年生产了4.4万辆车，目前市值690亿美元。小鹏和理想的市值也相当可观，分别为280亿美元和220亿美元。强大的融资能力帮助它们赢得在国内外扩张所需的资金。小鹏已经开始把汽车卖到了挪威这个欧洲最热衷购买电动汽车的国家。蔚来也即将进入挪威市场。

比地理市场更重要的是选对细分市场。特斯拉并不是第一家电动汽车制造商，却是第一家生产昂贵的大型豪华电动汽车的厂商，这样就可以消化高昂的电池成本。许多新公司也瞄准了利润最丰厚的豪华SUV和轿车。但随着大众旗下的奥迪和保时捷以及梅赛德斯等老牌汽车制造商入局，竞争正在升温。4月，有志于全球扩张的中国公司吉利推出了一款名为Zeekr的豪华电动车型。与此同时，大众市场也差不多热闹，通用汽车和福特最近都已宣布要大举押注电动车。

因此，其他细分市场可能是更好的选择。轻型商用车市场便是其中之一，新冠疫情带来的电子商务热潮加大了对这类车型的需求。咨询公司Interact Analysis的阿拉斯泰尔·海菲尔德（Alastair Hayfield）认为，运货车领域“还没有出现特斯拉”。汽车制造商目前不过是在现有车型中加上了电动汽车传动系统——这样的折中方案影响性能，并不能令人满意。这给

Arrival和Rivian等公司提供了机遇。另一个或许有利可图的细分市场是超级跑车。富有的汽油车发烧友们似乎愿意花200来万美元添置一台新玩具。Rimac和意大利的Pininfarina也将这些汽车看作向其他车厂出售电动汽车技术的试验台。中国的Silk-FAW合资企业将它开发的红旗S9混合动力超跑视为进入大众市场的途径。

然而，找对细分市场可能还不够。小鹏的总裁顾宏地承认，新企业必须提供某些真正与众不同的东西。Lucid的CEO彼得·罗林森（Peter Rawlinson）说，多年来，传统汽车公司在技术上一直古板守旧，“没有意识到这是一场技术竞赛”。随着汽车变得越来越像个人电子设备，企业将自身首先定位为科技公司、其次才是汽车制造商可能会带来一种优势。富士康的董事长刘扬伟认为，未来的驾驶体验将“由软件驱动，由软件定义”。

在投资者看来，创新的知识产权是张“闪亮的名片”，咨询公司高德纳的佩德罗·帕切科（Pedro Pacheco）说。但是，像许多中国的特斯拉模仿者在做的那样，只在普通电动汽车上安装上大尺寸触摸屏是不够的。由特斯拉首创的OTA软件更新、专有充电网络和网络直销现在都被看作是入场筹码。

因此，新来者都想方设法在这个行业打上自己的技术印记。Lucid的技术人员已经将自己的电池续航里程提高到517英里（832公里）。蔚来提供三分钟换电池服务，以求消除那些无法在家中充电的中国车主的后顾之忧。小鹏声称自己拥有业内最先进的语音控制系统。Fisker和Canoo提供的订阅服务让人们无需买车就能用车。

这些功能哪些值得拥有、哪些只是噱头，最终还是消费者说了算。但这也得在新车型生产和销售之后才有定论。一年生产几千辆车已经够难了（虽然这么搞赔钱倒是很容易）。真能把几十万辆车卖出去还赚到钱又完全是另一回事了。“生产地狱”差点让特斯拉倒闭。有了酷炫领先的软件，还得有大型压铸机、油漆车间和装配线作为后盾。因此，经纪公司盛博表示，制造一辆电动车在许多方面与制造汽油车没有太大区别，而且成本也不会

更低。专门建造一家年产10万辆左右的新工厂至少要砸10亿美元。

一些挑战者选择改造老工厂来减轻成本压力，比如特斯拉就低价买下了位于加州弗里蒙（Fremont）的一家废弃工厂。Rivian搬进了伊利诺斯州一座原属于三菱的老工厂。其他新来者正在与老牌企业合作，后者在维护漫长且复杂的供应链方面很有经验。百度已与吉利联手，而华为与吉利的国内竞争对手北汽、长安和广汽结盟。Fisker和蔚来都在走借助代工厂的轻资产路线，这类代工厂过去为大车厂生产小批量车或带有折叠式敞篷车顶等复杂功能的汽车。

Arrival的方法可能最为创新。在特斯拉和其他公司朝着“巨型”走时，这家英国公司却打出了“微型”旗号。由于商用车不像乘用车那样需要考虑造型或做定制化，它省掉了复合面板“单元”组装的生产线。这可以在购买加改造成本仅在四五千万美元的小工厂中完成。这些贴近销售市场的工厂每年能生产一万辆车，以较小的风险扩大了规模。

最后一个难关是把汽车卖给消费者。新一代电动汽车制造商大多摒弃了传统的经销商网络，转而采用特斯拉的在线销售模式，并辅之以产品展示店。但这种模式仍然留下一个挑战：需要建立一个服务网络来处理各种问题。购车者已经开始期待这样的网络，但扩大这一网络可是像扩大造车一样费钱又费事。高德纳的帕切科指出，即便是特斯拉的服务网络也还只是个半成品。在美国，底特律三大汽车制造商拥有近一万家提供售后服务的经销商；特斯拉有135家左右。

许多新公司都走不到售后这一步。有些已经在开倒车。以生产吸尘器闻名的英国公司戴森在电动汽车项目上投入了5亿英镑（6.4亿美元），却在2019年得出该项目永远不会赚钱的结论。同年，蔚来濒临破产，直到其总部所在地合肥的市政府出手相救。随着中国众多小型电动汽车公司的创意和资金枯竭，它们面临着被血洗的命运。Fisker的前身就是一家在2013年破产的公司。

在造车的种种复杂现实浮现之时，投资者的兴奋情绪也在减退（见图表

2）。Lordstown在调低了自家轻型货车的产量预期并表示需要更多资金后，市值已较2月的最高点下跌了65%。Canoo的商业计划受到的质疑与日俱增，目前股价已跌至不到去年12月上市时的一半。

简而言之，波士顿咨询公司的阿卡什·阿罗拉（Aakash Arora）指出，这些新公司需要树立品牌。他说，到目前为止，只有特斯拉做到了。赢得产品可靠的声誉可能要等待多年，而资本烧起来就像汽油点着火。新进入者需要有被信赖的品牌、雄厚的资金，还要在推出智能技术上有可靠的能力。在这三条上都绰绰有余的公司当属苹果。这家出品iPhone手机的公司研发电动汽车已经有几年了。坊间新的传言是它的电动汽车将在2025年前后投产。到那时，它的一些潜在竞争对手早就销声匿迹了。 ■



Noise pollution

Humans are imperfect, inconsistent decision-makers

In their new book, Daniel Kahneman, Olivier Sibony and Cass Sunstein offer strategies for improvement

Noise. By Daniel Kahneman, Olivier Sibony and Cass Sunstein. Little, Brown; 464 pages; \$32. William Collins; £25

NOISE IS UNWANTED variation in judgments that should be identical, which leads to inaccurate and unfair decisions. It is all around people all the time, though individuals fail to notice it. To get a sense of how it happens, perform a “noise audit” right now: open your phone’s stopwatch app and practice counting ten seconds. Now, with your eyes closed, count several times, hitting the lap button each time you believe ten seconds have elapsed.

Your answers weren’t perfect but noisy: slightly above or below the ten-second mark. And if they were consistently wrong in one direction, then there is bias too, which is a different form of error (you counted too quickly or slowly).

The problem of bias in decisions is well known and there are strategies that people can adopt to minimise it. For example, customers may be “anchored” on the first price they are presented with in a transaction, so they learn to consciously discard it before they negotiate. But noise is different precisely because it is less apparent. “It becomes visible only when we think statistically about an ensemble of similar judgments. Indeed, it then becomes hard to miss,” Daniel Kahneman, Olivier Sibony and Cass Sunstein write in their new book.

The divergences are stark. In a courthouse in Miami, one judge would grant

refugees asylum in 88% of cases while another would do so 5% of the time. A large study of radiologists found that the false-positive rate ranged from 1% to 64%, meaning that two-thirds of the time, a radiologist said a mammogram showed cancer when it was not cancerous. Doctors are more likely to prescribe opioids at the end of a long day. Judges made harsher decisions leading up to their breaks and on hotter days. An insurance firm's underwriters assessed premiums that varied by 55%, a difference that was five times greater than its management had imagined.

Not only do individuals differ with their peers, they often fail to agree with themselves. Wine experts tasting the same samples for a second time scored fewer than one in five identically. Four out of five fingerprint examiners altered their original identification decision when presented with contextual information that should not have been a factor in matching prints. In one medical study, assessing angiograms, physicians disagreed with their earlier judgments more than half the time.

Noise is sometimes good. When different investors size up a trade or book reviewers reach different assessments, the diversity of opinion is beneficial. But more commonly it creates problems. In law noise means unfairness. In business it can be costly.

Yet it can be reduced. The authors' remedies include a "noise audit" to measure the degree of disagreement on the same cases, to quantify the variation that is usually invisible. They also call for better "decision hygiene" such as designating an observer for group decisions, to prevent common biases and noisy judgments. For example, they can ensure that participants in a team reach independent assessments before coming together as a group to aggregate their decisions.

Another solution is to dispense with people altogether. Statistical models, pre-determined rules and algorithms in many cases are more accurate than

human judgment. The authors welcome artificial intelligence to make many decisions in society, but acknowledge that people are predisposed to resisting their answers, for lack of the personal, emotional quality in decision-making—even if it leads to inferior, or at least variable, decisions.

The trio speaks with credibility. Mr Kahneman is a Nobel laureate whose ideas on bias in human reasoning have reshaped economics and society; Mr Sunstein is a polymath scholar at Harvard and occasional government official putting his ideas into policy; Mr Sibony is a former McKinsey partner who teaches decision science at a French business school. Yet despite the book's title, the authors struggled to extract the signal from the noise, so to speak, needing some 400 pages to make their case. A tighter argument would have enhanced the ideas they present. ■



噪音污染

人类是不完美、前后不一的决策者

丹尼尔·卡尼曼、奥利维尔·西博尼和卡斯·桑斯坦在合著的新书中提出了改进策略
【《噪音》书评】

《噪音》。丹尼尔·卡尼曼、奥利维尔·西博尼和卡斯·桑斯坦著。利特尔布朗出版社；464页；32美元。威廉·柯林斯出版社；25英镑

本该一模一样的判断中出现了人们不想要的差异，这种差异便是“噪音”（noise），它导向了不准确和不公允的决策。噪音无时不有，尽管个体并不会注意到它。要了解它是如何产生的，不妨现在就来做一次“噪音审计”：打开你手机上的秒表应用，先练习一番，数个10秒。接着闭上眼睛，再数几遍，每次你觉得已经过了10秒，就按停计时器。

你每次计数的结果并不是正正好好，而是有噪音的：不是比10秒稍长些，就是略短了点。如果它们始终都往一个方向上错，那就说明还存在偏误，这就是另一种形式的错误了（你数得太快或太慢了）。

决策时会出现偏误的问题众所周知，人们可以采取一些策略来尽量减小它。例如，在交易中，客户可能会“锚定”在对方给出的第一个报价上，因此他们学会了要在谈判之前有意识地无视这个价格。但噪音之所以不同，恰恰是因为它不是那么明显。“只有当我们从统计学的角度综合考量一系列相似的判断时，噪音才变得明显起来。事实上，这之后你想不看到它们都难。”丹尼尔·卡尼曼（Daniel Kahneman）、奥利维尔·西博尼（Olivier Sibony）和卡斯·桑斯坦（Cass Sunstein）在他们的新书中写道。

分歧十分显著。在迈阿密的一家法院，一名法官裁定给予难民庇护的几率是88%，另一名法官是5%。一项针对放射科医生的大规模研究发现假阳性率在1%至64%之间——64%这个数字意味着当某位放射科医生说乳房X光片显示癌症时，有三分之二的机会都不是。医生更有可能在一天的辛苦工作快结束时开出阿片类药物。法官在临近休假和天气较热时会做出更严厉

的判决。在一家保险公司，不同承保人评估的保费相差55%，是公司管理层预期数字的五倍。

个人不光会与同侪不一致，还常常“自己打脸”。葡萄酒专家在第二次品尝相同的酒样时给出与之前完全相同的评分的几率还不到五分之一。向指纹鉴定人员提供背景信息后，有五分之四的人改变了自己最初的鉴定决定，而这些信息本不应成为匹配指纹时该考虑的因素。一项评估血管造影照片的医学研究发现，医生们下的判断与先前不符的情况占到一半以上。

有时有噪音是好事。当书评人或考量某个行业的各路投资者得出了相异的评估结果，这样的多样性观点是有益的。但噪音还是带来问题的情况居多。在法律上，噪音意味着不公平。在商业中，噪音可能造成高昂的代价。

不过噪音是可以减少的。三位作者给出了一些解决办法，其中包括“噪音审计”，用以衡量人们就同一案例得出的判断的差异程度，将人们通常看不出来变化量化出来。他们还呼吁改善“决策卫生”，比如在做群体决策时指定一名观察员，以防出现常见的偏误和有噪音的判断。例如，观察员可以确保团队中的参与者先分别做出评估，然后再作为一个团队将各自的决策整合起来。

另一个解决办法是干脆不让人参与。统计模型、预设规则和算法在很多情况下都比人类的判断更准确。三位作者乐见人工智能在社会中参与制定许多决策，但也承认它们给出的方案很容易遭到人们的抵触，因为这样的决策过程缺乏人情和温度——即使这些因素会导致做出低质或至少变化不定的决策。

三位作者的话颇具可信度。卡尼曼是诺贝尔奖获得者，他关于人在推理时会出现偏误的观点重塑了经济和社会；桑斯坦是哈佛大学一名博学多才的学者，间或在政府部门任职，将自己的想法付诸实际政策；西博尼曾是麦肯锡的合伙人，如今在一所法国商学院教授决策科学。不过，尽管该书以噪音为题，作者们自己要从噪音中提取出信号还是有些费力——乃至要花

400来页来说明白。如果论证能更紧凑些，他们提出的观点会更有力。■



A new architecture

A less loophole-riddled system for taxing companies is within reach

But governments should not expect a gusher of extra revenue

WHEN PEOPLE come to look back on Joe Biden's presidency, they may, depending on events in the coming months, conclude that one of his most consequential economic achievements was to reverse a decades-long global boom in corporate tax-dodging. His administration's call for an end to the “race to the bottom” has reinvigorated multilateral talks on rewriting international rules that encourage multinationals to funnel vast profits to tax havens. Two months after that call, America and other rich countries have agreed on a road map for reform. The deal paves the way for the biggest corporate-tax overhaul in a century.

Mr Biden's motives are not pure: he is driven less by principle than a desire to squeeze more out of American firms to finance his post-pandemic spending priorities. Nevertheless, the G7 countries' proposals, which their finance ministers approved on June 5th, are welcome. The international tax system sits on foundations laid in the 1920s. For much of the following century policymakers' concern was to avoid double taxation, not curb abuse. The result has been a steady rise in avoidance, further fuelled by the growth of tech firms and intangible assets, to the point where 40% of multinationals' overseas profits are shifted to havens. The OECD estimates this costs exchequers up to \$240bn a year—a tiny fraction of global economic output, but still a lot of unbuilt hospitals and unfixed roads.

Past attempts to plug this hole have been piecemeal. The G7 wants a more comprehensive fix. It has backed a global minimum corporate-tax rate of at least 15%, combined with a reallocation of taxing rights to give more to countries where firms have sales. Rishi Sunak, Britain's chancellor, who

chaired the G7 talks, called its accord “seismic”.

In fact it is only a first step. Reaching a global deal involves finding terms that 132 other countries, including China and India, can accept. Poor countries fear a rich-country stitch-up: the G7 could reap over 60% of the revenue gains from a minimum tax. Some havens will resist, including Ireland, which jealously guards its 12.5% corporate-tax rate—and has a veto on tax matters in the EU.

If these obstacles can be overcome, the reforms will still need to be passed into law. Many in America’s Congress worry that they may hurt its companies’ competitiveness. European countries want America to move first. America wants France, Britain and other countries that have introduced “digital-services taxes”, targeting the sales of Silicon Valley firms, to scrap them immediately. Agreeing to put them on hold would help move the delicate diplomacy forward. Europe’s levies have provoked retaliatory tariffs from America, which are currently suspended. The OECD reckons a tax-induced trade war would wipe more than 1% off global GDP.

Expectations also need tempering on how much of the revenue lost to avoidance will be clawed back. Most would come from the minimum tax. But a floor of 15% would raise global corporate-tax revenues by as little as 2.7%. The \$50bn-80bn that the combined reforms might raise is meagre beside multinationals’ \$6trn of global annual profits. The profit-reallocation part of the proposals looks like a lot of work for not much gain. Countries where an as-yet-undefined group of multinationals have sales would get to share taxing rights over at least 20% of any global profits those firms made above a 10% margin. The net gain from this fiddly exercise may not amount to much more than \$10bn.

Nonetheless, a Rubicon has been crossed. The tenor of the debate on tax

began to change after the global financial crisis and has now shifted fundamentally. Governments around the world agree that corporate-tax arbitrage has got out of hand and taxing rights must be better aligned with economic activity. Twenty years ago champions of tax competition had the upper hand. Now the dominant line of thinking is that tax sovereignty cuts both ways: countries have the right to set their own rates, but those undercut by low-tax jurisdictions also have the right to stop the plunder. Before the year is out, a majority of the world's governments may have agreed on changes that could obliterate the business models of zero-tax havens in the Caribbean.

Any deal emerging from the global talks would be far from perfect. It would raise only modest sums relative to covid-induced holes in budgets. It would curb, but not end, the use of loopholes; corporate tax departments are too clever for that. It is likely to give more to advanced economies than developing ones, meaning there will be pressure to revisit the deal. But it promises to reveal a route to a more rational, equitable tax system that is fit for an economy based on things you tap on a keyboard rather than drop on your foot. That is the destination negotiators need to keep in mind in the taxing months ahead. ■



【首文】新架构

不那么漏洞百出的企业税体系指日可待

但各国政府不能指望就此增加大笔收入

未来人们回顾拜登的总统任期时，可能会认为他最重要的经济成就之一是逆转了在全球盛行了数十年的企业避税潮——当然这还要看未来几个月事情的发展。拜登政府呼吁停止“逐底竞争”，这推动了各界重启多边谈判，商讨改写那些促使跨国公司把大量利润输送到避税天堂的规则。呼吁发出后两个月，美国和其他富裕国家已就改革路线达成共识。这将为一个世纪以来最大规模的企业税改革铺平道路。

拜登的动机并不单纯：他主要考虑的不是原则问题，而是要从美国企业身上榨出更多资金来支撑他的疫情后重大开支项目。但不管怎么说，七国集团的财长已在6月5日通过的改革方案是件好事。现行国际税收体系的基础是在上世纪20年代奠定的，之后一个世纪的大部分时间里，政策制定者关注的都是如何避免双重征税，而非防止滥用税收漏洞。结果是避税行为日渐增加，科技公司崛起和无形资产扩大更加剧了这种操作，跨国公司甚至已经把40%的海外利润都转移到了避税天堂。据经合组织估计，各国国库因此遭受的财政收入损失高达每年2400亿美元，虽然这只是全球经济产出的一小部分，但也足够建设许多医院和修很多路了。

以往尝试堵住这个漏洞的努力七零八落。七国集团想要一个更全面的解决方案。它支持全球推行至少15%的最低企业税，同时重新分配征税权，让作为公司销售市场的国家拥有更多权利。主持七国集团会谈的英国财政大臣里希·苏纳克（Rishi Sunak）称该协议是“震撼性的”。

实际上这只是第一步。要达成全球性的协议，就要制定出包括中国和印度在内的另外132个国家都能接受的条款。贫穷国家害怕富裕国家会操纵局面：在实行最低税率带来的收入增长中，七国集团国家可能拿走其中的六成以上。一些避税天堂将抵制协议，包括警觉地维护着自己12.5%企业税

的爱尔兰，而且该国在欧盟税收问题上拥有否决权。

就算能克服这些障碍，改革措施仍需通过立法。美国许多国会议员担心这些改革可能损害美国公司的竞争力。欧洲国家希望美国率先行动。美国则希望法国、英国等国立即撤销它们针对硅谷公司的销售开征的“数字服务税”。同意暂停这些税收将有助于改善微妙的外交关系。欧洲的征税已经引来了美国的报复性关税（目前已暂停）。经合组织估计，由征税问题引发的贸易战可能使全球GDP减少超过1%。

至于改革能追回多少因企业避税流失的收入，期望值同样需要调整。追回的收入将主要来自推行最低税率。但15%的最低税率也只能让全球企业税收入仅仅增加2.7%。与跨国公司六万亿美元的全球年利润相比，改革措施全部加起来可能带来的额外500亿至800亿美元收入微不足道。方案中有关利润再分配的安排看起来会事倍功半。针对一批尚未被明确定义的跨国公司，其销售所在国将可对其全球利润中超过10%的部分的至少20%征税。这项繁琐的计算带来的净收益可能也就略超过100亿美元。

然而，开弓没有回头箭。征税讨论的基调在全球金融危机后开始变化，现在已彻底转向。各国政府一致认为，企业税套利已经失控，征税权必须与经济活动相匹配。20年前，支持税率竞争的声音占了上风。而现在的主流思路是税收主权是双向的：国家有权制定自己的税率，但被低税率地区抢走收入的国家也有权出手阻止。今年年底前，全球大多数政府也许已能达成一些改革协议，让加勒比地区的零税率避税天堂商业模式消失。

从这轮全球谈判中得出的任何协议都远谈不上完美。相对于疫情造成的预算缺口，它带来的额外收入会很有限。钻税务漏洞的行为将被抑制，但不会就此终结，毕竟企业税务部门都精于此道。由于获益更多的更可能是发达经济体而非发展中国家，将会有修改协议的压力。但它有望打开一条路，通往一个更合理公平的税收制度，适应一种基于键盘而非实物的经济。在未来几个月繁重的协商中，谈判代表们需要牢记这个目标。■



False positive

America's approval of an Alzheimer's drug is premature

It may offer false hope and divert resources from more promising therapies

ON JUNE 7TH America's Food and Drug Administration (FDA) approved the first new drug since 2003 to treat Alzheimer's disease. The euphoric reaction in some quarters is understandable. A century of research has produced no effective treatment for Alzheimer's, which is marked by ever-worsening cognitive decline, and accounts for 60-80% of cases of dementia, a condition affecting perhaps 50m people worldwide and becoming ever more common as the world ages.

But, sadly, the FDA admits that it is not proven that the new drug, a monoclonal antibody to be sold under the name Aduhelm, actually works. The approval is misguided. It risks raising unrealistic expectations, wreaking financial harm on health-care systems, damaging the FDA's reputation for scientific impartiality and perhaps even diverting attention from more hopeful approaches to treating dementia.

It is also hard to understand. Last November ten of the 11 members of the FDA's own expert advisory panel voted to reject the application by the producer, Biogen of Cambridge, Massachusetts, for approval of the drug (the 11th was "uncertain"). The FDA's approval does not mean it accepts that the data so far show that Aduhelm is effective in slowing cognitive decline. Biogen's trials were at best ambiguous on this point, and indeed in 2019 were called off as failures. Rather, the agency is rewarding the drug's success in clearing brains of beta-amyloid, a protein that clumps between neurons and disrupts their functioning.

An "amyloid hypothesis" holds that the protein is not just a symptom of

the disease, but a prime cause. This is widely believed (all brains with Alzheimer's exhibit beta-amyloid build-ups). But it is just a hypothesis (not every brain with beta-amyloid exhibits cognitive impairment). The FDA has demanded a further trial, even as the drug goes into use, and has warned it may pull the drug if it is unsatisfactory. Biogen has said that the trial may take nine years. And if the drug is in wide use, withdrawing it would be difficult.

At \$56,000 a year, the cost of Aduhelm treatment will create huge problems for health insurers and providers. Certainly the stockmarket has rewarded Biogen's shares in the belief that a new blockbuster drug has just been given clearance. It is recommended only for people in the early stages of Alzheimer's, diagnosed by a costly PET scan, and will require a course of monthly intravenous administration at a medical facility. Patients will require close monitoring as many develop brain swellings. But given the lack of any alternative, millions of Americans will be clamouring for the treatment for loved ones with Alzheimer's.

The FDA's approval also risks actually impeding some dementia research. Aduhelm might make it hard to recruit participants for clinical trials for new drugs, and to assess the results of them (if many patients are already taking the drug). And it may divert more resources into fresh efforts to validate the disputed amyloid hypothesis.

That the evidence argued against the approval of Aduhelm does not mean that research into treatments for dementia is going badly. On the contrary, whereas a few years ago some pharmaceutical firms were withdrawing from the field, having written it off as a dead end, some neurologists now expect big breakthroughs. A better understanding is emerging of how the risk of developing dementia can be reduced, by living a healthier life. The age-specific incidence of dementia is actually declining in some Western countries. Blood tests make it far easier to diagnose those at high risk before

symptoms appear. And, according to Pharmaprojects, an industry database, another 148 drugs for Alzheimer's alone are in clinical development, only about 15% of which are directed at beta-amyloid.

Dementia remains one of the 21st century's greatest health, social and economic problems, and, for some neurologists, anything that stimulates greater efforts to understanding and treating it is welcome. That is why even some of those who have been baffled by the scientific basis of the FDA's Aduhelm approval have applauded it. Surely, however, hope lies not in lowering standards out of desperation, but in following the science. ■



【首文】空欢喜

美国对阿尔茨海默病新药的批准过于草率

这可能会带来虚假的希望，并把资源从更有潜力的疗法那里分走

六月七日，美国食品药品监督管理局（以下简称FDA）批准了一款治疗阿尔茨海默病的新药，这是自2003年以来的头一回。一些人对此兴奋不已，这是可以理解的。人们研究了一个世纪都没能找出治疗阿尔茨海默症的有效方法。这种疾病的特点是认知能力不断下降，在所有痴呆症病例中占60%到80%。全球约有5000万痴呆症患者，而随着世界的老龄化，这种病变得日益普遍。

但遗憾的是，FDA承认这款商品名为Aduhelm的单克隆抗体新药并未被证明切实有效。这项批准是一种误判。它有可能提高不切实际的期望，给医疗系统造成经济损失，损害FDA科学公正的声誉，可能还会分走那些更有希望的痴呆症疗法受到的关注。

这个决定也很令人费解。去年11月，该机构自己的专家顾问小组的11名成员中，有10人投票否决了位于马萨诸塞州剑桥市的生产商渤健（Biogen）对该药物的批准申请（剩下一人意见是“不确定”）。FDA的批准并不意味着它认可迄今为止的数据显示Aduhelm可以有效减缓认知下降。渤健在这一方面的试验结果充其量也是含糊不清，而实际上，在2019年试验已被认定失败而取消。更确切地说，FDA的批准是在奖赏该药物在清除大脑中的 β -淀粉样蛋白沉积上的成功，这种蛋白质会积聚在神经元之间，干扰其正常功能。

“淀粉样蛋白假说”认为，这种蛋白质不仅是阿尔茨海默病的症状，也是其主要成因。这种看法得到了广泛认同（所有阿尔茨海默病患者的大脑都显现出 β -淀粉样蛋白积聚）。但这只是一个假设（不是所有出现了 β -淀粉样蛋白的大脑都表现出认知障碍）。FDA已要求渤健开展进一步试验，即使该药物已经投入使用。它还警告说，如果试验结果不尽人意，它可能会

让该药物下架。渤健表示试验可能需要耗时九年。而且，如果药物已被广泛使用，召回将会很困难。

用Aduhelm治疗的费用为每年5.6万美元，这将给医疗保险公司和医疗服务机构带来巨大的问题。股票市场无疑奖励了渤健的股票，因为它相信一款重磅新药刚刚被绿灯放行。这款药物只推荐处于阿尔茨海默病早期阶段（可通过昂贵的PET扫描确诊）的病人使用，将需要每月在医疗机构接受一次静脉注射。病人需要被密切监护，因为许多人会出现脑肿胀。但由于再无替代方案，数百万美国人将争先恐后地让患有阿尔茨海默病的亲人用上这种药。

FDA这项批准实际上还可能妨碍到某些痴呆症研究。Aduhelm上市后，可能就很难招募到参与者加入新药物的临床试验，也就难以评估试验的结果（如果许多患者已经在使用Aduhelm的话）。而且FDA的这项决定可能还会将更多资源转移到那些试图验证有争议的淀粉样蛋白假说的新研究上。

尽管批准Aduhelm的依据并不充分，它并不意味着目前对痴呆症治疗的研究进展很糟。相反，尽管几年前一些制药公司退出了这个领域，认定它就是一个死胡同，但一些神经学家如今预期会出现重大突破。人们逐渐清楚地了解到可以通过更健康的生活方式来降低罹患痴呆症的风险。在一些西方国家，特定年龄组的痴呆症发病率实际上正在下降。有了血液测试，在高危人群出现症状之前就对其作出诊断已变得容易许多。根据制药行业数据库Pharmaprojects的数据，单是阿尔茨海默病就有其他148种药物正在临床研究中，其中只有约15%针对 β -淀粉样蛋白。

痴呆症仍旧是21世纪最严重的健康、社会和经济问题之一，而对一些神经学家来说，任何能激发人们付出更多努力去理解和治疗这种疾病的事物都值得欢迎。这就是为什么即便是在为FDA批准Aduhelm的科学依据感到困惑的人群当中，依然有人为之叫好。然而，毫无疑问，因无计可施而降低标准并不会带来希望，唯遵循科学才会。 ■



Schumpeter

Activist investors are both greening and greying

Engine No.1 represents a new breed of gadfly

ACTIVIST INVESTORS have some menacing tools of the trade. First comes the phone call, letting a boss know they have a new arrival on the share register. Then there is the slide deck, enumerating all the failings for which the boss is supposedly responsible. Sometimes the body language when predator and prey meet for the first time can be the most unsettling. In 2015, when Trian Partners, one of the biggest activist funds, took a \$2.5bn stake in GE, an American conglomerate, its founders, Nelson Peltz and Ed Garden, wore tailored suits—with sneakers—to their first meeting with Jeff Immelt, then GE's boss. "That note of informality amplified their power," two Wall Street Journal reporters wrote in a recent book, "Lights Out". "Amid the fine art displayed [at GE's headquarters], the sneakers were a reminder of their sovereignty."

It is easy to be cynical about such calculated displays of power. Some deride shareholder activism as a game of smoke and mirrors, in which hedge-fund bombasts loudly call for executives to do what they were going to do anyway, and executives use activists as cover for unpopular measures such as asset sales and job cuts.

That is too harsh. True, not all campaigns work (Trian's hasn't yet at GE). But often a bit of nastiness helps shake up lazy boards and make sure cashflows are better spent. Though the covid-19 pandemic has reduced the number of activist campaigns, two big global trends mean they are sure to rebound. One is the growth of funds that track stockmarket indices. Such passive investments can let managers off the hook for poor performance; corporate activists help rectify that. The second is climate change, which is forcing

companies to rethink their long-term strategies with potentially huge consequences for returns. Both trends are reflected in the fast growth of environmental, social and governance (ESG) investing—and with it ESG activism.

Of this new breed, none has made more of a splash than Engine No.1, an activist fund from San Francisco. It was founded only last year but has just successfully installed three directors on the board of ExxonMobil, arguing that the American oil giant is failing to prepare for a clean-energy future. It was an awe-inspiring feat (“supercool”, as one veteran gadfly put it). It also raised serious questions. Have shareholder crusaders morphed into climate campaigners? Will a hard-nosed focus on returns be replaced by mushy box-ticking? Will boardroom fuddy-duddies now sit amid woke eco-warriors? Hearteningly, even ESG activists themselves squabble over which of their tactics are friendlier to shareholders or the climate.

If anything, big activist hedge funds are getting nicer just as the newcomers are turning nasty. Former brutes like Elliott Investment Management, whose founder, Paul Singer, was once described by Bloomberg's reporters as “the world's most feared investor”, appear to have mellowed. Elliott has recently made peace with two high-profile CEOs, Jack Dorsey at Twitter, a social-media firm, and John Stankey at AT&T, a telecoms giant, despite formerly seeking their removal. It has taken a big stake in Dropbox, a software company, but has so far refrained from launching a public campaign against it. The bigger it gets, and the bigger its targets, the more it tries to take a “statesmanlike” approach, including by toning down its language. Though it has begun deploying ESG criteria in its campaigns, as have other veterans such as The Children's Investment Fund, a \$30bn hedge fund based in London, it is still mostly focused on boosting financial returns, and sometimes moves quickly in and out of positions.

The ESG-focused newbies argue that their horizons are longer, as is fitting

for firms that have topics like climate change high on their agendas. But if you expect them to be cuddlier than their forebears, think again. Because they lack capital to buy large stakes, their attacks need to resonate broadly among investors big and small in order to have any impact. Engine No.1, which owned just 0.02% of ExxonMobil's stock, achieved this by honing in on the dearth of energy experience on the supermajor's board, which it blamed for the company's underperformance against its peers. The fund's appointed directors have all had important jobs in energy. That makes them better guides to capital deployment during the transition away from fossil fuels, it argued. It helped that Darren Woods, ExxonMobil's boss, had so little credibility in this area that investors ignored his calls to reject the rebels.

The new activists' feistiness extends to each other. Engine No.1 has criticised ExxonMobil's board for lacking "successful and transformative energy experience". Presumably that includes Jeff Ubben, a veteran activist who recently set up Inclusive Capital Partners, an ESG-focused fund, and won a place on ExxonMobil's board earlier this year. Mr Ubben, former boss of ValueAct, a 21-year-old fund, who believes in negotiation more than confrontation, welcomes the changes to the board. But he laments that Engine No.1 launched its proxy campaign before consulting the board and management. He notes that it has left it up to the board to come up with a plan to turn the company around.

Gripes aside, both insist that their focus is on shareholder returns. An insider describes Engine No.1 as "a shareholder crusader for long-term value, not a climate crusader". Mr Ubben worries that the focus on returns is ebbing as index funds chase ESG investors, influencing proxy contests. A new firm of activists, Bluebell Capital Partners, has gone so far as to target Danone because its focus on sustainability was not matched by adequate financial returns. It helped oust the French dairy giant's former boss, Emmanuel Faber, earlier this year. "ESG cannot be an excuse for a company

to underperform," says Giuseppe Bivona, one of Bluebell's co-founders. Milton Friedman, the late Nobel-prizewinning economist and defender of shareholder value, to whom activists have always bent the knee, would be smiling. ■



熊彼特

维权投资者新旧势力并存

1号引擎代表新一代“牛虻”

维权投资者有一些很唬人的手段。首先是一通电话，让公司老板知道股东名册上出现了不速之客。然后是一套幻灯片，详细列举了这位老板理应负责的种种失败。捕食者与猎物初次见面时，他们的肢体语言有时可能最让人捏把汗。2015年，最大的维权基金之一特里安基金（Trian Partners）斥资25亿美元购入美国企业集团通用电气的股份。基金创始人纳尔逊·佩尔茨（Nelson Peltz）和埃德·加登（Ed Garden）头一回和通用电气时任老板杰夫·伊梅尔特（Jeff Immelt）碰面时，穿着定制西装，脚上却踩着运动鞋。“这个不拘礼数的细节放大了他们的气势，”《华尔街日报》的两名记者在最近出版的《熄灯》（Lights Out）一书中写道，“在（通用电气总部）陈设的高雅艺术品之间，运动鞋宣示着他们的无上权威。”

这种刻意的力量展示很容易招致怀疑。有人嘲笑股东维权主义不过是一种障眼法：对冲基金大张旗鼓地对公司高管施加压力，所要求的其实是对方本来就准备做的，而高管则借维权股东之名推行不受欢迎的措施，例如出售资产和裁员。

这么说未免太过苛刻了。诚然，并非所有的施压行动都能奏效（特里安基金在通用电气就还没有取得什么成果）。但往往，一点点招人烦的干涉就可以让懒散的董事会警醒起来，确保公司的现金流得到善用。尽管新冠疫情减少了维权行动，但两大全球趋势意味着它们势必会反弹。首先是股指基金的增长。这种被动投资可能会让业绩不佳的管理层逃脱问责，而维权投资者有助于纠正这种情况。其次是气候变化，它正迫使企业重新考虑自己的长期战略，这对回报可能有重大影响。这两种趋势都在ESG（环境、社会和治理）投资的快速增长中得到了反映——还有随之而来的ESG维权主义。

在这新一代势力中，要数来自旧金山的维权基金1号引擎（Engine No.1）最引人注目。该基金去年才成立，但已经以埃克森美孚未能就清洁能源的未来做好准备为由，成功在这家美国石油巨头的董事会拿下了三个席位。这是一个令人敬畏的壮举（用一位资深维权投资者的话说是“超级酷”）。这同时也引发了严肃的问题。股东斗士是否已经演变为气候活动家？对回报的务实追求会不会被感情用事的打钩检查替代？董事会里的守旧派是否会被觉醒的生态斗士包围？令人鼓舞的是，就连ESG维权人士自己也在争论他们的策略有哪些有利于股东，哪些有利于气候。

若说新旧势力有何不同，那就是在新来者朝着更蛮横的方向走之时，大型维权对冲基金却变得越来越和善了。之前跋扈的基金似乎已经缓和了态度，比如艾略特投资管理（Elliott Investment Management），它的创始人保罗·辛格（Paul Singer）曾被彭博社的记者形容为“世界上最让人畏惧的投资者”。艾略特此前曾谋求让两位著名首席执行官——社交媒体公司推特的杰克·多西（Jack Dorsey）和电信巨头AT&T的约翰·斯坦基（John Stankey）——解职，但最近已相安无事。它还收购了软件公司Dropbox的大量股份，但迄今还没有对它发起公开运动。它的规模越大、目标越大，就越倾向于采取一种“政治家式”的方式，包括缓和语气。与总部位于伦敦、规模达300亿美元的儿童投资基金（Children's Investment Fund）等其他老牌基金一样，艾略特已经开始在行动中引入ESG准则，但它最主要的目标仍是提高财务回报，有时会在短时间内买进卖出。

专注ESG的新势力声称自己的目光放得更加长远，契合那些高度重视气候变化等议题的公司。但若你以为它们会比前辈们更友善，那你就错了。由于它们缺乏购入大量股份的资本，在发起攻击时必须在大大小小的投资者中引起广泛共鸣才能奏效。1号引擎仅持有埃克森美孚0.02%的股份，但它抓住了这家石油超级巨头的董事会缺乏能源经验的软肋，声称这是公司业绩落后于同行的原因，从而获得了其他投资者的支持。该基金任命的董事都曾在能源领域担任要职。它声称这些人选能够在公司减少化石燃料的过渡期内更好地指导资本配置。同样帮了它一把的是，埃克森美孚的老板伍德伦（Darren Woods）在这个领域完全没有说服力，以至于投资者对他抵制此次叛乱的呼吁置若罔闻。

争强好斗的新势力之间也互生龃龉。1号引擎批评埃克森美孚的董事会缺乏“成功的能源业转型经验”，想必这也包括了资深维权人士杰夫·乌本（Jeff Ubben）。乌本近期成立了一家专注ESG的基金——普惠资本（Inclusive Capital Partners），并在今年早些时候加入了埃克森美孚的董事会。他之前曾经执掌已成立21年的基金ValueAct，坚信谈判好过对抗。他对这次董事会改组表示欢迎，但也叹息1号引擎并没有事先与董事会和管理层商谈就发起了代理权之战。他指出，这就把制定计划以扭转公司颓势的重任留给了董事会。

尽管相互指摘，大家都坚称自己的重点是股东回报。一位内部人士将1号引擎形容为“追求长期价值的股东斗士，而不是气候斗士”。乌本担心，随着指数基金迎合ESG投资者，对回报的关注正在减弱，影响了代理权的争夺。一家新的维权基金蓝铃资本（Bluebell Capital Partners）对回报的重视到了如此地步，以至于要盯上法国乳业巨头达能，因为这家公司关注可持续发展但没有获得合理的财务回报。今年早些时候，它推动罢免了达能的前老板范易谋（Emmanuel Faber）。“ESG不能成为公司表现不佳的借口。”蓝铃资本的联合创始人之一朱塞佩·比沃纳（Giuseppe Bivona）表示。受维权投资者膜拜的已故诺贝尔经济学奖得主、捍卫股东价值的米尔顿·弗里德曼可以含笑九泉了。 ■



Chasing pots of gold

Foreign asset managers are eyeing China's vast pool of savings

Do they stand a chance against home-grown competitors?

ZHANG KUN is the rock star of Chinese fund management. His name often makes headlines; whole articles are dedicated to his investment calls. Investors vie to get into his funds, one of which has reportedly delivered a return of 700% since it was launched eight years ago. He is among a growing number of managers who generate more hype than the firms that employ them. With personalities like Mr Zhang on its payroll, E-Fund, a state-owned investment group, hardly needs to advertise.

Now a swathe of foreign firms hopes to take on Mr Zhang and his ilk by entering China's asset-management industry. Last month Goldman Sachs, a Wall Street bank, announced a wealth-management venture with ICBC, China's largest commercial lender by assets. BlackRock, a giant American asset manager, will join forces with China Construction Bank (CCB). Amundi, a French firm, has linked up with Bank of China and Schroders, a British investment group, with China's Bank of Communications. In March JPMorgan Asset Management said it would buy a 10% stake in China Merchant Bank's wealth business. Nearly 20 global investors are setting up fund-management firms; others are launching private securities funds.

The prize is access to a pot of money worth 120trn yuan (\$18.8trn), which includes investments made by everyone from the average saver to the ultra-rich in mutual funds, trusts, wealth and other asset-management products. Though the pool of funds is smaller than in the West—asset managers in North America oversaw \$59trn last year, according to PwC, an accounting firm—it is expected to expand rapidly. As more people grow comfortable giving their money to managers instead of picking stocks or buying

property, China's pot could nearly treble, hitting 320trn yuan by 2030, reckons Oliver Wyman, a consultancy (see chart 1). But foreigners' attempts to crack other parts of China's financial market have yielded underwhelming results. Could this time be different?

For China's regulators, the new ventures are a high-stakes experiment meant to transform how savers think about investing. For years retail investors ploughed cash into deposit-like investment products sold and backed by state banks. The principal on such products was considered guaranteed, but the banks funnelled the cash towards high-risk borrowers such as small property developers or coal-mining outfits. By 2016 the banks' wealth-management arms oversaw around 13% of total banking assets (see chart 2). But regulators cracked down, no longer willing to see banks and ordinary savers exposed to the intensifying risks.

Guaranteed products have been banned. Meanwhile banks' wealth assets have been spun into new subsidiaries. These must wind down the old deposit-like products and design new ones based on net asset value. In 2020 the new units had 26trn yuan in assets under management, reckons CICC, an investment bank. It is with them that foreign investors have been invited to establish joint ventures.

The call sounds familiar. Foreign financiers have been knocking at China's door for generations, with an eye to every corner of the industry, from retail banking to securities. In 1995 CCB and Morgan Stanley, another Wall Street bank, set up CICC; in 2004 Goldman was allowed to establish the first foreign securities joint venture. But when you look back over the past two decades, the developments seem underwhelming and the returns meagre.

That was largely because China opened up only when home-grown firms were big enough to withstand competition. Some foreign retail banks

launched gung-ho expansion plans only to quit the market later, defeated by domestic giants' extensive branch networks. Securities joint ventures have taken more than a decade to pass majority control to foreign investors. Payments firms such as Visa and Mastercard were shut out until mobile payments became dominant and competition futile.

Wealth management could be different. For one, the foreigners do not face a mature market with insurmountable competition. Regulators' sweeping reforms mean that they are in fact entering what could become the world's largest market for retail wealth at an early stage.

This is evident in the financial products on offer today. China's mutual-fund industry has grown at a fantastic pace in recent years. Many firms now oversee 1trn yuan in assets. Money-market funds are ubiquitous. But product design is still in its infancy. Global firms are expected to bring a new level of sophistication. Tuan Lam of Goldman says his group will offer quantitative products such as algorithmic and factor-based strategies, and cross-border and alternative-asset investments. "These are not present in China right now," he notes.

Another benefit of the joint ventures is their links to China's largest financial firms. The banks and their tens of thousands of branches were key intermediaries during the first era of wealth management and, say experts, may also define the next. Their wealth-management subsidiaries have vast portfolios and huge numbers of clients. Take CCB. It has more than 14,700 branches; last year it managed 2.2trn yuan in wealth-management products and attracted more than 4.4m new investment and wealth-management clients. Access to customers is "one of the benefits of partnering with one of the largest banks in China", says Susan Chan of BlackRock.

Yet success will depend on foreigners' ability to establish and market themselves. Goldman and BlackRock have some name recognition in China

by virtue of their size. Amundi and Schroders, by contrast, are unknown outside financial circles. And teaming up with home-grown banks has some downsides. A potential customer at a bank branch will be offered a suite of products, which will include those designed and branded by the joint ventures, but also those designed solely by the bank. Online, joint-venture offerings will probably appear on smartphone apps on a list of commoditised products. The foreign groups will therefore have to make sure their offering is advertised sufficiently to clients—no easy task given that tens of thousands of banks' relationship managers will be responsible for sales. It can be done, but only with hefty investment in staff training, says Philip Leung of Bain, a consultancy.

Another problem is competing with superstars such as Mr Zhang, who often manage money for giant mutual funds. Financial news in China is abuzz with stories on the performance of star managers. Many retail investors make decisions based on such information. Few clients are interested in a fund's risk controls, notes Fabrice Maraval, an executive who has worked at two Sino-foreign financial ventures. Instead, they ask, "What's your ranking on the list of top fund managers?", he says.

Executives at several joint ventures bristle at the idea of hiring stars who market their funds. "It's just not our culture," says one. Instead they must slowly build trust with clients through solid performance and prudent risk controls. Zhong Xiaofeng of Amundi describes his group's strategy in China as a "long-haul effort". If foreigners are to give the stars a run for their money, it will have to be. ■



追逐金罐幻影

外国资产管理公司盯上了中国的巨额存款

它们有可能战胜本土竞争对手吗?

张坤是中国基金管理界的明星。他的名字常常登上新闻头条；整篇整篇的报道谈论他的投资决策。投资者争相认购他管理的基金——据报道，他的一只基金自八年前推出以来已实现了700%的回报率。如今，像张坤这样风头盖过了自己任职的公司的基金经理越来越多。有了张坤这样的明星员工，国有投资集团易方达几乎都不用做广告。

现在，许多外国公司希望进入中国的资产管理行业，与张坤及其同行一较高下。上个月，华尔街银行高盛宣布与中国资产规模最大的商业银行工商银行成立合资理财公司。美国资产管理巨头贝莱德（BlackRock）将与中国建设银行联手。法国公司东方汇理（Amundi）、英国投资集团施罗德（Schroders）分别与中国银行、中国交通银行建立了合作关系。今年3月，摩根大通资产管理公司表示将收购招商银行理财子公司10%的股份。近20家全球投资公司正在中国设立基金管理公司，另一些则在推出私募证券基金。

进入中国资产管理行业的好处是能接触到其中120万亿元人民币（18.8万亿美元）的巨额资金，包括从普通储户到超级富豪的各色人等对共同基金、信托产品、理财以及其他资产管理产品的投资。尽管这一资金规模小于西方——会计公司普华永道称北美的资产管理公司去年管理着59万亿美元的资金——但预期会迅速扩大。奥纬咨询（Oliver Wyman）估计，随着越来越多的人更放心把自己的钱交给投资经理，而不是自己选股或买房产，到2030年，中国的资金规模可能增加近两倍，达到320万亿元（见图表1）。但是，外国公司试图打入中国金融市场其他领域的尝试都没有得到令人满意的结果。这次会有所不同吗？

对中国监管机构来说，设立这些新的合资企业是高风险的实验，意在改变储户对投资的认知。多年来，散户投资者购买国有银行发售或背书的类似存款的理财产品，他们认为这类产品的本金是有保障的，但银行把这些资金输送给了小型房地产开发商或煤矿企业等高风险的借款方。到2016年，银行的财富管理部门管理的资金占到银行总资产的13%左右（见图表2）。但是监管机构不愿再看着银行和普通储户面临的风险日益加剧，于是出手严厉整治。

保本理财产品已被取缔。与此同时，财富管理部门从银行剥离出来，成为新的子公司。这些子公司必须逐步减少过去那些类似存款的理财产品，并设计基于资产净值的新产品。投资银行中金公司估计，2020年，这些新子公司管理的资产达到了26万亿元。外国投资机构正是受邀和这些子公司成立合资公司。

这种呼唤似曾相识。几代外国金融家都在敲中国市场的大门，他们看上了这个行业从零售银行到证券的每个角落。1995年，中国建设银行和另一家华尔街银行摩根士丹利成立了中金公司；2004年，高盛获准成立了中国第一家外国合资证券公司。但回顾过去20年会发现，事情的发展似乎不尽如人意，回报也很有限。

这在很大程度上是因为中国只有在本土企业发展壮大到足以抵御竞争时才会对外开放。一些外国零售银行推出了狂热的扩张计划，后来却被国内银行巨头庞大的支行网络击败，退出了市场。在合资证券公司，外国投资者花了十几年时间才获得多数控股权。Visa和万事达等支付公司一直被拦在门外，直到移动支付变成了主导支付手段，竞争已变得徒有其名。

财富管理可能会有所不同。首先，外资企业面对的并不是一个难以赢得竞争的成熟市场。监管机构的全面改革意味着它们是于早期阶段进入一个日后可能是世界最大的零售理财市场。

这一点在目前提供的金融产品中就体现得很明显。近年来，中国共同基金行业的发展速度惊人。许多公司现在管理着一万亿元的资产。货币市场基

金比比皆是。但产品设计仍很稚嫩。人们期待全球公司能够带来更成熟高级的产品。高盛的段林表示，高盛将提供基于因子的算法策略等量化产品，以及跨境和另类资产投资。“目前中国还没有这些产品。”他指出。

成立合资公司的另一个好处是能与中国最大的几家金融公司建立联系。在财富管理的第一个时代，这些银行及其数以万计的支行是关键的中间环节，而且据专家们说，它们可能也会定义下一个时代。它们的理财子公司拥有大量投资组合和庞大客户群。以建行为例，它拥有超过1.47万家支行，去年它管理了2.2万亿元的理财产品，吸引了440多万名新的投资和理财客户。能接触客户是“与这家中国最大银行之一合作的一个好处”，贝莱德的陈蕙兰表示。

然而，成功与否将取决于外国公司能否站稳脚跟并做好营销。高盛和贝莱德凭借自身规模在中国已经有了一定的知名度。相比之下，东方汇理和施罗德在金融界之外还鲜为人知。与本土银行合作也有一些缺点。银行的支行会向潜在客户提供一系列产品，其中既包括合资公司设计并冠以自己品牌的产品，也包括银行自己单独设计的产品。在线上，合资公司的产品可能会出现在智能手机应用里，与一长串同质化的产品并列。因此，外资公司必须确保能向客户充分宣传自己的产品。这绝非易事，因为会有数以万计的银行客户经理负责销售。贝恩咨询公司的梁霭中认为这是可以做到的，但前提是在员工培训方面投入巨资。

另一个难题是与像张坤这样的超级明星们竞争，他们大多为大型共同基金管理资金。中国的财经新闻充斥着有关明星经理业绩的报道。许多散户投资者根据这类信息做决策。很少有客户关注基金的风险控制，曾在两家中外合资金融公司工作过的高管法布里斯·马拉瓦尔（Fabrice Maraval）指出。相反，他说，他们常常会问“你在顶级基金经理名单上排第几？”

几家合资公司的高管对于聘请明星经理来营销基金的主意感到愤怒。“这就不是我们的文化。”其中一人表示。相反，它们必须通过稳健的业绩和审慎的风险控制逐步赢得客户的信任。东方汇理的钟晓峰用“漫长的努力”来描述自己的公司在中国的战略。如果外国公司不想输给这些明星，那将

不得不如此。 ■



Nuclear power

A firm founded by Bill Gates bets on a novel nuclear reactor

The hope is that it will work well with renewable-dominated power grids

SINCE HANDING over the reins as Microsoft's chief executive in 2000, Bill Gates has been best-known for his philanthropy. The Bill and Melinda Gates Foundation, one of the world's largest charities, has given billions of dollars to vaccination drives, family-planning clinics, research into drug treatments for malaria and more.

But Mr Gates has not abandoned the business world entirely. On June 2nd TerraPower, a company he founded in 2008, announced that it would build a demonstration of an exotic, high-tech nuclear power station in Wyoming. The firm's Natrium reactor is one of a gaggle of new designs that have emerged in recent years, as engineers try to come up with cheaper, simpler nuclear power plants that can provide low-carbon electricity with fewer of the cost and safety worries that have plagued the industry in the past.

The Natrium reactor makes two big changes to the standard nuclear-power-plant design. It replaces the liquid water that normally courses through the core with hot, liquid sodium (natrium, in Latin). And instead of using the heat generated by the reactor to make electricity directly, it first employs it to heat a tank of molten salt that acts as a giant battery. The upshot, the firm hopes, will be a cheaper reactor that is better suited to power grids that will increasingly be dominated by intermittent sources of energy such as wind turbines and solar panels.

Start with the reactor itself. Most nuclear power plants are light-water reactors (LWRs), a technology developed in America in the 1950s. They use ordinary water both to cool the reactor core and to increase the intensity of

the chain-reaction by moderating the speed of the neutrons that are emitted when uranium atoms split. Thus slowed, these neutrons are more likely to go on to split more atoms in turn.

Natrium employs hot, liquid sodium as a coolant, and dispenses with the moderator entirely. This is another idea that dates back to the 1950s, but one which has never been widely deployed. Yet sodium offers several advantages as a coolant, says Chris Levesque, TerraPower's boss. The liquid sodium's high temperature—around 500°C—makes the reactor more efficient. At the same time, liquid sodium is much less corrosive to pipes than hot water. And though the water in LWRs is pumped through at high pressure, Natrium is designed to operate at close to atmospheric pressure. That means pipes, containment buildings and the like can be less beefy without affecting safety. TerraPower reckons its reactor needs only 20% of the concrete required by an LWR of equivalent power, which helps keep down costs.

The firm's second big idea is its molten-salt energy-storage system. Inspiration for this came from the solar-power industry, says Mr Levesque. Solar-thermal systems (in contradistinction to the more familiar photovoltaic ones that generate electricity directly) have, for several years, used similar tanks to store excess solar energy harvested during the day. In Natrium's case, the sodium coolant transfers heat from the reactor into the molten-salt tanks. A separate set of pipes then removes heat from the tanks and uses it to produce electricity.

TerraPower hopes this arrangement will let the new reactor ramp its power output up and down, depending on the price of electricity. This is something that LWRs struggle to do. The firm's demonstration plant will usually produce 345 megawatts (MW) of electrical power. But by releasing the energy stored in the molten-salt tanks, it will be able to boost that to 500MW for over five-and-a-half hours. This should be a useful trick as

power grids fill up with wind and solar farms that are likely to cause power prices to fluctuate more than they do at present. Combined with lower construction costs, TerraPower hopes such agility will make its plant more economically attractive than older designs.

It all looks good on paper. But then, nuclear power always does. The industry has been plagued by delays and cost overruns for decades. Existing sodium-cooled reactors, most of which are experimental, have a spotty record. A plant in Japan suffered a serious fire in 1995 and was shut down for over a decade. The Superphénix reactor in France, built in 1974, proved extremely unreliable, and was offline for years at a time. It closed for good in 1998. (Other reactors, such as the Fast Flux Test Facility in Washington state, have better records.)

The Union of Concerned Scientists, an American not-for-profit organisation, argues in a report published in March that sodium's advantages as a coolant are counterbalanced by drawbacks. One is that a reactor which ran too hot might see its power output rise as a consequence. Unlike water, the loss of which shuts a reactor down for lack of moderation, sodium slightly damps the chain-reaction. If bubbles of sodium vapour formed in the coolant, that damping effect would diminish, risking a dangerous feedback loop of rising temperatures and growing power output.

The physics of such judgments are tricky. Few countries have as much nuclear experience as France, which generates around 70% of its electricity that way. Yet in 2015 French regulators said they could not determine whether sodium-cooled reactors are significantly safer than modern LWRs. TerraPower, moreover, insists that its Natrium plant is designed in a way that makes runaway reactions impossible.

America's government, for its part, thinks the technology has merit. It is chipping in \$80m to help TerraPower build the demonstration plant, which

the firm says should be ready by 2028. In the meantime, says Mr Levesque, TerraPower has been fielding inquiries from electricity firms interested in its technology. Whether Mr Gates's bet on a nuclear-power revival will pay off remains to be seen. ■



核能

比尔·盖茨创立的公司押注新型核反应堆

希望它能契合以可再生能源为主的电网

自2000年卸任微软首席执行官以来，比尔·盖茨最出名的事业是做慈善。比尔和梅琳达·盖茨基金会是全球最大的慈善机构之一，已在推动疫苗接种、计划生育诊所、抗疟疾药物治疗研究等领域捐赠了数百亿美元。

但盖茨并没有完全退出商界。6月2日，他于2008年创立的公司泰拉能源（TerraPower）宣布将在怀俄明州建造一座新式高科技术示范核电站。泰拉能源的Natrium反应堆是近些年出现的众多新核电站设计之一。工程师们一直在努力设计成本更低、构造更简单的核电站，希望它们既能提供低碳电力，又能减少过去一直困扰核电行业的成本和安全问题。

Natrium反应堆相对常规核电站设计有两大改动。它用热的液态钠（natrium在拉丁语中是钠的意思）代替通常流经堆芯的液态水。它不直接用反应堆产生的热量来发电，而是先用这些热量来加热充当巨大电池的熔盐罐。泰拉能源希望这样的反应堆成本会更低，也更适合未来的电网——它们日渐以风力涡轮机和太阳能电池板等间歇性能源为主。

先来看反应堆本身。大多数核电站都是轻水反应堆（LWR），这是上世纪50年代在美国开发的技术。LWR用普通水冷却反应堆堆芯，也用普通水给铀原子裂变时释放出的中子减速，从而加强链式反应——这些中子在放慢速度后更有可能继续让更多原子发生裂变。

Natrium反应堆用热的液态钠作冷却剂，完全不用减速剂。这个方案也可以追溯到上世纪50年代，但从未广泛应用过。然而用钠作冷却剂有几个优点，泰拉能源的老板克里斯·拉维斯克（Chris Levesque）说。高温液态钠（约500°C）可以提高反应堆效率。同时，液态钠对管道的腐蚀性比热水小得多。而尽管LWR中的水是高压水，Natrium反应堆的设计运行压力却接近大气压。这意味着管道、安全壳等设施不需要那么厚实就可以保证安

全。泰拉能源估计其反应堆只需要同等功率LWR所需混凝土的20%，这有助于降低成本。

泰拉能源设计上的第二大特点是熔盐储能系统。其灵感来自太阳能行业，拉维斯克说。过去几年来，光热系统（与人们更熟悉的直接发电的光伏系统不同）用类似的储能罐来存储白天收集的多余太阳能。在Natrium反应堆中，钠冷却剂将热量从反应堆转移到熔盐罐中，然后由另一套独立管道带走罐中热量用来发电。

泰拉能源希望这样的设计能让它的新核电站根据电价的浮动调整发电量。这是LWR难以做到的。泰拉能源的示范核电厂通常的发电量将在345兆瓦。但通过释放储存在熔盐罐中的能量，它将能把发电量增加到500兆瓦并维持五个半小时。这应该很有用处，因为随着风能和太阳能在电网中大行其道，未来电价浮动的幅度很可能比目前更大。再加上造价较低，该公司希望这种灵活度能让它的核电站比传统设计在经济效益上更具吸引力。

从理论上看，这一切都很好。但话说回来，核电在理论上一直都很好。几十年来，工期延误和成本超支困扰着核电业。现有的钠冷反应堆大部分是试验性的，表现有好有坏。日本的一家钠冷核电站于1995年发生严重火灾，随后关闭了十多年。建于1974年的法国超凤凰反应堆（Superphénix）极其不稳定，多次关闭，一关就是好几年，最终于1998年永久关闭。（华盛顿州的快速通量测试设施[Fast Flux Test Facility]等其他反应堆的情况要好一些。）

美国非营利组织忧思科学家联盟（Union of Concerned Scientists）3月发表的一份报告认为，用钠作冷却剂的优点会被缺点抵消。其中一个缺点是反应堆如果运行过热，可能会导致功率输出增加。在用水的情况下，停水会让反应堆因中子不能减速而停堆，钠则不同，它是略微抑制链式反应。如果冷却液中形成钠蒸汽的气泡，这种抑制作用就会减弱，有可能在温度升高和功率输出增加之间形成危险的反馈环。

这些判断的物理学原理很复杂。几乎没有哪个国家比法国的核电经验更丰

富，核电约占该国发电量的70%。然而在2015年，法国监管机构表示无法确定钠冷反应堆的安全性会明显高于现代LWR。而泰拉能源则坚称，以Natrium核电站的设计，失控反应不可能发生。

美国政府倒是认为这项技术有它的价值。它拿出了8000万美元帮助泰拉能源建造示范核电站，泰拉能源表示该核电站应该能在2028年之前投入运营。与此同时，拉维斯克表示，泰拉能源也在回应对其技术感兴趣的电力公司的询问。盖茨对核电复兴的押注能否得到回报，还需拭目以待。 ■



Programmes by programs

Composing by computer

Concerts may soon feature music written by artificial intelligence

THESE DAYS, anyone with a computer can be a composer. Sort of. Give a piece of commercial software such as Magenta, developed by Google, the first few notes of a song, and it will make something merrily tuneful out of them. Tuneful, but not sophisticated. At least, that is the view of Gerhard Widmer of Johannes Kepler University, in Linz, Austria.

In Dr Widmer's opinion, "what they create may contain certain statistical properties. It's not dissonant, but it's not actually music...It would create a piece that would last three days because it has no notion of what it wants to do. It doesn't know that things need an end, a beginning, and something in-between." He thinks he can do better. He wants to use artificial intelligence to explore how toying with a listener's expectations affects the perception of music, and then to employ that knowledge to create software which can produce something more akin to Beethoven than "Baa Baa Black Sheep". That means giving computers an ability to perceive subtleties they cannot currently detect but might, using the latest techniques, be able to learn. To this end, Dr Widmer is running a project called "Whither music?"—a title borrowed from a lecture series given at Harvard University in 1973 by Leonard Bernstein, a celebrated 20th-century composer.

When human beings listen to music, they subconsciously predict what the next note will be. One trick composers use is to toy with these expectations—sometimes delivering what is expected and sometimes deliberately taking an unexpected turn. Performers then enhance that emotional manipulation by adding expression—for example, by playing a particular phrase louder or more staccato than the one which came before.

One thing Dr Widmer is doing, therefore, is teaching computers to copy them.

To this end, he and his colleagues have amassed a huge body of recordings captured on specially designed instruments, notably the Bösendorfer 290 SE, a type of concert piano made in the 1980s which was rigged by the manufacturers with sensors that measure the force and timings of the pianist's key-pressing with great accuracy. The jewel of their collection is a set of performances on a 290 SE by Nikita Magaloff (pictured), a legendary concert pianist and Chopin expert, of almost all of Chopin's solo piano work. These were recorded at a series of six concerts which Magaloff gave in Vienna, shortly before his death in 1992.

The team's software takes data from these and other, humbler recordings and compares them with the score as written by the composer. It is looking for mismatches between the two—places, for instance, where the performer misses the beat by a few milliseconds or plays a note more forcefully than the score indicates. By analysing thousands of performances and comparing them with digitised versions of the composers' scores, the software learns what performers are choosing to accentuate when they play, and thus what those performers think is particularly interesting to the audience.

Other algorithms are being taught the rules of composition. “[Existing software models] take all the past notes that have already been played and predict the next note, which has nothing to do with how a human composer would compose,” Dr Widmer explains. “Composition is a planning process that involves structure. We want to create models that make predictions at several levels simultaneously.” The team are designing and training individual modules for different elements of music: melody, rhythm, harmony and so on—with the intention of combining them into a master program that can be trained on performances and scores *in toto*.

Once complete, the resulting megabyte maestro will decide not just which note follows which, but why that should be so and how that note should be played. “Instead of saying, ‘the next note is statistically likely to be a C’, it would say, ‘I believe that the next four bars will feature some kind of IV-I-V harmony [a common type of chord progression in Western music], because we had a similar pattern in a similar melodic context earlier in the piece’.”

Software of this sort might have applications beyond composition. Existing “recommender” algorithms struggle to generate musical playlists that appeal to particular tastes. A recent paper showed that they are good at suggesting pieces for fans of pop music with catholic appetites, but not for those who prefer a specific genre, such as heavy metal or rap. Software that understands musical expectancy might do a better job. A program which knows what to listen out for might discover that the music of Skepta or Slayer has specific types of musical surprises within it, and, on this basis, be able to recommend new music with similar surprises.

Whether computer software will ever be able to write music that stands up to comparison with the likes of Chopin or Cream remains to be seen. Dr Widmer remains sceptical, but it is hard to see why. Great art is often a product of knowing when to obey the rules and when to break them. And that is exactly what he is teaching his machines. ■



程序编曲

计算机作曲

或许不久后音乐会上将奏响人工智能谱写的曲子

现如今，只要有台电脑，人人都能是作曲家——算是吧。给谷歌开发的 Magenta 这类商业软件一首歌的前几个音符，它就能接着创作出欢快悦耳的旋律来。悦耳，却不够复杂精妙。至少，奥地利林茨的约翰内斯·开普勒大学（Johannes Kepler University）的格哈德·威德默（Gerhard Widmer）是这么觉得。

威德默认为，“软件创作出来的东西可能包含某些统计学上的特性。不能说它不和谐，但它实际上不是音乐……软件会创作一支持续三天的曲子，因为它对自己想要做的事没有概念。它不知道事物需要有结尾、开头和中间部分。”他认为他能做得更好。他想利用人工智能去探索干预听众的预期会如何影响他们对音乐的感知，然后再利用这些知识打造软件，让它能写出更接近贝多芬而不是《咩咩小黑羊》的乐曲。这就意味着要赋予计算机感知微妙之处的能力，目前它们还无法察觉这些，但通过最新的技术或许可以学会这种能力。为此，威德默正在开展一个名为“音乐何去何从？”（Whither music?）的项目——这个项目名称借用了 20 世纪著名作曲家伦纳德·伯恩斯坦（Leonard Bernstein）1973 年在哈佛大学的一个系列讲座。

人类在听音乐时，会下意识地预测下一个音符是什么。作曲家使用的一个技巧是操弄这些期望——有时让下一个音符符合预期，有时故意来个意想不到的转折。随后，演奏者通过增加表现力来加强这种对情感的操纵，比如更大声地演奏特定的乐句或比前面的乐句更多断奏。因此，威德默正在做的一件事便是教计算机模仿这一点。

为此，他和同事们收集了由专门设计的乐器录制的大量录音，尤其是贝森朵夫 290 SE，这是一种上世纪 80 年代制造的音乐会钢琴，它的制造商悄悄

在琴上安装了传感器，可以非常精确地测量钢琴家按键的力度和时间点。在他们收藏的录音中，最珍贵的一套是由传奇音乐会钢琴家、肖邦专家尼基塔·马加洛夫（Nikita Magaloff，见图）用贝森朵夫290 SE演奏的，几乎囊括了所有肖邦钢琴独奏作品。这些都是马加洛夫于1992年去世前不久在维也纳举办的一系列六场音乐会上录制的。

威德默团队的软件从这些和其他级别更低的录音中获取数据，并将之与作曲家写出的乐谱做比较。它正在寻找二者间的差异，比如演奏者在某处比原作的拍子慢了或快了几毫秒，或在演奏某处音符时比乐谱规定的更有力。通过分析数千场演奏，并将它们与作曲家乐谱的数字化版本做比较，软件了解了演奏者在演奏时选择加强力度的部分，从而了解到这些演奏者觉得听众会对什么内容特别感兴趣。

其他算法正在被教授作曲的规则。“（现有的软件模型）用前面所有已经被演奏过的音符去预测下一个音符，这和人类作曲家的作曲方式毫无关系，”威德默解释说，“作曲是一个需要顾及结构的规划过程。我们想打造出能够同时在几个层面作出预测的模型。”他的团队正在为不同的音乐元素设计和训练单独的模块：旋律、节奏、和声等——计划是将它们组合成一个主程序，可以用演奏和总谱来做整体训练。

一旦完成，生成的兆字节音乐大师将不仅决定音符的排列顺序，而且会决定应该这样排列的原因以及演奏音符的方式。“它不会说‘从统计学的角度，下一个音符可能是C’，而是会说，‘我认为接下来的四小节会出现某种IV-I-V和声（西方音乐中一种常见的和弦进行法），因为我们在乐曲前面部分一段类似的旋律中已经有过类似的形式。’”

这类软件的应用可能不限于作曲。现有的“推荐”算法很难生成符合特定音乐偏好的播放列表。近期的一篇论文显示，现有算法擅长为“杂食”的流行音乐爱好者推荐歌曲，但对那些喜欢特定音乐类型——比如重金属或说唱——的听众就力不从心了。了解音乐期望值的软件可能会表现更佳。一款知道自己要从音乐中寻找什么的程序可能会发现Skepta或Slayer的音乐中包含某种类型的音乐惊喜，并能在此基础上推荐带有类似惊喜的新的音

乐。

计算机软件是否能够写出肖邦或Cream乐队级别的音乐，还有待观察。对此威德默始终持怀疑态度。但看不出有什么理由认为这不可能发生。伟大的艺术往往是知晓何时遵守规则、何时打破规则的产物。而这一点正是他尝试教会机器的。 ■



Buttonwood

Why China has learned to relax about its currency

In a sign of tolerance, it has not slammed the door on capital inflows

IN A WORLD in which transparency has become a fetish, it is refreshing to try to get a read on the People's Bank of China (PBOC). Its various nods and winks give market analysts something to interpret—or over-interpret. On May 31st it announced that it would increase the proportion of foreign-currency deposits that commercial banks must keep on reserve at the central bank, from 5% to 7%. After some chin-scratching, PBOC watchers came to a conclusion: China was sending a signal that the yuan had been rising a bit too quickly.

China used to intervene directly—by buying and selling dollars—to get the exchange rate it wanted. As recently as 2016 it ran down its foreign-exchange reserves from \$4trn to \$3trn to support the yuan. But for the past four years or so its reserves have been stable; there has been no large-scale intervention to either put a floor under the yuan or to check its rise. The surprise is not that China has thrown a little sand in the gears of its currency market. It is that it has become so tolerant of some fairly big swings in the yuan's value.

The yuan began its recent ascent a year ago (see chart), as China's factories reopened and demand for goods surged in the locked-down rich world. Chinese exporters took a greater share of world manufacturing, says Mansoor Mohi-uddin, of Bank of Singapore, which in turn increased the trade demand for yuan. Some headwinds became tailwinds. The yuan had traded at a discount to reflect fears of an escalation in the Sino-American trade wars. Exporters worried about a further hit to their revenues were inclined to hoard dollars—in part as security against their dollar debts. The

prospect of Donald Trump's electoral defeat changed the picture. The chances of further tariffs on Chinese goods were much reduced. Moreover, monetary conditions favoured speculative flows out of dollars and into yuan. In contrast to the Federal Reserve, the PBOC did not slash interest rates when the pandemic struck. The seven-day reverse-repo rate, one of China's benchmarks, was trimmed by just 30 basis points to 2.2%, while the Fed funds rate was cut to 0.1%. The higher interest on offer in China's money markets favoured its currency.

That is not all. China has been opening its markets to overseas investors. Non-residents can more easily buy and sell stocks and bonds on the mainland's markets. China's government bonds and "A" shares have qualified for inclusion in global benchmarks, such as the MSCI equity indices and the Bloomberg Barclays bond index, which are tracked by huge pools of capital. A steady flow of foreign purchases has pushed up the yuan. China has not stood in the way. Tellingly on May 31st the PBOC picked a tool that does not interfere much with portfolio inflows.

Still, there is a paradox. China has relaxed its hold on the yuan at a time when the ruling Communist Party has sought to exert greater control on private-sector businesses and on Chinese life in general. If China-watchers know anything, it is that control is prized in Beijing. Being in control does not mean that everything has to be nailed down, though. In the eternal trilemma between monetary autonomy, openness to capital and currency stability, something has to give. China has chosen to forgo a stable currency. That allows it greater traction over the domestic money supply and credit growth, which its regulators are more fretful about.

China's global ambitions for the yuan also influence its policy choices. It has the world's second-largest bond market and third-largest stockmarket. Yet foreigners still own fairly few of its assets. Even central banks, which

have had access to China's bond markets for a while, keep only 2% of their reserves in yuan. That is barely more than they hold in the Canadian dollar. Four years ago there was a vigorous internal debate about the merits of freer capital flows, says Eswar Prasad of Cornell University. But for the past two years the consensus has shifted in favour of them. If the yuan is to be a global currency, it needs first to be set free.

Even so, no one is confusing the yuan with a free-floating currency. There are ways—including all that subtle central-bank semaphoring—for China to exert influence. It is still far from transparent about where its tolerance bands begin and end. Such ambiguity is wise: give the markets a number and they will test it. Perhaps surprisingly China has not stood in the way of a much stronger yuan. But its policymakers reserve the right to keep currency markets guessing. ■



梧桐

中国为何开始放松对人民币的控制

中国没有阻止资本流入，显现出宽容度

在如今这个极度崇尚透明度的世界里，试着解读中国人民银行的态度会让人精神一震。它的种种迂回暗示留给了市场分析师发挥的空间——或者是过度发挥。5月31日，人行宣布将商业银行的外汇存款准备金率由5%提高到7%。在一番挠头苦思后，人行观察人士得出了结论：中国正在发出人民币升值有点过快的信号。

中国以往通过买入和卖出美元直接干预以达到汇率目标。还在2016年，为了支撑人民币汇率，它动用大量外汇储备，使余额从4万亿美元降至3万亿。但在过去四年左右的时间里，中国的外汇储备保持了稳定；它并没有做出大规模干预来为人民币汇率托底或抑制其升值。中国稍微干预一下自己的外汇市场并不令人惊讶，让人意外的是它对人民币汇率的大幅波动变得如此宽容。

一年前，随着中国的工厂重启而还在封锁中的富裕国家对商品的需求激增，人民币开始了最近一轮升值（见图表）。新加坡银行的曼苏尔·莫希尤丁（Mansoor Mohi-uddin）表示，中国出口商在世界制造业中占据的份额增加，这反过来又增加了对人民币的交易需求。一部分不利因素也发生了逆转。此前，对中美贸易战升级的担心体现为人民币汇率出现折让。担心收入进一步受损的出口商倾向于囤积美元——一定程度上是为防范自身背负的美元计价债务风险。特朗普选举失利的前景扭转了这一局面。美国对中国商品进一步加征关税的可能性大大降低。此外，货币环境也有利于热钱从美元流向人民币。与美联储不同，人行在疫情爆发时没有大幅降息。中国基准利率之一的七天期逆回购利率仅下调30个基点至2.2%，而美国联邦基金利率下调至0.1%。中国货币市场上的较高利率也有利于人民币走强。

这还不是全部。中国近来在向海外投资者开放市场。非中国居民现在可以更方便地在中国大陆市场买卖股票和债券。中国政府债券和A股被纳入了全球基准指数，例如被庞大资本池跟踪的MSCI股票指数和彭博巴克莱债券指数。外资持续买入也推高了人民币。中国并没有加以阻挠。5月31日，人行选择了一种不会过分干涉投资流入的政策工具，就很能说明问题。

但还是有一个自相矛盾之处。中国放松了对人民币的管控，而与此同时执政的共产党正寻求加大对私营企业和中国人生活的总体控制。中国观察家很了解一点：北京极为看重这种控制。不过，掌控局面并不意味着要牢牢把控住所有事情。面对货币自主权、资本开放和汇率稳定这永恒的三难抉择，必须有所取舍。中国已经选择了放弃货币汇率稳定。这使得中国能更好地控制国内货币供应和信贷增长，而这些正是中国监管者更紧张的问题。

中国对人民币全球地位的雄心也影响着其政策选择。中国拥有世界第二大债券市场和第三大股票市场。但由外国人持有的资产比例仍然极低。虽然几年前外国央行就已获准进入中国债券市场，但人民币也只占它们外汇储备的2%，仅略高于加元占比。康奈尔大学的埃斯瓦尔·普拉萨德（Eswar Prasad）说，四年前中国国内还在激烈争论放松资本流动的利弊，但在过去两年里，共识开始转向支持资本流动。如果人民币要成为一种全球货币，首先要让它获得自由。

即便如此，没有人会把人民币误认作一种自由浮动的货币。中国还有很多手段对汇率施加影响——包括央行惯用的各种微妙暗示。它所能容忍的浮动区间的上限和下限仍远谈不上清楚透明。这种模棱两可的策略是明智的：给市场某个数字，它们就会测试它。中国并没有出手阻止人民币大幅走强，这一点也许出人意料。但中国的政策制定者仍然留有后手，货币市场恐怕还需要继续揣摩其意图。 ■



Schumpeter

The big-pharma firm that saw the future

Long ago Roche bet on personalised health care. Now its time has come

ROCHE IS A strange entity. The Swiss giant is the world's second-biggest drugmaker and one of big pharma's most profitable firms. But its largest shareholding group, mostly descended from Fritz Hoffmann-La Roche, who founded the company in 1896, is led by André Hoffmann, a nature lover and sustainability advocate who believes that the purpose of business is not mainly to make money. Even its bosses are discouraged from making a quick franc. Severin Schwan, an Austrian who has led the company since 2008, is only Roche's seventh CEO in 125 years. Much of his pay is tied up in company stock for ten years, giving him, as he puts it, "literally a vested interest" in its long-term future.

Another thing sets Roche apart from the crowd. For two decades it has nurtured an unflashy diagnostics division alongside its mainstay of drug production, in an effort to create more personalised health care. This unit, which accounts for almost a quarter of sales, has generated lower margins than pharmaceuticals, and puts off the sort of investors who yearn only for blockbuster medicines. Had it not been for the Hoffmanns' patience, some suspect, activists would have forced Roche to sell it or spin it off long ago.

And yet in the past year or so the ability to diagnose a disease in its early stages has fully come into its own. The division has helped the company through the covid-19 pandemic. Roche was not one of the star vaccine producers, but its workaday PCR and antigen tests bolstered profits despite a slowdown in cancer treatments, its biggest business. Moreover, advances in gene sequencing and other techniques from molecular biology helped identify SARS-CoV-2, the covid-19 virus, as well as ways to fight it. That has

highlighted the value of combining biotechnology and diagnostics. These are both fields in which Roche excels.

Far from shedding diagnostics, Roche is now doubling down on it, expanding into digitisation and advanced data analytics to create individually tailored cancer treatments. This is, says Tim Haines, boss of Abingworth, a biotech venture-capital firm, “the golden age of diagnostics”. Bets placed years ago are making the stodgy-sounding, Basel-based company look prescient.

Mr Schwan, whose background is in diagnostics, can barely contain his excitement. After a long conversation with *The Economist*, he came back for more a day later. As he explains, cancer is a panoply of diseases based on individual mutations. Diagnostics identifies genetic and other differences between patients, leading to the creation of more personalised treatments. The tailor-made market, by definition, is smaller than the one for blockbuster drugs, but if patients respond better to treatment, the value of drugs can be proportionally higher. Sifting through oceans of genomic data can produce yet more precision.

Accumulating reams of information on patients has long sat awkwardly with concerns about medical privacy. Less so now, Mr Schwan believes. He says the pandemic has helped change the mood in two ways. First, the use of data-crunching to speed up the fight against covid-19 has made health authorities, hospitals and doctors more amenable to the idea of sharing medical records—provided the information is anonymised. This is, after all, biotech, not big tech. “We are not in the advertising business,” he says. Second, regulators have shown what he describes as an “incredible” willingness to speed up drug approval by gaining access to clinical-trial data in real time. “Why should we not do the same for life-saving cancer medicines?”

Roche, which has recently fallen behind Merck, an oncology rival, in immunotherapy treatments, has been eagerly waiting for this digital tide to turn. Two American acquisitions in 2018 could prove particularly fruitful. One is Foundation Medicine, a gene-sequencing company that can identify cancers from DNA in blood samples, instead of from tumour biopsies. The other is Flatiron Health, a specialist in cancer-related health records that generates data on patients from the real world, supplementing clinical trials. Both produce what Roche calls insights on cancer. Like its diagnostics business, not only do they help it further its own drug development; they also sell services to rivals, making them businesses in their own right. They are not yet profitable, but one day, Mr Schwan says, the “insights” business could be a third pillar for Roche—as big, if not bigger, than diagnostics and pharma.

There are potential pitfalls. Biology is as messy and unpredictable as nature itself. Data analytics may not be as useful in biotech as in other industries. Roche will not have the field to itself. Silicon Valley tech giants are already muscling in. And Europe, where Roche is based, has long been squeamish about data-gathering and privacy. If that continues to apply to medicine, it will hobble the region’s health-care industry.

That said, Roche has a record of pulling off the unexpected. Stefan Schneider of Vontobel, a Swiss investment firm, notes that it has accomplished the rare feat of keeping profits ticking over even as patents on its three biggest cancer drugs, which had peak annual revenues of \$21bn, have expired. Its immunotherapy drug, Tecentriq, has recently shown promising results in early-stage lung-cancer care, which may be a big breakthrough. And it has mastered the art of buying trendy biotech firms without spoiling their innovative fizz.

Indeed, its success vindicates long-term thinking and shows that shareholders’ focus on notions like sustainability can co-exist with

commercial success. For all the Hoffmann family's influence, Mr Schwan is no softy. He defends high drug prices in America. He believes in strong intellectual-property protection. When America's government this year threw its support behind patent waivers for covid-19 vaccines, he compared it to communist East Germany's nationalisation of drugmakers. Roche may be unusual. As one of Europe's few world-class megafirms, it is ballsy, too.





熊彼特

这家大药厂预见了未来

罗氏在很久以前就押注个性化医疗。它的时机到了

罗氏是个奇特的存在。这家瑞士巨头是全球第二大制药公司，也是最赚钱的大药厂之一。但它最大的持股群体（主要是于1896年创立公司的弗里茨·霍夫曼-罗氏[Fritz Hoffmann-La Roche]的后裔）的领头人安德烈·霍夫曼（André Hoffmann）热爱自然，倡导可持续发展，认为企业的主要目的不在赚钱。罗氏甚至也不鼓励它的老板们去赚快钱。从2008年开始领导公司的奥地利人塞维林·施万（Severin Schwan）仅仅是罗氏创立125年来的第七任首席执行官。十年来，他的大部分薪酬都与公司股票挂钩，用他自己的话说，这让他从公司的长远未来中获得“实实在在的既得利益”。

还有一件事让罗氏与众不同。除了制药这一支柱业务，它在过去20年里还培育了一个不起眼的诊断部门，致力于打造更个性化的医疗服务。这个部门贡献了总销售额的近四分之一，但利润低于制药，这让那些只盯着畅销药的投资者望而却步。有些人怀疑，如果不是霍夫曼够耐心，维权投资者早就逼迫罗氏出售或剥离这个部门了。

但在过去一年左右的时间里，诊断处于早期阶段的能力充分显现了其价值。这个部门帮助罗氏捱过了新冠疫情的冲击。生产疫苗的明星厂商中没有罗氏，但它的常规PCR和抗原检测仍然提高了公司利润，即便它规模最大的抗癌业务增长放缓。此外，基因测序和其他源自分子生物学的方法帮助识别了新冠病毒及寻找抗击手段。这凸显了生物技术和诊断学相结合的价值，而这两个领域都是罗氏的强项。

罗氏非但没有放弃诊断业务，反而在加倍投入，将它扩展到数字化和先进的数据分析领域，以创建个性化的癌症治疗方案。生物技术风险投资公司Abingworth的老板蒂姆·海恩斯（Tim Haines）说，现在是“诊断技术的黄金时代”。多年前的押注让这家听起来古板守旧、总部位于巴塞尔的公司

看起来颇有先见之明。

本身是公司诊断部门元老的施万对此抑制不住地兴奋。在与本刊交流许久后，过了一天他又前来畅谈。他解释道，癌症是基于个体突变的一整组疾病。诊断学识别不同患者在基因和其他方面的差异，据此制定更个性化的治疗方案。个性化医疗的市场势必小于畅销药物，但如果患者对治疗的反应更好，药物的价值也会相应提高。筛查海量基因组数据还可以生成更精确的判断。

长期以来，搜集大量患者信息这件事总卡在担忧医疗隐私的问题上。施万相信现在没那么难办了。他说疫情从两个方面改变了氛围。首先，运用数据处理加快抗击新冠疫情让卫生主管部门、医院和医生更加乐意共享病历了——前提是信息匿名。这毕竟是生物科技，不是大科技。“我们又不是在做广告生意。”他说。其次，监管机构表现出了他描述为“不可思议”的意愿，愿意通过实时获取临床试验数据来加快药物审批。“在治疗癌症的救命药上，我们难道不应该也这么做吗？”

罗氏近年在免疫治疗方面落后于抗癌对手默克，一直在急切地等待数字信息收集上的趋势转向。它2018年在美国的两笔收购可能会结出硕果。一个是基因测序公司Foundation Medicine，它可以通过血液样本中的DNA来确诊癌症，而不必做肿瘤活检。另一家是Flatiron Health，专门研究癌症方面的医疗档案，生成真实患者数据来为临床试验数据提供补充。这两家公司都能带来罗氏所说的对癌症的洞见。就像它的诊断业务一样，这些业务不但帮助罗氏推进自己的药物研发，还可以把服务卖给竞争对手，让它们自成一门生意。它们目前尚未盈利，但施万表示，有朝一日“洞见”业务可能成为罗氏的第三大支柱，规模可能赶上甚至超过诊断和制药业务。

这类业务也有隐患。生物学就和大自然本身一样混乱且不可预测。数据分析在生物技术领域可能不如在其他行业有用。罗氏将无法独占这一领域。硅谷的科技巨头已经在强势挤入。而罗氏总部所在的欧洲长期都对数据收集和隐私问题神经敏感。如果这延及医药业，将阻碍欧洲医药业的发展。

不过，罗氏素有做成意想不到的事的本领。瑞士投资公司Vontobel的斯特凡·施耐德（Stefan Schneider）指出，在它的三大抗癌药物的专利过期之后（年收入峰值曾高达210亿美元），它仍然保持了盈利，这是一个罕见的壮举。罗氏的免疫治疗药物特善奇（Tecentriq）近期在早期肺癌治疗方面显现出了令人振奋的效果，有可能是一项重大突破。它还掌控了收购新兴生物技术公司却不破坏其创新活力的要诀。

的确，罗氏的成功证明了长线思维的正确性，也显示出股东关注可持续发展这类概念不必然与商业成功冲突。而尽管霍夫曼家族拥有强大影响力，施万也非弱咖。他为美国的高药价辩护。他相信强有力的知识产权保护。当美国政府今年提出支持豁免新冠疫苗的专利时，他把这比作共产主义东德对制药企业的国有化。罗氏或许与众不同。作为欧洲为数不多的世界级巨头公司之一，它也胆魄过人。 ■



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What it means to invest in Chinese offshore assets could be changing

Enforcing cross-border claims was often futile. Perhaps for not much longer

DISSIDENTS, SMUGGLERS and rogue executives have been hiding out on either side of the 40km border between Hong Kong and China for generations. Despite being part of the same country since 1997, the two jurisdictions have separate legal systems with limited interaction. Chinese companies have crossed the border in droves since the 1990s to access global capital markets. Investors, trusting in Hong Kong's independent legal system, have met them there, cash in hand. But when Chinese groups struggle to repay their debts, investors seldom attempt to chase them back over the border, where the bulk of the companies' assets are located. Enforcing cross-border claims has been excruciatingly difficult and often futile. That could now be changing, with important consequences for creditors both at home and abroad.

Global investors have long accepted the tenuous links between their money and Chinese assets. Take, for example, the legal structures known as variable-interest entities (VIEs) that have been used to connect hundreds of billions of foreign investors' dollars with Chinese-issued shares, despite having scant legal recognition in China. In the debt markets so-called keepwell deeds have thrived as a way of keeping offshore investors' nerves under control. They are a type of promissory note that obliges parent groups to help pay back investors should an offshore subsidiary default. But no investor has ever successfully used these notes, which back some \$90bn in dollar-denominated bonds, to force onshore companies to pay offshore debts. Creditor committees have been used to restructure debts that span the border. But more broadly it is rare that a Chinese court dealing with an insolvency case has recognised proceedings launched outside the

mainland, including in Hong Kong.

The recent turmoil unleashed by Huarong Asset Management, a state-owned Chinese financial firm with \$22bn in offshore debts, could cast a harsh glare on the disconnect between courts in China and Hong Kong. Huarong is the largest Chinese issuer of dollar-denominated debt, and the largest user of keepwell deeds. The Beijing-based group has not published its financial statements for 2020, leading to speculation that it will be restructured. Its troubles have sent yields on other state-backed debt soaring. Given the size of its borrowings and the scope of investors exposed to Huarong, a default by the group would force asset managers and hedge funds to rethink how they invest in state companies.

One question is whether keepwell deeds live up to their name. In January administrators in Beijing rejected creditors' cross-border claims on Peking University Founder Group, a tech company linked to one of China's top universities, because its keepwell deeds were based on English, not Chinese, law. The decision does not bode well for Huarong's creditors. Investors fear that any restructuring will prioritise onshore bondholders over those sitting just south of the Chinese border. "Keepwells will either go away or be redefined," says Alaa Bushehri of BNP Paribas Asset Management. Huge losses stemming from Huarong could even damage Hong Kong's reputation. "Cross-border investors may not find enough protection in Hong Kong, which may hurt its role as a fixed-income offshore centre for Chinese firms," Natixis, a French bank, noted in a research report.

Keepwells may not be a ticket across the border. But a parallel test of the legal firewall between China and Hong Kong is also playing out this year. On May 14th courts on both sides of the border said they could begin to mutually recognise some insolvency cases. The pilot project will help courts in Shanghai, Shenzhen and Xiamen acknowledge restructuring or liquidation orders from Hong Kong courts that involve assets in the three

mainland cities.

The scope for the test is narrow. Claimants must prove that the company's "centre of main interests" is in Hong Kong. This could be tricky; most Chinese firms listed in Hong Kong are incorporated in offshore centres such as the Cayman Islands. Over time, though, as courts on both sides of the border become more familiar with each other, it could "potentially break down the high barrier" between mainland China and Hong Kong, says Look Chan Ho, a barrister in Hong Kong who helped design the pilot. That could take years, warns another lawyer, who sees the pilot as largely symbolic.

Nevertheless, cross-border recognition for insolvency cases has taken on a new urgency for Chinese courts. It is not just foreign investors who are anxious for recourse. In recent years Chinese groups have fanned out across the globe, hoovering up flashy assets. Many, notably HNA, an airlines-to-finance conglomerate, have fallen on hard times. State creditors are eager to recover their losses by making claims on foreign assets, but may need recognition from foreign courts to do so. Reciprocity could help the Communist Party clean up the corporate mess.

China has not adopted the UN's framework on cross-border insolvency, which is widely used for international restructuring. But its courts are seeking recognition abroad. In 2019 a bankruptcy case under Chinese law received recognition by an American court for only the second time. That ruling stopped other claims on the Chinese firm's assets in America. In 2020, a Hong Kong court recognised a Chinese insolvency case concerning CEFC Shanghai International, part of a failed conglomerate that had gone on a spree in former Soviet republics. Both cases show that traffic between China and the rest of the world is increasingly two-way—leaving troubled executives with nowhere to hide. ■



重置违约设定

投资中国离岸资产的含义可能在改变

执行跨境索赔在过去往往是徒劳。这可能不会持续太久了

几代人以来，异见分子、走私犯和“老赖”高管一直在40公里港陆边界的这边或那边躲躲藏藏。虽然自1997年以来这两个司法辖区已归属于同一个国家，但它们的法律体系相互独立，彼此间的互动也很有限。自1990年代以来，中国大陆的企业成群结队地跨过这条边界以进入全球资本市场。对香港的独立法律体系抱有信心的投资者在那里会见它们，手里拿着现金。但是，当大陆企业难以偿还债务时，投资者很少尝试跨境把钱追回来——这些企业的资产大都位于边界的另一边。执行跨境索赔难度极大，且往往徒劳无果。这种情况现在可能正在改变，而这将对境内外的债权人都产生重大影响。

长期以来，全球投资者都了解他们的资金与中国的资产之间的纽带十分脆弱。以被称作可变利益实体（VIE）的法律结构为例，尽管它在中国大陆并没有获得多少法律承认，却已被用于将外国投资者的数千亿美元资金与中国发行的股票连接起来。在债券市场上，“维好协议”（keepwell deeds）作为减少离岸投资者紧张情绪的一种手段大行其道。这是一种本票，如果离岸子公司违约，母公司有义务帮助偿还投资者。但从来没有哪个投资者成功地使用这些票据（支撑着约900亿美元的美元计价债券）来迫使中国大陆企业偿付离岸债务。债权人委员会已被用于重组跨境债务。但更广泛来说，处理破产案件的中国法院极少承认在大陆以外地点启动的程序，包括在香港的。

背负220亿美元离岸债务的国有金融公司中国华融资产管理最近激起的一番风波，可能会凸显中国大陆和香港的法院之间的脱节。中国华融是中国最大的美元计价债券发行方，也是使用维好协议最多的企业。这家总部位于北京的集团没有公布2020年财务业绩，引发外界猜测它将被重组。它的麻烦已引发其他受国家支持的债务收益率飙升。鉴于它的借款规模和投资

者的范围，如果该集团违约，将迫使资产管理公司和对冲基金重新考虑如何投资国有企业。

一个问题是维好协议是否名副其实。今年1月，北京的破产管理人驳回了债权人对北大方正集团这家与中国顶尖大学之一关联的科技公司的跨境索赔，原因是其维好协议是基于英国法律而非中国大陆法律。这项决定对中国华融的债权人来说不是个好兆头。投资者担心任何重组方案都会优先考虑在岸债券持有人的权益，而不是那些就在边界以南的持有人。“维好协议要么会退场，要么被重新界定。”法国巴黎银行资产管理公司（BNP Paribas Asset Management）的阿拉·布谢里（Alaa Bushehri）表示。中国华融引发的巨额损失甚至可能损害香港的声誉。“跨境投资者在香港可能得不到足够的保护，这可能会损害其作为中国企业固定收益离岸中心的角色。”法国外贸银行（Natixis）在一份研究报告中指出。

维好协议可能不是一张过境票，但一项对中国大陆和香港之间法律防火墙的平行测试今年也启动了。5月14日，两边的法院都表示它们可能会开始相互认可一些破产案件。该试点项目将帮助上海、深圳和厦门的法院认可香港法院发出的涉及位于这三个大陆城市的资产的重组或清算令。

这次测试的范围很窄。索赔人必须证明公司的“主要利益中心”在香港。这可能不好办，因为多数在港上市的中国大陆公司都在开曼群岛等离岸中心注册。不过，帮助设计该试点项目的香港大律师何禄赞（Look Chan Ho）表示，随着时间推移，两边的法院彼此更为熟悉，这“有可能打破中国大陆和香港之间的高墙”。另一位律师则警告说这可能要等很多年，他认为这个试点项目在很大程度上不过是象征性的。

尽管如此，跨境认可破产案件对中国法院来说已呈现出新的紧迫性。急于追索的不仅仅是外国投资者。近些年中国大陆的集团在全球范围内扩张，大举吸纳花里胡哨的资产。许多公司已经陷入困境，其中突出的例子是业务范围涵盖从航空到金融的企业集团海航。政府债权人急于声索外国资产来弥补损失，但可能需要获得外国法院的认可才能这么做。互惠性可能有助于党清理企业界的烂摊子。

中国大陆没有采用被广泛用于国际重组的联合国跨境破产示范法框架。但其法院正在寻求域外承认。2019年，根据中国大陆法律启动的一个破产程序获得了美国法院承认——这在历史上还仅仅是第二回。这项判决中止了对这家中国大陆公司在美资产的其他索赔。2020年，香港一家法院认可了中国大陆法院启动的上海华信国际的破产程序，这家公司隶属的一个已倒台的企业集团曾在前苏联共和国掀起收购狂潮。这两个案例都表明，中国大陆与世界其他地区之间的往来越来越变得双向——让陷入麻烦的高管们无处藏身。 ■



Money, machines and mayhem

What history tells you about post-pandemic booms

People spend more, take more risks—and demand more of politicians

THE CHOLERA pandemic of the early 1830s hit France hard. It wiped out nearly 3% of Parisians in a month, and hospitals were overwhelmed by patients whose ailments doctors could not explain. The end of the plague prompted an economic revival, with France following Britain into an industrial revolution. But as anyone who has read “Les Misérables” knows, the pandemic also contributed to another sort of revolution. The city’s poor, hit hardest by the disease, fulminated against the rich, who had fled to their country homes to avoid contagion. France saw political instability for years afterwards.

Today, even as covid-19 rages across poorer countries, the rich world is on the verge of a post-pandemic boom. Governments are lifting stay-at-home orders as vaccinations reduce hospitalisations and deaths from the virus. Many forecasters reckon that America’s economy will grow by more than 6% this year, at least four percentage points faster than its pre-pandemic trend. Other countries are also in for unusually fast growth (see chart 1). The Economist’s analysis of GDP data for the G7 economies going back to 1820 suggests that such a synchronised acceleration relative to trend is rare. It has not happened since the post-war boom of the 1950s.

The situation is so unfamiliar that economists are turning to history for a sense of what to expect. The record suggests that, after periods of massive non-financial disruption such as wars and pandemics, GDP does bounce back. It offers three further lessons. First, while people are keen to go out and spend, uncertainty lingers. Second, crises encourage people and businesses to try new ways of doing things, upending the structure of the

economy. Third, as “Les Misérables” shows, political upheaval often follows, with unpredictable economic consequences.

Take consumer spending first. Evidence from earlier pandemics suggests that during the acute phase people behave as they have during the past year of covid-19, accumulating savings as spending opportunities vanish. In the first half of the 1870s, during an outbreak of smallpox, Britain’s household-saving rate doubled. Japan’s saving rate more than doubled during the first world war. In 1919-20, as the Spanish flu raged, Americans stashed away more cash than in any subsequent year until the second world war. When that war hit, savings rose again, with households accumulating additional balances in 1941-45 worth some 40% of GDP.

History also offers a guide to what people do once life gets back to normal. Spending rises, prompting employment to recover, but there is not much evidence of excess. The notion that people celebrated the end of the Black Death by “wild fornication” and “hysterical gaiety”, as some historians suppose, is (probably) apocryphal. The 1920s were far from roaring, at least at first. On New Year’s Eve 1920, after the threat of Spanish flu had decisively passed, “Broadway and Times Square looked more like the old days”, according to one study, but America nonetheless felt like “a sick and tired nation”. A recent paper by Goldman Sachs, a bank, estimates that in 1946-49 American consumers spent only about 20% of their excess savings. That extra spending certainly aided the post-war boom, though the government’s monthly “business situation” reports in the late 1940s were nonetheless filled with worry of an impending slowdown (and indeed the economy went into recession in 1948-49). Beer consumption actually fell. Consumers’ caution may be one reason why there is little evidence of pandemic-induced surges in inflation (see chart 2).

The second big lesson from post-pandemic booms relates to the “supply

side” of the economy—how and where goods and services are produced. Though, in aggregate, people appear to be less keen on frivolity following a pandemic, some may be more willing to try new ways of making money. Historians believe the Black Death made Europeans more adventurous. Piling on to a ship and setting sail for new lands seemed less risky when so many people were dying at home. “Apollo’s Arrow”, a recent book by Nicholas Christakis of Yale University, shows that the Spanish flu pandemic gave way to “increased expressions of risk-taking”. Indeed a study for America’s National Bureau of Economic Research, published in 1948, found that the number of startups boomed from 1919. Today new business formation is once again surging across the rich world, as entrepreneurs seek to fill gaps in the market.

Other economists have drawn a link between pandemics and another change to the supply side of the economy: the use of labour-saving technology. Bosses may want to limit the spread of disease, and robots do not fall ill. A paper by researchers at the IMF looks at a number of recent outbreaks of diseases, including Ebola and SARS, and finds that “pandemic events accelerate robot adoption, especially when the health impact is severe and is associated with a significant economic downturn.” The 1920s were also an era of rapid automation in America, especially in telephone operation, one of the most common jobs for young American women in the early 1900s. Others have drawn a link between the Black Death and Johannes Gutenberg’s printing press. There is as yet little hard evidence of a surge in automation because of covid-19, though anecdotes abound.

Whether automation deprives people of jobs, however, is another matter. Some research suggests that workers in fact do better in the aftermath of pandemics. A paper published last year by the Federal Reserve Bank of San Francisco finds that real wages tend to rise. In some cases this is through a macabre mechanism: the disease culls workers, leaving survivors in a stronger bargaining position.

In other cases, however, rising wages are the product of political changes—the third big lesson of historical booms. When people have suffered in large numbers, attitudes may shift towards workers. That seems to be happening this time: policymakers across the world are less interested in reducing public debt or warding off inflation than they are in getting unemployment down. A new paper from three academics at the London School of Economics also finds that covid-19 has made people across Europe more averse to inequality.

Such pressures have, in some instances, exploded into political disorder. Pandemics expose and accentuate pre-existing inequalities, leading those on the wrong side of the bargain to look for redress. Ebola, in 2013-16, increased civil violence in West Africa by 40%, according to one study. Recent research from the IMF considers the effect of five pandemics, including Ebola, SARS and Zika, in 133 countries since 2001. It finds that they led to a significant increase in social unrest. “It is reasonable to expect that, as the pandemic fades, unrest may re-emerge in locations where it previously existed,” researchers write in another IMF paper. Social unrest seems to peak two years after the pandemic ends. Enjoy the coming boom while it lasts. Before long, there may be a twist in the tale. ■



金钱、机器和骚乱

以史为鉴，看疫情后的繁荣

人们消费更多，冒更大风险——对政客的要求也更高

十九世纪三十年代初的霍乱大流行重创了法国。一个月内就有将近3%的巴黎人丧生，医院里挤满了病人，而医生对他们的病痛束手无策。这场瘟疫的结束推动了一轮经济复苏，让法国跟随英国进入了工业革命。但读过《悲惨世界》的人都知道，这场瘟疫也带来了另一种革命。巴黎的穷人受疫情的打击最沉重，对那些逃到乡下别墅躲避瘟疫的富人怒火中烧。随后法国经历了多年的政局不稳。

如今，当新冠肺炎仍在贫穷国家肆虐之时，发达国家已接近进入疫情后的繁荣期。随着疫苗接种减少了因感染新冠住院和死亡的人数，各国政府正逐步取消居家令。许多预测机构认为美国经济今年的增长率将超过6%，比疫情前的原有趋势至少高出四个百分点。其他国家也即将迎来非同寻常的快速增长（见图表1）。本刊对七国集团（G7）自1820年以来的GDP数据的分析表明，像这样多国相比原有趋势同步加速的情况很罕见。自上世纪50年代的战后经济繁荣以来还未曾发生过。

情形如此陌生，经济学家需要回顾历史才能预期未来。记录显示，在经历了战争和流行病等大规模非金融动荡之后，GDP确实会反弹。此外还有三条经验。首先，虽然人们对外出消费热情高涨，但不确定性挥之不去。其次，危机鼓励人们和企业尝试新的做事方法，从而颠覆经济结构。第三，正如《悲惨世界》所展示的，政治动荡往往随之而来，带来不可预测的经济后果。

先说消费者支出。以往流行病的证据表明，与过去一年新冠疫情期间的情况一样，在疾病爆发期人们没有机会消费，积攒下了储蓄。19世纪70年代上半叶天花爆发期间，英国家庭的储蓄率翻了一番。日本的储蓄率在一战期间翻了一番多。1919至1920年西班牙流感肆虐，美国人存下的现金比这

之后到二战之间的任何一年都多。到二战来临时，储蓄率再次攀升，1941至1945年家庭新积累的存款余额达到GDP的约40%。

当生活恢复正常后人们会怎么做，历史也给出了提示。支出会增加，促进就业复苏，但没有太多证据显示人们会无节制地消费。一些历史学家猜想，在黑死病结束后，人们用“疯狂私通”和“歇斯底里的狂欢”来大肆庆祝，但这种说法（很可能）只是传说，不足为信。上世纪20年代远远谈不上“咆哮”，至少在初期不是。据一项研究称，1920年新年前夜，西班牙流感的威胁彻底过去后，“百老汇和时代广场恢复了往日模样”，但感觉上美国仍是一个“病怏怏的国家”。高盛最近的一篇文章估计，从1946到1949年，美国消费者只花掉了他们过剩储蓄的20%左右。这些额外支出确实促进了战后的繁荣，但40年代末美国政府每月的“商业形势”报告仍然充满对经济放缓的担忧（而经济确实在1948到1949年陷入了衰退）。啤酒消费量实际上减少了。没有什么证据表明流行病会引发通胀激增，消费者的谨慎心态可能是原因之一（见图表2）。

疫情后繁荣的第二个重要经验与经济的“供给侧”有关，即商品和服务在哪里生产、如何生产。尽管总体而言人们在疫情之后似乎不太喜欢轻率行事，但一些人更愿意尝试新的赚钱方式。历史学家认为黑死病增强了欧洲人的冒险精神。大批人在家垂死之际，登船起航寻找新大陆似乎也没那么危险了。耶鲁大学的尼古拉斯·克里斯塔基斯（Nicholas Christakis）的新书《阿波罗之箭》（Apollo's Arrow）显示，西班牙流感过后出现了“更多的冒险行为”。事实上，1948年发表的一项为美国国家经济研究局（National Bureau of Economic Research）所做的研究发现，从1919年开始创业公司数量激增。今天，随着企业家寻求填补市场空白，发达国家再次出现了创办新企业的热潮。

其他经济学家指出在流行病和经济供给侧的另一项变化——采用节省劳动力的技术——之间存在关联。企业老板可能想要限制疾病传播，而机器人不会生病。国际货币基金组织（IMF）的研究人员的一篇论文分析了近些年爆发的一系列疾病，包括埃博拉病毒和SARS，发现“流行病加速了机器

人的应用，尤其是在疾病严重损害健康且与严重经济衰退相关时”。上世纪20年代也是美国快速自动化的时代，特别是在电话接线部门，这是上世纪初美国年轻女性最常见的一份工作。还有一些研究人员将黑死病和约翰内斯·古腾堡（Johannes Gutenberg）的印刷机联系起来。目前尽管传言很多，但尚没有确凿证据表明新冠疫情导致了自动化水平大幅上升。

不过，自动化是否会夺走人们的工作机会又是另一回事了。一些研究表明，工人在流行病之后的待遇实际上更好了。旧金山联储去年发表的一篇文章发现实际工资趋于上涨。在某些情况下，这背后的逻辑令人毛骨悚然：疾病让大量工人丧命，使幸存者在谈判中处于更有利的地位。

然而，在其他情况下，工资上涨是政治变革的产物——这是过往繁荣的第三大经验。当大批民众遭受苦难时，对工人的态度会改善。这一次似乎也是如此：比起减少公共债务或防止通货膨胀，世界各地的政策制定者对降低失业率更感兴趣。伦敦政治经济学院的三名学者发表的一篇新论文也发现，新冠疫情让欧洲人更加厌恶不平等。

在某些情况下，这种压力爆发为政治混乱。流行病暴露并加剧了业已存在的不平等，使处于弱势一方的人寻求纠正它。一项研究显示，2013到2016年，埃博拉使西非国家的国内暴力增加了40%。IMF最近研究了自2001年以来埃博拉、非典和寨卡病毒等五种流行病在133个国家的影响，结果发现它们导致社会动荡显著增加。“有理由认为，随着疫情消退，之前出现过动荡的地区可能会重现不安局面。”IMF研究人员在另一篇文章中写道。社会动荡看似会在此次疫情结束两年后达到顶峰。尽情享受即将到来的繁荣吧，不久之后情况恐怕就会有变。 ■



The best-laid battle plans

America both helps and hinders China's military-industrial complex

Domestic demand for weapons is up. But American sanctions may hobble Chinese armsmakers' tech ambitions

JIANGHANG AIRCRAFT EQUIPMENT has struggled to tantalise investors with the fuel systems and detachable petrol tanks it builds for Chinese warplanes. The company, controlled by Aviation Industry Corporation of China (AVIC), the country's biggest aerospace-and-defence conglomerate, had witnessed its share price slump by 50% since it went public in Shanghai last year. But in the first three months of the year demand for its wares has soared. On May 28th Jianghang said that net profit for the period nearly doubled, year on year. Trading in its shares subsequently had to be halted after their price rose by 10%, the maximum permitted one-day swing.

Jianghang is just one of dozens of military-linked companies on a high. Most are not publicly traded and disclose little financial information. State-owned builders of navy vessels have flotillas of listed subsidiaries. AVIC, the main group behind China's fighter-jet programme with more than 1trn yuan (\$157bn) in total assets, has 24 publicly traded divisions. To get a sense of the industry analysts track dozens of small military stocks. Citic Securities, an investment bank, covers 58. Everbright, a state-owned broker, follows 115.

The total weapons sales of China's four biggest firms that make them—of which AVIC is the largest—have been flat at just over \$50bn since at least 2015, according to the Stockholm International Peace Research Institute (SIPRI), a think-tank, even as those of foreign rivals have grown. But if the listed divisions are a guide, things may be looking up for the sector.

The combined operating income of firms followed by Everbright rose by 11% last year, to 475bn yuan. Citic reckons that net profits for the industry's

listed contingent grew by about 50% in 2020. As China's economy boomed in the first quarter, especially compared with last year's harsh covid-19 lockdowns, only agribusiness and miners of non-ferrous metals notched up faster year-on-year revenue growth than China's military-industrial complex.

The main reason for this armsmaking bonanza is China's increasingly chilly relationship with America. One note to investors from Huaxi Securities, a broker, was embellished with an image of two fists, draped in opposing American and Chinese flags, flying towards each other. America's attempts to "lock China out of technological advancement", Huaxi analysts say, is spurring new growth. Citic talks of "a period of volatility not experienced in 100 years" and predicts "a rare period of rapid development" in China's military-industrial enterprise as a result. SIPRI noted in December that Chinese arms groups were benefiting from a programme aimed at modernising its armed forces.

The domestic market is becoming increasingly important for Chinese weapons companies. According to SIPRI, China's arms exports declined by 8% between 2016 and 2020. At the same time, those of America, France and Germany grew. Chinese drones may be cheaper than Western ones but they are also seen as less capable.

In an effort to change that state of affairs, and bolster domestic armsmakers in the process, Chinese officials talk up "military-civilian fusion". This long-standing project aims to bring cutting-edge civilian technologies such as artificial intelligence and semiconductors into military supply chains, in keeping with the Communist Party slogan that "civilians and troops are members of the same household." The idea's manifestations include Hikvision, a state-owned maker of surveillance kit, which made 2.2bn yuan in net profit in the first quarter, up by 45% from a year earlier.

Ironic, then, that the same Sino-American tensions that are boosting Chinese armsmakers may end up undermining this strategy. The idea of civilian-military fusion spooked Donald Trump's administration and prompted it to bar American firms from supplying companies like Huawei, a giant maker of telecoms gear that is perceived as being close to the People's Liberation Army (PLA). The result has been disastrous for Huawei. Its revenues fell for the second consecutive quarter earlier this year. It is struggling to procure chips and more Western countries are shunning its 5G mobile networks.

Blacklisting by America may also deprive some defence-adjacent Chinese firms of a source of capital. Foreign ownership of military-linked stocks was thought to be low. It may soon be non-existent. Since January American investors have been barred from owning shares in China Spacesat, a state-owned Fortune 500 firm that helps run the country's space programme. The same month Fidelity Investments, an American asset manager, confirmed to its clients that it would sell some securities as a result of sanctions.

Mr Trump's successor, Joe Biden, shows little intention of easing the restrictions. On June 3rd he tightened some of them once again on firms with ties to surveillance and defence groups. A recent paper from the Centre for a New American Security, a think-tank, noted that the Chinese leadership's continued obsession with military-civil fusion reflects concerns that reforms to bring it about "have not progressed rapidly enough". American military strategists would love it if China's efforts to speed things along had the opposite effect. ■



最佳作战计划

美国对中国军工复合体的助力和阻碍

中国国内对武器的需求正在上升。但美国的制裁可能会阻碍中国军火制造商的技术野心

江航飞机装备公司此前难以用它为中国战机制造的燃油系统和可拆卸油箱吸引投资者。该公司由中国最大的航天和国防企业集团中国航空工业集团公司（AVIC，以下简称航空工业）控股，自去年在上交所上市之后股价曾下跌50%。但今年前三个月对其产品的需求猛增。5月28日，江航表示，当期净利润同比增长近一倍。随后其股价涨停（上涨达10%，被允许的最大单日波动）。

江航只是数十家走势喜人的军方关联公司之一。它们大多数都没有上市，并且披露的财务信息很少。国有海军舰艇制造商拥有大批上市公司。航空工业是中国战斗机项目背后的主要集团，总资产超过1万亿人民币，拥有24个上市的部门。为了解该行业，分析师跟踪了数十只小盘军工股票。投行中信证券覆盖58家，国有券商光大证券跟踪115家。

根据智库斯德哥尔摩国际和平研究所（SIPRI）的数据，至少自2015年以来，中国四大军火制造公司（其中航空工业是最大的一家）的总军火销售额一直持平，略高于500亿美元，而与此同时外国竞争对手的销售额不断扩大。但如果从已上市的部门的角度来看，这个行业的情况可能正在好转。

光大跟踪的公司去年的营业收入合计增长了11%，达到4750亿元。中信估计，该行业上市公司的净利润在2020年增长了约50%。中国经济在今年第一季度蓬勃发展（特别是与去年严厉的新冠疫情封锁相比），只有农业企业和有色金属矿商的同比增长超过了中国的军工复合体。

这轮军火制造热潮的主要原因是中美关系越来越冷淡。券商华西证券给投资者的一封信上画着两个拳头，分别裹着美国和中国国旗，正要

碰撞到一起。华西的分析师表示，美国“将中国封锁在技术进步之外”的尝试正在刺激新的增长。中信称其为“百年未有的动荡期”，并预测中国军工企业将因此迎来“难得的快速发展期”。SIPRI去年12月指出，中国军工集团正受益于一项旨在实现部队现代化的计划。

国内市场对中国军工企业来说变得越来越重要。SIPRI数据显示，2016年至2020年间，中国军火出口下降8%，而美国、法国和德国的出口有所增长。中国的无人机可能比西方的无人机便宜，但也被视为能力较差。

为了改变这种状况，并在此过程中支持国内军火制造商，中国官员大谈“军民融合”。这个长期项目旨在将人工智能和半导体等尖端民用技术带入军事供应链，正好符合共产党“军民团结一家亲”的口号。这一想法的一个体现是国有监控设备制造商海康威视，该公司第一季度实现净利润22亿元，同比增长45%。

具讽刺意味的是，正在推动中国军火制造商发展的中美紧张局势最终可能会破坏这一战略。军民融合的想法吓坏了特朗普的政府，促使其禁止美国公司向华为这样的公司供货，这家电信设备巨头被认为与中国人民解放军关系密切。其结果对华为来说是灾难性的。今年早些时候，其收入连续第二个季度下降。它在采购芯片方面步履维艰，而越来越多的西方国家正在对其5G移动网络避之不及。

上了美国的黑名单也可能让一些涉及国防的中国公司损失资金来源。军方关联股票的外国持股据信很低。可能很快还会降到零。自1月以来，美国投资者被禁止持有中国东方红卫星的股份，这是一家帮助运营中国太空计划的国有财富500强公司。同月，美国资产管理公司富达投资向其客户证实，由于制裁，它将出售一些证券。

特朗普的继任者拜登几乎没有放松限制的意图。6月3日，他再次对与监控和国防行业有关联的公司收紧了其中一些限制。智库新美国安全中心（Centre for a New American Security）最近的一篇论文指出，中国领导层对军民融合的持续痴迷反映了对实现这一融合的改革“进展不够迅速”的担

忧。如果中国欲速不达，那就正中美国军事战略家的下怀了。 ■



Simulating everything

Compared with climate, modelling of ecosystems is at an early stage

But it will help sustain biodiversity when more mature

EVERY FEW weeks from June 1963 until July 1968, Robert Paine, a zoologist, made the journey from Seattle, where he taught at the University of Washington, across Puget Sound to the rocky shores of Mukkaw bay. There, he had found virtually pristine tide pools that teemed with life—limpets, anemones, mussels, seaweeds and purple-and-orange seastars known as *Pisaster ochraceus*. The unspoiled landscape offered the perfect setting for what was to become a seminal experiment in ecology. On each visit, Dr Paine systematically removed all the seastars he could find from one patch of rock, lobbing them as far as he could into the waves.

He did this for five years, all the while carefully documenting how the shoreline communities evolved. Very little changed in the untouched areas. But in his seastar-free zone, everything was altered. *Pisaster* is a greedy carnivore that feasts on mussels, barnacles, limpets and snails. Released from their predator, these species began to spread out. The acorn barnacles took over first. Later, they were displaced by goose barnacles and mussels. By removing just one species, Dr Paine had triggered a domino effect. Soon, the number of species in the community had dropped from 15 to eight. By 1968, the mussels had taken over completely.

Dr Paine dubbed *Pisaster* a “keystone species”; remove it and the ecosystem is transformed. Large herbivores like rhinos are keystone species, spreading seeds of the plants they consume across vast areas, thus maintaining or altering vegetation. In the kelp forests of the Pacific Northwest, sea otters play a keystone role by munching on sea urchins. The urchins graze on kelp and, left unchecked, are capable of wiping out entire kelp forests on which

fish and seals depend.

Keystone species illustrate the complex webs of interactions that underpin biodiversity. Understanding, let alone predicting, the impact that removing one species can have on the rest of a non-linear system is devilishly complicated. Even if sensors and ecologists could log the identity and location of every living creature on the planet, such data would be worth little without an understanding of how everything relates to everything else.

Computer models are ideally suited to providing just that. General circulation models, for example, simulate the planetary climate, linking the physics that govern the formation and disintegration of ice sheets to the huge currents that push water through the ocean, and oceanic temperature gradients to the formation of storm systems over the continents. These models are so complex that they take months to run, even on the world's most powerful supercomputers. Climate science and policy would be nothing without them.

Ecology has few equivalents. One reason is that ecosystems are much harder to simulate. "In a physical system, you have a set of atoms or molecules that behave in a predictable way, even if it is complex," says Derek Tittensor, a marine-ecosystem modeller at Dalhousie University in Canada. Ecology, by contrast, deals in living things, whose interactions are determined by the unpredictable behaviour of individuals.

Added to this is the complexity of the pressures and stresses that modify ecosystems. Carbon dioxide and methane are produced by different processes and behave differently in the atmosphere, but fundamentally they both warm the atmosphere. Burning fossil fuels also produces a mix of particles which cool the climate. These emissions are all very different, but their effects can, to some approximation, be reduced to a single variable known as their "global-warming potential". Ecosystems, by contrast, are

affected by warming temperatures and changing water cycles, but also by chemical pollution, urban encroachment, hunting and overfishing. None of this can be reduced to just one or even a handful of quantitative variables.

And so ecosystem modelling remains in its infancy. Statistical models, built on relationships between historical data sets—for example, how the amount of vegetation in a tropical forest tends to grow or shrink as temperatures and rainfall vary—are easier to build, and have progressed furthest. But they cannot capture or predict the dynamic, non-linear ways ecosystems respond to change, including the tipping points at which cumulative damage to an ecosystem suddenly shifts it into a new regime, for example when deforestation tips a region from forest to savannah.

Doing that requires “process-based” or “mechanistic” models, which are harder to build, but can produce non-linearity and emergent behaviour. They are the ecological equivalent of general circulation models, and operate as fully functioning simulations of Earth’s biosphere. They are particularly useful for unpicking what is driving change in an ecosystem. If a fish population is growing, is it because rising temperatures have driven predators away, or because deforestation on land nearby is releasing iron-rich dust which is fertilising the local plankton population?

Marine science has produced a number of process-based models, though they are less uniform in their design than climate models. Some are built around food chains and the way they move biomass and energy around ecosystems; others focus on how well-suited different species are to particular ecological niches, or group species and their interactions based on body size, which is a reasonable predictor of an organism’s place in the food chain.

Over the past decade marine-ecosystem modellers have formed the Fisheries and Marine Ecosystem Model Intercomparison Project. Its goal

is to determine how fishing and climate change are likely to alter marine fisheries around the world, which provide 11% of the animal protein humans consume. “Fish-MIP” develops standardised scenarios that can be run across global and regional marine-ecosystem models. As with climate modelling, the idea is to run the same simulations on different models and combine the results into robust projections that can inform policy decisions. Fish-MIP studies suggest that larger fish species, which make up most of what humans consume, are affected most by climate change, as are the tropics, where people tend to be more dependent on catches and more vulnerable to economic instability and poor nutrition.

But simulating the effects of fishing operations is more complicated than studying the impact of rising temperatures, as assumptions have to be made about a range of variables, from how the industry will redistribute fishing fleets as fish migrate towards the poles, to how fishing technology will change, and whether changing attitudes towards sustainability will mean more marine protected areas. The climate-modelling community handles such uncertainty by drawing up standardised hypothetical scenarios and producing climate projections for each one. But the scenarios do not yet take into account the ways in which humans effect biodiversity, such as by overfishing.

Modelling is far less advanced for land ecosystems. “Dynamic global vegetation models” can simulate human impacts on plants but do not represent non-human animals. And though there are at least eight global marine-ecosystem models that simulate life in the ocean, there is just one process-based model that includes life on land: the Madingley model, first published in 2014, which represents life both on land and in the ocean.

Named after the village in Britain where it was devised, it breaks down land and ocean into grid cells that are up to 200 square km (77 square miles). Climatic conditions are set for each cell, which are also populated with

organisms, so long as they weigh more than ten micrograms. To simplify the equations involved, the model groups organisms by size, habitat and function. It therefore cannot distinguish between two species of small songbird that live in the same region, but it does simulate interactions between, say, megafauna and their prey.

All this allows for *in silico* experiments in which all the world's top predators are wiped out entirely, an extension in space of Dr Paine's famous seastar experiment but also an extrapolation of current global trends. An assessment in 2014 of 31 of the world's largest mammalian carnivores found that three-quarters of them were in decline, and 17 occupied less than half of their historical territory. Using the Madingley model, Selwyn Hoeks at Radboud University in the Netherlands, and his colleagues found that removing all carnivores weighing more than 21kg triggered a domino effect in food chains with the net result that the total amount of vegetation on Earth decreased. Their results were published in 2020 in the journal *Ecography*.

Ecologists have long argued that conserving large carnivores has tangible benefits beyond the cuddly feeling of saving tigers. According to the "green Earth hypothesis", no carnivores means more herbivores and thus fewer plants. Vegetation soaks up carbon dioxide, so less plant life would amplify global warming. What of the reverse, where all plant life is gradually removed? Changing landscapes, particularly through agriculture, is humanity's greatest impact on biodiversity, and one that is likely to increase. Expanding agriculture reduces the amount of plant life at the base of food webs. Tim Newbold, of University College London, and colleagues simulated the removal of increasing amounts of vegetation from China, France, Libya and Uganda. They found that once 80% of plant life was gone, entire food chains began to collapse and could not be rebuilt by simply restoring the plants.

As well as predicting outcomes, global ecosystem models make it possible to test policies. What would be the consequence of reintroducing a species from a population bred in captivity? Would the decline of a species be halted or reversed if a percentage of its territorial range were protected, or would it be more efficient to create a corridor between two existing protected areas?

Carbon storage, clean water, clean air, abundant crops and fish are all examples of “ecosystem services” that benefit humanity. The principle is undeniable on a grand scale, but the details are harder to map. “We don’t have any frameworks which link biodiversity changes to changes in ecosystem functioning, and on to the services that humans derive from those ecosystems,” says Michael Harfoot of the UN World Conservation Monitoring Centre and co-author of the Ecography paper.

Statistical models try to infer changes in ecosystem services from, for instance, trends in forest cover. But process-based models need further refinement so that changes in temperatures or land use can be linked to changes in biodiversity—and then, in turn, to the functioning of ecosystems and the services they provide. “That is probably the next big frontier for ecosystem modelling,” says Dr Harfoot, “and essentially, also, for conservation.”

For now, this remains some way off. Today’s ecosystem models are widely compared to where climate models were in their earliest days of development, about 50 years ago. “Given the urgency of the situation, we need ecosystem models to be where climate models will be in ten years’ time,” says Dr Newbold. ■



模拟一切

生态系统建模相比气候建模尚处于早期

但它在更加成熟后将有助于维持生物多样性【专题报道《保护生态多样性》系列之四】

从1963年6月到1968年7月，动物学家罗伯特·潘恩（Robert Paine）每隔几周就会从他任教的华盛顿大学所在的西雅图出发，穿过普吉特海湾到达穆卡湾的岩石海岸。在那里，他发现了几乎完全处于原始状态的潮汐池，充满了各种各样的生物——帽贝、海葵、贻贝、海藻，还有被称作“赭色海星”（*Pisaster ochraceus*）的紫色和橙色的海星。未受破坏的景观提供了一个完美的实验环境，而他的实验后来也成为生态学上开创性的实验。每次造访时，潘恩都会有计划地从一片岩石上取下他能找到的所有海星，并全力将它们远远抛入海中。

他这样做了五年，与此同时仔细地记录下这些海岸线社区的演变过程。在他没有干预的区域几乎没有变化。但在他的无海星区，一切都变了。赭色海星是一种贪婪的食肉动物，以贻贝、藤壶、帽贝和蜗牛为食。没有了捕食者，这些物种开始扩散。首先接管的是橡子藤壶。后来，它们被鹅藤壶和贻贝取代。通过移除一个物种，潘恩博士引发了多米诺骨牌效应。很快，这个社区中的物种数量从15种减少到8种。到1968年就完全被贻贝占据了。

潘恩将赭色海星称为“关键种”——去除它后生态系统就会发生变化。像犀牛这样的大型食草动物是关键种，它们将食用的植物种子散播到广阔的区域，从而维持或改变植被。在太平洋西北部的海藻林中，海獭通过咀嚼海胆而发挥着关键的作用。海胆以海藻为食，如果没有制衡，它们能够消灭鱼类和海豹赖以生存的整个海藻林。

关键种反映了生物多样性背后复杂的互动网络。要了解去除一个物种会对非线性系统的其余部分产生什么样的影响是极端复杂的，更不用说预测了。哪怕传感器和生态学家可以记录地球上每个生物的身份和位置，但如

果不了解每个事物与其他事物之间的关系，这些数据将毫无价值。

计算机模型非常适合提供这种关系。例如，大气环流模型用来模拟全球气候，将控制冰盖形成和解体的物理学与海洋中推动水流的巨大洋流联系了起来，也将海洋温度梯度与陆地上风暴系统的形成联系起来。这些模型非常复杂，即使在世界上最强大的超级计算机上也需要几个月才能跑完。没有它们，气候科学和政策将一文不值。

几乎没有什幺能与生态学相提并论。原因之一是对生态系统的模拟要困难得多。“在物理系统中，你有一组原子或分子以可预测的方式运行，哪怕它很复杂。”加拿大达尔豪斯大学海洋生态系统建模师德里克·蒂滕索（Derek Tittensor）说。相比之下，生态学涉及生命体，决定其相互作用的是个体不可预测的行为。

此外还有改变生态系统的压力的复杂性。二氧化碳和甲烷由不同的过程产生，在大气中的表现也不同，但总体来说它们都使大气变暖。燃烧化石燃料还会产生使气候降温的颗粒混合物。这些排放都非常不同，但它们的影响在某种程度上可以简化为一个单一的变量，称为“全球变暖潜力”。相比之下，生态系统受到气温升高和水循环变化的影响，但也受到化学污染、城市侵占、狩猎和过度捕捞的影响。所有这些都无法简化为一个甚至少数几个定量的变量。

正由于此，生态系统建模仍处于起步阶段。根据历史数据集之间的关系建立的统计模型比较容易建立，进展也最大，一个例子是热带森林中的植被数量如何随着温度和降雨量的变化而趋于增长或收缩。但它们无法捕捉或预测生态系统对变化做出的动态非线性反应，包括累积的损害在达到“临界点”时突然将生态系统转变为新类型，例如森林砍伐使一个地区从森林转变成了稀树草原。

要捕捉这类动态需要“基于过程的”或“机械论”模型。这些模型更难构建，但能够产生非线性和新兴行为。它们是大气环流模型的生态等价物，运行时模拟全功能的地球生物圈。它们对于找出推动某个生态系统变化的因素

特别有用。如果一个鱼类种群在增长，是因为气温升高驱离了捕食者，还是因为附近陆地上的森林砍伐正在释放富含铁的灰尘，为当地的浮游生物种群提供了更多养料？

海洋科学已经产生了许多基于过程的模型，尽管它们的设计不像气候模型那样统一。有些是围绕食物链及其在生态系统中移动生物质和能源的方式而建立的；还有些则关注不同物种对特定生态位或群体物种的适合程度，或是基于体型大小对物种及其相互作用进行分组（体型是生物体在食物链中所处位置的合理预测指标）。

在过去的十年中，海洋生态系统的建模人员建立了“渔业和海洋生态系统模型比对项目”（Fish-MIP）。其目标是确定捕鱼和气候变化可能会如何改变世界各地的海洋渔业，这些渔业为人类消费提供了11%的动物蛋白。Fish-MIP开发了可以在各种全球和区域海洋生态系统模型上运行的标准化场景。与气候建模一样，其想法是在不同的模型上运行相同的模拟，并将结果组合成可以支撑政策决策的可靠预测。Fish-MIP的研究表明，较大的鱼类物种（构成人类消费的大部分）受气候变化的影响最大，还有热带地区，那里的人们往往更依赖捕捞，更容易受到经济不稳定和营养不良的影响。

但是模拟捕捞作业的影响比研究气温上升的影响更为复杂，因为必须对一系列变量进行假设，从随着鱼类向极地迁移，渔业将如何重新分配捕捞船队，到捕捞技术将如何演进，还有改变对可持续性的态度是否意味着出现更多海洋保护区等。气候建模社区处理这种不确定性的方法是制定标准化的假设情景，并为每个情景做出气候预测。但这些情景尚未考虑人类影响生物多样性的方式，例如过度捕捞。

陆地生态系统的建模远没有那么先进。“动态全球植被模型”可以模拟人类对植物的影响，但里面没有涉及非人类的动物。而虽然至少有八个全球海洋生态系统模型模拟海洋中的生命，包含了陆地生命的基于过程的模型却只有一个——“马丁利模型”（Madingley Model）。它于2014年首次发布，同时考虑了陆地和海洋的生命。

这个模型以设计出它的英国村庄命名，将陆地和海洋分解成最大200平方公里的网格单元。它为每个单元设定气候条件并添上生物，只要这种生物的重量超过10微克。为了简化所涉及的方程，该模型按大小、栖息地和功能给生物分组。因此，它无法区分生活在同一地区的两种小型鸣禽，但它确实模拟了比如巨兽与其猎物之间的相互作用。

所有这一切都让计算机可以推演假如世界上所有顶级捕食者被完全消灭会怎样。这是对潘恩著名的海星实验的扩展，也是对当前全球趋势的推断。2014年对31种世界上最大的哺乳食肉动物的评估发现，其中有四分之三数量正在减少，17种动物的领地还不到其历史领地的一半。利用马丁利模型，荷兰拉德堡德大学的塞尔温·霍克斯（Selwyn Hoeks）和他的同事们发现，去除所有体重超过21公斤的食肉动物会引发食物链中的多米诺骨牌效应，最终结果是地球上的植被总量减少。他们的研究结果发表在2020年的《Ecography》期刊上。

生态学家长期以来一直认为，除了拯救老虎让人心头柔软之外，保护大型食肉动物还有切实的好处。根据“绿色地球假说”，没有食肉动物意味着更多的食草动物，从而让植物减少。植被吸收二氧化碳，因此植物的减少会加剧全球变暖。如果反过来，让所有植物都逐渐消失会怎么样呢？地形地貌变化，尤其是因农业造成的变化，是人类对生物多样性最大的影响，而且这种影响很可能还会增加。农业扩张减少了食物网底层的植物量。伦敦大学学院的蒂姆·纽博德（Tim Newbold）和同事模拟了从中国、法国、利比亚和乌干达去除越来越多的植被。他们发现，一旦80%的植物消失，整个食物链就会开始崩溃，并且无法通过简单地恢复植物来重建。

除了预测结果外，全球生态系统模型还可以测试政策。重新引入一个来自人工饲养种群的物种会产生什么后果？如果其领地范围有一部分受到保护，一个物种的衰退能否被阻止或逆转？还是在两个现有保护区之间建立一条走廊会更有效？

碳储存、清洁水源、清洁空气、丰富的农作物和鱼类都是造福人类的“生态系统服务”的例子。这个原则在宏观上是不可否认的，但细节却更难描

绘。“我们没有任何框架能将生物多样性的变化与生态系统功能的变化联系起来，继而再与人类从这些生态系统中获得的服务联系起来。”《Ecography》论文的合著者、联合国世界保护监测中心（UN World Conservation Monitoring Centre）的迈克尔·哈福特（Michael Harfoot）说。

统计模型试图从诸如森林覆盖的趋势推断生态系统服务的变化。但基于过程的模型需要进一步完善，以便关联温度或土地使用的变化与生物多样性的变化，进而与生态系统的功能及其提供的服务联系起来。“这可能是生态系统建模的下一个前沿领域，”哈福特说，“也可以说是生态保护的前沿。”

目前，这还有一段路要走。今天的生态系统模型被普遍拿来与气候模型发展的初期相提并论——那大约是50年前了。“鉴于形势的紧迫性，我们需要生态系统模型在十年后达到气候模型届时的水平。”纽博德说。■



Back from the dead

Reviving extinct species may soon be possible

Banking cells from endangered species can help in other ways, too

LATE ONE day in April 2002, a delicate blue-beige bird with a white collar and black eye mask was released into the dense forest on the Hawaiian island of Maui. The bird, a female, was one of just three remaining po'ouli (pronounced poh-oh-oolee), a species of honeycreeper that had been discovered in 1973. Believing there to be one male among the three, researchers were desperate to arrange a match. The birds, however, did not appear in the least bit concerned about the fate of their species. To help things along, earlier that day a team had caught the female, fitted her with a small radio transmitter and set her free where the male had last been seen. The next morning they set off with aerials to track the female's progress. They soon found her, resolutely making her way back across the island to her own territory.

Conservation is full of such failed romances. When a species is reduced to a few individuals, researchers will go to great lengths to set up arranged marriages. If wild matings cannot be facilitated, they may try to breed animals in captivity and then release them back into the wild. Thus, the California condor was brought back from 22 individuals; the Arabian oryx from just nine. With the po'ouli, the decision was made to bring the reluctant trio in for captive breeding. The male was caught in September 2004. He was old, had only one eye and died a few weeks later. The other two birds were spotted around the same time, then never seen again.

And that, you might think, was the end of the po'ouli's tragic tale. But reproductive and genetic technologies developed in the past decade mean other outcomes are now conceivable, as it were. A cluster of cells from

the one-eyed male is held at the San Diego Wildlife Biodiversity Bank, also known as the Frozen Zoo. Banking tissue samples from wild species is not unusual: seed banks have done this since the early 20th century. In the San Diego facility, however, tissue samples are not just stored, but are grown in living cell cultures. Oliver Ryder, director of conservation genetics, remembers peering through a microscope to look at the po'ouli's chromosomes, aware that he was looking at the genetic material of a species that had already expired. "Extinction is, for a lot of people, kind of an abstract concept, but for some of us it has a really visceral feeling," he says.

Dr Ryder and others are developing techniques that might, theoretically, make it possible to create a live newborn long after the last members of its species have died. They are not the first to attempt this. In 2009, a team of researchers announced they had delivered the kid of a bucardo, a species of wild goat that had gone extinct nine years earlier. A skin biopsy taken from the last female had produced live cells. The team removed the bundle of DNA from inside those cells and injected it into the emptied eggs of a domestic goat. Using a zap of electricity, they fused the DNA with the egg's cellular "shell" and produced more than 400 embryos, all carrying the goat's genes. Over 200 embryos were transferred to the wombs of surrogate domestic goats, leading to just one live birth. It was delivered by caesarean section in 2003, but lived for only "some minutes", according to an account in the journal *Theriogenology*.

The technique that produced the short-lived bucardo kid was similar to that used to create Dolly, a cloned sheep, in 1996. Its DNA was primarily inherited from a single individual. Even if it had lived, it could only ever have given rise to a population of clones, the opposite of biological diversity, for which genetic diversity is essential. Efforts to rescue a species from the brink of extinction must begin long before it is reduced to just one individual, or even three.

The po'ouli's frozen cells, therefore, are unlikely ever to give rise to a new population of birds. But alongside them in San Diego are tubes that hold a different promise. They contain the remains of not one but 12 northern white rhinoceroses, five males and seven females. The northern white rhino is what is known as "functionally extinct": the last male, Sudan, died in 2018, leaving behind just two females, a mother-and-daughter pair in Kenya, dubbed Najin and Fatu. Nevertheless, at a meeting in Vienna in 2015, researchers agreed on a twin-track approach to de-extinction.

The first approach, led by a group called BioRescue, uses a version of in-vitro fertilisation involving rather more international travel than most human procedures. Five times since 2019, a team of researchers, conservationists, park rangers and veterinarians have gathered in the park to harvest oocytes (immature egg cells) from the ovaries of one or both females, who are placed under general anaesthetic for the procedure. The oocytes are immediately flown to Italy, where they are fertilised with thawed sperm from a dead male whose cells are banked in Germany. Sperm are injected through a needle directly into the eggs. They are then placed in a specially designed incubator equipped with a camera that allows the team to monitor the cells as they develop. Any embryos that successfully develop in the dish are placed in liquid nitrogen for safe-keeping until such a time as the team is ready to implant them into a womb.

The most recent egg collection was performed on March 28th. A total of 19 oocytes were obtained from Fatu; 14 were fertilised with sperm from Suni, a male who died in 2014. Four developed into viable embryos, bringing the total number of frozen embryos to nine. The next step will be to transfer embryos to a surrogate. Neither Najin nor Fatu is thought to be capable of a safe pregnancy, so the embryos will instead be entrusted to female southern white rhinos, a related species with a healthy wild population. Before implanting them, BioRescue has been testing the IVF procedure using southern white rhino cells. This has resulted in seemingly healthy

embryos, but none has yet led to a live birth. The team hopes that doing the embryo transfers in the wild, rather than at a zoo in Europe, will improve the chances of success.

Thomas Hildebrandt of the Leibniz Institute for Zoo and Wildlife Research, who is leading much of the work, says there is a short window for the transfers to happen because Najin and Fatu are both quite old. “We can try to preserve biological material very nicely,” he says, “but we can’t preserve social knowledge. And we have only two rhinos which can teach the calf how to behave as a northern white rhino.” Moreover, this IVF approach still faces the fundamental limits of genetic diversity. Fatu’s embryos carry only her and Suni’s genes. But the cells stored at -196°C in San Diego and other frozen stores carry much more, and they hold the key to the second strategy for saving the northern white rhino.

To determine whether they could theoretically build a healthy population, Dr Ryder sequenced the San Diego collection. “We found that there was more genetic variation in those 12 than in the [roughly 20,000-strong] standing population of southern white rhinos,” he says. “If we could turn those cells into animals, there is no reason the northern white rhino shouldn’t be able to recover.”

What is needed now is the means of turning frozen skin cells from long-dead rhinos into viable eggs. A way to do that has been demonstrated by Katsuhiko Hayashi, a reproductive biologist at Japan’s Kyushu University, and colleagues. In 2016, the team created baby mice from skin cells and sperm. They did this by taking cells from the tail tips of adult mice, growing them in culture, then flooding them with chemical signals that reprogrammed some of them to become “induced pluripotent stem cells”—special cells that can develop into any other cell found in the body, including oocytes. The oocytes were then fertilised and implanted into the wombs of surrogates, resulting in live mice, which went on to produce their

own offspring.

A mouse, of course, is very different to a rhinoceros. Nevertheless, earlier this year, Marisa Korody of the San Diego Zoo Wildlife Alliance and colleagues at the Scripps Research Institute in La Jolla wrote that they had successfully reprogrammed skin cells belonging to nine of the 12 dead northern white rhinos to become induced pluripotent stem cells. BioRescue has had similar success. Not all such cells are truly pluripotent, so it is not a given that the team will be able to make oocytes. Initial tests, though, are promising.

Today, the frozen collection at the San Diego Wildlife Biodiversity Bank contains more than 10,000 cell lines belonging to 1,100 species and subspecies of vertebrates, plus tissue and blood samples that have not yet been cultured. Other biobanks are held by members of the Frozen Ark project, run by Britain's University of Nottingham. Whether or not reviving extinct species becomes possible in the next few years, such biobanks can already be used to improve genetic diversity in endangered species. The American black-footed ferret, for example, was all but wiped out in the 20th century before being rescued through captive breeding of 18 surviving animals. In 2015 researchers showed that inseminating females with frozen sperm from the Smithsonian Conservation Biology Institute could increase the ferrets' genetic diversity.

Similar work could one day restore commercially valuable populations, such as threatened fisheries—but only if cells are banked now for an unknown future. That said, not all tissues lend themselves to being preserved in liquid nitrogen. Cryopreservation is also expensive and energy-intensive. So far, according to a paper published in July 2020 by Joseph Saragusty at the University of Teramo in Italy and colleagues, sperm from just 116 species, or approximately 2% of all mammals, have been preserved, as well as eggs from “just a handful” and embryos from 51

species. Live births produced from frozen mammalian sperm have been reported in only around 45 species. But cryopreservation can hold species in suspended animation while new technologies are invented or existing ones improved. As Kurt Benirschke, who founded the San Diego collection, had the foresight to declare: "You must collect things for reasons you don't yet understand". ■



起死回生

复活灭绝物种或很快成为可能

来自濒危物种的库存细胞还有其他用处【专题报道《保护生态多样性》系列之五】

二〇〇二年四月的一天晚些时候，一只漂亮的蓝色和米色的鸟，戴着白项圈和黑眼罩，被释放到夏威夷毛伊岛的茂密森林中。这只雌鸟是仅存的三只毛岛蜜雀（po'ouli，发音为 poh-oh-oolee）之一，这是1973年发现的一种蜜旋木雀。研究人员相信这三只鸟中有一只雄鸟，因此急于安排相亲。然而，这些鸟似乎丝毫不担心它们物种的命运。为助成好事，当天早些时候，一个团队抓住了这只雌鸟，给她安装了一个小型无线电发射器，然后把她放回了人们最后一次见到雄鸟的地方。第二天早上，他们开始用天线追踪雌鸟的进展。他们很快就找到了她——她正毅然决然地穿越全岛返回她自己的领地。

动物保护充满了这种失败的罗曼史。当一个物种减少到几个个体时，研究人员会不遗余力地建立包办婚姻。如果不能促成野外交配，他们可能会尝试圈养动物，然后将它们放回野外。用这种方法，加州神鹫从22只个体中恢复过来；阿拉伯大羚羊则是从仅仅9只开始。对于毛岛蜜雀，他们决定将这不情愿的三只圈养繁殖。雄鸟于 2004年9月被抓获。他年纪大了，只有一只眼睛，几周后就死了。另外两只鸟大约在同一时间被发现，然后再也没有见到过。

你可能会想，这就是毛岛蜜雀悲惨故事的结局了。但过去十年发展起来的生殖和遗传技术差不多意味着现在可以想象另一种结果了。这只独眼雄鸟的一组细胞被保存在圣地亚哥野生动物生物多样性银行（San Diego Wildlife Biodiversity Bank），人称“冷冻动物园”。保存野生物种的组织样本并不罕见：种子银行自20世纪初就开始这样做了。然而，在圣地亚哥的设施中，组织样本不仅被储存，而且在活细胞培养基中生长。保护遗传学主任奥利弗·莱德（Oliver Ryder）记得曾通过显微镜观察毛岛蜜雀的染色体，清楚意识到自己正在观察一个已经消失的物种的遗传物质。“对于很

多人来说，‘灭绝’是一个抽象的概念，但对我们中的一些人来说，会有直观的发自肺腑的感受。”他说。

从理论上说，莱德等人正在开发的技术可以在物种的最后一个成员死亡很久之后创造出一个活的新生个体。他们不是第一批尝试这样做的人。

2009年，一组研究人员宣布他们产下了一只小“布卡多”（bucardo），这是一种九年前灭绝的野山羊。取自最后一只雌性布卡多的皮肤活检留下了活细胞。该团队从这些细胞内取出了DNA束，将其注射到一只家山羊的空卵中。电击一下，他们将DNA与卵子的细胞“壳”融合在一起，产生了400多个胚胎，所有胚胎都携带了这只山羊的基因。超过200个胚胎被转移到代孕的家山羊的子宫中，最后只有一例活产。根据《动物生殖学》（Theriogenology）期刊的一篇报道，它于2003年通过剖腹产分娩，但只活了“几分钟”。

生下这只短命的小布卡多的技术类似于1996年用于创造多莉（一只克隆绵羊）的技术。它的DNA主要是从单个个体遗传而来的。即使它活下来，也只能产生克隆种群，完全是生物多样性的反面——对生物多样性而言，遗传多样性至关重要。将一个物种从濒临灭绝的边缘拯救回来的努力必须在它减少到只有一个甚至三个个体之前很久就开始。

因此，毛岛蜜雀的冷冻细胞不太可能产生新的鸟类种群。但与它们一起存放在圣地亚哥的一些试管蕴含着另外一番前景。它们包含不是一头、而是12头北方白犀牛的遗骸——五头雄性和七头雌性。北方白犀牛属于所谓的“功能性灭绝”：最后一只雄性——取名“苏丹”——于2018年去世，只留下了两只雌性，这对在肯尼亚的母女分别叫“纳金”和“法图”。尽管如此，在2015年于维也纳举行的一次会议上，研究人员就“去灭绝”的一套双管齐下的方法达成了共识。

第一种方法由一个名为“生物救援”（BioRescue）的组织领导，它使用体外受精的一个版本，其中涉及的国际旅行比大多数人类手术都要多。自2019年以来，由研究人员、环保主义者、公园护林员和兽医组成的团队已

经五次聚集在公园里，从一只或两只雌性的卵巢中收获卵母细胞（未成熟的卵细胞），手术过程中将其全身麻醉。卵母细胞立即被空运到意大利，在那里用保存在德国的死去雄性的解冻精子授精。精子通过针头直接注射到卵子中。然后将它们放置在一个专门设计的孵化器内。该孵化器配备了一个摄像头，让团队能够全程监控细胞发育过程。在培养皿中成功发育的任何胚胎都被放置在液氮中以安全保存，直到团队准备好将它们植入子宫。

最近一次取卵在今年3月28日进行。从法图身上获得了总共19个卵母细胞，其中14个接受了来自于2014年去世的雄性“苏尼”的精子授精。4个发育成可存活的胚胎，使冷冻胚胎总数达到9个。下一步将是将胚胎转移到代孕者身上。研究人员认为纳金和法图都不能安全怀孕，因此胚胎将被委托给雌性南方白犀牛，这是一种具有健康野生种群的相关物种。在植入它们之前，“生物救援”一直在使用南方白犀牛的细胞测试体外受精程序。这得到了看似健康的胚胎，但尚未有活产。该团队希望在野外而不是在欧洲的动物园进行胚胎移植能够提高成功的机会。

领导大部分工作的莱布尼茨动物与野生动物研究所（Leibniz Institute for Zoo and Wildlife Research）的托马斯·希尔德布兰特（Thomas Hildebrandt）说，胚胎移植的时间窗口很短，因为纳金和法图都很老了。“我们可以尝试很好地保存生物材料，”他说，“但我们无法保存社会知识。而且我们只有两只犀牛可以教小犀牛如何像北方白犀牛一样行事。”此外，这个体外受精策略仍然面临遗传多样性的基本限制。法图的胚胎只携带她和苏尼的基因。但储存在-196°C的圣地亚哥和其他冷冻库的细胞携带的基因要多得多，它们是拯救北方白犀牛的第二个策略的关键。

为了确定理论上能否建立一个健康的种群，莱德对圣地亚哥的收藏品进行了测序。“我们发现，这12头犀牛的遗传变异比南方白犀牛的〔大约20,000头〕的现存种群更多，”他说，“如果我们能把这些细胞变成动物，那么北方白犀牛就没有理由不能恢复。”

现在需要的是将死去已久的犀牛的冷冻皮肤细胞变成能存活的卵子。日本

九州大学的生殖生物学家林克彦及同事已经演示了一种方法。2016年，该团队用皮肤细胞和精子创造出了小鼠宝宝。他们的方法是从成年小鼠的尾尖取出细胞，在培养基中培养，然后用化学信号淹没，使其中一些细胞转化为“诱导性多能干细胞”——这种特殊的细胞可以发育成在小鼠体内发现的任何其他细胞，包括卵母细胞。接着将卵母细胞受精并植入代孕者的子宫，生下活体小鼠，再让它继续生产自己的后代。

当然，老鼠与犀牛非常不同。尽管如此，今年早些时候，圣地亚哥动物园野生动物联盟的玛丽莎·克洛狄（Marisa Korody）和拉霍亚的斯克里普斯研究所（Scripps Research Institute）的同事撰文称，他们已经成功地将12头死去的北方白犀牛中的9头的皮肤细胞转化为诱导性多能干细胞。生物救援也取得了类似的成功。并不是所有这样的细胞都是真正的多能细胞，因此团队是否能够获得卵母细胞也并非十拿九稳。不过，初步测试显现出了希望。

今天，圣地亚哥野生动物生物多样性银行的冷冻收藏品包含超过10,000种细胞系，属于1100种脊椎动物和亚种，另外还有尚未培养的组织和血液样本。其他生物库由英国诺丁汉大学运营的冷冻方舟（Frozen Ark）项目的成员持有。无论在未来几年内复活灭绝物种是否成真，此类生物库都已经可被用于改善濒危物种的遗传多样性。例如，美国黑足雪貂在20世纪几乎被捕杀殆尽，之后通过把幸存的18只圈养繁殖而获救。2015年，研究人员表明，用来自史密森尼保护生物学研究所（Smithsonian Conservation Biology Institute）的冷冻精子对雌性授精可以增加黑足雪貂的遗传多样性。

类似的工作有朝一日或可恢复具有商业价值的种群，例如受威胁的渔业，但前提是细胞现在被储存起来以用于未知的未来。尽管如此，并非所有组织都适合保存在液氮中。冷冻保存也十分昂贵，耗能巨大。到目前为止，根据意大利泰拉莫大学的约瑟夫·萨拉加斯蒂（Joseph Saragusty）及同事于2020年7月发表的一篇论文，仅有116个物种的精子被保留——约占所有哺乳动物的2%，另外还有“屈指可数的”物种的卵子和51个物种的胚胎。仅有约45个物种被报告利用冷冻哺乳动物精子获得活产。但是，在发明新技

术或改进现有技术的同时，冷冻保存可以使物种处于假死状态。创建圣地亚哥生物库的库尔特·贝尼希克（Kurt Benirschke）的话很有先见之明：“你必须出于你还不了解的原因收集东西。”■



Boom time

Will commercial jets break the sound barrier once again?

Maybe. But not for a few years yet

FOR 27 YEARS Concorde epitomised jet-setting glamour. Yet its elegant delta wings came with the ear-splitting noise of thirsty military-derived engines; champagne was served in a cramped cabin with small seats; and cruising at twice the speed of sound, which just about halved the time for an Atlantic crossing, cost twice the regular business-class fare. Devotees shed a tear after its farewell flight in 2003, following a fatal crash in 2000 and the terrorist attacks of September 11th 2001. Most business travellers shrugged.

“Picking up where Concorde left off” is how Blake Scholl, chief executive of Boom Supersonic, describes Overture 1, the jet which the American startup is developing. It will propel up to 88 passengers 1.7 times as fast as sound while avoiding Concorde’s drawbacks. This appeals to United Airlines. On June 3rd it agreed to buy 15 planes, with an option for 35 more. JAL and Virgin Atlantic have options to acquire 30 between them. Mr Scholl promises that supersonic fares, once only for the very rich, will now be “for everyone”—or at least those who can afford to fly business on the same route. Better aerodynamics, materials and engines are intended to keep operating costs 75% below those of Concorde. Civilian engines will propel the aircraft in relative quiet and use sustainable fuel to head off criticism from environmentalists. Mockups of the cabin look suitably plush.

UBS, a bank, thinks supersonic travel has a future. It puts the cumulative size of the market at between \$80bn and \$280bn by 2040, depending on regulatory hurdles and whether the planes are delivered on time, on budget and operate as promised. Mr Scholl is eyeing the upper end of that range, a potential market for 1,200 Overture 1s at \$200m each. Then he hopes

to make progressively bigger craft offering lower fares and higher speeds. Spike, another American firm with supersonic ambitions, is developing an 18-seat business jet that doesn't make a loud boom.

Is this pie in the sky? A distant caveat-strewn commitment is good publicity for United and for Boom when it seeks more funding. It is unlikely that much cash has yet changed hands. Overture 1 is not set to enter service until 2029. Aerion, another firm that hoped to build an 8-10-seat business jet, unexpectedly folded in May despite orders worth more than \$11bn and backing from Boeing, America's giant aeroplane-maker.

National regulations banning supersonic speeds over land rule out trips across North America, home to lots of business travellers and most of the world's business jets. Morgan Stanley, a bank, reckons that at \$120m, double the price of a similar subsonic plane, even the ultra-rich wouldn't pay to cut four hours from a transatlantic trip. Tellingly, Boeing itself has no plans to go supersonic. Nor has Airbus, its European arch-rival (which was involved in the Concorde project). The passenger-jet duopoly reckons that cheaper and cleaner flying is more important than speed. Breaking the sound barrier is still some way off for the ordinary punter. ■



音爆时代

商用飞机会再度突破音障吗？

也许会，但近几年还不行

在服役的27年里，协和式超音速客机成了遨游世界的光鲜生活的象征。不过与它优雅的三角翼相伴的是源自军用的高油耗发动机震耳欲聋的噪音；机上供应香槟，但客舱逼仄，座位狭小；它以两倍于音速的速度飞行，让跨越大西洋所需的时间差不多减去一半，不过票价也比一般商务舱高出一倍。在发生了2000年的致命空难和2001年9月11日的恐怖袭击之后，2003年协和式飞机完成告别飞行，信徒们流下了眼泪。大多数商务旅行者只是耸了耸肩。

“它继承了协和式客机的遗风”，美国创业公司Boom Supersonic的首席执行官布莱克·绍尔（Blake Scholl）这样描述公司正在研发的飞机“1号序曲”（Overture 1）。它将最多能搭载88名乘客，以1.7倍音速飞行，同时还会避免协和式客机的缺点。这在美联航看来很有吸引力。6月3日，该公司同意购买15架飞机，另取得35架的优先购买权。日本航空和维珍航空共拥有30架飞机的优先购买权。绍尔承诺，过去只有富人们才负担得起的超音速机票现在“人人都买得起”，或者至少是那些在同样航线上买得起商务舱的人。一号序曲更符合空气动力学，材料更佳，引擎更强，因而运营成本比协和低75%。民用发动机会让飞机在相对安静的环境中飞行，并会使用可持续燃料，以免被环保主义者指摘。机舱模型看起来足够舒适高档。

瑞银看好超音速旅行。它预计到2040年这一市场的累计规模将在800亿至2800亿美元之间，具体数字待看监管障碍以及飞机是否按时、按预算交付和按预期运营。绍尔现在盯着的是这一预测区间的上限，这一规模下可以消化1200架单价2亿美元的1号序曲。之后，他希望逐步造出更大的飞机，价格更低，速度更快。另一家有超音速雄心的美国公司Spike正在开发一种18座的低音爆公务机。

这会不会是空中楼阁？对美联航和寻求更多融资的Boom公司来说，留有较长的兑现期并时不时做一些补充声明是一种不错的自我宣传。目前还不太可能有大量现金交易。1号序曲要到2029年才开始服役。另一家公司Aerion希望造出八座到十座的公务机，尽管获得了超过110亿美元的订单和美国飞机制造巨头波音的支持，却在5月出人意料地倒闭了。

美国法规禁止在本土超音速飞行，这就排除了穿越北美的航行，而这里是众多商务旅行者和世界上大多数公务机的所在。摩根士丹利认为，Aerion公务机1.2亿美元的单价是类似的亚音速飞机价格的两倍，即使是超级富豪也不愿意花这么多钱来让自己的跨大西洋旅行缩短四个小时。波音自己并没有超音速飞机的计划，这一点很能说明问题。它的欧洲头号竞争对手空中客车公司（曾参与协和式客机项目）也没有。这两家垄断了喷气式客机的巨头认为，更便宜、更清洁的飞行比速度更重要。对于普通旅行者来说，突破音障还需时日。 ■



Serving a higher purpose

The Chinese state is pumping funds into private equity

It sounds too good to be true to private investors—and it might be

STATE CASH is burning a hole in the pocket of Shenzhen's Communist Party secretary. Wang Weizhong told angel investors late last year that if they set up a fund in the south China tech hub, the government would bear 40% of their losses. For the monstrous 400bn-yuan (\$62bn) state fund backing such activity, an investment of 3m yuan—the size of a typical angel investment—is a rounding error. For private investors the invitation sounds too good to be true. It might be.

After several years of loose monetary conditions and bumper dealmaking, liquidity in private equity (PE) in China began to dry up in 2018. New regulations made it harder for banks and insurers to invest. So-called “government-guided” funds set up by local governments or national ministries, by contrast, thrived. Local authorities were encouraged to launch such investment vehicles to lure startups to their cities, along with talent, technology and, eventually, tax revenues. Owing to a lack of in-house investment talent, most of them have acted as limited partners (LPs) in private-sector funds.

More than 1,000 government-guided funds have cropped up across China since 2015. By late 2020 they managed some 9.4trn yuan, according to China Venture, a research firm. A national fund focused on upgrading manufacturing technology held 147bn yuan at the last count. One specialising in microchips exceeded 200bn yuan in 2019. Almost every city of note across China operates its own fund. A municipal fund in Shenzhen says it has more than 400bn yuan in assets under management, making it the largest city-level manager of its kind. In the northern city of Tianjin,

the Haihe River Industry Fund is putting to work 100bn yuan along with another 400bn yuan from other investors.

As a result, PE in China is now flush with state financing. In 2015 private-sector money made up at least 70% of limited-partner funds pouring into the industry. By the end of 2019, state-backed funds accounted for at least that much. Their dominance has only increased since then; by some counts they hold more than 90% of the money in Chinese funds of funds (ie, those that invest in other funds). According to Chinese media, learning to deal with government funds is now a “required course” for PE managers.

A degree of state influence is now unavoidable. But whether that is beneficial or not is hotly contested. Some investors and advisers say taking government cash can help align private and public interests. “Government LPs can open doors for you,” says Kiki Yang of Bain, a consulting firm. State fund managers often understand local policy objectives and can steer investors in the right direction, says a venture-capital investor. The influence can go too far, however: Shenzhen Capital, a huge state fund, posted pictures on its website of a meeting it held in December where it helped each of the 42 companies it had invested in to launch a Communist Party committee. These are seen as a way to imbue private companies with party ideology.

There are other drawbacks, too. Government funds are “squeezing out other LPs”, says one of China’s top venture-capital investors. Clear mismatches in interests have also surfaced. Members of China’s PE elite cut their teeth at global investment groups such as KKR and TPG, two American firms. Their main aim is to produce hefty returns for LPs. Not so for government-guided funds. “Rarely do you have a guided fund that is chasing returns,” says an adviser to several of them. Instead, state investors are mainly trying to engineer a windfall in local tax revenues by attracting new companies, especially tech groups. Balancing these interests can lead to tensions, says

one China-based investor, and often results in investments that hinge on whether or not a company is willing to move to a specific city. Some even fear such problems could gradually lower overall returns for private-sector investors.

So far, though, the arrangement has worked well for many private funds. With smaller funds dying off over the past few years—either owing to lack of capital or huge losses—competition for target assets has eased a little. The market is healthier, investors say, as private and state capital is channelled to better fund managers.

But will it last? One lingering concern for some PE investors is that government funds might dispense with the middlemen, and do more of their own direct investing. Several large government funds have been recruiting from private-sector banks and law firms, bolstering their ability to cut deals, notes a lawyer who works with them. “They are starting to compete with us directly,” says the venture-capital investor. Private investors will appreciate state cash much less when they are vying to outbid it. ■



服务于更高目标

中国政府正向私募股权大举注资

在私人投资者听来这好到不真实——可能确实如此

深圳市委书记王伟中急于把口袋里的国家经费花出去。去年底他告诉天使投资人，如果他们在中国南方的这个技术中心设立一个基金，政府会承担他们40%的损失。支持这类投资活动的政府基金的规模已达到4000亿元人民币之巨，相比之下一笔典型的天使投资——300万元人民币——连个零头都算不上。在私人投资者听来，这个邀请好得叫人难以置信。他们的怀疑可能有其道理。

在经过几年宽松的货币环境和繁多的交易之后，中国的私募股权(PE)的流动性从2018年开始枯竭。新的监管规定使银行和保险公司更难进行投资。与之形成反差的是，由地方政府或国家部委设立的所谓“政府引导”基金却推进得如火如荼。地方政府被鼓励推出这类投资工具来吸引创业公司搬到它们的城市，一并带来人才、技术，以及最终是——税收。由于缺乏自己内部的投资人才，这些基金多数在私营部门基金中充当有限合伙人(LP)。

自2015年以来，中国各地已涌现了一千多只政府引导基金。据研究公司中国风险投资研究院称，到2020年底，它们管理着约9.4万亿元人民币。一只专注于提升制造技术的国家基金在最近一次统计时持有1470亿元。另一只专注微芯片的基金在2019年持有的资金超过2000亿元。中国几乎每个有名的城市都运作着自己的基金。深圳一只市政基金称其管理的资产超过4000亿元，使其成为同类市级投资管理者中规模最大的一支。在北方城市天津，海河产业基金正投入1000亿元，连同来自其他投资者的4000亿元一起运转起来。

其结果是，中国的私募股权投资如今充斥着国家融资。2015年，私营部门资金至少占到注入该行业的有限合伙人基金的70%。到2019年底，国家支

持的基金已经至少占到了这个比例。而此后这种主导地位更是有增无减。根据某些统计，它们持有中国的基金中基金（即投资于其他基金的基金）资金的90%以上。中国媒体称，学习如何处理政府基金现在已是私募股权经理的“必修课”。

某种程度的国家影响已无可避免。但这是否有益，争论很激烈。一些投资者和顾问说接受政府现金有助于协调私人和公共利益。“政府有限合伙人可以作为敲门砖。”咨询公司贝恩的杨琪琪说。一位风险资本投资者表示，政府基金经理通常了解地方政策目标，可以引导投资者朝正确的方向走。然而这种影响有可能走过头：庞大的政府基金深创投在其网站上发布了它在去年12月召开的一次会议的照片，在那次会上它帮助自己投资的全部42家公司分别设立了党支部。这被视为向私营企业灌输党的意识形态的一种方式。

还有其他弊端。中国一位顶尖的风险投资者说，政府基金正在“排挤其他有限合伙人”。利益上的明显不一致也开始浮出水面。中国私募股权投资精英圈的成员在美国公司KKR和TPG等全球投资集团中得到初步历练，他们的主要目标是为有限合伙人带来丰厚回报。但政府引导基金不是这样。“你很少看到有哪家引导基金在追求投资回报的。”为几只政府引导基金提供咨询的一名顾问说。相反，政府投资方主要试图通过吸引来新企业——尤其是科技集团——来为地方税收创造意外收获。一位身在中国的投资者表示，尝试平衡这些利益可能会导致紧张拉锯，并且往往导致投资决定取决于一家公司是否愿意搬到特定城市。一些人甚至担心这类问题会逐渐降低私营部门投资者的总体回报。

不过，到目前为止，这种安排对许多私募基金来说效果不错。过去几年中，规模较小的基金不是因为资金不足就是因为巨额亏损而纷纷消失，这让对目标资产的竞争有所缓和。投资者表示，现在市场更健康了，因为私人和国家资本被引导到更好的基金经理那里。

但这能持续下去吗？一些私募股权投资者有一个挥之不去的担忧：政府基金可能会撇开中间人，更多地开始自己直接投资。一位为政府基金提供服

务的律师指出，几只大型政府基金从私营银行和律师事务所挖人已有一段时日，它们想要增强自己达成交易的能力。“它们开始与我们直接竞争了。”这位风险投资者说。当私人投资者需要努力比国家出价更高，他们对国家的钱就喜欢不起来了。 ■



Bridging the gap

Technology can help conserve biodiversity

But it can only happen in conjunction with action by policymakers

PROTECTING THE biological, ecological and genetic diversity that sustains life on Earth is the mission of the United Nations Convention on Biological Diversity. But progress has been slow, to put it mildly. A list of 20 conservation targets, known as the Aichi targets, was drawn up in 2010, with a 2020 due date. In the event, not a single one of the goals was met in full (see chart).

In 2020, IPBES (the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, a body created to bridge the gap between biodiversity science and policy) published a global appraisal of the state of biodiversity. Written by 145 experts from 50 countries who reviewed 15,000 research and government sources, it offered a sobering message. “The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever,” said Sir Robert Watson, chairman of IPBES. “We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide.”

According to the 2020 Living Planet Report, produced by WWF and the Zoological Society of London, two conservation and research groups, populations of mammals, birds, amphibians, reptiles and fish shrank by 68% on average between 1970 and 2016. Two years earlier, it had found the decline to be 60% for the years spanning 1970 and 2014, suggesting that losses are accelerating. Human activity is thought to be causing species to disappear around 100 times faster than the natural background rate.

As this Technology Quarterly has shown, an explosion of technology, from

nano pore DNA sequencing to global computer models, is expanding human understanding of ecosystems. Yet most biodiversity indicators are still heading in an alarming direction. How can advances in technology be coupled to the policy changes needed to reverse the decline? It will require three things.

The first step is to knit together the various monitoring systems in order to provide a clear picture of what is going on and what needs to be done. The siloed nature of ecological science, in which teams focus on a particular animal, plant or ecological niche, has created a patchwork of initiatives and data rather than a comprehensive, global approach. At the moment it is not even possible to draw up an accurate summary of the number, location and type of different sensors around the world, let alone the species they are monitoring. Wildlife Insights, an online global repository for camera traps, has logged thousands of cameras, but is constantly discovering more. One country recently informed it that it had another 1,000 sensors that had not yet been logged, for example. A survey due to be published later this year by WildLabs, a network of conservation-technology users, found that financing, co-ordination and capacity-building are critical to the development and adoption of conservation technology.

Shared practices, databases and platforms, such as Wildlife Insights, are starting to close the gap. In addition, says Tanya Berger-Wolf, a computer scientist and ecologist at Ohio State University, ecosystem-wide observation networks are needed to measure everything from the structure of a landscape and its climatic conditions, to the location and identity of animal species, and how they interact with each other and with human infrastructure.

The second step is to create more powerful and detailed ecosystem models, so that they can be used to develop and analyse policy changes, for example on land use, fishing rights, farming practices and regulation of pollutants.

Computer simulations have been instrumental in deepening the understanding of climate change, projecting future impacts, building public and political awareness, and designing policies. Global ecosystem models are decades behind by comparison. Better models would let policymakers set more specific and effective targets. The 2010 Aichi list was hopelessly detailed in its breakdown of what needed to be done, while remaining vague and qualitative about how targets should be met. Governments are now negotiating a new list, which is due to be signed off at an intergovernmental summit scheduled to take place in October 2021, setting goals for 2030 and 2050. Simple, quantifiable targets and clear methods for measuring success, as exist for climate change, are urgently needed.

Third, once monitoring systems, models and policies are in place, technology can help assess and enforce those policies, and make the case for adjusting or extending them as appropriate. If marine protected areas are expanded, for example, ecosystem monitoring can both measure the impact on fish stocks, and keep an eye out for unauthorised fishing boats.

All this will require funding for monitoring and enforcement. And at the moment, most technology for conservation is developed in rich countries, while most biodiversity is concentrated far away in poorer ones. Even when American or European kit makes it into the hands of researchers, park rangers or land managers, maintenance is a problem. More training, and greater use of open-source platforms that put knowledge in the hands of people on the ground, can help. But ultimately there will need to be broader mechanisms for richer countries to assist poorer ones.

Many of the necessary policies will overlap with those needed to address climate change. But not all of them. Understanding how ecosystems are changing, and measuring the impact and effectiveness of interventions, will be critical to conserving biodiversity. Technology cannot solve the problem on its own. But it is hard to imagine how the problem can be solved without

it. ■



弥合差距

技术可以帮助保护生物多样性

但只有联合政策制定者的行动才能实现【专题报道《保护生态多样性》系列之六】

保护维持地球生命的生物、生态和遗传多样性是《联合国生物多样性公约》（United Nations Convention on Biological Diversity）的使命。但说得客气点，它进展缓慢。2010年制定的清单有20个保护目标，称为“爱知目标”，截止日期为2020年。到头来，没有一个目标完全实现（见图表）。

2020年，IPBES（生物多样性和生态系统服务政府间科学政策平台，一个旨在弥合生物多样性科学与政策之间差距的机构）发布了一份对生物多样性状况的全球评估。它由来自50个国家和地区的145名专家撰写，他们审查了15,000项研究和政府资料，给出了一个发人深省的讯息。“我们和所有其他物种依赖的生态系统的健康状况正在以前所未有的速度恶化，”IPBES主席罗伯特·沃森爵士（Sir Robert Watson）说，“我们正在侵蚀我们的经济、生计、粮食安全、健康和生活质量的基础。”

根据世界自然基金会和伦敦动物学会这两个保护和研究小组发布的《地球生命力报告2020》（2020 Living Planet Report），哺乳动物、鸟类、两栖动物、爬行动物和鱼类的数量在1970年至2016年间平均减少了68%。两年前，它发现在1970年至2014年间数量下降了60%，这表明损失正在加速。人类活动被认为导致物种消失的速度比自然背景灭绝率快了100倍左右。

正如本技术季刊已论述的那样，从纳米孔DNA测序到全球计算机模型的爆炸式技术增长正在拓展人类对生态系统的理解。然而，大多数生物多样性指标仍在朝着令人担忧的方向发展。技术进步怎样才能与扭转这种衰退所需的政策变化相结合？这将需要三件事。

第一步是将各种监控系统结合在一起，以便清楚地了解正在发生的事和需

要做的事。生态科学的孤立特性——团队专注于特定的动物、植物或生态位——创建了零碎的举措和数据，而不是综合性的全球方法。目前甚至无法准确总结世界各地不同传感器的数量、位置和类型，更不用说它们正在监测的物种了。野生动物观察（Wildlife Insights）是相机陷阱的在线全球存储库，已记录了数千个摄像头，但仍在不断发现更多。例如，一个国家最近向该平台报告称它还有另外1000个尚未记录的传感器。一项将于今年晚些时候由生态保护技术用户网络WildLabs发布的调查发现，融资、协调和能力建设对于保护技术的开发和采纳至关重要。

共享实践、数据库以及像野生动物观察这样的平台开始弥合差距。此外，俄亥俄州立大学的计算机科学家和生态学家塔尼娅·伯格-沃尔夫（Tanya Berger-Wolf）说，需要覆盖整个生态系统的观测网络来测量一切，从景观结构及其气候条件，到动物物种的位置和身份，以及它们相互之间以及与人类基础设施之间如何互动。

第二步是创建更强大和更详细的生态系统模型，让它们可用于制定和分析政策变化，例如土地使用、捕鱼权、耕作方式和污染物监管。计算机模拟已经显著加深了人们对气候变化的理解，帮助人们预测未来的影响，建立公众和政治意识以及设计政策。相比之下，全球生态系统模型落后了几十年。更好的模型将让决策者设定更具体而有效的目标。2010年的“爱知清单”对于需要完成的工作的分类巨细靡遗，对于如何实现目标却含糊其辞大而化之。各国政府现在正在谈判一份定于今年10月举行的政府间峰会上签署的新清单，以设定2030年和2050年的目标。我们亟需像在气候变化方面已经存在的简单、可量化的目标和衡量成功的明确方法。

第三步，一旦监测系统、模型和政策到位，技术可以帮助评估和执行这些政策，并为适当调整或扩展它们提供理据。例如，如果扩大海洋保护区，生态系统监测既可以衡量对鱼类种群的影响，又可以密切关注未经授权的渔船。

所有这一切都需要为监督和执法提供资金。目前，大多数保护技术是在富裕国家开发的，而大多数生物多样性集中在遥远的较贫穷国家。即使设法

将美国或欧洲的工具包送到了研究人员、公园管理员或土地管理者的手中，后续维护也成问题。通过更多培训和更多地使用开源平台来将知识交到基层人员手中会有所帮助。但说到底，富裕国家将需要有更广泛的机制来帮助贫穷国家。

许多必要的政策将与应对气候变化所需的政策重叠。但不是全部。了解生态系统如何演变并衡量干预措施的影响和有效性对于保护生物多样性将至关重要。单凭技术本身解决不了问题，但是很难想象若没有它又如何能解决。 ■



Cracking the code

The sequencing of genetic material is a powerful conservation tool

You can learn a lot from the faeces, skin cells and other traces that animals leave behind

IN SEPTEMBER AND October 2000, the carcasses of several northern hairy-nosed wombats and some fragments of intestine were discovered in Australia's Epping Forest National Park, apparently left behind by a mystery predator. Cattle farming has shrunk the wombats' natural habitat and consequently their population, which reached a low of just 20-30 animals in the 1970s before land-management policies helped push numbers back up to roughly 100 in the early 2000s. By sequencing DNA extracted from the Epping Forest remains, researchers identified six males and one female. But what had slain 6% of the known wombat population?

Suspicion fell on either dingoes or wild dogs, and the final answer came packaged inside faeces collected in the park. Some yielded the same genetic sequences as the carcasses. They had been left by dingoes. The team had identified their killers, and in 2002 a 20km protective fence was put up around the forest.

Environmental DNA, or eDNA, has emerged as an increasingly popular tool among conservation biologists and land managers, as DNA-sequencing tools have become progressively smaller, faster and cheaper. The field began in the late 1980s, when microbiologists started using it to look for bacteria in rivers and sediment. This had previously involved smearing water or dirt on Petri dishes to grow colonies of the resident microbes and then identifying them under the microscope, based on the shape of the colonies or how they responded to being stained with dye. It was lengthy and error-prone. Extracting DNA from samples instead, and comparing their genetic sequence to reference libraries, was quicker and more reliable.

The same approach was adopted and built upon in the early 2000s by ecologists, who were aware that the animals they studied were constantly shedding DNA in faeces, saliva, blood, scales and sloughed tissue. Gathering and sequencing this material provided valuable information without needing to interact with the animals themselves. The approach found particular favour early on with researchers studying freshwater systems. By simply dipping a test tube into a stream, they could find out if a target species was present and even how abundant it was.

Because trace amounts of DNA can be amplified before sequencing using a method called polymerase chain reaction (PCR, the same method used to detect SARS-CoV-2 in coronavirus testing), eDNA studies can detect species present in low numbers—a useful tool for tracking down rare species, or spotting invasive ones before they wreak havoc on a fishery. Other studies have sought evidence that escapees from fish farms were mating with wild populations, potentially eroding them.

DNA from scat, as wild animal droppings are known, can map out food chains without having to capture and kill animals in order to examine the contents of their guts. Killing large or rare species like whales, even for conservation purposes, poses ethical and practical challenges. But whale scat has the great advantage of buoyancy. Finding a turd floating in the middle of the ocean is made easier with the help of dogs that are trained to sniff out the signature smells of excrement belonging to a range of endangered species. DNA in the netted excrement can be analysed to determine what the animal ate, or what bacteria live in its gut.

On land, researchers can use eDNA from faeces, urine or hair to see how populations are interacting. In Malaysia, an ongoing project is focused on whether sub-populations of the Malayan tiger are still connected when deforestation has fragmented their habitat. In Britain eDNA is used to monitor a protected newt. Other projects have begun to show that cells left

in footprints in snow can yield enough DNA to identify species and possibly sex.

Several groups are attempting to identify all the individuals belonging to a population from footprint DNA, which would transform monitoring of populations, help with the tracking of animals as they roam across wide areas without the need for radiotags, and setting sustainable hunting quotas. Researchers at the US Forest Service are trying this with wolves.

So-called “metagenomic” studies use eDNA to map the genetic make-up of entire communities, such as coral reefs, or the vast, largely unexplored bacterial community that lives deep inside the Earth’s crust and whose biomass is an order of magnitude greater than that of all animals combined. Such studies can offer a genetic snapshot that might take years of field studies to establish.

The field is booming, but there are challenges. It can be difficult to tell when eDNA was deposited. DNA sampled at one point in a river could have come from anywhere upstream. And species identification is only as good as the species-specific genetic barcodes and reference genomes that serve as points of comparison. This has spurred a rush of projects to either identify a unique genetic signature for every species, such as the International Barcode of Life, or sequence the whole genomes of as many species as possible (see chart). The \$4.7bn Earth Biogenome Project aims to sequence 1.5m species in ten years. As well as collecting and preserving genomes, such genetic databases can be mined for information on susceptibility to disease, or for potential medicines.

But even though genetic sequencing has become much cheaper since the late 20th century, it remains prohibitively expensive for most researchers outside America, Europe and China. Sequencing technologies are

improving rapidly, however. In particular, Oxford Nanopore, a British company, has developed portable technology that allows sequencing to be done in the field, not just in the lab. It relies on nanopore sequencing, a technique in which strands of DNA are drawn through a nanometre-sized pore in a biological membrane. Each of the four letters of the DNA alphabet produces a distinct electrical signal as it passes through the pore, allowing the sequence to be read in real time.

Oxford Nanopore's Min ION, a USB-powered, pocket-sized device, allows every part of the sequencing process to be done in the field. Sequences are produced within an hour. The devices are relatively affordable: prices start at around \$1,000, though subsequent recharges are needed to run more samples. They have been used to sequence viruses in Brazil, amphibian DNA in Tanzania and bacteria on the International Space Station.

The technology also opens up new possibilities for investigation and enforcement. Genetic sequencing in the field can be used to identify the nature and origin of illegal bushmeat, fish or smuggled ivory. A paper published in *Forensic Science International: Genetics* in March 2021 compared results obtained by the Min ION with the standard sequencing methods used in wildlife forensics. It found the results to be comparable, potentially paving the way for handheld devices to be used in wildlife-crime prosecutions. ■



破解密码

遗传物质测序是强大的生态保护工具

你可以从动物留下的粪便、皮肤细胞和其他痕迹中了解很多事【专题报道《保护生态多样性》系列之三】

二〇〇〇年九、十月间，在澳大利亚的埃平森林国家公园（Epping Forest National Park）发现了几具北方毛鼻袋熊的尸体和一些肠道碎片，看起来应该是某种神秘捕食者干的好事。养牛业缩小了袋熊的自然栖息地，也因此导致它们数量减少。它们在1970年代一度减少到只剩二三十只，后来在土地管理政策的作用下，于本世纪初回升到100只左右。研究人员对从埃平森林的尸体中提取的DNA做了测序，确定它们是六雄一雌。但是，是什么东西一举杀死了已知袋熊数量的6%呢？

疑犯要么是澳洲野犬，要么是野狗，而谜底就包含在从公园收集的粪便中。一些粪便测出了与袋熊尸体相同的基因序列，它们是澳洲野犬留下的。研究小组验明了凶手身份。随后在2002年，埃平森林周围竖起了20公里长的防护栅栏。

随着DNA测序工具不断变得更小、更快也更便宜，环境DNA——也就是eDNA——日益成为保育生物学家和土地管理者常用的工具。该领域始于1980年代后期，当时微生物学家开始用这种方式寻找河流和沉积物中的细菌。在此之前，他们在培养皿上涂抹河水或泥沙来培养常驻微生物，然后在显微镜下观察这些菌落的形状或被染料染色时如何反应来识别它们。这个过程冗长且容易出错。相比之下，从样本中提取DNA并将其基因序列与资料库做比对的方法更快也更可靠。

生态学家在本世纪初期采纳和发展了这一方法，当时他们已经意识到自己研究的动物不断地在粪便、唾液、血液、鳞片和脱落的组织中遗留下DNA。收集这些材料并对其测序提供了有价值的信息，而无需与动物本身互动。这种方法在早期尤其受到研究淡水系统的研究人员的青睐。只需简单地把一根试管浸到溪流中，他们就可以查明目标物种是否存在，甚至数

量多少。

在开始测序前，研究人员可以使用名为聚合酶链反应的方法（PCR，在新冠病毒检测中也用到这种方法）来扩增痕量DNA，所以eDNA调研可以检测到调研场所中数量很少的物种。这就提供了一种有用的工具来追踪稀有物种，或在入侵物种对渔业造成严重破坏前就发现它们。其他研究已经在寻找证据去证明从养鱼场逃脱的鱼正与野生种群交配，可能会逐渐削弱野生鱼类。

根据野生动物粪便中的DNA就可以绘制出其食物链，而无需捕杀动物来查看它们肚肠里有什么。杀死大型或稀有物种，比如鲸鱼，即使是出于保护的目的，也会带来伦理和实践上的挑战。但鲸鱼的粪便有一个巨大的优点就是能漂浮。在训练有素的狗的帮助下——它们可以嗅出一系列濒危物种粪便的标志性气味——人们就更容易找到汪洋大海中漂浮的这些鲸鱼粪便了。分析打捞到的粪便中的DNA可以确定鲸鱼吃了什么，或者肠道中有什么细菌。

在陆地上，研究人员可以用粪便、尿液或头发中的eDNA来观察种群间的互动。马来西亚一个进行中的项目关注在森林砍伐导致马来亚虎的栖息地支离破碎后，它们的亚种群是否仍存在联系。在英国，eDNA被用于监测一种受保护的蝾螈。其他项目已开始表明，有时雪地脚印中遗留的细胞带有足够多的DNA来识别物种，可能还能识别性别。

几个团体正试图从足迹DNA中识别属于同一种群的所有个体，这将带来种群监测的革命，帮助追踪在广阔地区漫游的动物而不需要用到无线电标签，也可帮助制定可持续的狩猎配额。美国林务局的研究人员正在对狼做这种尝试。

所谓的“宏基因组学”研究使用eDNA来绘制如珊瑚礁这样的一整个群落的基因构成，或存活在地壳深处、基本上未经探索的广大细菌群落——这个群落的生物量比所有动物的总和还大一个数量级。此类研究可以提供可能需要很多年实地考察才能建立的基因快照。

这个领域正在迅速发展，但也存在挑战。有时很难判断eDNA是何时留下的。在河流中某处采样的DNA可能来自上游任何地方。而物种识别环节的表现又取决于作为对照物的物种特异性遗传条形码，及参考基因组本身的质量。这触发了一系列研究项目，要么是为每个物种确定独一无二的遗传特征——例如国际生命条形码（International Barcode of Life），要么对尽可能多的物种做全基因组测序（见图表）。耗资47亿美元的地球生物基因组计划（Earth Biogenome Project）的目标是在十年内完成150万个物种的测序。除了收集和保存基因组外，此类基因数据库还可用于挖掘有关疾病易感性或潜在药物的信息。

但是，尽管自20世纪后期以来基因测序的成本已经大幅下降，对于美国、欧洲和中国以外的大多数研究人员来说它仍然昂贵得令人却步。不过，测序技术正在迅速改进。尤其是英国公司牛津纳米孔（Oxford Nanopore）开发了一种便携技术可以现场测序，而不是仅仅在实验室中测序。在这种纳米孔测序技术中，一条条DNA链被引导穿过生物膜上的纳米级小孔。DNA字母表中的四个字母在穿过这个孔时都会产生不同的电信号，从而可以实时读取序列。

牛津纳米孔公司的Min ION是一种USB供电的袖珍设备，让测序过程的每一步都能在取样现场完成。它在一小时内给出序列。这些设备相对来说不算昂贵——约1000美元起步，但需要后续充电才能给更多样本测序。它们已被用于对巴西的病毒、坦桑尼亚的两栖动物DNA以及国际空间站上的细菌测序。

这项技术还为调查和执法开辟了新的可能性。实地基因测序可用于识别非法捕获的野味和鱼类或走私象牙的特征和源头。今年3月发表在《国际法医学：遗传学》（Forensic Science International: Genetics）上的一篇论文将Min ION测得的结果与在野生动物法医学中使用的标准测序法做比对。它发现结果具有可比性，这可能为在野生动物犯罪起诉中采用手持设备铺平了道路。 ■



The other environmental emergency

Loss of biodiversity poses as great a risk to humanity as climate change

Technology has a growing role to play in monitoring, modelling and protecting ecosystems, writes Catherine Brahic

HUMAN SOCIETIES depend on healthy ecosystems. People consume their products in the shape of fish, meat, crops, timber and fibres such as cotton and silk. Medicines may be directly harvested from the natural world or inspired by molecules and mechanisms found within it. The ecosystems that crops depend upon are regulated by living things. Through photosynthesis, trees and other plants take in carbon and pump out oxygen. In doing so they remove roughly 11bn tonnes of carbon dioxide from the atmosphere each year, equivalent to 27% of what human industry and agriculture emits (the oceans absorb a further 10bn tonnes).

The services that ecosystems provide to humanity depend, in turn, on there being a diversity of living things. More than 75% of global food-crop types, including coffee, cocoa and almonds, are pollinated by animals. The complex web underpinning every food chain and ecosystem means that the narrow range of species that humans eat and exploit cannot be sustained without the existence of a much greater diversity of animals, plants and bacteria.

More diverse forests store more carbon than monocultures. Skipjack tuna makes up roughly half of the global tuna catch for human consumption. As young animals, they eat zooplankton, which is to say very small floating animals like tunicates, ctenophores and small crustaceans as well as the larvae of larger animals. As adults, they eat smaller fish, squid and crustaceans. To conserve the skipjack, all this diversity in its food chain must also be conserved.

Since the 1990s, alarmed by studies showing rapid declines in animal and plant species around the globe, ecologists have talked of an impending mass extinction. It would be the sixth in the Earth's history, but one unlike any that has come before. Surveys show that the loss of biodiversity is the result of a combination of factors: climate change, pollution, human exploitation of land, sea, plants and animals, and the displacement of some species into new territories where they play havoc with existing ecosystems. Uniquely in Earth's history, each of these drivers of ecological change is caused by a single species: *Homo sapiens*.

When IPBES (the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, similar to the Intergovernmental Panel on Climate Change) published its assessment of the state of global biodiversity in 2019, it offered a sobering picture. Roughly 1m animal and plant species were deemed to be at risk of extinction, more than at any other point in human history. These included many that are used in farming. At least 9% of the 6,200 breeds of domesticated mammals that humans eat, or use to produce food, had become extinct by 2016, and at least 1,000 more are threatened. More than one-third of continental land area and nearly three-quarters of freshwater resources are used to produce crops or livestock, but environmental degradation has damaged the land's ability to support these activities. And one-third of marine fish stocks were being unsustainably exploited in 2015.

The biodiversity crisis poses as great a risk to human societies as climate change. Yet it has a fraction of the public profile. In part that is because the loss of biodiversity cannot be neatly quantified, as climate change can, into parts per million of carbon dioxide, or degrees above pre-industrial average temperatures. And the webs that link species within and across ecosystems are even more complex than the processes that drive climate change.

Understanding a problem, however, is a necessary step towards solving it.

And that is where technology can help. This Technology Quarterly will consider its role in monitoring, preserving and restoring ecosystems and species. Only by measuring the state of ecosystems can their health be assessed, losses be quantified, and the effectiveness of interventions be evaluated.

As well as monitoring biodiversity, technology can also be deployed to protect it. And in some cases it may even be able to reverse losses, by bringing extinct species back from the dead. Ironically, it is humanity's use of technology, whether in simple forms such as chainsaws or dragnets, or more complex ones such as modern agriculture and transportation, that is chiefly responsible for biodiversity loss. The challenge now is to deploy it so that it is not just part of the problem, but part of the solution. ■



另一个环境紧急状况

生物多样性丧失和气候变化一样危险

本专题作者凯瑟琳·布拉伊克认为，技术将在监测、模拟和保护生态系统方面发挥日益重要的作用【专题报道《保护生态多样性》系列之一】

人类社会依赖健康的生态系统。人们消费这些系统的产物，比如鱼、肉、农作物、木材和纤维（比如棉和丝绸）。药物可以直接从自然界获得，也可以受在自然界中发现的分子和机制启发而来。农作物依赖的生态系统受生物的调节。通过光合作用，树木和其他植物吸收二氧化碳并释放氧气。以这种方式，它们每年从大气中移除约110亿吨二氧化碳，相当于人类工业和农业排放量的27%（海洋吸收了另外100亿吨）。

生态系统为人类提供的服务又依赖生物多样性。全球超过75%的粮食作物种类，包括咖啡、可可和杏仁，都由动物授粉。虽然人类食用和利用的物种范围很窄，但由于每条食物链和每个生态系统都靠复杂网络支撑，假如没有种类多得多的动物、植物和细菌存在，这些物种就无法维续。

更多样化的森林能比单树种森林储存更多的碳。鲣鱼约占到了全球供人类消费的金枪鱼捕捞量的一半。它们在年幼时吃浮游动物，也就是像被囊动物、栉水母和小型甲壳动物等非常小的漂浮动物，还有更大些的动物的幼体。成年后，它们吃较小的鱼、鱿鱼和甲壳动物。为保护鲣鱼，就必须保护它的食物链中的全部多样性。

自1990年代以来，显示全球动植物物种迅速减少的研究让生态学家们警觉起来，他们谈论即将发生的大规模灭绝。这将是地球历史上的第六次，但不同于以往任何一次。调查表明，生物多样性的丧失是多种因素共同作用的结果：气候变化、污染、人类对陆地、海洋、植物和动物的开发利用，以及某些物种迁移到新地域而对那里现有的生态系统造成严重破坏。在地球上前所未见的是，这些驱动生态变化的因素中的每一个都是由单个物种——智人——造成的。

类似于政府间气候变化专门委员会（IPCC）的组织“生物多样性和生态系统服务政府间科学政策平台”（IPBES）在2019年发布了它对全球生物多样性现状的评估，描绘了一幅发人深省的图景。大约有100万种动植物物种被认为有灭绝的危险，比人类历史上任何时候都多。其中包括许多用于农业的物种。人类食用或用于生产食物的6200种驯养哺乳动物中，到2016年至少有9%已经灭绝，另外还有至少1000种有灭绝的危险。超过三分之一的大陆土地面积和近四分之三的淡水资源被用于生产农作物或饲养牲畜，但环境退化损害了土地支持这些活动的能力。而在2015年，三分之一的海洋鱼类资源正遭到不可持续的开发。

生物多样性危机对人类社会构成的风险和气候变化一样大。但相比之下它引发的公众关注却极少。原因之一是生物多样性的丧失没法像气候变化那样被精确地量化——气候变化可以量化为多少PPM（百万分率）的二氧化碳或高于工业化前平均温度几度。而在生态系统内部和之间连接物种的网络甚至比推动气候变化的过程还要复杂。

然而，理解问题是迈向解决问题的必要一步。而这是技术可以提供帮助的地方。本期技术季刊将审视技术在监测、保护和恢复生态系统和物种方面扮演的角色。只有通过测量生态系统的状态，才能评估其健康状况，量化其损伤，考察干预措施的效力。

除了监测生物多样性，还可以部署技术来保护这种多样性。而在某些情况下，它甚至有可能让灭绝的物种起死回生来逆转损失。不无讽刺的是，人类对技术的运用——无论是以链锯或拖网这样简单的形式，还是现代农业和运输等更复杂的形式——正是导致生物多样性丧失的罪魁祸首。眼下的挑战是部署技术，使它不仅仅构成问题，更构成解决方案。■



Pest control

Genetic engineering may help control disease-carrying mosquitoes

It produces fit and healthy eunuchs

EVERY YEAR, hundreds of millions of people catch mosquito-borne diseases like malaria and dengue fever. Hundreds of thousands die. Drug treatments are imperfect. And, despite decades of effort, vaccines have, for many of these diseases, proved tricky to develop.

Better, then, to stop those infections happening in the first place, by exterminating—or at least suppressing—the mosquitoes that carry the diseases. In a paper just published in the Proceedings of the National Academy of Sciences, a team of researchers led by Craig Montell, of the University of California, Santa Barbara, describe how CRISPR-Cas9, a new and powerful genetic-engineering process, could help to do just that.

Dr Montell and his colleagues used CRISPR to boost an existing control method called the sterile insect technique (SIT). This involves releasing lots of sterilised males into the wild. Females that mate with these males produce no offspring. Repeated releases can reduce populations dramatically. SIT has been used in North America to eliminate screwworm flies, an agricultural pest, and to suppress several species of crop-munching fruit flies.

It has been tried on mosquitoes, too, but with less success. One reason seems to be side-effects of the procedure. To sterilise them, males are zapped with radiation or exposed to toxic chemicals. This works, but it damages them in other ways, too. The result can be sickly individuals that struggle to compete in the mating game with their wild counterparts.

Dr Montell and his colleagues hoped that CRISPR might offer an alternative.

Their first step was to look for genes which, when disabled, would render male mosquitoes infertile. They began their hunt in fruit flies, a stalwart of genetic research. They focused on a gene that, when removed, made male fruit flies sterile—and which was present in a similar form in their target mosquito species, *Aedes aegypti*, which is the vector of, among other illnesses, yellow fever, dengue and Zika virus. Disabling the equivalent gene in male *Aedes* likewise left them infertile.

Crucially, the genetic tweak involved did not appear to hinder the modified mosquitoes in any other way. On every measure of healthiness they performed as well as their wild counterparts. And even though they were firing blanks, they were still able to mate with females in the laboratory.

Although the details are not fully understood, says Dr Montell, once female mosquitoes have mated a few times, they become less receptive to doing so again. Mating with an infertile male is therefore not only fruitless in itself, but should also leave a female less interested in unmodified males in future. Sure enough, a series of experiments conducted in cages suggested that releasing between five and six genetically modified males for each wild male was enough to cut the number of reproducing females by half. Upping that ratio to 15:1 dropped it by 80%.

There is more work to do before field trials, says Dr Montell. But having established the principle, he is excited to see where the work might lead. That the target gene is found in both fruit flies and *Aedes* suggests it is likely to exist in other disease-carrying mosquitoes, too. And that the engineered males leave no offspring means fewer worries about any unintended consequences which might arise from releasing millions of genetically modified organisms into the environment.

More speculatively, the team is pondering whether it might be possible to create males which can outplay their un-engineered cousins at the mating

game, despite being infertile. Improving on millions of years of evolution would usually be hard. Even if researchers could find an alteration that improved a male's attractiveness, it would probably reduce the animal's overall fitness. Such a genetic tweak would ordinarily be winnowed out by natural selection over subsequent generations. But because each generation of males is created anew in a laboratory, says Dr Montell, there is no long run to worry about. If the team can find the right mutation, such genetically engineered hommes fatales could give mosquito-suppression efforts an even bigger boost. ■



害虫防治

基因工程可能有助于控制携带疾病的蚊子

它能生成健壮但无生殖能力的蚊子

每年有数以亿计的人感染疟疾和登革热等蚊媒疾病。成千上万人死去。药物治疗并不完美。而且，尽管付出了几十年的努力，许多此类疾病的疫苗研发还是困难重重。

所以最好是在一开始就不让这类感染有机会发生，方法是消灭携带这些疾病的蚊子，或者至少抑制其繁殖。在近日发表在《美国国家科学院院刊》上的一篇论文中，加州大学圣巴巴拉分校的克雷格·蒙特尔（Craig Montell）领导的一个研究小组描述了CRISPR-Cas9这种强大的新型基因工程技术如何有望帮助实现这一目标。

蒙特尔和他的同事们用CRISPR技术加强了一种已有的防治方法——不育昆虫技术（SIT）。这一方法是将大量绝育的雄虫放归野外。与这些雄虫交配的雌虫无法繁殖后代。如此反复放归就会大大减少种群数量。在北美，SIT已被用于消灭农业害虫螺旋蝇，也用于抑制几种吃农作物的果蝇。

这种方法也曾在蚊子身上试验过，但效果不太好。原因之一似乎是它的副作用。要使雄蚊绝育，得让它们受到辐射或暴露在有毒化学物质中。这的确能够实现绝育，但也会对它们造成其他损害。结果可能让它们变成了病怏怏的个体，在交配竞赛中敌不过野生雄蚊。

蒙特尔和同事希望CRISPR技术能够提供另一种绝育选择。他们的第一步工作是寻找那些在失效后会导致雄蚊不育的基因。他们开始在基因研究的“老朋友”果蝇身上寻找这样的基因。他们重点研究了一种基因，去除它会让雄性果蝇不育，在他们的目标埃及伊蚊（*Aedes aegypti*）身上也存在类似形式的基因。埃及伊蚊是黄热病、登革热和寨卡病毒等疾病的传播媒介。让雄性伊蚊身上相应的基因失效同样会让它们不育。

至关重要的是，这番基因微调看来没有影响到被改造的蚊子的其他方面。它们在每一项健康指标上的表现都和野生同类一样好。即使丧失了繁殖能力，它们在实验室中仍然能够与雌蚊交配。

蒙特尔说，虽然还不完全清楚细节，但雌蚊在交配过几次之后会变得不大愿意再交配。因此，与不育的雄蚊交配不仅本身不会有成果，应该还会减少雌蚊之后对野生雄蚊的兴趣。果不其然，在蚊笼里进行的一系列实验表明，释放五六倍于野生雄蚊数量的经基因改造雄蚊，就足以让繁殖期的雌蚊数量减少一半。将这一比例提高到15倍后，繁殖期雌蚊的数量下降了80%。

蒙特尔说，在开展实地试验之前还要做更多工作。但既然已确定了原理，他对于这项工作有可能带来的前景感到很兴奋。在果蝇和伊蚊身上都发现了目标基因，这表明它可能也存在于其他携带疾病的蚊子身上。而鉴于这样经基因改造的雄性不会留下任何后代，也就无需太过担心将数百万经基因改造的生物释放到环境中可能产生的意外后果。

研究小组有一个更大胆的构想：是否可能创造出尽管不能生育、但却能在交配竞赛中压过它们未经基因工程改造的近亲的雄性。要对历经数百万年的进化成果做改进往往很困难。即使研究人员能够找到某种可以提高雄性吸引力的改动，也可能会降低动物的整体健康状况。这样的基因微调通常会在后代的自然选择中被淘汰掉。但是蒙特尔说，因为每一代雄性都是在实验室里新创造出来的，所以不用担心任何长期效应。如果研究小组能找到正确的突变基因，这种经基因改造的“致命美男”可能会为防蚊灭蚊工作再添马力。 ■



Free exchange

Is the pandemic accelerating automation? Don't be so sure

The pessimists could, of course, eventually be proven right

AS ECONOMIES REOPEN, labour shortages are still worsening. In America the number of unfilled vacancies, at 9.3m, has never been so high. Job postings in Canada are 20% above pre-pandemic levels. Even in Europe, slower out of the post-lockdown gates, a growing number of employers complain of how hard it is to find staff. Debates over labour shortages have focused on welfare policy and economic disruption. But the phenomenon has a deeper lesson. It tells us something about the myths of automation.

Economists have confidently asserted that a wave of job-killing robots was sweeping the labour market. The IMF says the pandemic is “hastening a shift in employment away from sectors more vulnerable to automation”. In a recent co-written article Joseph Stiglitz, a Nobel prizewinner, says the extra costs of covid-19 are “accelerating the development and adoption of new technologies to automate human work.” In congressional testimony last year Daron Acemoglu of the Massachusetts Institute of Technology suggested that more firms were “substituting machines for workers”. But can pandemic-induced automation really be creating an army of surplus workers if employers are complaining of a deficit?

The economists had good reason to believe that job-killing automation would surge. Recessions often lead firms to adopt more robots, in part because labour gets more expensive as revenues but not wages decline. In a pandemic bosses have an extra incentive to automate jobs, as research by the IMF has shown. Robots do not need to socially distance. Nor do they get sick. Thanks largely to government stimulus programmes, firms have also accumulated spare cash, which they may now be able to deploy on robotics

or on artificial-intelligence software.

Those who believe that automation is speeding up can point to many examples. In Ohio Lee's Famous Recipe Chicken, a restaurant chain, has installed automated voice systems to take drive-through orders. Pittsburgh's international airport recently became America's first to use ultraviolet robots for cleaning. British farmers boast of using ever more machines to pick strawberries and kill weeds. The number of news stories mentioning both "pandemic" and "automation" is growing at an annual rate of 25%.

The automation debate is heavy on speculation and anecdote. It is light on evidence. The citation from one prominent work to justify the claim that automation was "already" happening included a New York Times article and a theoretical microeconomics paper. According to some research, last year automatable jobs vanished in large numbers; but it is hard to disentangle the effect of technological change from lockdowns. It is true that America's GDP is nearly at its pre-pandemic level even as the level of employment is 7m lower. This, some say, shows that the economy can get by with many fewer people. But it could just mean that productivity per worker has risen, perhaps because of poorly understood things like remote working. Many of those on the sidelines will get jobs as fear of the virus fades and they find something which suits them, in turn raising output above pre-pandemic levels.

It is not only labour shortages which undermine the story of a growing wave of job-killing robots. In America the wages of the worst-paid workers, who are thought to be especially vulnerable to automation, are rising more quickly than the average, in contrast to the aftermath of the financial crisis. Borrowing a methodology from the Federal Reserve Bank of St Louis, The Economist has divided America's labour market into "routine" and "non-routine" roles. Routine jobs involve patterns which are easier for robots to learn: say, data entry or checking out goods in a supermarket. For four

decades routine jobs have slowly declined as a share of the total, as robots have improved (see chart).

So far, however, the covid-induced downturn is bucking the trend. Had the pre-pandemic rate continued, we estimate that in May 2021 routine jobs would have accounted for 40.9% of overall employment. In fact they now account for 41.4%, meaning that America now has in the order of 1m “extra” routine jobs than expected. Perhaps the uncertainty over variants is deferring some investment in robotics. The mere act of installing new machinery is also more difficult in a world of travel bans and quarantine. American imports of industrial robots fell by 3% in 2020.

Australia may be a better place to look for signs of a job-killing wave. After some strict lockdowns the country has been under fairly loose domestic restrictions for over a year, giving a glimpse of what may lie in store elsewhere. Adapting the results of a government study in 2015, we gave 335 occupations (from “hotel and motel managers” to “complementary health therapists”) a score from zero to 100, reflecting how automatable they seem.

Automatable jobs were in relative decline before the pandemic, falling to 57% of the workforce by 2019. The trend has continued, with evidence of a covid-19 acceleration: 55% of Australians are now employed in vulnerable occupations. (We found similar trends in New Zealand.) Yet Australia’s unemployment rate is nearly as low as before the pandemic. Howls from employers about labour shortages are even louder than in America. Automation is not, it seems, putting people on the economic scrapheap.

The pessimists could eventually be proved right. But even if they are not, predictions of a world without work will continue. This is because the enduring fear of the march of the machines is not really the result of a dispassionate analysis of the evidence. It could hardly be so, when centuries of technological improvement have never led to widespread structural

unemployment. Countries with more robots tend to have less joblessness, not more.

Worries about technological unemployment are instead the expression of something else. They reflect a deep-seated fascination with and fear of technology. And they reflect many economists' concern to get policymakers to pay more attention to the job prospects of people with the least marketable skills, who are always most vulnerable to economic shifts and shocks. These are perfectly understandable motivations. But next time you hear a warning about job-killing robots, think twice. ■



自由交流

疫情加速自动化？别那么肯定

当然了，悲观主义者最终可能是对的

随着各经济体重启，劳工短缺的问题仍在加剧。美国的职位空缺数量达到930万，创历史新高。加拿大的这一数字比疫情前水平高出20%。即使在重启较慢的欧洲，也有越来越多雇主抱怨招聘难。对劳动力短缺的讨论一直围绕福利政策和经济动荡展开。但这一现象包含着一个更深层次的启示，反映出一些关于自动化的迷思。

经济学家们曾很有把握地断言，一股消灭就业机会的机器人热潮正席卷劳动力市场。国际货币基金组织称，新冠疫情“正在加速职位从较易受自动化影响的行业转移”。诺贝尔经济学奖得主约瑟夫·斯蒂格利茨（Joseph Stiglitz）在近期一篇合著文章中表示，新冠疫情带来的额外成本正“促使人们加速开发和采用新技术以将人的工作自动化”。麻省理工学院的达隆·阿西莫格鲁（Daron Acemoglu）去年在国会听证会上指出，越来越多的公司“在用机器取代工人”。但是，如果雇主都在抱怨请不到人，那疫情引发的自动化浪潮真的产生了大批过剩劳动力吗？

经济学家确实有充分理由相信消灭职位的自动化浪潮将汹涌而来。经济衰退往往导致企业使用更多机器人，一个原因是如果公司收入下降但工资不降，劳动力成本就变得更高。国际货币基金组织的研究表明，在大流行病中，企业老板们还有一个额外的动力来推进自动化。机器人不需要保持社交距离，也不会生病。而由于政府的经济刺激计划让企业也有了一些闲钱，或许它们现在可以拿这些钱来购置机器人或人工智能软件。

相信自动化正在加速的人可以举出许多例证。俄亥俄州的连锁餐厅“李氏秘制鸡”（Lee's Famous Recipe Chicken）在自己的“免下车”取餐窗口安装了自动语音系统。匹兹堡国际机场最近成为美国首个采用紫外线机器人清洁工的机场。英国农民自豪地表示自己正在使用越来越多机器采摘草莓和

除草。同时包含“疫情”和“自动化”两大关键词的新闻报道数量一年增长了25%。

有关自动化的这场争论充满了猜测和道听途说，却没多少实证。一位知名学者为证明自动化“已然”发生，引用了《纽约时报》的一篇文章和一篇理论性的微观经济学论文。一些研究显示可被自动化的职位在去年大量消失，但这是因技术变革还是封城措施所致还很难分辨。诚然，美国的GDP已恢复至接近疫情前水平，而与此同时就业数字仍比之前低700万。有人认为这表明即便劳动力大量减少，经济也仍能正常运作。然而，这可能只是因为劳动者的平均生产率提高了，也许是因为一些尚未被充分了解的因素，比如远程工作。随着对病毒的恐惧消退，许多目前未就业的人会找到适合自己的工作，继而推动产出超越疫情前水平。

机器人兴起消灭就业的说法显得牵强，不单单是因为企业招不到人。在美国，收入最低的那些工人被认为最容易被自动化取代，但他们目前工资上升的速度快过平均水平，与金融危机后的情况相反。本刊借用圣路易斯联储的方法，把美国劳动力市场的工作分为“例行”和“非例行”两种。例行工作具有机器人更容易学会的模式，例如数据输入或超市结账。40年来，随着机器人的改进，例行工作在总体就业中的占比逐渐下降（见图表）。

然而到目前为止，疫情引发的这轮衰退却是逆势而行。假如保持疫情前的走势，我们估计到今年5月例行工作会占总体就业的40.9%。而实际上这个数字是41.4%，这意味着美国目前比预期多了约100万个“额外”例行职位。也许新冠病毒变异的不确定性让人们推迟了对机器人技术的某些投资。面对种种旅行禁令和隔离检疫措施，光是安装新机器也阻碍重重。美国的工业机器人进口量在2020年下降了3%。

要寻找机器消灭就业的信号，澳大利亚可能是个更好的地方。在早先实施了一些严苛的封城措施后，澳大利亚改为相当宽松的国内限制已有一年多，让人得以一瞥其他国家以后可能出现的景象。基于2015年一项政府研究的结果，我们给335种职业（包括“酒店及汽车旅馆经理”以至“辅助保健治疗师”）打分，最低0分，最高100分，来表示它们显现出的被自动化取

代的可能性。

疫情前，可被自动化的岗位相对呈减少趋势，到2019年降至占岗位总数的57%。疫情发生后这个趋势继续，而且有证据显示它因疫情加速。目前有55%的澳大利亚人从事容易被自动化取代的工作。（我们在新西兰也发现了类似的趋势。）然而，澳大利亚的失业率几乎和疫情前一样低。雇主们对劳动力短缺的怨声甚至比美国还要大。这样看来，自动化并没有把人们丢进经济垃圾堆。

悲观主义者最终可能是对的。但即便他们错了，对人类失去工作的预言仍将不绝于耳。这是因为人们对于机器进军就业市场的长久恐惧并非源自基于证据的冷静分析。情况不太可能如此，毕竟几个世纪的技术进步从未导致广泛的结构性失业。拥有更多机器人的国家失业率往往更低而非更高。

对技术性失业的担忧实则是另一些情绪的表现。它们反映出人们对技术根深蒂固的迷恋和恐惧。它们也反映出许多经济学家希望政策制定者能多关注一个群体的就业前景——这些人最缺乏可供在市场上推销自己的技能，总是最容易受到经济转型和危机的影响。这些动机完全可以理解。不过，下次你再听到机器人消灭工作的警告时，再多想想。■



Car trouble

The rise and fall of Carlos Ghosn

A new book explains the spectacular implosion of his relationship with Nissan

Collision Course. By Hans Greimel and William Sposato. Harvard Business Review Press; 256 pages; \$30 and £22

THE MAIN events of the scandal that brought down Carlos Ghosn, whose restless energy made other globetrotting bosses look work-shy, are appropriately book-ended by flights on corporate jets. The drama began with grainy television footage of Japanese prosecutors boarding the plane that delivered an unwitting Mr Ghosn to his arrest in Tokyo in November 2018. It culminated in his skipping bail on several charges of financial impropriety around a year later. Stripped of his leadership of a giant conglomerate, he was smuggled out of Japan on another private jet, this time hidden in a box.

Because of that clandestine escape, “Collision Course” by Hans Greimel and William Sposato, two Tokyo-based journalists, at times reads like a spy thriller. But their main aim and achievement is to give the clearest account yet of the deep-rooted causes of Mr Ghosn’s predicament. Underpinning the entire tale—and Mr Ghosn’s status as a corporate superstar—was Renault’s rescue in 1999 of near-bankrupt Nissan, an alliance, later joined by Mitsubishi, which he built into the world’s biggest carmaker.

The terms of Nissan’s bail-out gave Renault, in which the French government has a large shareholding, control of the Japanese firm, but Nissan got no say over Renault in return. The alliance stopped short of a full merger, which, in the car industry, had usually ended in disaster. This arrangement led to seething resentment at Nissan, which gradually became

the bigger company and the main source of profits. Mr Ghosn kept a lid on the tensions between the two carmakers—their engineers rarely agreed on anything—through the force of his personality.

But they boiled over as Mr Ghosn sought, at the French government's behest, to make the alliance “irreversible”. Nissan read this as code for a full merger that would cement Gallic dominance. This, claims Mr Ghosn, led some in Nissan to manufacture charges in order to get rid of him. Nissan's version is that he was a greedy tyrant who regarded the Japanese firm as a personal bank account. This claim gained more credence when French prosecutors also began an investigation of Mr Ghosn, including into the funding of a lavish party thrown for his wife's birthday at the palace of Versailles—a far cry from his Japanese prison cell, where a bowl of rice gruel counted as luxury.

The authors point to a clash of corporate cultures as the reason he may have sought to circumvent pay disclosure using a deferred-pay scheme, which Nissan claimed broke the law. In Japan and France CEOs are paid far less than equivalent American bosses; doubtless he thought his skills should be properly rewarded by global standards. The competing narratives were never aired in court, though, after Japan's criminal-justice system—which relies on prolonged incarceration and intense interrogation to obtain a confession—collided with Mr Ghosn's stubborn refusal to admit any wrongdoing. Eventually released on bail, he fled in the belief that he would not receive a fair trial and would remain under house arrest for years.

Some readers may be dismayed by the authors' reluctance to speculate on the verdict should the trial have gone ahead (they conclude that, given the “arcane” accusations of financial irregularities, a “ruling is likely to be just as abstruse”). But the end result is that Mr Ghosn remains trapped, these days in Lebanon, where he is safe from the international arrest warrants that might be executed should he board any more corporate jets. Meanwhile the

alliance he created, languishing without its leader, may yet break apart. ■



汽车故障

卡洛斯·戈恩的大起大落

一本新书解释了他与日产的惊天大决裂【《迎头相撞》书评】

《迎头相撞》。汉斯·格雷梅尔和威廉·斯波萨托著。哈佛商业评论出版社；256页；30美元/22英镑

跟卡洛斯·戈恩（Carlos Ghosn）闲不住的劲头比，其他满世界飞的老板都是懒人。他因丑闻倒台，而其中主要事件的起止恰好都发生在公务机上。这场大戏始于一段模糊的电视画面：2018年11月在东京，日本检方登上飞机，逮捕了一脸茫然的戈恩。大约一年后，面对几项金融不当行为指控的他弃保潜逃，这出戏达到了高潮。他被剥夺了一家巨型企业集团的领导权，被用另一架私人飞机偷送出日本，这次是躲在一个箱子里。

由于那次秘密逃亡，汉斯·格雷梅尔（Hans Greimel）和威廉·斯波萨托（William Sposato）这两位驻东京记者的《迎头相撞》（Collision Course）有时读起来就像一部惊悚间谍小说。但他们的主要目标是对戈恩陷入如此困境的深层原因给出迄今为止最清晰的解释。他们做到了。为整个故事——以及戈恩的企业界超级明星地位——奠定基础的是雷诺在1999年对濒临破产的日出手相救。后来三菱也加入了进来，戈恩将这个联盟打造成为世界最大的汽车制造商。

对日产的纾困条款让雷诺（法国政府持有其大量股份）得到了这家日本公司的控制权，但反过来日产在雷诺的问题上没有发言权。这个联盟倒还没有达到全面合并的地步，在汽车行业里全面合并通常都以灾难告终。这种安排导致日产极度不满，而它已逐渐成为两家公司中更大的那家和主要的利润来源。戈恩凭借自己的强势个性压制住两家汽车制造商之间的紧张关系——两家的工程师很少能就什么事达成一致。

但是，当戈恩在法国政府的授意下寻求让联盟“不可逆转”时，这种紧张关系爆发了。日产将戈恩的意图解读为全面合并的信号，而这会加强法国人

的主导地位。戈恩声称这促使日产的一些人为了踢走他而捏造罪名。而日产的说法是戈恩是个贪婪的暴君，把日产当成了个人银行账户。当法国检方也开始调查戈恩时，日产的这个说法变得更加可信了。调查的内容包括为庆祝戈恩妻子的生日而在凡尔赛宫举办的一场奢华派对的资金来源——当时的盛景与戈恩在日本牢房的光景相比是天差地别，在那里，一碗稀饭都算得上奢侈品了。

戈恩可能试图利用延期支付方案来规避薪酬披露，日产称这违反了法律。两位作者指出，戈恩此举背后的原因是企业文化冲突。在日本和法国，首席执行官的工资远低于同等级别的美国老板；他无疑认为自己的本领理应获得符合全球标准的恰当回报。然而，当日本的刑事司法系统（靠长期监禁和高强度的审讯来获得供词）撞上拒不认罪的戈恩，这些对立的说法始终没有在法庭上碰一碰。他最终被保释，但认为自己不会得到公正的审判，还会被软禁多年，于是出逃。

两位作者不愿推测如果当时审讯正常推进的话会做出怎样的裁决，部分读者对此可能会感到失望（作者们得出结论称，鉴于戈恩受到的财务违规指控如此“难懂”，“判决很可能同样玄奥”）。但最终的结果是戈恩目前仍被困在黎巴嫩，在那里国际逮捕令不能对他做什么，但如果他再登上公务班机的话，逮捕令可能就会执行。与此同时，他创建的联盟在没有领袖的情况下日渐松垮，有分裂的可能。 ■



Sensors and sensibility

All kinds of new technology are being used to monitor the natural world

Smartphone components have made sensors cheaper, and machine learning can help analyse the resulting data

THE NEW FOREST CICADA had not been seen in seven years when it caught the attention of Alex Rogers, an ecologist and computer scientist at the University of Oxford. The insect is the only cicada native to the British Isles. It spends 7-8 years underground as a nymph, then emerges, reproduces and dies within six weeks. During its short adult life, it produces a high-pitched hiss that would make it easier to detect, were it not at the upper limit of human hearing. Its call is audible to children but not to most adults. It can, however, be picked up by smartphone microphones. This led to the invention of AudioMoth, an “acoustic logger” that can be set to listen for a particular sound and record it.

The device takes its name from the fact that moths can hear sounds across a wide frequency spectrum. It is roughly 60mm square and 15mm thick and includes a smartphone microphone, a memory card and a basic processing chip, powered by three AA batteries. Dr Rogers’s startup, Open Acoustic Devices, sells them for \$60 through a group-purchasing scheme which helps keep costs low. At that price, “you can deploy many more devices, you can post them out to people and if they get lost or stolen, it doesn’t really matter,” says Dr Rogers. To date, some 30,000 AudioMoths have been scattered around the globe. A smaller version has just been launched and is being incorporated into an experiment to study how African carnivores are responding to warmer temperatures by monitoring the sounds they make, such as panting.

The AudioMoth is just one example of the explosion in the use of sensors to

monitor ecosystems that has occurred in the past decade. Such devices are peppered across forests and national parks, attached to trees or the backs of animals. As well as recording environmental data, such as temperature or humidity, they also monitor the nature, number and movement of living things.

Motion-activated camera traps have captured images of the shyest snow leopards. Microphones monitor bat colonies, known to harbour diseases that can jump to humans, and coral reefs, whose crackling sounds are thought to broadcast their location to nearby fish. Radio tags attached to animals capture data about their behaviour as they go about their daily lives. The Icarus project has around 5,000 lightweight tags, weighing just five grams each, attached to animals on all continents. The sensors track the animals' movements to within a few metres, along with the local temperature, pressure and humidity—all of which is relayed back to researchers via an antenna on the International Space Station.

Technologies borrowed from the smartphone industry, including batteries, cameras, microphones and chips, have helped make such sensors smaller, cheaper and more capable. Before the Icarus project developed its five-gram sensors, most radio tags weighed 15-20g. A future version will reduce the weight to just one gram, allowing the tags to be attached to even smaller creatures. Smartphone technology has also reduced the cost and size of camera traps. TrailGuard, a device developed by Resolve, an American environmental group, houses a tiny camera in a package the size of a Sharpie pen, which is hard to spot once it has been hung in a tree.

Another hot technology, machine learning, has revolutionised the task of scanning through the resulting sound recordings, images and other readings, many of which are false alarms. Working with researchers in artificial intelligence, conservationists can rely on algorithms to do the

recognising for them. Big tech firms, including Google and Microsoft, are also getting involved. Wildlife Insights, a collaboration of seven large conservation organisations, with support from Google, is trying to create a single space where all camera traps will log their data (its database currently counts 16,652 camera-trap projects in 44 countries). Its machine-learning models can filter out the blank images that make up the majority of camera-trap pictures and identify hundreds of species in the remaining ones. Wild Me, an NGO based in Oregon, has algorithms for 53 species, capable of distinguishing between individual animals based on their stripes, spots or wrinkles.

As sensors get smarter, they are increasingly able to process data themselves—at the network edge, rather than centrally in the cloud—which reduces the need to transmit or store data unnecessarily. If sensors are networked, they can also raise the alarm right away if they spot something important. TrailGuard is different from most camera traps in that it is built to identify poachers, rather than wildlife. During its demonstration phase, it was installed in one of Africa’s largest wildlife parks, and detected two humans as they entered the area. Within a minute, images had been sent to the park’s headquarters, where staff confirmed that they showed two poachers, who were later arrested. Relaying data back to researchers can be tricky, however, as wildlife surveys are often carried out in remote areas with little or no mobile-network coverage. Sending data via satellite works well, but is expensive—though prices may fall as new constellations in low-Earth orbit become available.

Putting devices on the ground, or attached to animals, is not the only way to monitor ecosystems. It can also be done from the air or from space. Regional, and even global, snapshots can be generated using instruments mounted on planes or by scanning the Earth using satellites. The dozens of Earth-observation instruments orbiting the planet can collect information about land use, detect blooms in oceanic plankton, monitor emissions from

forest fires, and track oil spills or the break-up of polar ice sheets. Remote sensing has long been used by environmental groups keen to monitor deforestation rates in remote regions.

But satellite imagery can be flawed. Viewed from above, some tropical tree plantations can look like native forest. And although spotting large areas that have been clear-cut is simple, identifying regions where selective logging, clearing of underbrush or overhunting of seed-dispersing animals is degrading the integrity of a forest is much more difficult. A study published in *Nature* in 2020 found that only 40% of remaining forests have high integrity; the remaining 60% have been degraded in some way. In 2019, an international team of ecologists and forestry experts showed that taking into account the degradation of seemingly intact forests increased estimates of forestry emissions six-fold, compared with just looking at emissions caused by clear-cutting. This research relied on a combination of remote-sensing data with numerical modelling and on-the-ground fieldwork.

New tools to assess forests' health are becoming available, the most important of which is LIDAR—a technique which is similar to radar except that it employs infrared laser light instead of radio waves, and can map out spaces in high resolution and in three dimensions. Pointed at a tree, it can generate a 3D model of its entire structure, including the position of every branch to within a millimetre. Such data can be used to estimate the volume and mass of a tree, or an area of forest, and hence its carbon content.

The Global Airborne Observatory takes this kind of 3D modelling one step further. The brainchild of Greg Asner of Arizona State University, it combines LIDAR with spectrometers and cameras mounted on a plane. Two high-powered laser beams fired out from beneath the plane sweep over the landscape, creating a detailed 3D model of everything underneath, from the treetops to the ground. At the same time, the spectrometers bounce light

of various wavelengths off the foliage. Using a reference library containing thousands of dried and frozen plant samples, the team has worked out how to identify individual plant species from the spectroscopic data and determine their moisture content. The result is a detailed picture of the landscape showing the shape, size and species of individual trees, from which the carbon content and overall health of the forest can be determined.

In May 2021, Dr Asner and his team launched a related tool focused on the oceans. Coral bleaching, caused by warmer seas, damages reefs. Thousands of associated species, from sponges to octopuses, depend on the health of their home reef. The Allen Coral Atlas uses high-resolution satellite imagery and machine learning to monitor bleaching events in real time by detecting changes in the reflectivity of reefs. A trial run, in Hawaii in 2019, identified bleaching that field surveys had missed. The hope is that by detecting it as it occurs, other causes of stress such as fishing can be reduced, giving reefs a better chance of recovery. ■



传感器和感知力

各种各样的新技术被用于监测自然界

智能手机组件使传感器变得更便宜，而机器学习可以帮助分析收集到的数据【专题报道《保护生态多样性》系列之二】

当新森林蝉吸引到牛津大学生态学家、计算机科学家亚历克斯·罗杰斯（Alex Rogers）的注意时，它已经销声匿迹七年了。这种昆虫是唯一一种原产于不列颠群岛的蝉。在若虫期它会在地下度过七八年，然后在六周内出土，繁殖，死去。在它短暂的成年期，它会发出尖锐的嘶嘶声，如果不是因为已经触及人类听力上限，它会更容易被发现。孩子们可以听到它的叫声，大多数成年人都听不到。但是，它可以被智能手机的麦克风拾取。一种名为“音蛾”（AudioMoth）的发明由此问世，这种“声学记录器”可以被设置成听取并记录特定的声音。

这种设备会有这样的名字，是因为飞蛾可以听到很宽的频率范围内的声音。它约60平方毫米大、15毫米厚，包括一个智能手机麦克风、一张存储卡和一个基本处理芯片，由三节AA电池供电。罗杰斯博士的创业公司“公开声学设备”（Open Acoustic Devices）以60美元的团购价格出售它们，这有助于降低人们的使用成本。以这个价格，“你可以部署更多设备，可以把它们寄送给人们，如果弄丢了或被偷了也没什么要紧。”罗杰斯说。迄今约有3万只音蛾散布在全球各地。一个较小的版本刚刚推出，目前正被纳入一项实验中，通过监测非洲食肉动物发出的声音（例如喘气）来研究它们对更温暖的气候做出什么反应。

“音蛾”只是过去十年中大量运用传感器监控生态系统的一个例子。这些设备遍布森林和国家公园，附着在树上或动物的背上。除了记录温度或湿度等环境数据外，它们还监测生物的特性、数量和运动。

动作激活的相机陷阱已经捕捉到了最神出鬼没的雪豹的影像。麦克风监测蝙蝠群落，众所周知它们携带着可能传染给人类的疾病。还有珊瑚礁，人们认为它们发出的咔嗒声是向附近的鱼广播自己的位置。附着在动物身上

的无线电标签会在它们日常活动的过程中捕捉行为数据。伊卡洛斯（Icarus）项目有大约5000个轻巧的标签，每个仅5克重，佩戴在各大洲的动物身上。传感器会跟踪动物的运动（精确到几米），以及本地的温度、压力和湿度。所有这些信息都通过国际空间站上的天线传回给研究人员。

从智能手机行业借来的技术，包括电池、摄像头、麦克风和芯片，已帮助这类传感器变得更小、更便宜，也更强大。在“伊卡洛斯”项目开发出其5克重的传感器之前，大多数无线电标签的重量在15到20克。未来的版本会轻至1克，这样标签就可以贴到更小的生物身上。智能手机技术也降低了相机陷阱的成本和尺寸。由美国环保组织Resolve开发的设备“踪迹警卫”（TrailGuard）在一个锐意记号笔大小的套件中藏了一个微型相机，挂到树上很难被发现。

另一项热门技术机器学习则彻底改变了筛选所获的录音、图像和其他读数这项任务，这些信息包含大量虚假警报。与人工智能研究人员合作后，生态保护主义者可以依赖算法来识别它们。包括谷歌和微软在内的大型科技公司也参与其中。“野生动物观察”（Wildlife Insights）是七个大型生态保护组织组成的联合机构，正在谷歌的支持下尝试创建一个供所有相机陷阱记录数据的单一空间（其数据库目前共包含44个国家和地区的16,652个相机陷阱项目）。它的机器学习模型可以过滤掉构成相机陷阱大部分画面的空白图像，并在剩余的图像中识别成百上千个物种。位于俄勒冈州的非政府组织Wild Me用算法识别53个动物物种，能根据条纹、斑点或皮肤褶皱来区分各个动物。

随着传感器变得越来越智能，它们自己处理数据的能力也越来越强。数据处理发生在网络边缘而不是中央云，这就减少了不必要的数据传输或存储。如果传感器都联网，它们还可以在发现重要情况时即刻发出警报。“踪迹警卫”与大多数相机陷阱的不同之处在于它识别的是偷猎者而非野生动物。它在演示阶段被安装在非洲最大的野生动物园之一里，在两个人入园时发现了他们。不到一分钟，图像就被发送到动物园总部，工作人员核

实图像展示的是两名偷猎者，他们稍后被捕。不过，要把数据传回给研究人员有时并不容易，因为野生动物考察通常在很少或没有移动网络覆盖的偏远地区进行。通过卫星发送数据的效果很好，但很贵。不过随着近地轨道上新卫星群的出现，价格可能会下跌。

在地面上安装设备或让动物佩戴它们并不是监测生态系统的唯一途径。它也可以从高空或太空中完成。使用安装在飞机上的仪器或使用卫星扫描地球可以生成区域甚至全球快照。环绕地球运行的几十个地球观测仪器可以收集有关土地使用的信息，探测海洋浮游生物大量繁殖，监测森林火灾的碳排放，追踪石油泄漏或极地冰盖破裂。遥感技术长期以来被热衷于监测偏远地区森林砍伐率的环保组织使用。

但卫星图像可能存在缺陷。从高空俯瞰，一些热带树木种植园会好像原始森林。而虽然要发现大片已被全面砍伐的区域很简单，要识别那些正因选择性伐木、清除灌木丛或传播种子的动物被过度捕猎而导致完整性降低的森林区块则要困难得多。2020年发表在《自然》杂志上的一项研究发现，地球剩余的森林中仅40%具高度完整性；其余60%已经发生某种程度的退化。2019年，一个由生态学家和林业专家组成的国际团队表明，相比于仅考虑因森林清伐造成的排放量，如果把看似完整的森林的退化也计入考量，林业排放量的估计值将增加六倍。这项研究有赖于遥感数据与数值建模及实地考察的结合。

评估森林健康的新工具正在出现，其中最重要的是激光雷达——一种类似于雷达的技术，除了它用的是红外激光而不是无线电波，并且可以以高分辨率三维绘制空间图。把它对准一棵树，可以生成再现其整个结构的三维模型，包括每根树枝的位置，精确至毫米。此类数据可用于估算一棵树或一片森林的体积和质量，从而估算其碳含量。

全球机载天文台（Global Airborne Observatory）将这种三维建模更往前推进了一步。亚利桑那州立大学的格雷格·阿斯纳（Greg Asner）构建的这个实验室将激光雷达与安装在飞机上的光谱仪和相机结合起来。从飞机下方射出的两束高功率激光束扫过整个景观，为下方从树梢到地面的所有事物

创建出细致的三维模型。与此同时，光谱仪从树叶上反射出各种波长的光。对照一个包含成千上万个干燥和冷冻植物样本的资料库，该团队已经研究出如何从光谱数据中识别单个植物物种并确定其水分含量。得到的结果是一幅详尽的景观图，显示每一棵树木的形状、大小和种类，以此判断整片森林的碳含量和总体健康状况。

5月，阿斯纳博士和他的团队推出了一个相关的针对海洋的工具。海洋水温上升导致的珊瑚白化会破坏珊瑚礁。而从海绵到章鱼的数以千计的相关物种都依赖它们的珊瑚礁家园的健康。艾伦珊瑚礁地图集项目（Allen Coral Atlas）使用高分辨率的卫星图像及机器学习，通过检测珊瑚礁反射率的变化来实时监测白化现象。2019年在夏威夷开展的一次试运行发现了被实地考察遗漏的白化现象。研发人员希望，通过在白化发生时就发现它，可以减少捕鱼等其他压力源，增加珊瑚礁复原的机会。■



The Economist Film

Covid and globalisation - trailer

Before the pandemic, globalisation was already in retreat. Now that trend looks set to accelerate.



经济学人视频

新冠与“慢球化” - 预告

早在疫情爆发前，全球化就已经出现了倒退。现在，这一趋势显然还在加速。



Vanguard of the non-working class

At 54, China's average retirement age is too low

The government's efforts to raise it face stiff opposition

AT ABOUT 54, the average age of retirement in China is among the lowest in the world. This is a problem. Since standards were set, life expectancy has soared while the number of working adults—those whose labour, in effect, supports retirees—has begun to shrink. But persuading people that they should work longer is proving hard. In 2008 the government said it was mulling the idea of raising retirement ages, but backed away amid a public outcry. Now it feels it can wait no longer.

The pressure to act is evident. Current retirement ages were set in the 1950s, when the average person was expected to die before reaching that stage. For most men in China the age is 60, much lower than the average of 64.2 in the OECD, a club mostly of rich countries. For female civil servants the age is 55; for blue-collar women it is 50.

Yet life expectancy in China is now just two years short of the OECD average of 79, so a Chinese retiree on a state pension usually needs several more years of support from government funds than his or her rich-world equivalent. In 2019 the public-pension system covered almost 1bn adults, more than any other such scheme in the world. The country's main pension fund may run out of money by 2035, the Chinese Academy of Social Sciences, an official think-tank, has warned.

The government appears not yet to have decided how to reform the system. The current five-year economic plan, a 142-page document that was approved in March, contains merely a sentence on the topic, calling for adjustment in “small steps” and “flexible implementation”. But its inclusion

means that changes are all but certain to begin before the plan expires in 2025: the government rarely announces a goal that may not be attainable.

Officials say retirement ages will be lifted in stages, a few months at a time. China's main state-run news agency, Xinhua, said two possible approaches were being considered. One would raise the retirement age for both men and women to 65, with the age for women being raised faster so that both reach the end point simultaneously. The other method would involve first raising the retirement age for women to 60, and then both sexes advancing to 65 at the same pace.

Since the government revealed that the five-year plan would call for older Chinese to work longer, social media have reverberated with debate about the idea. On Weibo, a Twitter-like platform, posts tagged with “postpone the retirement age” have received 620m views and launched more than 100,000 discussions. Many comments have been critical, with some blaming the country's draconian one-child-per-couple policy for exacerbating the population's ageing. (The limit was increased to two children in 2016, and will soon be raised again, to three.) In 2020 a survey of 96,000 people by a newspaper in Wuhan found that more than 80% opposed later retirement. They wondered whether they would have the stamina to keep working into their 60s, and also whether—if not in a secure job already—they would still be employable. Firms often discriminate against older people when recruiting.

Concerns about the possible impact on social stability may explain why the government's plans have kept slipping. In 2008 it hinted that reforms would begin in 2010. They didn't. In 2015 a senior official said a detailed plan would be revealed in 2017. Again, no show. The government does not always pay much heed to public opinion when shaping policy: the one-child restriction was never popular. But in this case it may worry about angering a large number of people in urban areas where it is especially keen to prevent

unrest (the one-child policy was most resented in the countryside). Most farmers carry on working until they are forced to stop by poor health: a rural pension scheme was introduced in 2009, but it provides far less support than urban residents enjoy.

Lifting the retirement age is a bit more popular among government employees. Of almost 170,000 respondents to a survey conducted in 2016 by China Youth Daily, an official newspaper, more than 80% said delaying retirement was more favourable to government employees (presumably because such people are considered less likely to be fired for becoming older and therefore, as is commonly imagined, less energetic). One civil servant told Xinhua his boss had doctored his own records to make his age appear younger. “This way, he holds onto power longer,” the bureaucrat said.

But young workers grumble about raising the age. They suspect they will have to wait longer for promotions as older workers occupy jobs for longer. Online, they use a common idiom to describe such seniors, accusing them of “squatting on the toilet without taking a shit”. In reality, lifting the retirement age will be harder on older workers who may struggle to retain their jobs when so many of their younger peers are far better educated. And concerns about job insecurity, especially as they get older, are pushing more young people to apply for jobs in the civil service.

Raising retirement ages may create another problem. China’s fertility rate (the average number of children a woman can expect to have in her lifetime) is among the world’s lowest. On May 31st the Communist Party said married couples would be allowed to have three children to help the country “cope” with its ageing. (In 2018 the share of people over 60 was almost one-fifth; by 2050 it will be more than one-third.) But many families rely on grandparents for child care. When parents retire, the probability that their child gives birth increases by between 44% and 61%, says a study by Fudan University. If grandparents have to work longer, the government will have to spend

more on kindergartens and introduce rules to force employers to make better provisions for working parents. Grappling with China's demographic woes will involve many tough reforms. ■



不劳动阶级先锋队

中国54岁的平均退休年龄过低了

政府提高这一标准的举措面对强烈反对

中国的平均退休年龄在54岁左右，为全球最低标准之一。这是个问题。标准是以前设定的，此后预期人均寿命大幅提高，成年劳动力（实际上，他们的劳动撑起了退休人员的生活）的人数却开始缩减。但事实证明，说服人们延长工作年限不容易。2008年，政府表示在研究提高退休年龄，但在公众的强烈反对中搁置。现在政府感到不能再拖了。

采取行动的压力显而易见。目前的退休年龄是在上世纪50年代制定的，当时的预期人均寿命还低于退休年龄。在中国，大多数男性60岁退休，远低于经合组织（成员主要为富裕国家）64.2岁的平均水平。而中国女性公务员55岁退休，女性蓝领工人是50岁。

但是，现在中国的人均预期寿命只比经合组织79岁的平均水平低两岁，因此中国退休老人通常需要比富裕国家的老人多领几年政府退休金。2019年，中国的公共养老金系统覆盖近10亿成年人，规模大于世界任何其他同类系统。官方智库中国社科院警告称，国家主要的养老基金可能在2035年前耗尽。

政府似乎还没有决定如何改革这一系统。当前的五年规划（今年3月通过的这份文件长142页）关于这个议题只有一句话，提出按“小步调整”和“弹性实施”的原则推进。但加入这句话也就意味着在2025年“十四五”规划结束前几乎肯定会开始改革——中国政府绝少宣布可能无法达成的目标。

官员们透露，退休年龄将分阶段延迟，每次延迟几个月。中国主要官方媒体新华社称，政府目前正在权衡两个可能的方案。一是把男性和女性的退休年龄都提高到65岁，女性的延后速度快于男性，这样就能同时达到新标准。另一个方案是先把女性的退休年龄提高到60岁，再以统一的速度把男女退休年龄提高至65岁。

自政府透露“十四五”规划将推进延迟退休以来，社交媒体上对此热议不断。微博上带“延迟退休年龄”话题的帖子浏览量达6.2亿，引发了超过10万条讨论。许多评论持批评态度，一些人指责中国严厉的独生子女政策加剧了人口老龄化。（2016年一孩限制放松至二孩，很快再次放松至三孩。）2020年，武汉一家报纸对96,000人的调查发现，超过80%的受访者反对延迟退休。他们表示不知道自己60多岁时是否还有足够的精力继续工作，以及是否还找得到工作——如果自己还没有捧着某个铁饭碗的话。年龄歧视在企业招聘中很常见。

政府的计划屡屡流产，可能是担心这项改革会冲击社会稳定。2008年，政府暗示改革将于2010年启动。后来并无动静。2015年，一位高官表示详细计划将于2017年公布，结果同样没了下文。政府在制定政策时不是总那么重视民众意见：独生子女政策就从来不受欢迎。但这次，政府可能担心触怒大量城市居民，而城市地区正是政府的维稳重心（对独生子女政策最不满意的是农村地区）。大多数农民反正会一直工作到健康状况不允许为止：虽然政府在2009年推出了农村养老金计划，但提供的支持远低于城市居民享有的水平。

公务员对延迟退休的接受度更高一点。官媒《中国青年报》2016年调查的近17万名受访者中，超过八成人认为延迟退休对公务员更有利，大概是觉得这类人更不可能因为上了年纪（普遍认为年纪大的人会精力不济）而被解雇。一位公务员告诉新华社记者，他的上司就在档案里把年龄改小了。“这样他就可以掌权更久。”他说。

但年轻劳动者对延迟退休怨声载道。他们估计因为老人们迟迟不退，自己就要等更久才能晋升。在网上，他们用一句俗话来形容这些上级，说他们“占着茅坑不拉屎”。在现实中，提高退休年龄对年长员工的影响会更大——面对那么多受教育背景好得多的年轻同事，他们可能难以保住职位。对工作不稳定的担忧，特别是怕上了年纪失业，正促使越来越多年轻人去考公务员。

提高退休年龄还可能造成另一个问题。中国是全球生育率（一名女性一生

中平均生育子女数量)最低的国家之一。5月31日，中国共产党宣布允许每对夫妻生育三名子女，以帮助国家“应对”老龄化问题。(2018年，60岁以上人口占中国总人口的近五分之一；到2050年，这一比例将上升至超过三分之一)。但许多家庭依赖祖父母来照顾小孩。复旦大学的一项研究指出，父母退休后，子女生孩子的可能性会上升44%至61%。如果祖父母一辈必须工作更久，政府将不得不在幼儿园方面投入更多资金，并出台规则要求雇主为在职父母提供更好的支持。中国要应对人口结构困境，将涉及许多艰难的改革。■



ETH and chips

Crypto-miners are probably to blame for the graphics-chip shortage

Secondhand graphics-card prices move nearly in lockstep with those of Ethereum

THE PAST year has been rough for gamers. Just as covid-19 brought in-person entertainment to a halt, the cost of graphics processing units (GPUs) needed to run computer games soared. Graphics cards like Nvidia's RTX 3080, with a suggested price of \$699, have fetched up to \$2,400. When bricks-and-mortar stores get a few in stock, buyers queue up overnight.

Prices for all types of chips have risen of late, for myriad reasons. Silicon wafers are scarce. Manufacturers have suffered disruptions. Scalpers use bots to buy up inventory. Chinese-made chips face American tariffs. And demand for personal computers is the highest since 2010.

Nonetheless, data from Keepa, a website that tracks Amazon listings, show that asking prices for GPUs have risen faster than have those for central processing units (CPUs). The data also suggest that miners of Ethereum, the second-largest cryptocurrency, are to blame for gamers' woes.

GPUs and CPUs both perform calculations, but they are used for different purposes. GPUs are specialised chips that excel at matrix algebra, which is required for 3D graphics and machine-learning tasks like translating languages. They are also the best tool for mining Ethereum (though not bitcoin). In contrast, CPUs are more versatile, and handle most everyday operations.

In general, chips lose value over time as new, more powerful ones are developed. Technological gains have slowed since the 1990s, but CPUs still obey this trend. For example, a nine-year-old CPU like Intel's Core i7-3770 sells for a third of its release price.

However, prices for GPUs have risen so much that even geriatric graphics cards, such as AMD's RX580, have gained value. It was released in 2017 at a suggested price of \$229, and is now listed at more than \$700.

In theory, such appreciation could reflect the growing popularity of gaming and machine learning. However, secondhand market data suggest a different cause.

Since 2015 asking prices for six GPUs tracked by Keepa have moved in lockstep with Ethereum's value. In late 2017 the currency's first big rally coincided with a surge in listed GPU prices. Once the crypto bubble burst, GPU costs fell back to earth.

Another boom began last year. As Ethereum's price rose from \$107 in March 2020 to \$4,400 in May 2021, the value of mining hardware once again followed suit. In six months, the six GPUs' listed prices climbed by 150%. Those of CPUs barely budged.

The GPU shortage has hurt data scientists and computer-aided-design users as well as gamers. Some relief may be on the way. Ethereum's price is now 40% below its record high. GPU prices have yet to fall, but if history is any guide, they probably will soon. Moreover, Nvidia has tried to cripple its GPUs' mining power, while promising to sell new cards targeted at miners. It is also cutting back on its output of older products to focus on newer ones.

However, without greater production, customising chips will not end the shortage. Nvidia's RTX 3080 Ti, one of its first cards with reduced mining power, is listed on Amazon at double its suggested price. ■



以太币和芯片

显卡芯片短缺可能要归咎于加密货币挖矿

二手显卡的价格几乎与以太币的价格同步波动

过去的一年对游戏玩家来说不好过。新冠疫情令聚集性娱乐活动暂停，而玩游戏所需的图形处理器（GPU）价格猛涨。像英伟达（Nvidia）RTX 3080这样的显卡的建议售价为699美元，现在已经涨到了2400美元。当实体店有少许现货时，买家会通宵排队。

近来各种芯片都已涨价，原因有很多。硅片稀缺。制造商遭遇生产中断。黄牛党用机器人程序抢购库存。中国制造的芯片面临美国的关税。另外，对个人电脑的需求达到了2010年以来的最高水平。

不过，追踪亚马逊商品信息的网站Keepa的数据显示，GPU的要价比中央处理器（CPU）上涨得更快。数据还表明，第二大加密货币以太币（Ethereum）的挖矿机要为游戏玩家的困境负责。

GPU和CPU都执行运算，但用途不同。GPU这种专用芯片擅长矩阵代数，这是3D图形和机器学习任务（如翻译）所需要的。它们还是挖以太币（尽管不是比特币）的最佳工具。相比之下，CPU的通用性更强，处理了大多数日常操作。

总体说来，随着更强大的新一代芯片面世，旧芯片的价格随时间下降。自上世纪90年代以来，技术进步已经放缓，但CPU仍然遵循这一趋势。例如，像英特尔酷睿i7-3770这样上市已九年的CPU的售价只有刚发布时的三分之一。

但GPU的价格却涨了许多，就连AMD的RX580这样的老款显卡也升值了。它于2017年发布，当时建议价格为229美元，现在市价超过700美元。

理论上看，这种升值可能表明游戏和机器学习越来越受欢迎。但二手市场

的数据却显示另有原因。

自2015年以来，Keepa跟踪的六款GPU的要价一直与以太币的价格同步涨跌。2017年末，以太币首次大幅上涨的同时，GPU的市价也飙升。到这种加密货币的泡沫破裂时，GPU价格跌回正常水平。

另一场热潮始于去年。以太币的价格从去年3月的107美元升至今年5月的4400美元，加密货币挖矿机硬件的价格再次随之上涨。六个月里，这六款GPU的市价上涨了150%。而CPU的价格几乎没有变动。

GPU的短缺不仅伤害了游戏玩家，也伤害了数据科学家和计算机辅助设计用户。接下来情况可能会有所缓解。现在以太币的价格比历史高点低40%。GPU的价格还没有下降，但从历史经验来看，降价可能为时不远了。此外，英伟达已试图削弱其GPU的挖矿能力，同时承诺销售专用于挖矿的新显卡。它还削减了旧款产品的产量，集中生产新产品。

不过，如果不提高产量，定制芯片并不能解决短缺问题。英伟达的RTX 3080 Ti是它首批削弱了挖矿能力的显卡之一，在亚马逊网站上的市价是其建议价格的两倍。 ■



Brace, brace

Three corporate giants are posing a stiff test for Chinese banks

The country's big lenders dare to be dull

NOT LONG ago the conventional wisdom was that China would do whatever it took to save its biggest companies from failing. Times have changed. Three corporate giants—Evergrande, the country's biggest property developer; Huarong, its biggest investor in bad bank assets; and Suning, a retail giant—are all suffering from financial distress.

The three firms' long rush to expand has collided with slower growth, tighter credit and stricter regulatory scrutiny. Their bonds are trading at discounts of roughly 25% to face value, showing that investors have priced in a significant chance that they will default.

People in the financial industry are debating whether the government really will let them fail. An analyst with a large asset manager that holds Huarong bonds says his firm believes the state will eventually rescue the “bad bank”, given how integral it is to cleaning up non-performing loans in the financial system. A former adviser to the central bank says that Evergrande and Suning may be more expendable, posing fewer systemic dangers.

In the first instance, the troubles of these firms are a reflection of their own mismanagement. Evergrande has more debt than any other listed Chinese company. Huarong had a chairman who was executed for bribery. Suning sprayed cash around with abandon, buying trophy assets such as Inter Milan, the football club.

But the government's willingness to let them go to the brink also points to something else: its confidence that the banking sector is now solid enough to cope with a big bout of turbulence. That was not always the case. In

2015 Chinese banks were struck by a near-crisis when more than \$1trn in cash rushed out of the country and corporate defaults rose. Several banks eventually needed bail-outs.

Many investors still see them as being in a weakened position. With few exceptions, Chinese banks listed on the Hong Kong stock exchange trade far below their reported asset values, implying a high degree of pessimism about their prospects. The root problem is their ultra-rapid credit issuance of the past 15 years, when their loan books grew ninefold, nearly twice as fast as the overall economy.

Yet any fair assessment of China's banks must grapple with changes that have made them safer. Regulators have unwound some of their off-balance-sheet chicanery, exemplified by a curtailment of their loans to other financial firms. Such loans, which make it hard to know where risk resides, had soared to 78% of GDP by the end of 2016. Today they are down to about 54%.

Banks are also better prepared for bumps ahead. They had capital buffers equivalent to 14.7% of their assets at the end of 2020, a record high. Even as bad loans climbed to nearly 2% last year, the highest in more than a decade, banks made enough cash provisions to cover a near-doubling. The government also now requires the biggest banks to prepare resolution plans in case of trouble.

These changes bring China more in line with global regulatory standards, albeit with a twist. In most countries the overriding goal is to avoid having to get the state to save reckless banks. In China, however, the state already owns majority stakes in most large banks.

"The question is, do you wipe out equity which is already public money and then put in fresh taxpayer money? Or do you avoid wiping out equity

to begin with?" says Nicholas Zhu of Moody's, a credit-rating agency. Regulators are, he says, taking a mixed approach, likely to support lower-yielding senior debt but not junior debt such as perpetual bonds.

The weakest banks in China are almost entirely its smallest ones. They generally have dodgier assets, less-professional management and thinner capital cushions. Rather than dealing with them one by one, regulators are working to bind them together. Mergers are under way in the provinces of Liaoning, Shanxi and Sichuan. "Consolidation is something we expect. It allows for higher requirements for corporate governance and risk control," says Vivian Xue of Fitch, another credit-rating agency.

Perhaps the biggest concern about China's banks today is not their recklessness but whether regulators are themselves creating new risks with a new set of lending rules. Worried about the property sector, they have told banks to cap their mortgages and other property lending to no more than 35% of their loan books. Meanwhile, regulators ordered banks last year to increase loans to smaller firms by between 30% and 40%.

"In the past regulators complained that banks all looked alike, and wanted them to serve different client bases," says May Yan, an analyst with UBS, a bank. "Some of the recent regulations are making banks look the same." Their income trends are already more similar. Take, for instance, the ten biggest banks in China. Virtually all posted profit growth of about 2% last year, with the least differentiation among their results on record.

This trend suggests that the main risk for Chinese banks is a lack of diversification. Along with having similar lending profiles, their assets are overwhelmingly concentrated within China. Overseas loans now account for just 2% of their lending portfolios. All the loan-loss provisions, capital buffers and improved governance may make them safer. But ultimately the only measure that really matters is the health of the Chinese economy. ■



准备抵御冲击

三大企业巨头对中国银行业构成严峻考验

该国的大型银行无惧变得单调死板

不久前人们还普遍认为中国会不惜一切挽救它最大的企业，不让它们倒下。此一时，彼一时。中国最大的房地产开发商恒大、最大的银行不良资产投资者华融、零售巨头苏宁这三家巨头企业目前都深陷财务困境。

这三家公司长期以来极力扩张，但遭遇了增长放缓、信贷收紧和更严格的监管审查。它们的债券以相当于面值约25%的折扣交易，这表明投资者已经预期它们违约的可能性很大。

金融业人士正在争论政府是否真的会任由它们倒下。某家持有华融债券的大型资产管理公司的一名分析师说，他所在的公司相信国家最终会挽救华融这家“坏账银行”，毕竟它在清理金融系统中的不良贷款方面不可或缺。一位前央行顾问表示，恒大和苏宁或许是更可舍弃的，因为它们构成的系统性风险更小。

首先来说，这些公司的麻烦反映了它们自身管理不善。恒大的债务比哪家中国上市公司都要多。华融的一名董事长因受贿被执行死刑。苏宁肆意挥霍现金，购买足球俱乐部国际米兰等华而不实的资产。

但是，政府愿意任由它们走向崩溃边缘也说明了另一件事：它相信银行部门现在已经足够稳固，可以应对一场大的动荡。情况并非一向如此。2015年，逾一萬亿美元现金流出中国，企业违约率上升，中国银行业由此遭遇了一场近乎危机的冲击。最终有几家银行需要纾困。

许多投资者仍然认为它们元气大伤。除了极少数个例以外，在香港交易所上市的中资银行的交易远低于其公布的资产价值，这意味着投资者对它们的前景高度悲观。根本问题是它们在过去15年里超高速发放信贷，期间贷款账目增长了九倍，几乎是整体经济增速的两倍。

然而，要对中国银行业做出公正的评估，就必须设法了解那些已经让它们变得更安全的变化。监管机构已经破除了它们的一些表外欺诈行为，比如限制它们对其他金融公司放贷。这种贷款让人很难知道哪里暗藏风险，截至2016年底此类贷款已飙升至GDP的78%。如今这一比例已降至54%左右。

银行也做了更妥善的准备以应对前方颠簸。到2020年底，它们的资本缓冲水平相当于其资产的14.7%，创历史新高。尽管去年不良贷款率攀升至近2%，为10多年来的最高水平，但银行的准备金足够覆盖增加近一倍的不良贷款。政府现在还要求那些最大的银行预备好解决方案，以防出现问题。

这些变化让中国变得更加符合全球监管标准，尽管还是有一处不同。在大多数国家，压倒一切的目标是避免让政府出手拯救鲁莽行事的银行。然而在中国，政府已拥有大多数大型银行的多数股权。

“问题是，你是要把本来就已是公共资金的股权一笔勾销，然后再投入新的纳税人的钱，还是说你一开始就避免抹除股权？”信用评级机构穆迪的诸蜀宁说。他表示，监管机构正在采取一种混合的方式，很可能会支持收益率较低的优先债务，但不会支持永久债券之类的次级债务。

中国最弱的银行几乎全都是那些最小的银行。它们通常资产更不可靠、管理更不专业、资本缓冲更薄弱。监管机构没有选择逐一处理它们，而是在努力将它们捆绑在一起。辽宁、山西和四川的小银行正在合并。“我们乐于看到整合。这样就可以对公司治理和风险控制提出更高的要求。”另一家信用评级机构惠誉（Fitch）的薛慧如表示。

或许，中国银行业如今最让人担忧的不是它们不顾后果，而是监管机构自己是否在用一套新的贷款规则制造新的风险。出于对房地产行业的担忧，监管机构已经要求银行将抵押贷款和其他房地产贷款的上限控制在不超过其贷款总额的35%。与此同时，监管机构去年指示银行把对小企业的贷款增加30%至40%。

“过去，监管机构抱怨银行看起来都一个样，希望它们能为不同的客户群服务，”瑞银（UBS）分析师颜渭之表示，“而近年的一些规定正让银行都变成一个样。”它们的收入趋势就已经变得越发相似了。以中国最大的十家银行为例，去年它们几乎全都公布了约2%的利润增长，是有记录以来利润增长差异最小的一次。

这一趋势表明，中国银行业的主要风险是不够多元化。除了贷款组合相似，它们的资产绝大多数都集中在中国国内，海外贷款目前只占其贷款组合的2%。贷款损失准备金、资本缓冲和治理改善——种种这些可能会影响它们变得更安全，但说到底，唯一真正重要的衡量标准是中国经济的健康状况。 ■



Cyber-heists

The methods and menace of the new bank robbers

Hacker gangs go after the money—and the data

TALK TO BANKERS and some will tell you that when it comes to cyber-crime, they are second only to the military in terms of the strength of their defences. And yet trawl the dark web, as Intel 471, an intelligence firm, did on behalf of The Economist in May, and it is obvious that attempts to breach those walls are commonplace. One criminal was detected trying to recruit insiders within America's three biggest banks, JPMorgan Chase, Bank of America and Wells Fargo, offering a “seven-to-eight-figure” weekly payment to authorise fraudulent wire transfers. Another was auctioning the details of 30m accounts at Bank Mellat in Iran (a country of 83m).

Such activity represents the handiwork of a new breed of bank robber. Forget the hold-ups of yore. Today's smartest hackers are likely to be backed by rogue states, such as North Korea and, to a lesser extent, Iran, or tolerated by countries such as Russia and China. They benefit from unprecedented resources and protection from law-enforcement agencies. As well as attempting to empty accounts, they also target data for insider trading.

As one of the first industries to offer online transactions, banks have been fending off hackers since the dawn of the internet. They spend more on cyber-security than any other sort of firm—\$2,691 per employee—and manage to foil a lot of the attempted thefts. Nonetheless, since 2016, no industry has suffered more from attacks than banks (see chart).

Speaking to Congress in May, Jane Fraser, who runs Citigroup, a Wall Street giant, called hacks the biggest threat to America's financial system. Jamie Dimon of JPMorgan Chase has said they could become “an act of war”. The

result is that banks are under constant pressure to prepare for the worst. “It’s not a matter of ‘if’, it’s a matter of ‘when’,” says the head of cyber-security at a central bank. The bankers need to know the methods and motives of their enemies. What have they learned and can they remain a step ahead?

As in other industries, attempts to rob banks online generally start with “phishing”, or tricking an employee into downloading a benign-looking software, known as a “Trojan”, that, once installed, creates a backdoor for other viruses to infect the company’s systems. The ruses can be elaborate. In 2019, when hackers infiltrated Redbanc, an interbank network connecting Chile’s ATM system, they faked a lengthy hiring process, complete with rounds of video interviews, just to fool one victim into downloading and running a Trojan.

Once the backdoor is installed, the hackers have numerous modi operandi. These have evolved over time. In the early to mid-2010s a popular tactic was to alter banks’ databases to inflate balances on existing accounts in order to drain them with fraudulent online transfers. Another was to steal the names and passwords of employees authorised to access SWIFT, the interbank messaging system that banks use for international transfers, in order to make fraudulent transfers to the robbers’ own bank accounts. In the world’s biggest cyber-heist, in 2016, thieves transferred funds from an account the Bangladeshi central bank held at the Federal Reserve Bank of New York to banks in the Philippines, Sri Lanka and other parts of Asia. They stole \$81m.

Ransomware attacks, such as those common elsewhere in business, are on the rise. But banks are exposed in other ways, too. One example is “jackpotting”, where malware manipulates ATMs into spitting out lots of cash, accessible to fake cards, even if no funds exist. Thieves then hire packs of money mules, typically from local mafias, to stage multiple withdrawals at once. Using such methods, in 2018 criminals got away with \$13.5m from

India's Cosmos Bank through 15,000 cash-machine withdrawals in just two hours.

Another tactic is to turn websites that banks visit regularly into poisoned "watering holes", most infamously in 2017 when criminals successfully targeted 104 mostly financial firms in 31 countries, including seven banks in Britain and 15 in America. In this case the websites of central banks in Poland, Mexico and others were booby-trapped so that banks would download malicious files and infect themselves with malware. These could be used to spy on the banks, steal their data and ultimately make fraudulent transfers (though in most cases the intrusion appears to have been discovered before money was stolen).

Sometimes it is data, not money, that the robbers are after. The latest trick is to steal financial-market data from within banks in order to facilitate insider trading. A survey by VMware, a cyber-security firm, of 126 financial firms worldwide found that 51% saw a rise in such attacks last year. Portfolio managers in America and Britain that were recently breached saw suspicious activity whenever they were about to trade, says Tom Kellermann, the firm's strategy boss.

The multiplicity of methods is compounded by the malevolence of those involved. Originally heists were mostly conducted by private thieves from former Soviet states. They included Carbanak, a notorious syndicate that stole over \$1bn from 100 banks after 2013 (its masterminds were arrested in 2018). But since America cut North Korea out of its financial system in 2017, the hermit state has doubled down on its relationship with criminal gangs as a way of "making profit and evading sanctions", says Michael D'Ambrosio, a top investigator in America's secret service. Variously named Lazarus, Bluenoroff or BeagleBoyz, such state-sponsored entities have access to vastly more resources and personnel than mere criminals. Their members often live under cover in Russia and China, says Mark Arena of Intel 471.

An indictment by America's Department of Justice published in January accuses two individuals, linked to a North Korean military intelligence agency, of attempting to steal more than \$1.3bn via cyber-enabled bank heists and ATM raids, as well as extorting cryptocurrency companies.

Moreover, rogue states often form joint ventures with private gangs. One of them, a Russian-speaking outfit that operates an infamous Trojan-for-hire called Trickbot, provides access to many infected computers. Some cyber experts were shocked recently when they found that it had been used in conjunction with North Korean malware in recent attacks.

It is not clear how much money drains out of the back door. Numbers crunched by Advisen, a consultancy, suggest banks have lost about \$12bn to cybercrime since 2000, around three-quarters of which have come from data breaches. Studies suggest every hour of business interruption costs a bank \$300,000 on average; a typical data breach causes losses of \$6m.

But banks usually forbid staff from discussing such attacks, and the reported numbers dramatically underestimate the problem. Though many institutions are obliged to report serious hacks to regulators and, sometimes, customers, rules change frequently and vary across jurisdictions, meaning disclosure is haphazard.

Moreover, initial losses can be dwarfed by second-order effects. The average incident puts 27% of customers at high risk of closing down their accounts at a targeted firm, and sinks companies' share prices by 5-7% on average, says John Meyer of Cornerstone Advisors, a consultancy. A Supreme Court case in Britain this summer could make class-action lawsuits by customers affected by cyber-breaches easier, exposing banks to hundreds of millions of pounds in potential damages.

Not everything is going the criminals' way, though. Forensic firms are doing

a good job of attributing attacks to specific hacking groups, and intelligence agencies at linking web handles to real people. Some gangs are neutralised or caught. In September the American army launched a cyber offensive that weakened TrickBot, the North Korea-backed Trojan. In January Ukrainian police, in an operation with European and American counterparts, arrested the thieves running Emotet, another botnet allegedly responsible for at least \$2.5bn in theft since 2014.

Banks strive to build nimbler fortifications and hire friendly “white-hat” hackers to probe their own defences. The biggest are spending more: in June Bank of America said it would invest \$1bn annually to counter mounting threats. A survey by Deloitte found that financial firms spent an average 0.48% of their revenue on cyber-security last year, up from 0.34% in 2019. Applied to the industry’s total revenue in 2020, that would make for \$23bn-worth in spending in America alone.

But things may get worse because, firstly, banks’ networks are becoming costlier to secure. “We recognise that we’re never going to prevent everything,” says the cyber chief of a top American bank. “So we have to have layered defences that assume multiple defences will fail.” The multiplication of internet-connected devices, the digitalisation of banking, and remote working are offering new points of entry for attackers. Akamai, a security firm that serves eight out of the world’s top ten banks, witnessed 736m attacks against financial firms’ web-based applications last year, a two-thirds increase from 2019. The expansion of fintech firms without consistent regulation is creating blind spots. And banks’ migration to the cloud, on paper deemed more secure, could backfire if it ends up concentrating risk on just a few platforms, says Jano Bermudes of Marsh, an insurance broker.

Secondly, the criminals have more resources—both technological and financial—at their disposal. According to security experts, they mainly

focus on expelling intruders before they have time to loot. Yet, says one, soon hackers are likely to use artificial intelligence to shorten an attack from start to finish—the “kill chain” in the jargon. Cyber-gangs are also growing rich. Maze, one of them, announced its “retirement” in November after pocketing over \$100m in ransoms in a year. Moreover, up-and-coming criminals are attempting to surf on the top tier’s success. Last autumn, hackers posing as Lazarus and Fancy Bear (an infamous Russian group) threatened over 100 financial firms with distributed denial-of-service attacks, in which “botmasters” mobilise vast networks of infected machines to flood their targets with internet traffic if they do not pay a ransom.

Such hackers can count on thriving secondary markets to monetise their loot. On ToRReZ, an eBay lookalike that The Economist recently visited via an ultra-private browser, credit-card details go for \$25 a pop—or four for the price of three. For \$4.99, a tutorial offers help in building phishing websites copying those of Barclays, a British bank. Purchases are paid in cryptocurrencies that can be cashed out in bank accounts opened with fake IDs (a driving licence from Tennessee costs \$150, for instance). The new bank robbers are as criminally entrepreneurial as ever. ■



网络盗窃

新一代银行劫匪的手段和威胁

“黑”帮要钱也要数据

和银行家聊一聊，他们中一些人会告诉你，在防范网络犯罪方面银行的防御力量仅次于军队。然而，就像情报公司Intel 471受本刊委托在5月所做的，搜查暗网会发现，试图突破银行防御的攻击显然很普遍。一名犯罪分子被发现试图从美国最大的三家银行——摩根大通、美国银行和富国银行——招募内部人员，以每周“七到八位数”的高价让他们批准欺诈性电汇。另一名犯罪分子在网上拍卖伊朗国民银行（Bank Mellat）3000万个账户的信息，伊朗的总人口也就8300万。

这些都是新一代银行劫匪的行径。忘记过去的抢劫方式吧。当今最聪明的黑客很可能受朝鲜和伊朗等流氓国家的直接支持（伊朗支持的程度较轻些），或者很可能被俄罗斯和中国等国容忍。他们获益于前所未有的资源和执法机构的保护。除了试图掏空银行账户，他们还瞄准了用于内幕交易的数据。

作为最早提供在线交易的行业之一，银行自互联网诞生之日起就一直在抵御黑客。它们在网络安全上的投入比其他任何类型的企业都要多（平均每个员工的网络安全支出为2691美元），并成功挫败了许多盗窃企图。尽管如此，自2016年以来，银行业遭受的网络攻击仍多过任何其他行业（见图表）。

5月，华尔街巨头花旗集团的老板简·弗雷泽（Jane Fraser）在出席国会听证会时表示，黑客攻击是美国金融体系面临的最大威胁。摩根大通的杰米·戴蒙（Jamie Dimon）曾表示，黑客袭击可变成“战争行为”。结果是银行一直承受着为最坏情况做好准备的压力。“这不是‘如果’的问题，而是‘何时’的问题。”一家央行的网络安全负责人说。银行家需要了解敌人的手段和动机。那么他们已经了解到些什么？能否先敌一步呢？

与对其他行业发动的攻击一样，在网上抢劫银行通常都从“网络钓鱼”开始，也就是诱骗某个员工下载看似无害的软件。一旦安装了这种“特洛伊木马”，它就会为其他病毒创建后门，从而感染公司的整个系统。整个诡计可能煞费苦心。2019年，黑客入侵连接智利ATM系统的银行间网络Redbanc时，伪造了一个包括多轮视频面试的漫长招聘过程，只为骗到一名受害者下载并运行特洛伊木马。

一旦安装了后门，黑客就有很多种作案手法。这些手法还在不断发展。2010年之后的几年里，流行的手法是更改银行的数据库，增加现有账户的余额，通过欺诈性在线转账抽空这些账户。另一种方法是窃取有权使用SWIFT（银行在国际汇款时使用的银行间消息系统）的员工的用户名和密码，以向黑客自己的银行账户发起欺诈性转账。在2016年世界上最大的网络黑客盗窃案中，窃贼将孟加拉国央行在纽约联邦储备银行账户里的资金转到了菲律宾、斯里兰卡和亚洲其他地区的银行。他们共盗取了8100万美元。

在其他商业领域常见的勒索软件攻击行为正在增加。但银行还面对一些其他的攻击方式。比如“吐钞攻击”：用伪造的银行卡通过恶意软件操纵ATM机吐出大量现金，哪怕这些假卡里根本没有钱。然后窃贼会雇用一帮“钱骡子”同时多次取款，这些“钱骡子”通常都是当地的黑帮成员。2018年，犯罪分子通过这种方法在短短两个小时内从印度Cosmos银行的ATM机上取款1.5万次，窃得1350万美元。

另一种手段是将银行定期访问的网站变成有毒的“水坑”，最臭名昭著的水坑攻击发生在2017年，犯罪分子成功攻击了31个国家的104家企业，其中大多数是金融机构，包括七家英国银行和15家美国银行。在这次攻击中，波兰、墨西哥和其他一些国家的央行网站被设下水坑陷阱，引导银行下载恶意文件，进而感染自己的系统。通过这些恶意软件可以监视银行，窃取它们的数据，并最终发起欺诈性汇款（尽管在大多数情况下，银行似乎都在资金被盗之前发现了系统被入侵）。

有时，窃贼瞄上的是数据而不是钱。他们最新的伎俩是从银行内部窃取金

融市场数据，便于他们进行内幕交易。网络安全公司威睿（VMware）对全球126家金融公司展开的一项调查发现，51%的公司去年遭受的此类攻击有所增加。威睿的战略主管汤姆·凯勒曼（Tom Kellermann）表示，近期受过黑客入侵的美国和英国投资组合管理公司在每次交易前都会发现可疑活动。

作案手法之多，再加上参与其中的势力抱持的恶意，让情况更为复杂。最初的网络大盗主要是前苏联国家的民间窃贼。其中包括臭名昭著的卡巴纳克（Carbanak）黑客组织，它在2013年之后从100家银行窃得10亿多美元（其主谋于2018年被捕）。但自美国于2017年将朝鲜从其金融体系中孤立出去之后，这个隐秘国家加大了与犯罪团伙的联系，借此“牟利并逃避制裁”，美国特勤局高级调查员迈克尔·丹布罗西奥（Michael D'Ambrosio）说。比起一般的犯罪分子，Lazarus、Bluenoroff或BeagleBoyz等名目繁多、受国家支持的黑客组织能获得的资源和人力要多得多。组织成员经常隐匿在俄罗斯和中国，Intel 471的马克·阿雷纳（Mark Arena）表示。根据美国司法部1月公布的一份起诉书，美国已指控两名与朝鲜军事情报机构有关联的人员意图通过网络银行抢劫、入侵ATM机及敲诈加密货币公司的方式窃取超过13亿美元的传统货币和加密货币。

此外，流氓国家经常与犯罪团伙联手。其中一个讲俄语的组织运行着一个名为Trickbot的可自定义木马程序，这个臭名昭著的程序允许攻击者访问众多受感染的计算机。一些网络专家近来震惊地发现，这一程序与朝鲜的恶意软件一道部署在近年的网络攻击中。

尚不清楚有多少资金从后门流出。咨询公司Advisen的数据显示，自2000年以来，银行因网络犯罪损失了约120亿美元，其中约四分之三是因为数据泄露。研究表明，业务每中断一小时，受影响的银行平均损失30万美元；一次数据泄露事件通常造成600万美元损失。

但银行通常禁止员工讨论此类攻击，而且公布的损失往往轻描淡写。尽管许多金融机构有义务向监管机构报告严重的黑客攻击（有时对客户也有此义务），但监管规则经常变化，且因司法辖区而异，这意味着信息披露杂

乱无章。

此外，次级效应可能会让初始损失相形见绌。平均而言，每次网络攻击很可能会让27%的高风险客户关闭它们在被攻击公司的账户，并导致公司股价平均下跌5%至7%，咨询公司基石顾问（Cornerstone Advisors）的约翰·迈耶（John Meyer）表示。今年夏天英国最高法院审理的一宗案件可能会让受数据泄漏影响的客户更容易提起集体诉讼，让银行有可能面临数亿计英镑的赔偿。

不过，窃贼们也并非高枕无忧。金融取证公司追查具体是哪个黑客组织发动了攻击，情报机构把网名与真人对上号，两者都表现出色。一些团伙被瓦解或抓捕。去年9月，美国军方在网上发起攻势，削弱了朝鲜支持的特洛伊木马程序TrickBot。今年1月，乌克兰警方与欧洲和美国警方联合行动，逮捕了运行Emotet的网络大盗，Emotet也是一个僵尸网络，据称自2014年以来盗窃了至少25亿美元。

银行在努力打造更灵活的防御工事，并聘请友好的“白帽”黑客来排查自己的系统。规模最大的那些银行投入更多，比如美国银行就在6月表示它将每年投入10亿美元应对日益严重的网络威胁。德勤的一项调查发现，金融企业去年在网络安全方面的投入平均占收入的0.48%，高于2019年的0.34%。按2020年金融业的总收入来计算，那么网络安全支出仅在美国就达到了230亿美元。

但情况可能会变得更糟，首先是因为维护银行网络安全的成本越来越高。“我们认识到永远不可能做到无懈可击，”美国一家顶尖银行的网络安全主管说，“所以我们必须做分层防御，假定多道防御都会被突破。”联网设备的增加、银行业数字化和远程办公为攻击者提供了新的突破口。阿卡迈科技（Akamai）是一家网络安全公司，全球十大银行有八家是它的客户，该公司去年见证了7.36亿次针对金融企业网络应用的攻击，比2019年增加了三分之二。金融科技公司不断扩张但尚没有统一的监管，正在造成许多盲点。而银行向云端迁移虽然理论上说应该更安全，但如果最终导致风险集中在少数几个平台上，可能就会适得其反，保险经纪公司达信

(Marsh) 的哈诺·伯尔姆兹 (Jano Bermudes) 表示。

其次，现在罪犯们在技术和资金方面都有更多资源可供调遣。安全专家称，他们主要专注在入侵者未及实施抢劫之前将其驱逐。然而，一位专家表示，黑客很可能很快就会利用人工智能来缩短行话称作“网络攻击链”的整个攻击过程。网络犯罪团伙也越来越有钱。其中一个团伙Maze在一年内攫取了超过1亿美元的赎金后，于去年11月宣布“隐退”。此外，新冒头的势力正在试图借用同行大佬的名头。去年秋天，有黑客冒充Lazarus和Fancy Bear (“奇幻熊”，一个臭名昭著的俄罗斯黑客组织) 对100多家金融公司发出威胁，如果它们不付赎金，就对它们发出分布式拒绝服务攻击，也就是由“僵尸网络操控者”操纵巨量被感染的计算机网络，用大规模互联网流量淹没目标。

这些黑客可以依靠兴旺的二级市场来将赃款变现。本刊最近通过一个超私密浏览器访问了一个相当于eBay的网站ToRReZ，在这里信用卡账户信息的价格为每张25美元，还能买三送一。只需4.99美元就可以买到教程，教你创建仿冒英国巴克莱银行的钓鱼网站。支付用的是加密货币，可以通过用假身份证件（比如150美元一张的田纳西州驾照）开设的银行账户兑现。新一代银行劫匪在作案道路上冒险进取的精神一如既往。 ■



On the simmer

Does America's hot housing market still need propping up?

Fed officials debate whether and when to taper support

“TRULY EXTRAORDINARY.” That was how Craig Lazzara of S&P Global, the firm that compiles a widely watched measure of house prices in America, described its reading for the month of April, released on June 29th. House prices rose by 14.6% year over year, the fastest rate in the 34-year history of the index (see chart, top panel). Houses listed for sale are on average snapped up in just 17 days, a record low. On Reddit, a social-media site, would-be buyers bemoan missing out on house after house because they are unwilling to forgo inspecting the property on which they plan to spend hundreds of thousands of dollars, something that most successful buyers are apparently doing.

The Federal Reserve still has monetary policy on ultra-loose mode. Interest rates are anchored at zero and the central bank is buying \$120bn-worth of assets each month—\$80bn of Treasuries and \$40bn of mortgage-backed securities—in order to depress long-term interest rates. This stance is in many ways still justified. There are 7.6m fewer jobs in America than there were before the pandemic. A large minority of adults remains unvaccinated. And yet consumer-price inflation has climbed to an annual rate of 4.9%, and commodities and labour are in short supply. A real-time estimate of economic output compiled by the Federal Reserve Bank of Atlanta puts annualised GDP growth in the second quarter at a heady 8.3%. If true, America has recovered all the output lost during the pandemic and even added more.

The case of the housing market aptly illustrates how different corners of the economy are pulling the Fed along at different speeds, if not in different

directions. The current property craze is at least in part spurred on by loose monetary policy. Low mortgage rates, which are a function of prevailing yields on mortgage-backed securities, tend to entice would-be homebuyers. Given that the housing market is already fired up, it might seem odd that the Fed is juicing it further by buying mortgage-backed securities and suppressing mortgage rates.

Even some Fed officials are discomfited by this turn of affairs. In an interview with the Financial Times on June 27th Eric Rosengren, the president of the Boston Fed, said that America could not afford a “boom-and-bust cycle” in the housing market that would threaten financial stability. He is not alone. Robert Kaplan, the head of the Dallas Fed, has said that there are “some unintended consequences and side-effects of these [mortgage-backed-security] purchases that we are seeing play out”, including contributing to rocketing house prices. James Bullard, the president of the St. Louis Fed, told CNBC on June 18th that “maybe we don’t need to be in mortgage-backed securities with a booming housing market.”

At the Fed’s monetary-policy meeting on June 15th and 16th Jerome Powell, its chairman, made clear that the central bank is not yet ready to stop buying assets, but has begun to discuss when might be appropriate. One option might be to do what Mr Rosengren called a “two-speed taper”, slowing mortgage purchases more quickly than purchases of Treasuries. If housing needs less support than the wider economy this seems a sensible step. The Fed has already begun to offload corporate bonds bought through an emergency programme launched in spring 2020, because the liquidity crunch that prompted intervention has abated.

A two-speed taper probably would not dent the housing market by much. For a start, the heat seems also to reflect a fall in supply during the pandemic, rather than low rates alone. And in any case, it is not as if the

mortgage-backed-security market operates in isolation from broad monetary conditions. Yields tend to closely track those of Treasuries, even when the Fed is not buying up assets (see chart, bottom panel). If the central bank is not ready to tighten monetary policy yet, then a hot housing market might be a side-effect it has to live with. Still, it probably does not need to egg property prices on. ■



快要沸腾

火热的美国楼市还需要浇油吗？

美联储官员争论是否以及何时该缩减支持

“确实异乎寻常。”标普全球（S&P Global，它编制的美国房价指数广受关注）的克雷格·拉扎拉（Craig Lazzara）如此形容该公司于6月29日发布的美国4月房价指数。美国房价同比上涨了14.6%，是该指数创立34年来录得的最快增速（见图表上半部分）。挂牌出售的房屋平均只要17天就被抢购走，为史上最快。在社交媒体网站Reddit上，准买家们哀叹一次次“抢房”失败，只因不愿意不看房就拿出几十万美元，而大多数成功买家显然正是这么做的。

美联储的货币政策仍处于超宽松模式。利率锚定为零，美联储每月购入1200亿美元的资产（包括800亿美元美国国债和400亿美元抵押担保证券）以压低长期利率。从多方面来说，这一政策选择仍旧是合理的。美国当前就业人数比疫情前少760万。还有相当一部分成年人仍未接种新冠疫苗。而消费者价格年化通胀率已攀升至4.9%，大宗商品和劳动力供应短缺。亚特兰大联储对经济产出的实时估计显示，第二季度的年化GDP增速高达8.3%。果真如此的话，那么美国已经收复了疫情期间的产出损失，甚至还有所增长。

美国楼市状况恰恰显示出经济的不同部分正以不同的速度、甚至往不同的方向拉扯美联储。目前的楼市热潮至少有一部分是受到了宽松货币政策的刺激。较低的按揭贷款利率（随抵押担保证券现行收益率的变化而变化）往往会刺激想要买房的人行动。既然楼市已经被点燃，美联储却还在购入抵押担保证券和压低按揭贷款利率，继续火上浇油，可能会显得有些奇怪。

连美联储的一些官员也对事情的走向感到不安。6月27日，波士顿联储主席埃里克·罗森格伦（Eric Rosengren）在接受英国《金融时报》采访时

说，美国经不起一轮楼市“大热转暴跌”的折腾，这将威胁金融稳定。这么想的不止他一人。达拉斯联储主席罗伯特·卡普兰（Robert Kaplan）表示，“我们看到这些（抵押担保证券）购买行动正在产生始料不及的后果和副作用”，包括促使房价飙升。圣路易斯联储主席詹姆斯·布拉德

（James Bullard）6月18日对CNBC频道表示：“楼市火热的时候，也许我们就不再购入抵押担保证券了。”

在6月15日和16日召开的美联储货币政策会议上，主席鲍威尔明确表示，美联储尚未准备好停止购入资产，但已开始讨论这样做的适当时机。一种选择可能是采取罗森格伦所说的“双速缩减”，即放缓购入抵押担保债券和美国国债，但让前者的减速快于后者。如果楼市所需的支持低于整体经济，那这似乎是明智之举。美联储已开始抛售通过2020年春季启动的紧急计划购入的公司债券，因为促使美联储在当时做出干预的流动性紧缩已得到缓解。

“双速缩减”可能不会对楼市造成太大影响。首先，楼市火爆不单是低利率的反映，疫情期间房地产供应减少似乎也是一个原因。而且，在任何情况下，抵押担保证券市场的运作都不能脱离货币大环境。即使美联储不购入资产，抵押贷款收益率也往往紧随国债收益率变化（见图表下半部分）。如果美联储还没有准备好收紧货币政策，也许只能接受楼市火热这一副作用。不过，它很可能不需要再对房价推波助澜了。■



The future of war

A thought-provoking reflection on how AI will change conflict

Algorithms may make proficient soldiers but poor generals

I, Warbot. By Kenneth Payne. Oxford University Press; 336 pages; \$29.95. Hurst; £20

THE UN'S Panel of Experts on Libya rarely grabs the headlines. But its valedictory report in March caused a furore. It noted that in a battle around Tripoli last year, Libya's government had "hunted down and remotely engaged" the enemy with drones—and not just any drones. The Kargu-2 was programmed to attack "without requiring data connectivity between the operator and the munition". The implication was that it could pick its own targets.

Was this a true autonomous weapon, or just a clever missile? In June the Turkish manufacturer insisted that, contrary to its own marketing, for now the drone required a human to push the button. This sort of technology is at the heart of "I, Warbot" by Kenneth Payne, a thought-provoking reflection on how artificial intelligence (AI) will change conflict.

In some ways, the story is familiar. It involves the entwined histories of computing and warfare; the recent evolution of new, powerful forms of AI modelled on the neurons of the brain rather than the logic of the mind; and the ensuing possibilities for weapons to see what is around them—and strike with superhuman speed and precision. Mr Payne, an academic at King's College London, is especially bullish on the potential of swarms, "a menagerie of specialist robots" that can concentrate to attack and melt away just as quickly.

"The tactical implications are profound," he predicts. The offence will

dominate. Defenders will have to rely on deception, generating clouds of decoy targets, rather than on protections like armour and fortification. Martial virtues such as courage and leadership will give way to technical competence. Dividing armed forces into services optimised for land, air and sea may look increasingly strange in a world of machines that can range across them.

Above all, though, “I, Warbot” is a reminder that war is about more than tactics. It is about choosing which battles to fight, how to knit them into a successful campaign and how to connect military victories to political aims—in short, war is about strategy. And soldiery and strategy are fundamentally different. Computer programs can already defeat human pilots in simulated dogfights. But could they come up with the bold, swift and visionary attacks that let Napoleon Bonaparte knock out one European army after another?

Algorithms can certainly outwit opponents in games that blend skill, chance and psychology. In 2017 Libratus, a computer program, saw off four poker stars. AI can also innovate: in 2016 AlphaGo, another program, thrashed a world champion of Go, an ancient Chinese board-game, with moves that dazzled onlookers.

But, argues Mr Payne, this is a simulacrum of genius, not the real thing. These gizmos exhibit “exploratory creativity”—essentially a brute-force calculation of probabilities. That is fundamentally different from “transformational creativity”, which entails the ability to consider a problem in a wholly new way, and requires playfulness, imagination and a sense of meaning. All that may depend on emotion, and thus on parts of human biology alien to computers. “AI is a statistical processor par excellence”; but in essence it remains “a wonderfully sophisticated abacus”.

A proficient soldier, the warbot may thus be a limited general. The problem

is that the line between tactics and strategy can blur. Battlefield decisions can have geopolitical ramifications. Consider the case of B-59, a Soviet submarine pounded by American depth-charges during the Cuban missile crisis of 1962. The frazzled captain ordered the use of a nuclear-tipped torpedo. Conscious of the stakes, Vasily Arkhipov, the second-in-command, refused to authorise the launch.

Would a computer have done so? “A warbot is likely to be more accurate, proportionate and discriminate” than humans, says Mr Payne. The risk is that “a machine is undeterred by the sobering fear of things getting out of hand.” ■



未来战争

对人工智能会如何改变战事的深思

算法也许能打造精兵，但难以成就强将【《我，战争机器人》书评】

《我，战争机器人》，肯尼斯·佩恩著。牛津大学出版社，336页，29.95美元。赫斯特出版社，20英镑

联合国的利比亚问题专家小组很少登上头条。但今年3月，该小组的一份总结报告激起了波澜。报告指出，去年在的黎波里周边的一场战役中，利比亚政府运用无人机“追击并远程攻击”敌军。这种名为Kargu-2的无人机非同一般，它被设定为“无需在操作员和本机之间做数据连接”就能发动攻击，也就是说，它能自主选择攻击目标。

这究竟是一款名副其实的自主武器，还是只是一种智能导弹？6月，其土耳其制造商坚称，就目前而言，这款无人机在发起攻击时仍需要人类按下操作按钮。这和它在营销时的说法自相矛盾。这类技术正是肯尼斯·佩恩（Kenneth Payne）的新著《我，战争机器人》（I, Warbot）讨论的核心，书中对人工智能（AI）将如何改变军事冲突的思考发人深省。

在某些方面，这些内容并不稀奇。它涉及计算与战争交织的历史、模拟大脑神经元而非思维逻辑的强大新型AI的进展，以及武器因而可能“看见”周围环境——并以人类无法企及的速度与精度发起攻击。佩恩是伦敦国王学院的一名学者，他特别看好“无人机群”的潜力，即可以快速聚集攻击而后又快速分散的“专用机器人集群”。

“这对战术有深远的影响。”他预测。进攻方将占尽上风。防御方只得依赖障眼法，制造大量诱饵目标，而不再是依赖装甲和防御工事。勇气和指挥等军事素养将让位给技术能力。机器将会跨越海陆空的界限，使得把军队划分为三个军种显得日益不合时宜。

然而最重要的是，《我，战争机器人》提醒人们，战争不仅仅在于战术。

它关乎选择去打哪些仗，如何部署它们来赢得一整个战役，以及如何把军事胜利与政治目标连接起来——简言之，战争关乎战略。而战斗能力和战略部署根本是两回事。在模拟空战中，计算机程序已经可以击败人类飞行员。但它们能想出拿破仑一世一一击溃欧洲各国军队时采用的那些大胆、迅捷、富有远见的战法吗？

在结合技巧、概率和心理战的游戏中，算法确实有可能战胜对手。2017年，名为冷扑大师（Libratus）的计算机程序就击败了四位顶尖扑克选手。AI也能创新：2016年，另一个名为阿尔法狗（AlphaGo）的程序走出令人诧异的棋着，最终击败了围棋世界冠军。

但佩恩认为，这只是对人类才智的模拟，而非才智本身。这些程序展现的“探索性创造力”实质上是对概率的蛮力运算。这与“变革性创造力”有质的区别，后者需要以全新方式看待问题的能力，也需要一种随性顽皮、想象力和意义感。这一切可能都依赖于情感，也就是计算机所缺失的那部分人类生物特质。“AI是卓越的统计学处理器”，但本质上仍不过是“一个非常精密的算盘”。

所以，战争机器人可以是精兵，但可能做不了强将。问题在于战术和战略之间的界限会模糊。战场上的决策可能产生地缘政治后果。想想1962年古巴导弹危机期间遭美国深水炸弹围截的苏联潜艇B-59。当时烦躁不堪的艇长下令发射装有核弹头的鱼雷，但副艇长瓦西里·阿尔希波夫（Vasily Arkhipov）意识到其中的利害关系，拒绝批准发射鱼雷。

换了是计算机，它会这样做吗？相比人类，“战争机器人可能更精准、更均衡、辨别力更强”，佩恩指出。但危险之处是“机器不会因为对局面可能失控生发出令人清醒的恐惧而却步”。 ■



Rocks and hard places

Big miners' capital discipline is good news for investors

Not, alas, for the planet

HIGH IN THE mountains of southern Peru lies Quellaveco, a vast open-pit copper mine. It is one of the world's largest untapped deposits of the red metal. Anglo American, a mining giant and its majority owner, has, along with another investor, spent over \$5bn getting it up and running. It is expected to come online in 2022. Once operational it will add more than 10% to the copper output of Peru, the world's second-biggest producer of the stuff.

In the past when commodity prices were surging, as they have been of late (see chart 1), the world's miners would be piling into projects like Quellaveco. This time the notable thing about it is its uniqueness. Few of the diversified mining behemoths—Anglo American, BHP, Glencore, Rio Tinto and Vale—have big new mines in the works. That is partly because of the industry's long lead times; Anglo bought Quellaveco in 1992. But other forces, too, lie beneath the subdued investment. They will have consequences for the mineral-intensive energy transition towards a climate-friendlier world.

The big five miners consolidated their market power with a spate of huge mergers in the 2000s, just in time for China's emergence as a voracious consumer of metals. The result was a 15-year supercycle of high prices. Miners splurged around \$1trn chasing higher volumes and mega-projects. Many proved disastrous—perhaps a fifth of that investment was returned to shareholders, according to one estimate. After a round of firings, a new generation of mining bosses promised to do better. In the past few years value, not volume, became the industry's watchword. “We will never lose

our capital discipline," vows Eduardo Bartolomeo, boss of Vale.

So far the miners have kept their promise. Although capital spending in the industry has grown since 2015, it is still 50% below its peak in 2012. Most of that has gone on sustaining current output, not adding new capacity. Even as rising metals prices have padded profit margins, spending on exploration has stayed low, notes Danielle Chigumira of Bernstein, a broker (see chart 2). That is a break from the past.

Whether the sobriety lasts will depend on a fresh crop of CEOs. In the past 18 months three of the big five got new bosses. In January 2020 Mike Henry took the reins at BHP. A year later Jakob Stausholm became boss of Rio Tinto, after his predecessor was fired in the wake of the destruction of a 46,000-year-old Aboriginal site in Australia. On July 1st Gary Nagle took the top job at Glencore, ending Ivan Glasenberg's 19-year reign at the Swiss-based trader-turned-miner. Mark Cutifani, Anglo American's boss, may retire next year.

Their biggest challenge is responding to the energy transition. The companies have taken some defensive steps, getting out of the most carbon-intensive operations. Rio Tinto left the thermal-coal business in 2018. On June 6th Anglo spun off its coal operation. BHP and Vale have promised to do the same. Mines across the world are emitting less carbon dioxide, as operators invest in renewable power and try to electrify mining vehicles.

On paper, the energy transition could be a mining bonanza. If the world is to meet the Paris climate agreement's target of limiting global warming to 1.5°C above pre-industrial levels, the demand for metals such as cobalt, copper, lithium and nickel will explode. The International Energy Agency, a forecaster, calculates that an electric car needs six times the mineral content of one with an internal combustion engine. The average onshore wind farm

is nine times more resource-intensive than a gas-fired power plant.

Shifting towards green metals is, however, proving harder than moving away from dirty minerals. The big-five miners' portfolios are weighed down with commodities from the past supercycle. Iron ore and fossil fuels still account for over half their mining revenues and three-quarters of their gross operating profits. High metal prices make potential targets look dear.

The other option, developing their own projects, also presents problems. One is investors. Since torching shareholder value the last time around, miners have been on a tight leash. Bosses "know the way to be sacked is to have one of these mega-projects", says one big investor. Much of the cash flowing in thanks to surging commodity prices is going back to shareholders in record dividends and buy-backs. One mining executive fears that the fat returns have changed the make-up of his shareholders, attracting yield-hungry investors averse to growth projects.

Second, many energy-transition metals are simply too small a market for the big miners to bother with. Take lithium, which is used in batteries. In 2004 Rio Tinto discovered a large deposit in Jadar in Serbia. When the project comes online in a few years it may add 2-3% to Rio's revenue, reckons Liam Fitzpatrick of Deutsche Bank. That is not enough to move the needle at a firm with a market value of \$140bn. The market for cobalt is even smaller.

The exception is copper. Its ubiquitous use in electrical wiring makes it one of the biggest metals markets by value even today. If the world is to meet its climate goals, demand for it could almost triple. However, finding a big new copper project is hard. Prospected deposits are getting smaller and ore grades worse. That makes mining them more expensive. Possibly except for swashbuckling Glencore, big miners increasingly steer clear of less-explored copper-rich regions like the Democratic Republic of Congo

(DRC), which tend to be politically unstable. Even when miners find a seam, increasing output is a slog—and becoming more of one as public pressure mounts on miners to mitigate risks to the local environment and residents. The average mine takes over 15 years to move from discovery to production.

Then there is resource nationalism. The covid-19 pandemic has emptied government coffers. Miners worry that they will be asked to make up the shortfall. Chile, the world's largest copper producer, is rewriting its constitution. A new bill making its way through parliament could slap an 80% tax on mining profits. Peru's left-wing president-elect, Pedro Castillo, wants to tax mining profits at 70%. Zambia and Panama, two other copper-rich countries, are also considering higher taxes.

One thing that could loosen the mining supermajors' purse-strings is competition. Small firms, such as Lithium Americas and Global Cobalt, hope to strike it big. So do some non-Western giants. Norilsk Nickel, a large Russian miner, plans to invest \$15bn-17.5bn over five years (last year it spent \$1.7bn). Zijin Mining, a Chinese rival, also has big expansion plans. If prices stay high—which some mining bosses doubt given their rapid rise, as well as copper's slide since its peak in May—certain big projects in tricky places like the DRC may begin to look attractive again.

Price support could come courtesy of governments in the West. On June 8th the White House published an inter-agency review of supply chains, arguing for more action in securing critical minerals, including lithium and nickel. The EU wants to do the same with its green industrial strategy. Mr Bartolomeo of Vale expects miners to forge more strategic partnerships with national authorities in the future.

If supply does not increase, however, shortages of some metals such as copper may prove unavoidable. Some of the shortfall could perhaps be met by substituting other metals or more recycling of previously used ones. But

not all of it. Investors applaud the mining bosses' newfound restraint. The planet may prefer a return to past exuberance. ■



两难之地

矿业巨头的资本约束对投资者是好消息

可惜对地球不是好事

在秘鲁南部的高山上，有一个叫作奎拉维科（Quellaveco）的巨大露天铜矿。它是世界上最大的未开发铜矿之一。矿业巨头英美资源（Anglo American）和它的大股东联合另一家投资者，已经为开采该铜矿投入了50多亿美元。预计该铜矿将于2022年投产。一旦投入运营，它将让秘鲁这个世界第二大产铜国的铜产量增长超过10%。

过去，当大宗商品价格像近来一样飙升时（见图表1），世界各地的矿业公司就会蜂拥启动奎拉维科这样的项目。这一次，值得注意的是这种项目很罕见。英美资源、必和必拓（BHP）、嘉能可（Glencore）、力拓（Rio Tinto）以及淡水河谷（Vale）这五家多元化经营的矿业巨头目前基本没有什么筹建中的大型新矿。部分原因是采矿业从勘探到投产的周期太长——英美资源早在1992年就收购了奎拉维科。但在投资低迷的背后还有一些其他因素。它们将给能源业向气候友好的转型带来影响，这个转型过程会用到大量矿产。

本世纪头十年，五大矿业公司通过一连串大规模并购巩固了自己的市场势力，其时正好赶上中国成为金属消费大户。这引发了一个长达15年的大宗商品价格高企的超级周期。矿业公司追逐更高的产量和超大型项目，狂撒了约一万亿美元。事实证明，许多投资是灾难性的——一项估计显示投资者大概收回了其中的五分之一。在经历了一轮换帅潮之后，新上任的矿老板们承诺扭转局面。在过去几年里，价值——而不是产量——成为了这个行业的口号。淡水河谷的老板爱德华多·巴托洛梅奥（Eduardo Bartolomeo）誓言：“我们永远不会丢掉自己的资本约束。”

到目前为止，这些矿商遵守了自己的承诺。尽管该行业的资本支出自2015年以来有所增长，但仍比2012年时的峰值低50%。大部分资金都用于维持

现有产量，而不是增产。即便是在金属价格上涨拉高了利润率之时，勘探支出仍保持在较低水平（见图表2），经纪公司盛博的丹妮尔·奇古米拉（Danielle Chigumira）指出。这一反既往。

这种节制能否持续将取决于新一批CEO。过去一年半中，五大巨头中有三家换了老板。去年1月，迈克·亨利（Mike Henry）开始执掌必和必拓。一年后，雅各布·斯陶舒勒姆（Jakob Stausholm）成了力拓的老板，他的前任因为力拓毁坏了澳大利亚一个有着4.6万年历史的土著遗址而被解雇。7月1日，加里·内格尔（Gary Nagle）出任嘉能可CEO，此前伊凡·格拉森伯格（Ivan Glasenberg）统领这家总部位于瑞士、由贸易商转型而来的矿业公司长达19年。英美资源集团的老板马克·卡蒂芬尼（Mark Cutifani）可能在明年退休。

他们最大的挑战是应对能源转型。这些公司已经采取了一些防御性措施，退出了一些碳排放最密集的业务。2018年，力拓放弃了热能煤业务。6月6日，英美资源集团剥离了煤炭业务。必和必拓和淡水河谷也承诺要这么做。随着运营商开始投资可再生能源并努力推动采矿车辆电气化，全球矿山排放的二氧化碳正在减少。

理论上说，能源转型可能是一轮大淘金。要实现巴黎气候协议的目标，把全球变暖幅度限制在比工业化前水平高1.5℃以内，世界对钴、铜、锂和镍等金属的需求将会激增。据预测机构国际能源署（International Energy Agency）计算，一辆电动汽车所需的矿物是一辆内燃机汽车的六倍。一座普通的陆上风电场消耗的金属资源是燃气发电厂的九倍。

然而，目前看来，向环保金属转型比摆脱污染型矿物更难。五大矿商的投资组合目前充满了上一轮超级周期中累积的大宗商品。铁矿石和化石燃料仍占它们矿业收入的一半以上、营业毛利润的四分之三。高企的金属价格使得潜在收购目标看上去很昂贵。

另一种选择是自己开发项目，这也有问题。首先是投资者。在上次烧掉股东价值后，矿商一直受到严格约束。一位大投资者说，老板们“知道去做

一个这样的超大项目就是想被炒鱿鱼”。因大宗商品价格飙升而流入的大量现金都以创纪录的股息和回购返还给了股东。一位矿业高管担心，丰厚的回报已经改变了自己公司的股东构成，引来了一味追求收益而不愿投资成长型新项目的投资者。

其次，对于大型矿商来说，能源转型所需的许多金属的市场太小，不足以让它们费心。以用于电池的锂为例。2004年，力拓在塞尔维亚的雅达尔（Jadar）发现了一个大型锂矿。德意志银行的利亚姆·菲茨帕特里克（Liam Fitzpatrick）估计，如果这个项目在几年内投产，可能会为力拓的收入带来2%至3%的增长。但对一家市值1400亿美元的公司来说，这只是杯水车薪。钴的市场甚至更小。

铜是个例外。即使到了今天，它在电线上的普遍应用令它依然是按价值计最大的金属市场之一。要实现气候目标，世界对铜的需求可能会增加近两倍。然而，找到一个新的大型铜矿不容易。勘探发现的矿藏越来越小，矿石品位越来越低。这推高了采矿成本。可能除了勇猛无畏的嘉能可之外，大矿商越来越不愿涉足铜储量丰富而勘探不多的地区，比如政局动荡的刚果金。即使发现了矿层，要增产也是个艰难的过程。而且由于矿商承受着来自公众日益增多的压力，要求减轻对本地环境和居民的风险，这个过程还会进一步拉长。现在从勘探到投产平均需要15年以上。

还有资源民族主义。新冠疫情掏空了各国政府的金库。矿商担心自己会被要求填补资金缺口。世界最大的产铜国智利正在修改宪法。一项等待议会通过的新法案可能会对矿业利润征收80%的税。秘鲁的左翼当选总统佩德罗·卡斯蒂洛（Pedro Castillo）希望对矿业利润征收70%的税。另外两个主要产铜国赞比亚和巴拿马也在考虑提高税率。

有一样东西可能会让矿业巨头松开自己的钱袋子，那就是竞争。像美洲锂业（Lithium Americas）和全球钴业（Global Cobalt）这样的小公司希望大获成功。一些非西方的矿业巨头也是。俄罗斯大型矿业公司诺里尔斯克镍业（Norilsk Nickel）计划在五年内投资150亿至175亿美元（去年该公司投资了17亿美元）。中国竞争对手紫金矿业也有庞大的扩张计划。如果金

属价格保持在高位，刚果金等棘手地区的某些大型项目可能会再次变得有吸引力，尽管鉴于金属价格上涨极快，且铜价在5月的峰值后下滑，一些矿老板对金属价格能否一直保持高位持怀疑态度。

西方一些政府可能会为金属价格提供支持。6月8日，白宫发布了一份关于供应链的跨部门评估报告，要求采取更多行动，确保锂、镍等关键矿产的安全。欧盟也想通过其绿色产业战略实现同样的目标。淡水河谷的巴托洛梅奥预计，未来矿商将与各国政府建立更多的战略合作关系。

然而，如果不增加供应，铜等一些金属的短缺可能不可避免。其中一些缺口或许能通过用其他金属替代或加大回收利用来弥补。但不是所有缺口都能弥补。投资者赞赏矿老板们近年来的自我约束。地球可能更希望回到过去挥霍的局面。 ■



Selling like hot cakes

Investors cannot get enough of Chinese e-grocers

Will this cause indigestion?

WET MARKETS in China have suffered more than most businesses in the pandemic. After one in Wuhan was blamed as the source of covid-19, officials ordered others to shut. Shoppers have been reluctant to frequent bustling outdoor stalls selling fresh meat and vegetables. Many may never reopen—not least because they are being rapidly displaced by online rivals. The value of online sales of fresh produce in China, which amounted to 293bn yuan (\$45bn) in 2019, before the pandemic, may rise to 570bn yuan by the end of 2021 (see chart). That would put e-grocers' share of fresh-food spending at 11%, double what it was before covid-19. It could hit 18% by the middle of the decade.

Until recently e-grocery was a small add-on to other e-commerce offerings of giants such as Alibaba or JD.com, rather than a big business in its own right. No longer. JD.com is busily adapting its logistics network, China's most sophisticated, to handle fresh produce. Last year Alibaba spent \$3.6bn on a grocery-store chain, and it has been building a network of supermarkets that can be used to get groceries to online shoppers. Pinduoduo, another big e-merchant, raised \$6bn in 2020 to boost its grocery operations. It ferries produce to neighbourhood shops where buyers can pick up orders, overcoming the problem of the costly last mile, says David Liu, the company's vice-president of strategy.

At the same time, challengers are taking a bite out of the market. Missfresh claims to control 28% of Chinese e-grocery deliveries that rely of distributed mini-warehouses: small, refrigerated neighbourhood storage centres, which the company is credited with inventing. By keeping the products

closer to customers, Missfresh says it was able to fulfil orders in an average of 39 minutes in 16 cities during the first three months of the year. Dingdong Maicai, which has 10% of the domestic market and is the dominant e-grocer in the greater Shanghai region, has built a similar set of units. WM Tech, with a market share of around 17% in northern China, can count on the retail chops of its boss, Zhang Wenzhong, who founded Wumart as China's answer to Walmart in 1994. Like Alibaba, it can use its hundreds of retail outlets as warehouses.

China's fragmented agricultural sector, a relative absence of industrial farming, poor transport links to rural areas and patchy cold-supply chains beyond cities all add to the costs in what is already a business with wafer-thin margins. Missfresh, Dingdong and dozens of smaller rivals are burning cash as they scramble for market share in the hope of adding millions of new customers. The pair alone notched up a combined 9.7bn yuan in net losses during 2019 and 2020. WM Tech makes a profit, but that is thanks in large part to its conventional retail operation.

All this leads Arun George of Smartkarma, a research firm, to fear a repeat of China's e-bike boom and bust, which left cities littered with clapped-out bicycles and investors with holes in their pockets. Adding to the uncertainty, Chinese authorities are paying closer attention to dominant technology firms, as well as to the plight of overworked scooter-borne delivery drivers. A government official recently went undercover to reveal their arduous 12-hour days for little pay. In January one desperate delivery worker set himself on fire over unpaid wages.

Pessimists like Mr George are, though, in the minority. Rural infrastructure is improving and the government may, despite the sting operation, prefer millions of drivers with tough jobs to millions of restive jobless. And the e-grocers have deep-pocketed patrons. Tencent, China's most valuable

internet company, has backed both WM Tech and Missfresh. Dingdong has secured an investment from SoftBank, a free-spending Japanese technology group. Tiger Global, an aggressive American hedge fund, which bets on promising markets rather than single startups, is also bullish. It holds a 12% stake in Missfresh and a smaller one in Dingdong.

As for broader appetite for Chinese e-grocers, it is about to be tested. In June both Missfresh and Dingdong unveiled plans for initial public offerings in New York. WM Tech is eyeing a flotation in Hong Kong. The three companies could raise a total of \$2bn. That would be enough to keep them fresh for a while—but also to leave investors with indigestion. ■



新鲜热卖

投资者对中国的食品杂货电商胃口大开 会消化不良吗？

在疫情中，中国菜市场遭受的损失超过了大多数行业。在武汉的一处市场被指为新冠肺炎的传染源后，官方下令关闭其他菜市场。购物者不愿频繁光顾户外人来人往、售卖新鲜肉类和蔬菜的摊位。许多菜市场可能永远不会再重开，主要是因为它们正在被线上竞争对手迅速取代。在疫情爆发前的2019年，中国生鲜农产品的线上销售额为2930亿元，到2021年底，这一数字可能会上升到5700亿元（见图表）。这将使得食品杂货电商在生鲜食品支出中所占的份额达到11%，是疫情前的两倍。到2025年左右，这一比例可能会达到18%。

不久之前，食品杂货电商还只是阿里巴巴或京东等巨头在做其他电商业务时捎带的一个小附加服务，而不是一项独立的大业务。但现在不一样了。京东正忙着调整它那全国最先进的物流网络来更好地处理生鲜产品。去年，阿里巴巴以36亿美元收购了一家食品杂货连锁店，并一直在打造一个超市网络，可以用来将食品杂货送到网上购物者手中。另一家大型电商拼多多在2020年融资60亿美元来提升其食品杂货业务。该公司战略副总裁九鼎表示，它把产品送到附近的店铺，买家可以在那里提货，解决了最后一公里配送成本高昂的问题。

与此同时，挑战者也在抢占市场份额。每日优鲜称它掌握了28%的中国食杂电商配送，依靠的是分散的迷你仓库——小型的社区冷藏仓储中心，这被认为是该公司的一项创新。该公司称，通过让产品离客户更近，今年前三个月它在16个城市的平均履单时间为39分钟。叮咚买菜占国内食杂电商市场份额10%的份额，在长三角地区占据主导地位，它也建立了一系列类似的仓储单位。物美科技在中国北方的市场份额约为17%，它依靠的是老板张文中的零售技能。张文中在1994年创立了中国市场自己的沃尔玛——物美超市。和阿里巴巴一样，它可以把自己的几百家门店用作仓库。

中国的农业部门分散，现代化程度相对不足，农村地区交通落后，城市以外冷链参差不齐，这些因素都增加了一个本已利润微薄的行业的成本。每日优鲜、叮咚买菜和几十家规模更小些的竞争对手都在烧钱争夺市场份额，希望增加数百万新客户。2019年和2020年期间，单是这两家公司就合计净亏损97亿元。物美科技是盈利的，但在很大程度上要归功于它的传统零售业务。

所有这些都让研究公司Smartkarma的阿伦·乔治（Arun George）担心中国共享单车的兴衰史将重演——如今城市各处散落着破旧的自行车，而投资者的钱袋空空。进一步增加了不确定性的是，中国当局正在加强看管占主导地位的科技公司，以及关注工作过劳的外卖员的困境。一位政府官员最近“卧底”打工，揭示了外卖员每日辛苦劳作12个小时却收入微薄的现状。今年1月，有位绝望的外卖员因为被拖欠工资而自焚。

不过，像乔治这样的悲观主义者是少数。农村基础设施正在改善。而且尽管做了卧底调查，政府可能宁可社会上有上千万辛苦劳作的送货员，也不要上千万焦躁不安的失业者。食品杂货电商也有财力雄厚的投资人。中国市值最高的互联网公司腾讯就一并资助了物美科技和每日优鲜。叮咚买菜已经从出手大方的日本科技集团软银那里获得了一笔投资。投资风格彪悍的美国对冲基金老虎环球（Tiger Global）押注有前景的市场而非某家创业公司，它同样对这个市场看涨。它持有每日优鲜12%的股份，还有更少一些的叮咚买菜的股份。

而更广泛人群对中国食品杂货电商的胃口将经受考验。6月，每日优鲜和叮咚买菜都公布了在纽约上市的计划。物美科技正考虑在香港上市。这三家公司可能总共融资20亿美元。这足以让它们在一段时间内保持新鲜，但也会让投资者消化不良。■



After the disease

The long goodbye to covid-19

The pandemic is still far from over, but glimpses of its legacy are emerging

WHEN WILL it end? For a year and a half, covid-19 has gripped one country after another. Just when you think the virus is beaten, a new variant comes storming back, more infectious than the last. And yet, as the number of vaccinations passes 3bn, glimpses of post-covid life are emerging. Already, two things are clear: that the last phase of the pandemic will be drawn-out and painful; and that covid-19 will leave behind a different world.

This week The Economist publishes a normalcy index, which reflects both these realities. Taking the pre-pandemic average as 100, it tracks such things as flights, traffic and retailing across 50 countries comprising 76% of Earth's population. Today it stands at 66, almost double the level in April 2020.

Yet the ravages of covid-19 are still apparent in many countries. Consider our index's worst performer, Malaysia, which is suffering a wave of infections six times more deadly than the surge in January and scores just 27. The main reason for this is that vaccination remains incomplete.

In sub-Saharan Africa, suffering a lethal outbreak, just 2.4% of the population aged over 12 has had a single dose. Even in America, where vaccines are plentiful, only around 30% of Mississippians and Alabamans are fully protected. Although the world is set to produce around 11bn doses of vaccine this year, it will be months before all those jabs find arms, and longer if rich countries hog doses on the off-chance that they may need them.

The lack of vaccination is aggravated by new variants. Delta, first spotted in India, is two to three times more infectious than the virus that came out of

Wuhan. Cases spread so fast that hospitals can rapidly run out of beds and medical staff (and sometimes oxygen), even in places where 30% of people have had jabs. Today's variants are spreading even among the vaccinated. No mutation has yet put a dent in the vaccines' ability to prevent almost all severe disease and death. But the next one might.

None of this alters the fact that the pandemic will eventually abate, even though the virus itself is likely to survive. For those fortunate enough to have been fully vaccinated and to have access to new treatments, covid-19 is already fast becoming a non-lethal disease. In Britain, where Delta is dominant, the fatality rate if you become infected is now about 0.1%, similar to seasonal flu: a danger, but a manageable one. If a variant required a reformulated vaccine, it would not take long to create.

However, as vaccines and treatments become more plentiful in rich countries, so will anger at seeing people in poor ones die for want of supplies. That will cause friction between rich countries and the rest. Travel bans will keep the two worlds apart.

Eventually flights will resume, but other changes in behaviour will last. Some will be profound. Take America, where the booming economy surged past its pre-pandemic level back in March, but which still scores only 73 on our index—partly because big cities are quieter, and more people work from home.

So far it looks as if the legacy of covid-19 will follow the pattern set by past pandemics. Nicholas Christakis of Yale University identifies three shifts: the collective threat prompts a growth in state power; the overturning of everyday life leads to a search for meaning; and the closeness of death which brings caution while the disease rages, spurs audacity when it has passed. Each will mark society in its own way.

When people in rich countries retreated into their houses during lockdowns, the state barricaded itself in with them. During the pandemic governments have been the main channel for information, the setters of rules, a source of cash and, ultimately, providers of vaccines. Very roughly, rich-country governments paid out 90 cents for every dollar of lost output. Slightly to their own amazement, politicians who restricted civil liberties found that most of their citizens applauded.

There is a vigorous academic debate about whether lockdowns were “worth it”. But the big-government legacy of the pandemic is already on display. Just look at the spending plans of the Biden administration. Whatever the problem—inequality, sluggish economic growth, the security of supply chains—a bigger, more activist government seems to be the preferred solution.

There is also evidence of a renewed search for meaning. This is reinforcing the shift towards identity politics on both the right and the left, but it goes deeper than that. Roughly one in five people in Italy and the Netherlands told Pew, a pollster, that the pandemic had made their countries more religious. In Spain and Canada about two in five said family ties had become stronger.

Leisure has been affected, too. People say they have had 15% more time on their hands. In Britain young women spent 50% longer with their nose in a book. Literary agents have been swamped with first novels. Some of this will fade: media firms fear an “attention recession”. But some changes will stick.

For example, people may decide they want to escape pre-pandemic drudgery at work, and tight labour markets may help them. In Britain applications to medical school were up by 21% in 2020. In America business creation has been its highest since records began in 2004. One in three Americans who can work from home wants to do so five days a week, according to surveys.

Some bosses are ordering people into the office; others are trying to entice them in.

It is still unclear whether the appetite for risk is about to rebound. In principle, if you survive a life-threatening disease, you may count yourself as one of the lucky ones and the devil may care. In the years after the Spanish flu a century ago, a hunger for excitement burst onto the scene in every sphere, from sexual licence to the arts to the craze for speed. This time the new frontiers could range from space travel to genetic engineering, artificial intelligence and enhanced reality.

Even before the coronavirus came along, the digital revolution, climate change and China's rise seemed to be bringing the post-second-world-war, Western-led order to an end. The pandemic will hasten the transformation.





【首文】疫情之后

与新冠肺炎的漫长告别

疫情远未结束，但其后遗症已经浮现

什么时候才是尽头？一年半了，新冠疫情蔓延到一个又一个国家。就当世人以为病毒已被打败的时候，新的变种又卷土重来，传染性更甚于前。然而，随着疫苗接种超过30亿剂次，后疫情时代的生活面貌正在浮现。现在有两件事已经明确无疑：疫情的最后阶段将漫长而痛苦；疫情过后的世界将截然不同。

本刊在近日发布了一个“正常化指数”来反映上述两个方面。该指数将疫情前的平均水平设定为100，追踪了50个国家（占全球人口76%）的航班、道路交通和零售等数据。今天该指数的分值为66，几乎是2020年4月的两倍。

不过许多国家仍深陷疫情之中。例如在指数中垫底、仅得27分的马来西亚，该国近来遭遇新一波疫情，致死率是1月那一波的六倍。造成这种情况的主要原因是疫苗接种仍然不足。

在遭受一波疫情致命打击的撒哈拉以南非洲地区，12岁以上人口中只有2.4%接种了第一剂疫苗。即使是疫苗充足的美国，在密西西比州和阿拉巴马州也只有大约30%的人获得完全保护。尽管全球今年将生产约110亿剂疫苗，但全部完成注射这些疫苗还需要好几个月的时间，如果富裕国家为了以防万一而囤积疫苗，时间还会更久。

疫苗接种不足的问题因为病毒新变种的出现而更加严峻。德尔塔毒株首先在印度发现，传染性是来自武汉的毒株的两到三倍。其传播速度之快，有时医院病床迅速爆满，医护人员不足（有时连氧气都供应不及），即使在接种率达到30%的地区也是如此。如今，病毒变种甚至在已经接种的人群中蔓延。到目前为止，病毒的突变尚未削弱疫苗防止几乎所有重症和死亡的效力。但下一次突变就说不定了。

所有这些都不能改变疫情终将消退的事实，即使病毒本身很可能会继续存活下去。对于那些有幸完全接种疫苗以及可以获得新疗法的人来说，新冠肺炎已经很快成为一种非致命性疾病。在传播的病毒以德尔塔变种为主的英国，目前感染后的致死率约为0.1%，类似于季节性流感，属于危险但可控的程度。如果需要为某个变种重新开发疫苗，花的时间也不会太长。

然而，随着富裕国家的疫苗和治疗手段日益丰富，对穷国民众因供应匮乏而难逃一死的愤怒也会与日俱增。这将引发富国与世界其余地区之间的矛盾。旅行禁令将让这两个世界彼此隔离。

航班终将恢复，但其他行为的变化会继续下去。有些会有深远的影响。以美国为例，其经济的景气程度在3月已超过疫情前水平，但在我们的指数中仍只得到73分——部分原因是大城市变得冷清，更多人在家工作。

目前看来，新冠疫情的遗留影响仍将遵循以往大流行病的模式。耶鲁大学的尼古拉斯·克里斯塔基斯（Nicholas Christakis）指出了三个转变：集体威胁促使国家权力扩增；日常生活被颠覆导致人们寻找生活的意义；疫病肆虐时面对死亡的威胁人人谨小慎微，待它消退后人们又会格外胆大妄为。每一种转变都将以自己的方式深刻地影响社会。

在封锁期间，富裕国家的国民闭门不出，政府也紧锁国门。在疫情中，政府是信息的主要渠道、规则的制定者、现金的来源，最后也是疫苗的提供者。据非常粗略的计算，在富裕国家，政府出资填补了90%的产出损失。限制公民自由的政客发现大部分民众都表示拥护，连他们自己都略感意外。

关于封锁到底是否“值得”，学术界正在激烈争论。但作为疫情后遗症的大政府现象已经清晰可见。看看拜登政府的支出计划就知道了。无论问题是什么——不平等、经济增长缓慢、供应链安全——更大、更积极的政府似乎是首选的解决方案。

还有证据表明，人们正在重新寻找意义。这进一步加强了左翼和右翼都向身份政治转变的趋势，但影响不止于此。民调机构皮尤研究中心（Pew）

的调查发现，在意大利和荷兰，约有五分之一的受访者表示这次疫情让他们的国家变得更信奉宗教。在西班牙和加拿大，约五分之二的人表示家庭关系变得更紧密了。

休闲娱乐也受到了影响。人们表示闲暇时间多了15%。在英国，年轻女性看书的时间增加了50%。各种小说处女作如雪片般飞向文学经纪人。其中一些新现象会逐渐消失，媒体公司就担心会迎来“注意力衰退”。但有些会持续下去。

例如，人们可能决定不再回到疫情前辛苦乏味的工作岗位，而劳动力市场吃紧可能会让他们如愿以偿。在英国，报读医学院的人数在2020年上升了21%。在美国，新成立公司数量已达到自2004年有记录以来的最高水平。调查显示，可以在家工作的美国人当中，有三分之一希望一周五天都能在家办公。一些老板命令员工回到办公室，也有老板尝试想些办法吸引他们回去。

目前还不清楚风险偏好是否会反弹。一般来说，从一种危及生命的疾病中幸存下来，你可能就会自认是幸运儿，对一切都无所顾忌。一个世纪前爆发的西班牙流感过后的几年里，几乎在每个领域都迸发出对刺激的渴求，从纵欲、艺术，到对速度的狂热追求。这一次，新的前沿领域可能是太空旅行、基因工程、人工智能和增强现实。

即使在新冠病毒出现之前，数字革命、气候变化和中国崛起似乎已经在终结二战后西方主导的秩序。疫情将加速这一转变。■



Free exchange

Stubborn optimism about China's economy after a decade on the ground

Even as the tenth year of Xi Jinping's rule approaches, China is still dynamic and restless

PICTURE THE moment of confusion in a taxi in Guiyang, a city in south-western China. Your columnist had asked the driver to go to the new district. “The new new district or the old new district?” he asked. It was, it emerged, the old new district—a place that seven years ago, on an earlier visit to Guiyang, had looked like the sort of ghost town then dominating horror stories about China’s economy, full of giant empty buildings. This time, however, the problem was the exact opposite. What was meant to be a quick jaunt turned into a traffic-clogged headache, the taxi crawling along in a sea of red tail lights. The old new district had filled in, and then some.

One reason why it is good for journalists to stay in a country for a long stint is that it helps breed humility. Assumptions that once appeared iron-clad gather rust as the years roll by. That is true for most places. But it is especially so when covering something as complex as China’s economy, which your columnist had the privilege to do over the past decade.

This, to be clear, is not a *mea culpa* for being overly gloomy. There were also times of excess optimism about China’s capacity for change. Take rebalancing. As far back as 2007 Wen Jiabao, then China’s prime minister, decried its economy as “unstable, unbalanced”—evidence, it seemed, that leaders grasped the problem and were ready to act. Yet the economy only became more unstable, culminating in a nearly epic meltdown in 2015. And it is as unbalanced as ever, with investment running far ahead of consumption. Nevertheless, it is hard to escape the conclusion that in the economic realm, China got more right than wrong over the past decade.

How else to score its performance when, despite many predictions of doom, it doubled in size during that time?

A common riposte is that this success is illusory—that the government has simply delayed the comedown from its debt-fuelled high. The deferral of pain is certainly part of the mix. Perhaps the safest bet in economics is that when growth slows sharply, China will unveil yet more infrastructure projects and call on banks to make still more loans. And if those projects or loans fail, officials have few qualms about orchestrating bail-outs and roll-overs.

What is less appreciated is that China's ability to engage in such engineering is itself a measure of success. The government can lean on its banks because they are enormously profitable to begin with. The telltale signs of an overdrawn economy—high inflation, rampant unemployment and corporate malaise—exist in pockets in China, but they are the exception, not the rule.

This point was driven home when your columnist moved from Beijing to Shanghai in 2014. Each city has its charms, but Shanghai unquestionably offers a more flattering picture of the economy. Beijing, a showcase for political power, is blotted by the hulking headquarters of state-owned enterprises. Day trips take reporters to China's greatest economic calamities, from overbuilt Tianjin to coal-mine carnage in Inner Mongolia. In Shanghai, which functions remarkably well for a city of 25m, reporters instead hop over to see high-tech innovators in Hangzhou, nimble exporters in Wuxi and ambitious entrepreneurs in Wenzhou. They show that even as the tenth year of Xi Jinping's rule approaches, two of the fundamental underpinnings of China's economic dynamism remain intact: red-blooded competition in the private sector and the restless quest of millions upon millions of ordinary people to improve their lot in life.

These days, saying nice things about China's economy comes with baggage, not least because of the Communist Party's insistence that its growth record is proof of its superior political system. It is true that the government has had a crucial hand in the country's development, starting with the fact that it has been "Infrastructure Week" just about every week in China since 1990.

The correct response to the party's boasting is not to deny China its success, but to insist on proper attribution. Japan, South Korea and Taiwan were its forerunners in using repressed financial systems to enable investment and in relying on exports to become more competitive. China has repeated all this, albeit at a far greater, and arguably more impressive, scale. At the same time, its sustained rapid growth of the past four decades has less to do with the wisdom of the Politburo than with the work of a brilliant Saint Lucian economist, Sir Arthur Lewis, who in the 1950s explained that shifting labour from low-value farming to higher-value industry can, if managed right, engender just such a catch-up process.

The coming decade is sure to prove more challenging. With 65% of Chinese people already in cities and the population close to peaking, Mr Lewis would point out that there is little scope for further gains from turning farmers into factory workers. Parallels between China and the Asian dynamos of yesteryear are breaking down. China is older and more indebted than they were at the same stage. Whereas most countries seek to strengthen the rule of law as they mature, Mr Xi is cultivating stronger party control.

Add to that a treacherous external environment. Faced with the threat of economic decoupling from the West, it is only rational for China to pursue greater self-reliance. Thanks to its size and sophistication, it may well triumph in key sectors, from semiconductors to robotics. But the sorry history of import substitution globally should make clear that this is a sub-optimal strategy involving much waste and eventually leading to lower growth.

All this is almost enough to turn you into a China bear: to predict not an almighty crash but rather an ineluctable slide towards stagnation. In conversations with analysts and investors, versions of this narrative crop up again and again. That it has become something like the consensus view is the single biggest reason why your columnist, after a long run in China, suspects that its economy will fare considerably better. ■



自由交流

在华工作十载，坚持看好中国经济

习近平执政近十年，中国仍然充满活力，不安于现状

想象一下笔者在中国西南部城市贵阳的一辆出租车里的困惑一刻。跟司机说开去新区，他问，“是去新新区还是旧新区？”原来，笔者要去的是旧新区。七年前去贵阳时，旧新区到处都是空置的高楼，看起来像一座鬼城——这个词在当时有关中国经济的恐怖故事中随处可见。然而这一次问题截然相反。笔者原本打算快去快回，结果遇到烦人的大塞车，出租车在红色尾灯的长龙中龟速前行。旧新区已不再是一座空城，它甚至有些拥挤不堪了。

长期在一个国家工作对记者们不无裨益，原因之一是有助于培养谦逊的品格。经年累月之下，曾经看似铁定的假定开始长出锈迹。这在大多数地方都会发生。但在报道中国经济这样复杂的对象时就更是如此了，而笔者有幸在过去十年从事这项工作。

需要澄清的是，这不是要为自己的过度悲观认错。过去也有一些对中国的变革能力过度乐观的时候。以经济再平衡为例。早在2007年，时任总理温家宝就批评经济“不稳定、不平衡”，这似乎表明领导人已经找准了问题并准备采取行动。然而经济却变得更加不稳定，到2015年几乎全面崩溃。而中国经济如今还是一样地不平衡，投资远远超过消费。尽管如此，难免还是会得出这样的结论：在经济领域，中国在过去十年里做对的事多过做错的。否则又该怎么评价它在这个时期——尽管有那么多关于中国经济崩溃的预测——实现了经济规模翻番呢？

常见的一种反驳是这种成功只是错觉，中国政府只是延迟了由举债推动的高增长的跌落。延迟痛苦当然是其中一个因素。或许，在经济学中最安全的一个押注就是当增长急剧放缓时，中国会推出更多基建项目，并号召银行提供更多贷款。而如果这些项目或贷款失败，官员会毫不犹疑地统筹

安排纾困和借新还旧。

不太被人领会的一点是，中国的这种组织能力本身就是一种成功。政府能够依靠银行是因为它们本就利润丰厚。那些经济透支的明显迹象——高通胀、高失业率和企业萎靡不振——在中国小范围存在，但它们是例外而非常态。

这一点在笔者2014年从北京搬到上海时体会深切。两个城市各有其魅力，但上海展现出的经济面貌毫无疑问更加正面。政治权力中心北京淹没在庞大的国企总部大楼中。从北京出发做一天的游历，记者就可以看到从天津的过度建设到内蒙古的煤矿乱象等中国最严重的经济灾难。拥有2500万人口的上海运转相当不俗，从上海出发，记者可以到杭州了解那里的高科技创新企业，到无锡拜访经营灵活的出口商，到温州采访雄心勃勃的企业家。从中可以看到，在习近平执政将近十年之际，中国经济活力的两个根基仍然完好：私营部门的激烈竞争，以及亿万普通民众对更好生活的不懈追求。

如今，说中国经济的好话是要有所顾虑的，尤其是因为中国共产党坚持认为经济增长的成就证明了其政治制度的优越性。的确，政府在中国的发展中发挥了至关重要的作用，你首先能想到的是，自1990年以来，在中国几乎每周都是“基础设施周”。

对于中共的自夸，正确的回应不是否认中国的成功，而是坚持找到正确的原因。在此之前，日本、韩国和台湾就利用受抑制的金融体系来促进投资，并依靠出口来提高竞争力。中国大陆重复了这一过程，不过规模要大得多，也可以说更令人赞叹。然而，过去40年中国的持续快速增长与其说是依靠政治局的智慧，不如说是更多体现了圣卢西亚（Saint Lucian）的杰出经济学家阿瑟·刘易斯（Arthur Lewis）的研究成果，他在上世纪50年代解释说，如果管理得当，把劳动力从低价值的农业转移到更高价值的产业可以产生这样的赶超过程。

未来十年肯定会更具挑战。由于中国的城镇人口已占65%，而人口总量接

近顶峰，刘易斯如若在世会指出，从把农民变成工厂工人中继续获得增长的空间已所剩不多。中国与昔日亚洲经济强国之间的相似之处正在消失。与处于同一阶段的那些国家相比，中国老龄化程度更高，负债也更多。那些国家在进入成熟期时大多数寻求加强法治，而习近平正在加强共产党的控制。

与此同时外部环境也颇为险恶。面对与西方经济脱钩的威胁，中国追求更大程度的自力更生完全合理。由于中国经济规模庞大且门类齐全，它很可能在从半导体到机器人技术等关键领域获得成功。但全球范围里进口替代的糟糕历史应该能说明这是一种次优策略，会造成大量浪费，并最终导致增长放缓。

所有这一切几乎足以让你看空中国——不是预测经济全面崩盘，而是不可避免地滑向发展停滞。在与分析师和投资者的对话中，这种预测以不同形式一再浮现。它已接近成为某种共识，不过在中国工作这么多年后，这正是笔者认为中国经济的走势会比预测好很多的最主要原因。 ■



Social skills

The vital art of talking to strangers

Three books explain why it matters—and can easily be lost

Hello, Stranger. By Will Buckingham. Granta; 336 pages; £16.99

The Power of Strangers. By Joe Keohane. Random House; 352 pages; \$28. Viking; £16.99

Fractured. By Jon Yates. Harper North; 348 pages; \$28.99 and £20

ATTITUDES TO STRANGERS tend to follow a familiar pattern. Children are taught never to speak to unknown grown-ups, especially those regarded by their parents as untrustworthy. The onset of adolescence and young adulthood brings a bursting desire to interact with all sorts of people, particularly the kind who might not elicit family approval. Whether the resulting encounters are sexual or social, they confer a thrilling frisson of escape.

Social circles generally narrow again as people find life-partners, form households and produce offspring of their own. Time becomes scarce; new friendships are often based on sharing the burden of child care. Some people never recover the youthful zest for unforeseen liaisons. Professional duties swell even as parental ones diminish, and the inclination sags. In old age, even if curiosity and charisma remain undimmed, frailty makes new serendipitous connections harder to establish.

But that is not the whole story. In mid-life and beyond people can still experience the joy of a random meeting, however short, which somehow touches a nerve. That might involve nothing more than a smile, or a chance remark that hits an emotional spot; or it might be an unexpectedly deep

conversation on a plane or train, a surge of mutual understanding that is life-affirming even if the interlocutor is never seen again. This aspect of the promise and peril of strangers has enticed storytellers—from the rapture of “Brief Encounter” and “Before Sunrise” to the ruin of “Strangers on a Train”. The knowledge that the exchange will be a one-off can permit a delicious, uninhibited frankness.

In the age of covid-19 and Zoom, the chronological pattern has been warped. Instead of their hazy possibilities and risks, strangers have assumed an all-too-literal role as a looming source of infection. During lockdowns they are officially to be avoided. Yet youngsters still long, dangerously, for the ecstasy of communion, not just with edgy individuals but anonymous crowds. People of all ages have come to miss the human stimulation of busy high streets or trains, or the comforting sense of fellowship in a cinema or theatre audience.

So this is an apt moment for three books about meeting strangers. Will Buckingham has written a moving memoir of finding solace, after the death of his life-partner, in travelling and talking in lands such as Myanmar that are culturally distant from his native England. Joe Keohane, an American journalist, argues that communicating empathetically with strangers is vital and potentially life-changing. Jon Yates, who runs a youth charity based in London, frets that deep fissures in Western societies are making it impossible for people to reach, even casually, between classes, religions, ethnicities and generations.

All three authors make sweeping generalisations about the evolution of human society, from hunter-gatherers to the age of Homer and beyond. But they are more interesting when they reflect, using personal experience or scientific research, on how people live and communicate now. In different ways, they all make two separate but related points. First, interacting meaningfully with a new person can bring huge rewards—but it is a skill

that must be cultivated and can easily be lost. Second, the self-segregation of modern Western societies means that, for many people, conversing with some fellow citizens seems pointless, undesirable or outlandish. The second problem exacerbates the first: if you consider others beyond the pale, why make the effort to get to know them?

As both Mr Keohane and Mr Yates emphasise, in Britain and America political divisions have ossified into tribal ones. Supporters and opponents of Brexit live in discrete clusters; Republicans and Democrats see each other as bad people, not fellow Americans whose opinions happen to differ. These opposing sides have become strangers to one another. Mr Buckingham focuses on the pleasures and pitfalls of encounters in remote places where the stakes are lower because the acquaintanceships are bound to be temporary—in a holiday flat-share in Helsinki or while travelling through the Balkans. But, like the other two, he notes that wariness of unfamiliar people is neither new nor insuperable.

Mr Keohane and Mr Yates offer tips on befriending strangers. Mr Keohane describes exercises in which groups of Republicans and Democrats were, with great difficulty, coaxed to overcome stereotypes and see one another as rounded individuals. They were trained to ask each other good questions and avoid name-calling. Mr Yates discusses the case for a kind of national social service that would encourage youngsters to mix with other groups and generations. Both have homely micro-solutions that readers can apply in daily relations—assume the best of others, remember that most have stories they are longing to tell, react philosophically when a friendly approach is rebuffed.

A telling point that none of the books captures is a paradoxical one: some of the most sophisticated forms of interaction between strangers occur in societies that are chronically divided. Think, for example, of rural Northern Ireland, or of parts of the former Ottoman Empire, such as Lebanon, where

residents have lived in separate communal silos. In ways impenetrable to outsiders, the denizens of such places develop perfect antennae for the affiliation of a stranger and adjust their remarks accordingly. The ensuing exchanges occur within well-understood parameters—including a sense that social categories are resilient and pleasantries will not change them. But tact allows people from antagonistic camps to have amicable encounters and transactions.

All three authors are inclined to overstate the ability of brief interactions to stave off conflict. Yet at least this much is true: a capacity to engage with new people in civilised, humane and meaningful ways is a necessary condition for social peace, even if it is not a sufficient one. That points up a half-hidden cost of covid-19. Children educated on screen; teenagers bouncing off the walls; adults working at home; lonely pensioners: more or less everyone's social skills have been atrophying, with consequences not only for individuals but, perhaps, for the fabric of society.

As lockdowns lift, people are now stumbling back into a world of accidental collisions, some eagerly, some queasily, most with an odd sensation of novelty after a year of hibernation. The lesson of these books is that the easing of restrictions is not just a coveted opportunity to reconnect with those you love and resemble. It also restores a freedom, long taken for granted even if little used, to come to know the profoundly different. ■



社交技能

与陌生人交流的重要技艺

三本著作诠释其重要性以及为何容易丧失【《你好，陌生人》、《陌生人的力量》、《碎裂》书评】

《你好，陌生人》，威尔·巴金汉姆著。格兰塔出版社，336页，16.99英镑。

《陌生人的力量》，乔·基奥恩著。兰登书屋，352页，28美元；维京出版社，16.99英镑。

《碎裂》，乔恩·耶茨著。哈珀诺斯出版社，348页；28.99美元/20英镑。

人们对陌生人的态度往往落入一套常见的模式。在孩童时被教导不要和不认识的大人说话，特别是那些被父母认为不值得信任的人。到了青春期和二十出头，又会产生与各种人交流的强烈愿望，特别是家人可能不认可的那种人。无论这会发展出性关系还是一般的社交关系，都会带来一种逃离的强烈兴奋感。

随着人们找到终生伴侣、组建家庭、生儿育女，社交圈通常再度缩小。时间变得不够用了，这时建立的新友谊往往都是基于分担育儿负担。有些人再也没有重燃年轻时随性结交的那股劲头。在为人父母的责任逐渐减轻之时，工作负担又在加大，交朋友的意愿也随之下降。到了老年，即使好奇心和魅力不减，年老体衰还是让邂逅新朋友变得更不容易。

但这并非故事的全部。在中年甚至之后，人们仍能收获萍水相逢的喜悦，这些相遇无论多短暂，也会以某种方式触动人们的神经。可能只是一个微笑，或偶然间直抵心头的一句话，也可能是在飞机或火车上一次意外的深谈，即使此后再不相见，那一刻的意气相投也有振奋人心的作用。陌生人带来的这种希望与冒险让故事创作者着迷，比如电影《相见恨晚》（Brief Encounter）和《爱在黎明破晓前》（Before Sunrise）中的一见倾心，以

及《火车怪客》（Strangers on a Train）中的灭顶之灾。知道自己经历的只是一期一会，会让人无拘无束地坦呈自我而感觉美妙。

在新冠疫情和Zoom会议的时代，这套按时间发展的模式已被扭曲。陌生人不再意味着朦胧的可能性和风险，而是成了切实逼近的感染源。实施封锁期间，官方要求人们避免接触陌生人。不过，年轻人依然不顾危险，渴望与前卫人士乃至无名人群交流的狂喜。所有年龄段的人都开始怀念商业街或火车上的拥挤人群带来的新鲜感，或者是在电影院、剧院里有其他观众相伴的慰藉。

三本关于遇见陌生人的新书应运而生。威尔·巴金汉姆（Will Buckingham）书写了一部感人的自传，讲述了伴侣去世后，他在缅甸等文化上与家乡英国相去甚远的地方旅行和交谈并从中找到慰藉的经历。美国记者乔·基奥恩（Joe Keohane）认为，带着同理心与陌生人交流至关重要，可能带来改变一生的影响。在伦敦经营一家青少年慈善机构的乔恩·耶茨（Jon Yates）担心，西方社会深刻的裂痕正在导致人们无法跨阶级、宗教、种族和世代往来，哪怕只是很随意的接触。

三位作者都对人类社会从狩猎采集到荷马时代及以后的演进做了笼统的概括。但书中更有趣的部分是他们通过个人经历或科学研究来反思人们今天如何生活和交流。他们殊途同归地提出了两个独立又有关联的观点。首先，与陌生人的有意义的互动可以带来巨大的回报，但这是一种必须有意识地培养而又很容易丧失的技能。第二，现代西方社会的自我隔离意味着，对许多人来说，与社会上其他人对话无意义、不可取甚或古怪。第二个问题加剧了第一个问题，因为假如你认为其他人和自己格格不入，那何必费劲去了解他们？

正如基奥恩和耶茨所强调的，在英国和美国，政治分歧已经僵化到“部落化”。英国脱欧的支持者和反对者生活在相互隔离的群体中；共和党人和民主党人都视对方为坏人，而非只是恰好观点不同的同胞。这些对立双方形同陌路。巴金汉姆则专注探讨在遥远地域偶遇的乐趣和陷阱，在这种情况下没有多少利害关系，因为这种相识必然是短暂的——比如在赫尔辛基

的共享度假公寓或在巴尔干半岛的旅行。但是，和其他两位作者一样，他指出，对陌生人的戒心既不新鲜，也非无法克服。

基奥恩和耶茨提供了一些结交陌生人的技巧。基奥恩以美国共和民主党群体的沟通训练为例，展示了如何异常艰难地引导他们克服思维定势，视彼此为具有多面性的人。训练中，他们要学会向对方提出有意义的问题，避免诋毁和谩骂。耶茨则探讨了推出一种国家层面的社会服务，以鼓励年轻人融入其他群体和世代。这两本书都提出了一些简单易懂的微观解决方案，供读者运用于日常人际关系——把别人往好处想；记得大多数人都有渴望倾诉的故事；当友善接触被拒绝时，要泰然处之。

有一个看似矛盾但又特别能说明问题的关键点，这三本书都没有提及：陌生人之间一些形式最复杂的互动发生在长期分裂的社会中。想想北爱尔兰的农村地区，或者前奥斯曼帝国的部分地区（如黎巴嫩），那里的居民一直生活在不相往来的孤岛式社区内。这些地方的居民以局外人看不透的方式发展出了完善的直觉，可参透陌生人的来历，并相应地调整自己的言谈。随后发生的交流有着清楚明白的界限——包括意识到社会类别群体是有适应力的，他们不会因客套而改变。但通过运用技巧，来自对立阵营的人也能友好地接触和交易。

三位作者都倾向于夸大短暂互动在避免冲突上的作用。但至少有一点是对的：以文明、人道和有意义的方式与陌生人接触的能力即便不是社会和平的充分条件，也是必要条件。这就突显了疫情的一个半隐藏成本。在屏幕上接受教育的儿童、精力无处释放的青少年、在家工作的成年人、孤独的退休人士——差不多所有人的社交技能都在退化，这影响的不仅是个人，也许还有社会结构。

随着封锁解除，人们正磕磕绊绊地重回那个充满意外碰撞的世界。对此有人急切，有人不安，但困居一年后，大多数人都带着一种奇怪的新鲜感。这三本书教给我们的是，社交限制的放宽不仅给了人们渴求的机会与所爱之人或同道中人重新连结，也让他们重获自由——一种一直被视为理所当然却又很少行使的自由——去了解那些与自己志趣迥乎不同的人。■



The Economist film

Will Covid kill globalization?

Even without the pandemic, another pillar of globalization would be facing challenges – the flow of data across borders.



经济学人视频

新冠会终结全球化吗？

即使没有疫情大流行，全球化的另一大支柱也将面临挑战 -- 信息的跨境流动。



Hit and run

China's communists take control of tech

The attack on Didi shows how high a price the Communist Party puts on control

ONE INTRIGUING question about China is whether it can combine thuggish, autocratic politics with the predictable rules and property rights that entrepreneurs and capital markets need to thrive. The government's recent attack on Didi Global, a Chinese ride-hailing firm that has just listed its shares in New York, suggests not. It is a warning to investors around the world—and to anyone hoping to make their fortune by setting up in China.

Didi is one of China's superstar firms, with 493m users (more than Uber), 15m drivers and a presence in Brazil and Mexico. It listed its shares on June 30th, raising cash from global investors and valuing the firm at \$68bn. Its prospectus contained 60 pages of "risk factors", including a regulatory crackdown, that most investors snoozed over. But almost immediately one of them turned up.

It seems that Didi had pursued the listing against the wishes of the Cyberspace Administration of China. On July 4th the regulator struck back, saying that Didi had violated rules on collecting personal data, and banned it from mobile app stores in China. That sent Didi's share price tumbling by over 20%. Marco Rubio, a hawkish American senator, said that it was "reckless" to allow Didi to float in New York.

China's tech industry has been one of the most dynamic areas of the global economy in the past decade. Hundreds of large startups have yet to follow giants such as Alibaba, Tencent and Didi by listing their shares. The intersection of e-commerce, payments and "super-apps" means that most daily transactions in China can take place on a smartphone. Global capital

and talent have been critical to the industry's rise. Didi has big foreign shareholders, including SoftBank and Uber, and owns a stake in Grab, a South-East Asian rival. Many of its top brass were educated at Western universities and have worked at American firms. Almost all the largest Chinese tech firms are listed in America or Hong Kong rather than the mainland. They have cosmopolitan executives and benefit from a flow of ideas across borders.

The crackdown began last year when Chinese regulators cancelled the \$300bn flotation of Ant Group in Hong Kong and Shanghai at the last minute. The government went on to threaten other tech firms and to humble tycoons, not least Jack Ma, the co-founder of Alibaba and founder of Ant.

All governments worry about data privacy and monopolies, but China's interventions signal a systematic attack on tech by the party. On July 7th Bloomberg reported that China might re-examine the use of "variable-interest entities", a legal structure that underpins almost all foreign investment in Chinese tech. The message is clear: powerful tech firms must defer to the Communist Party, their bosses should keep quiet and foreign owners' property rights can be violated.

An optimistic view is that the crackdown is political theatre. Global firms have often been burned in China only to recover. South Korean and Japanese companies have faced boycotts and protests that later faded away. China's government shuns foreign banks for a while, to punish them for perceived errors, but eventually welcomes them back.

This time may be different. Foreign investors have lost hundreds of billions of dollars, which may permanently alter the supply of global capital to China. To fill that hole, Chinese firms will depend on less sophisticated

mainland markets. Once again entrepreneurs and investors must weigh and reweigh the vast rewards of China's markets against the risks of its opaque laws, bullying officials and paranoid rulers. If you were risk-hungry, unorthodox and keen to start a business that breaks the mould, would you still choose to do so in China? ■



【首文】打击并接管

中共控制科技业

对滴滴挥出重拳显示党不惜代价加强管控

关于中国有一个耐人寻味的问题，就是它能否把粗暴威权的政治制度与企业家及资本市场蓬勃发展所需的可预测的规则和产权结合起来。刚在纽约上市的中国网约车公司滴滴最近遭到政府整顿，表明这个问题的答案是否定的。这向全世界的投资者发出了警示，也对任何想在中国创办企业来赚取财富的人敲响了警钟。

滴滴是中国的超级明星企业之一，拥有4.93亿用户（多于优步）和1500万名司机，并且已打入巴西和墨西哥市场。6月30日滴滴上市，向全球投资者融资，估值达680亿美元。它的招股书中“风险因素”占了60页，包括监管打击，大多数投资者都没仔细看这部分内容。但就在滴滴上市后，其中一个风险随即显现。

看起来滴滴在纽约上市有违国家网信办的意愿。7月4日，该监管机构做出回击，称滴滴违法违规收集个人信息，并通知国内手机应用商店下架“滴滴出行”。这导致滴滴股价暴跌超过20%。美国鹰派参议员马可·鲁比奥（Marco Rubio）说，批准滴滴在纽约上市是“鲁莽”之举。

过去十年，中国的科技行业一直是全球经济中最具活力的领域之一。还会有成百上千大型创业公司跟随阿里巴巴、腾讯和滴滴等巨头的步伐公开上市。电子商务、支付和“超级应用”的交汇意味着中国大多数日常交易都可以在智能手机上完成。全球资本和人才对该行业的崛起至关重要。滴滴拥有软银和优步等外资大股东，自己持有东南亚竞争对手Grab的股份。它的许多高管在西方大学接受教育，曾在美国公司工作。几乎所有最大规模的中国科技公司都在美国或香港上市，而不是在中国大陆。它们拥有国际化的高管队伍，并从跨国界的思想流动中受益。

打击行动始于去年，当时中国监管机构在最后一刻叫停了蚂蚁集团在香港和上海估值3000亿美元的上市计划。此后政府继续威吓其他科技公司，驯服科技大亨，尤其是阿里巴巴联合创始人及蚂蚁集团创始人马云。

所有政府都担心数据隐私和垄断问题，但中国的干预行动显示中共对科技公司的打击是系统性的。7月7日，彭博社报道中国可能会重新审视对“可变利益实体”的使用，这种法律架构支撑了几乎所有对中国科技业的外国投资。政府传达出的信号很明确：强大的科技公司必须服从党，其老板们应保持低调，外国所有者的产权可能被侵犯。

有一种乐观的看法认为，这轮打压只是政治戏码。跨国公司在中国经常受打击，之后总会恢复过来。韩国和日本公司都曾遭遇抵制和抗议，后来也慢慢平息了。中国政府曾把外国银行拒之门外，以违规之名加以惩罚，但最终还是把它们迎了回来。

但这次可能不一样。外国投资者已经损失了数千亿美元，这可能会永久改变全球对中国的资本供应。中国公司将依赖不够成熟的中国大陆市场来填补资金缺口。企业家和投资者这回又得再三权衡利弊：中国市场回报巨大，但法律不透明、官员肆意打压、统治高层偏执多疑。假如你热爱冒险、标新立异，渴望创立一家别具一格的公司，你是否仍会选择在中国这样做？ ■



Global growth

The new fault lines on which the world economy rests

Global growth is coming back fast. But the recovery from the pandemic is uneven and fragile

THE PANDEMIC caused a fearsome economic slump, but now a weird, exhilarating boom is in full swing. The oil price has soared, while restaurants and haulage firms are having to fight and flatter to recruit staff. As listed firms signal that profits will hit an all-time high this year, stockmarkets are on a tear. An index produced by JPMorgan Chase and IHS Markit suggests that global growth is at its highest since the exuberant days of 2006.

Any escape from covid-19 is a cause for celebration. But today's booming economy is also a source of anxiety, because three fault lines lie beneath the surface. Together, they will determine who prospers, and whether the most unusual recovery in living memory can be sustained.

The first fault line divides the jabs from the jab-nots. Only those countries getting vaccinations into arms will be able to tame covid-19. That is the condition for shops, bars and offices to reopen permanently, and customers and workers to have the confidence to leave their homes. But only one in four people around the world has had a first dose of vaccine and only one in eight is fully protected. Even in America some under-vaccinated states are vulnerable to the infectious Delta variant of the virus.

The second fault line runs between supply and demand. Shortages of microchips have disrupted the manufacture of electronics and cars just when consumers want to binge on them. The cost of shipping goods from China to ports on America's west coast has quadrupled from its pre-pandemic level. Even as these bottlenecks are unblocked, newly open

economies will create fresh imbalances. In some countries people seem keener to go for a drink than they do to work behind the bar, causing a structural labour shortage in the service sector. House prices have surged, suggesting that rents will soon start to rise, too. That could sustain inflation and deepen the sense that housing is unaffordable.

The final fault line is over the withdrawal of stimulus. At some point, the state interventions that began last year must be reversed. Rich-world central banks have bought assets worth over \$10trn since the pandemic began and are nervously considering how to extricate themselves without causing a flap in capital markets by tightening too fast. China, whose economy did not shrink in 2020, offers a sign of what is to come: it has tightened credit policy this year, slowing its growth.

Meanwhile, emergency government-aid schemes, such as unemployment-insurance top-ups and eviction moratoriums, are beginning to expire. Households are unlikely to get a fresh infusion of “stimmies” in 2022. Deficits will contract rather than expand, dragging down growth. So far, economies have largely avoided a wave of damaging bankruptcies but nobody knows how well firms will cope once emergency loans come due and workers can no longer be furloughed at taxpayers’ expense.

You might think that an event as extreme as a pandemic, combined with the unprecedented government response to it, would eventually trigger an equally extreme global economic reaction. Pessimists worry about a return to 1970s-style inflation, or a financial crash, or that capitalism’s underlying energy will be drained by state handouts. Such apocalyptic outcomes are possible, but they are not likely. Instead a better way to think about the unusual outlook is to examine how the three fault lines interact differently in different economies.

Start with America. With abundant vaccines and enormous stimulus, it is

at the biggest risk of overheating. In recent months inflation has reached levels not seen since the early 1980s. Its labour market is coming under strain as economic activity shifts. Even after a rise of 850,000 in the number of jobs in June and accounting for abundant vacancies, the number of people working in leisure and hospitality is 12% lower than before the pandemic. Workers are reluctant to return to the industry, which has pushed up wages. Hourly pay is almost 8% higher than in February 2020. Perhaps they will come back when emergency unemployment benefits expire in September. But countries without such a scheme, like Australia, are also seeing a labour shortage. Attitudes to work may be changing at the bottom of the income spectrum, among waiters and cleaners, not just among well-heeled professionals who dream of yachts and sabbaticals. All this suggests that America's economy will run hot, with continual pressure on the Federal Reserve to tighten policy.

Elsewhere in the rich world the picture is less exuberant. It includes some jab-nots, like Japan, which has fully vaccinated less than 15% of its population. Europe is catching up on vaccines, but its smaller stimulus means that inflation has not reached American levels. In Britain, France and Switzerland 8-13% of employees remained on furlough schemes at the end of May. In all these economies the risk is that policymakers overreact to temporary, imported inflation, withdrawing support too quickly. If so, their economies will suffer, just as the euro area suffered after the financial crisis of 2007-09.

Low- and middle-income countries are in a bind. They should be benefiting from surging global demand for commodities and factory goods, but they are struggling. Indonesia, battling another covid-19 wave, is redeploying oxygen from industry to hospitals. In 2021 the poorest countries, which are desperately short of vaccines, are forecast to grow more slowly than rich countries for only the third time in 25 years.

Even as covid-19 weakens their recoveries, emerging markets face the prospect of higher interest rates at the Fed. That tends to put downward pressure on their currencies as investors buy dollars, raising the risk of financial instability. Their central banks do not have the luxury of ignoring temporary or imported inflation. Brazil, Mexico and Russia have raised interest rates recently, and more places may follow. The combination of jabbing too late and tightening too soon will be painful.

The economic cycle has been frantic, leaving the slump far behind in only a year. Perhaps by the summer of 2022 most people will be vaccinated, business will have adapted to new patterns of demand and stimulus will be unwinding in an orderly way. In this weird boom, however, beware those fault lines. ■



【首文】全球增长

世界经济版图下方的新断层线

全球经济正迅速恢复增长。但疫情后的复苏不均衡且脆弱

新冠疫情造成了可怕的经济衰退，但现在一种怪异又令人兴奋的繁荣正如火如荼地上演。油价已经飙升，而餐馆和运输公司为了招募人手不得不各出奇招。上市公司预期今年盈利将创历史新高，股市也一路高歌猛进。摩根大通和埃信华迈（IHS Markit）编制的一项指数显示，全球经济增长正处于2006年繁荣期以来的最高水平。

任何从疫情悲剧的挣脱都可喜可贺。但今天红火的经济也引发了焦虑，因为繁荣的表面之下隐藏着三条断层线。它们将共同决定谁将成功，以及这场人们记忆中最不寻常的复苏能否持续下去。

第一条断层线分隔接种与未接种区域。只有那些完成疫苗接种的国家才能遏制疫情。这是商店、酒吧和办公室长期重开、顾客和员工有信心走出家门的前提条件。但全世界只有四分之一的人口接种了第一剂疫苗，只有八分之一的人口获得了完全的保护。即使在美国，一些接种率低下的州也可能受到强传染性的德尔塔毒株的冲击。

第二条断层线出现在供给与需求之间。消费者对电子产品和汽车的需求激增，与此同时微芯片供应短缺却干扰了这些产品的生产。将货物从中国运到美国西海岸港口的成本已经比疫情前翻了两番。即使这些瓶颈得到了缓解，重新开放的经济体又将造成新的失衡。在一些国家，人们似乎更愿意去酒吧小酌，而不是去吧台工作，导致服务业出现结构性人力短缺。房价飙升，预示着租金很快也将上涨。这可能会维持通胀高企，并让人们愈发感到住房成本难以承受。

最后一条断层线来自刺激措施的退出。自去年开始的政府干预到了某个时候总得退出。自疫情爆发以来，富裕国家的央行已经购买了价值超过10万亿美元的资产，现在正紧张地考虑如何抽身才不致因收紧过快而引发资本

市场恐慌。中国经济在2020年没有萎缩，它提供了未来前景的预演：今年它收紧了信贷政策，放缓了增长。

与此同时，政府的紧急援助计划也开始到期，例如额外的失业救济和租客保护令。家庭在2022年不太可能再收到新的“刺激支票”。赤字将开始收缩而非扩张，拖累经济增长。到目前为止，各经济体基本上避免了出现破坏性的破产潮，但一旦紧急贷款到期，而劳动者不能再靠纳税人的钱休无薪假并领取补偿时，没人知道企业将何以应对。

你可能会认为，像疫情这样的极端事件，加上政府前所未有的应对措施，最终会引发同样极端的全球经济反应。悲观者担心会重返上世纪70年代那种大通胀，或是一场金融崩溃，或者资本主义的基础能量会被政府救济消耗殆尽。这种世界末日般的结局有可能出现，但概率不大。要思考这一不寻常的前景，更好的办法是考察这三条断层线在不同经济体中不同的相互作用。

先看美国。疫苗充足加之庞大的经济刺激措施，使得美国呈现出最大的经济过热风险。最近几个月，通胀达到了上世纪80年代初以来的最高水平。随着经济活动的转变，劳动力市场正在承压。即使6月份总体就业人数增加了85万，并有大量职位空缺，休闲和酒店业的就业人数仍比疫情前低12%。劳动者不愿重返这个行业，这推高了工资。时薪比2020年2月高出近8%。也许到了9月紧急失业救济到期之后工人还会回来。但在澳大利亚等没有发放紧急失业救济的国家也出现了劳动力短缺。对工作的态度变化似乎不仅仅发生在梦想着游艇和休假的富裕专业人士中间，也浮现于服务员和清洁工这类收入最低的人群中。所有这一切都表明美国经济将不断升温，美联储也将持续受到收紧政策的压力。

在其他发达国家，状况没有那么火热。其中包括一些在疫苗接种上落后的国家，例如完全接种率还不到15%的日本。欧洲的接种水平正在迎头赶上，但其经济刺激规模相对较小，意味着通胀尚未跟上美国的水平。在英国、法国和瑞士，截至5月底仍有8%到13%的员工依赖无薪休假计划。对于所有这些经济体，风险在于政策制定者对暂时的输入性通胀反应过度，

过快撤回支持。这将打击其经济，就像2007至2009年金融危机后在欧元区发生的那样。

中低收入国家陷入了困境。它们本应从全球对大宗商品和工业品的需求激增中获益，眼下却在苦苦挣扎。印尼正在抗击新一轮疫情，被迫将工业用氧气调配给医院。最贫穷的国家极度缺乏疫苗，预计在2021年的经济增速将低于富裕国家，这将是25年来仅仅第三次。

新兴市场的复苏被疫情拖累之际，仍需面对美联储加息的前景。一旦加息，投资者将买入美元，通常会给新兴货币构成下行压力，增加金融不稳定的风险。这些国家的央行没有忽视暂时性或输入性通胀的余地。巴西、墨西哥和俄罗斯最近都提高了利率，更多国家可能会效仿。接种太晚再加上紧缩太早，境况将相当痛苦。

这一轮经济周期非常疯狂，仅用一年的时间就将衰退远远抛在后面。也许到2022年夏天，大多数人将已接种疫苗，企业已经适应了新的需求模式，同时刺激措施也将有序撤出。然而，在这场怪异的繁荣之中，要小心提防那些断层线。 ■



Edifice complexities

The future of Silicon Valley headquarters

What will happen to technology companies' pricey digs?

“THIS IS ONE of the healthiest buildings in San Francisco.” Giving a tour of the new headquarters of Uber on a recent afternoon, Michael Huaco, the ride-hailing giant’s head of “workplace and real estate”, does not hide his pride. And he has plenty to be proud of. Employees make their way to work stations up a wood-panelled staircase, then through a sun-soaked atrium which doubles as the conduit for the building’s natural ventilation. Meeting rooms and nooks with couches abound; desks are scarce. This being tech central, there is, naturally, a juice bar and a yoga studio.

There is only one niggle. Many Uber employees may prefer to keep working from home and come in only a couple of days a week, if at all. “No one really knows,” concedes Mr Huaco. His firm is not alone. Up and down Silicon Valley technology companies are wondering what will happen when they fully reopen after the summer break. Where they go, others often follow. How tech solves its HQ conundrum may therefore once again blaze the trail for new work spaces and practices in other industries, says Charlton Hutton of M Moser Associates, a design agency.

When it comes to offices, Silicon Valley has been an odd, some would say ridiculous, place. For an industry whose avowed goal is to digitise all of life by having software “eat the world”, most big firms’ work practices looked remarkably analogue. Before the pandemic, daily presence in the office was expected. Many spent hundreds of millions of dollars on headquarters to accommodate a large part of their workforce. Uber’s new San Francisco digs reportedly cost \$130m to build; the company has told investors it will spend \$1bn over 20 years on leases in the city. Salesforce, a business-software

giant, is paying the developer of Salesforce Tower nearly \$560m over 15 years to lease 30 of its 61 floors. Apple's spaceship-like base in Cupertino (pictured), which can accommodate up to 13,000 people, cost the iPhone-maker \$5bn, or \$385,000 per employee.

Tech is not the first to suffer from the “edifice complex”. From the Chrysler Building and Sears Tower to the Bank of China's iconic Hong Kong headquarters, companies have always erected monuments to their success. Technology firms have reasons beyond self-aggrandisement to covet posh quarters. Fancy workplaces help such businesses, which live and die by the quality of their human capital, to attract employees, in effect becoming a key part of the pay package. They enable teamwork, which most founders believe, rightly or wrongly, to be indispensable for innovation. And since many fast-growing startups lack a long history, offices where everyone congregates can help imbue the troops with the corporate mission. It may be no coincidence that Airbnb's feel like a high-end Airbnb.

Even so, tech temples had begun to seem anachronistic long before covid-19 washed up on California's shores. Traffic was making the daily commute an insufferable two-hour ordeal. Most computer programmers came to the office but really worked elsewhere—in the cloud, managing projects with Trello, on Zoom and Slack. Designed to be lively, tech offices were often eerily quiet. Realising this, companies began to open more of them beyond the Valley, and to make more use of the virtual realm. The pandemic then gave the shifting equilibrium a shove, notes Nicholas Bloom of Stanford University. Although it is hard to predict where exactly all the bits will land, the contours of tech HQs of the future are coming into view.

For starters, most will be smaller. As in many other sectors, tech firms will blend remote and office work. When Andreessen Horowitz, a leading venture-capital firm, recently asked its 226 portfolio companies to describe work in the future, two-thirds said “hybrid”. Uber is reportedly trying to

lease out a third of its new headquarters to other tenants.

Offices will also look different. Firms are throwing out desks and creating spaces for employees to socialise and collaborate. Okta, a digital-identity manager, is becoming a “dynamic working” space. In its remodelled headquarters most rooms will be easy to reconfigure, and let people gather more easily. M Moser Associates expects the pre-pandemic ratio, of half of office space reserved for individual work and less than a third for meetings, roughly to flip. The daily battle for meeting rooms, legendary in tech, will be less fierce.

As physical space shrinks the virtual sort will expand. The pandemic has already set off a battle among Google, Microsoft and Salesforce over which will be the dominant platform for online work. Some less well-known services have seen user numbers go through the roof, among them Figma, a tool for prototyping apps and websites, Miro, a virtual whiteboard, and Envoy, which helps firms conduct health screenings, order food or book a desk.

To avoid remote workers feeling like second-class citizens, many companies are pursuing a “digital first” policy for meetings. When Salesforce’s employees can meet digitally, they should, says Brent Hyder, the firm’s human-resources chief. Or, as he puts it, “We’re all equal on Zoom.” Many businesses are planning more off-site meetings to compensate for the extra screen time (and rekindle social bonds). “Since we will pay much less for real estate, we will have lots of budget for such things,” says Marco Zappacosta, boss of Thumbtack, a marketplace matching customers with local plumbers, dog walkers or other service providers.

The most radical firms are doing away with headquarters altogether—becoming fully “distributed”, in the jargon. Snowflake, a data-management firm, now only maintains an “executive office” in Bozeman,

Montana. The firm's centre of gravity has moved from its former base in California to local offices around the world. This makes sense given that, as Denise Persson, its chief marketing officer, points out, "95% of our customers are outside of Silicon Valley." In May Coinbase, a cryptocurrency exchange, said it no longer had a headquarters and that it would shut its San Francisco office next year.

As these shifts take effect they will reshape tech's Californian heartland. More firms will hire remote workers outside the region. More will follow Oracle, Tesla and others, and move their head offices to cheaper, less congested and lower-tax jurisdictions such as Texas or Florida. Silicon Valley will persist, though perhaps less as a place and more as a global network. ■



大厦情结

硅谷公司总部的未来

科技公司昂贵的办公室何去何从？

“这是旧金山最健康的建筑之一。”迈克尔·华科（Michael Huaco）说。近日一个下午，网约车巨头优步的这位“工作场所和房地产”部门负责人带领访客参观了公司新总部，毫不掩饰自己的自豪之情。他确实有很多值得骄傲的地方。员工们沿木质楼梯拾级而上，然后穿过一个洒满阳光的中庭走向工位，这个中庭同时也是建筑的自然通风管道。会议室和配有沙发的角落比比皆是，桌子很少。在这么注重科技的地方，自然有一个果汁吧和一个瑜伽室。

只有一个小小问题。许多优步员工可能宁愿继续在家工作；就算去办公室，也顶多一周去个两三天。“没人说得准。”华科承认。这个问题不是这家公司独有。硅谷上下的科技公司目前都不清楚，等夏休期过后它们全面重开时会是什么情况。而其他公司往往都会追随它们的脚步。因此，穆氏建筑设计（M Moser Associates）的查尔顿·赫顿（Charlton Hutton）表示，科技公司在解决其“总部难题”的过程中可能会再一次成为开路先锋，引领其他行业开创新的工作空间和工作方式。

在办公室这件事上，硅谷一直挺奇怪的，有的人会说它简直荒谬。科技行业宣称要让软件“吞噬世界”，以实现生活方方面面数字化，然而大多数大公司的工作方式看起来却还停留在模拟时代。在疫情发生前，它们预设员工每天都要去办公室上班。许多公司花费数亿美元建造总部，来容纳大部分员工。据称优步在旧金山的新办公室造价1.3亿美元，该公司已通报投资者，它将在20年内在这座城市花费10亿美元在租金上。商业软件巨头Salesforce将在15年内向Salesforce大厦的开发商支付近5.6亿美元，以租赁该建筑61层中的30层。苹果位于库比蒂诺的总部状如太空船（见图），耗资50亿美元，最多可容纳1.3万人，相当于每个员工38.5万美元。

并非只有科技行业受“大厦情结”所累。从克莱斯勒大厦（Chrysler Building）、西尔斯大厦（Sears Tower）到中国银行标志性的香港总部大楼，企业总在为自己的成功“竖碑”。而科技公司渴望豪华总部的原因不止自我标榜。这些企业的生死存亡取决于人力资本的质量，而高大上的工作场所有助于吸引员工，实际上这已成为待遇的重要组成。这样的工作场所能促成团队合作，而无论正确与否，大多数创始人都认为团队合作对于创新不可或缺。此外，由于许多快速发展的创业公司都没有悠久的历史，能让所有人都集结在一处的办公室有助于向所有员工灌输企业使命。爱彼迎总部给人的感觉就像一家高端民宿，这也许不是巧合。

即便如此，早在新冠肺炎登陆加州海岸之前很久，科技公司各自的“神殿”就已经开始显得不合时宜了。交通堵塞让每日的通勤成了两小时的折磨，难以忍受。大多数计算机程序员人在办公室，实际上却是在其他地方工作——在云端用Trello管理项目，或在Zoom和Slack上。科技公司办公室的设计原本是为了营造活跃的氛围，但现实中却常常安静得诡异。意识到这一点后，各家公司纷纷开始在硅谷之外设立更多办公室，并多加利用虚拟办公手段。斯坦福大学的尼古拉斯·布鲁姆（Nicholas Bloom）指出，工作方式本就在发生改变，疫情又加了一把力。尽管很难预测科技公司未来总部的所有细节，但其轮廓正在显现。

首先，大多数总部的规模会缩小。和其他许多行业一样，科技公司将会把远程办公和办公室办公结合起来。近期，顶尖风投公司安德烈森-霍洛维茨（Andreessen Horowitz）请自己投资的226家公司描述未来的办公方式，结果它们有三分之二提到“混合式”。据报道，优步正试图将新总部三分之一的空间租出去。

办公室的外观也会改变。企业正撤掉办公桌，并为员工创造社交和合作的空间。数字身份管理公司Okta正在成为一个“动态办公”空间。它的总部经过了改造，里面大多数房间都将易于重新改装，好让人们更方便地聚集。疫情发生前，有一半的办公空间留作个人办公之用，不到三分之一的空间用于会议，穆氏建筑设计预计这两个比例大致会调转。科技公司日常的会议室争夺战出了名地激烈，但今后员工们用不着争得那么凶了。

随着物理空间的缩小，虚拟空间将会扩大。疫情已在谷歌、微软和Salesforce之间引发了一场战斗，它们都想成为在线工作的主导平台。一些没那么知名的服务的用户数也已飙升，比如Figma、Miro和Envoy。Figma是一个为应用和网站制作原型的工具，Miro是一种虚拟白板，Envoy帮助公司开展健康筛查、订餐和预定办公座位。

为了避免远程工作者觉得自己沦为二等公民，许多公司正在推行“数字优先”的会议政策。Salesforce的人力资源主管布伦特·海德尔（Brent Hyder）表示，只要自己公司的员工能用数字方式会面，他们就该这么做。或者，正如他所说的，“我们在Zoom上人人平等。”许多企业正在规划更多办公室外碰面活动，以平衡屏幕时间的增多（并重建社会联结）。Thumbtack的老板马可·萨帕科斯塔（Marco Zappacosta）说：“既然我们在房地产上的花费会大大减少，在这些方面就会有很多预算。”Thumbtack是一个在线市场，为顾客与当地的水管工、帮忙遛狗或提供其他服务的人牵线搭桥。

那些最激进的公司干脆开始取消总部——用行话来说就是完全采用“分布式”办公。数据管理公司Snowflake现在只在蒙大拿州的博兹曼（Bozeman）保留了一个“行政办公室”。该公司的重心已经从位于加州的前总部转移到了世界各地的地方办事处。正如其首席营销官丹尼斯·佩尔松（Denise Persson）指出的那样，鉴于“我们95%的客户都在硅谷之外”，这么安排很合理。5月，加密货币交易所Coinbase表示它不再有总部，并将于明年关闭其旧金山办事处。

随着这些转变的推进，它们将重塑硅谷这个位于加州的科技核心地带。更多公司将从硅谷以外的地方雇用远程员工。更多公司将追随甲骨文和特斯拉等公司的步伐，将总部办公室迁至成本更低、拥堵更少、税收更低的地方，例如得克萨斯或佛罗里达。硅谷将继续存在，只不过可能更多是作为一个全球网络而非一个地方存在。 ■



Rings on the ropes

The 2020 Olympics will be memorable, but not in the way Japan hoped

Even if disaster is averted, a sense of national renewal will remain elusive

CLOUDS GATHERED over Komazawa stadium in Tokyo as the Olympic torch arrived on July 9th. Because of the pandemic, the traditional public relay was replaced by a small ceremony behind the stadium's closed doors. Protesters outside held signs that read "Protect lives not the Olympics" and "Extinguish the Olympic torch". As Kyogoku Noriko, a civil servant, put it, "Now is not the time for a festival." More enthusiastic onlookers lined a nearby footbridge, hoping to catch a glimpse of the flame through the stadium's rafters. For Honma Taka, an office worker, the torch offered "a bit of light within the darkness".

Mr Honma longingly recalled a brighter day in the same park eight years earlier, when he joined thousands of others to celebrate as Tokyo won the right to host the games. Abe Shinzo, Japan's prime minister at the time, said he was happier than he had been when he became prime minister. Mr Abe saw the Olympics as a chance to lend credence to his bullish catchphrase: "Japan is back". He hoped the games would help the country snap out of its gloom after decades of economic stagnation, demographic decline and devastating natural disasters. The games, says Taniguchi Tomohiko, a special adviser to Mr Abe, were seen as a source of "a commodity that was in scarce supply: hope for the future".

The grand designs had a powerful precedent in the previous Tokyo Olympics, in 1964. Just two decades after defeat in the second world war, those games came to encapsulate both Japan's rise from the ashes and its re-entry into the global community. Tokyo, which had been reduced to cinders by American firebombing, was smartened up. New roads and rail lines,

including the first shinkansen, or bullet train, were built. “There was a feeling in the 1960s that everyday life was becoming richer: today is better than yesterday, and tomorrow will be better than today—and the Olympics became a symbol of this,” says Togo Kazuhiko, a former ambassador who was a student at the time. The excitement left a lasting impression on a generation, including Mr Abe, who invoked his childhood memories of 1964 when Tokyo won the bid for this year’s games.

If not for the pandemic, excitement may well have materialised again. The current Tokyo Olympics has had its share of controversies, from an over-budget stadium to rank sexism from the (now departed) head of the organising committee. Nor would a sporting event alone be enough to resolve Japan’s problems. But the games were shaping up to be a source of pride. Tens of thousands of young Japanese had signed up to volunteer. Japan planned to welcome 40m foreigners in 2020, when the games were originally scheduled. Tourists would have found an impeccably clean, safe, well-run metropolis. Akita Hiroyuki, a commentator for Nikkei, a Japanese daily, reckons that the Olympics could have been a “white ship” that catalysed the country to “wake up and open up”. (The Americans who forced Japan to open to the world in the 19th century arrived in “Black Ships”.)

Instead, the games will be held without fans, foreign or domestic, in a city under a state of emergency. Ito Yuko, one of the fans gathered outside Komazawa stadium, lamented that the mood is “200% different” from 1964, when she first fell in love with the Olympics. Rather than coming together for the games, Japan has been riven by them. Recent polls show that as many as 80% of Japanese did not want them to go ahead this year.

The sense that national leaders are pulling an unwilling population into a disaster has led to comparisons not with the previous Tokyo Olympics, but with the war that preceded them. Even Emperor Naruhito, who almost never speaks about politically sensitive matters, has made his concerns about

pressing on with the games known.

Opposition to the Olympics stems only in part from fears of covid-19. Japan has managed the pandemic well by global standards, with just 15,000 deaths; Tokyo has seen just eight covid-19 deaths so far this month. But many Japanese feel that the success has been thanks to ordinary people who behaved responsibly and made sacrifices in their personal lives, whereas the government is stubbornly persisting with a risky undertaking. “It’s not just the health crisis, but the democratic crisis—it’s the lack of accountability,” says Nakano Koichi of Sophia University.

Many fume that the interests of sponsors, TV networks and the International Olympic Committee (IOC) seem to be more important than those of the Japanese people. That the games have moved forward despite public opinion shows they are “not for the people”, but for “the people to whom the money flows”, says Miyakawa Taku, a software engineer who joined the protest outside Komazawa stadium.

Things could go badly wrong. A covid-19 outbreak in the Olympic Village could prevent events from being held and leave competitions with asterisks in the history books. A careless member of the press or an official delegation could sneak off and seed a larger outbreak among the Japanese public. Athletes from the developing world could bring a more infectious strain of the virus home, turning the games into a global superspreader event. Such a fiasco would reinforce a sense of Japan’s decline and leave the public more wary of engagement with the outside world.

Japan might also manage to keep the virus mostly under control and the sport on schedule. Executing the games in such difficult circumstances could instead serve as a reminder of Japan’s ability to overcome adversity. Either way, the legacy of these Olympics will be contested. “If this was a picture, we could say that the frame itself has become rotten,” says Sakaue

Yasuhiro, a sports historian at Hitotsubashi University in Tokyo. “The picture might turn out to be beautiful, but it is still surrounded by this rotten frame.” ■



悬着的五环

东京奥运的难忘将非日本所愿

即使不至于以灾难收场，也难以带来民族复兴之感

七月九日，奥运火炬抵达东京驹泽奥林匹克公园的体育场，天空乌云密布。受疫情影响，奥运火炬穿街过巷传递的传统改为一个小型仪式，在该体育场内闭门举行。场外抗议者举着写有“保护生命而非奥运会”和“熄灭奥运火炬”的牌子示威。公务员京谷纪子说，“现在不是举行庆典的时候”。更多支持奥运的市民兴致勃勃地站在附近的天桥上围观，希望透过体育场的梁架看一眼奥运圣火。公司职员本间贵宽（音译）说，火炬带来了“黑暗中的一点光明”。

本间贵宽神往地回想起八年前更明媚的一天，当时也是在驹泽奥林匹克公园里，他和成千上万人一起庆祝东京赢得了2020年奥运会的主办权。时任日本首相安倍晋三说自己比当选首相时还高兴。安倍视奥运会为一个契机来印证他那句豪迈的口号：“日本回来了”。他希望奥运会有助日本走出近几十年来经济停滞、人口衰老缩减，以及毁灭性自然灾害频发的阴霾。安倍的特别顾问谷口智彦表示，奥运会被视为“未来希望”这一稀缺商品的源泉。

这些宏伟设想有一个强有力的前提——1964年的东京奥运会。这届赛事展示了日本在二战战败仅20年后便从灰烬中崛起，并再次融入国际社会。之前被美国轰炸成废墟的东京被整饬一新，新建了公路和铁路线，包括第一条新干线也就是高速铁路。“上世纪60年代有种感觉，就是每日的生活变得越来越丰盛：今天比昨天好，明天会比今天好，举办奥运会成了这种感觉的象征。”当年还是学生的日本前任驻外大使东乡和彦说。这种兴奋感给一代人留下了不可磨灭的印象，包括安倍本人，他在日本赢得2020奥运会主办权时就提到了自己对1964年的童年回忆。

如果不是因为疫情，日本很可能已经再次热血沸腾起来。这届东京奥运会

争议不断，从体育场馆预算超支，到组委会主席（现已离职）发表性别歧视言论。仅仅一场体育赛事也不足以解决日本的问题。但它原本毕竟还是在朝着“光荣的源头”迈进。数以万计的日本年轻人报名做志愿者。日本原本估计在去年也就是这届奥运会原定举办的年份迎来四千万外国人，游客们所见的东京会是一个无比洁净、安全、管理完善的大都市。日本报纸《日经新闻》的评论员秋田浩之认为，奥运会本可成为催化这个国家“觉醒与开放”的一艘“白船”。（19世纪迫使日本向世界开放的美国人是乘坐“黑船”前来的。）

而现在，奥运会将在没有外国和国内观众的情况下，在一个处于紧急状态的城市举行。聚集在驹泽体育场外的奥运迷之一伊藤裕子（音译）叹息说，现在的气氛比起最初让她爱上奥运会的1964年“差了百分之两百”。日本非但没有为奥运会齐心协力起来，反而弄得四分五裂。最近的民意调查显示，多达80%的日本人不希望今年继续举办这场赛事。

这让人感觉国家领导人正在把不情愿的民众拽入一场灾难。人们由此联想到的不是1964年的东京奥运会，而是它之前那场战争。就连几乎从不谈论政治敏感问题的德仁天皇也表达了对继续举办奥运会的担忧。

对疫情的恐惧只是人们反对这次奥运会的其中一个原因。以全球标准来看，日本对疫情的控制相当不错，总死亡人数仅为15,000，本月迄今东京仅有八例死亡。但许多日本人认为，这归功于老百姓在个人生活中负责任地行事和做出牺牲，而政府却一意孤行坚持冒险办赛。“这不仅是健康危机，还是民主危机，显示了问责的缺失。”上智大学的中野晃一说。

赞助商、电视网和国际奥委会的利益似乎比日本国民的利益更重要，这让很多人深感愤怒。政府无视民意执意举办奥运，表明奥运会“不是为民众”而办，而是为了“金钱利益所向的人群”，在驹泽体育场外参加抗议活动的软件工程师宫川拓说。

事态可能会严重失控。奥运村内若爆发疫情，可能导致赛事无法进行，在奥运史册上留下一个个星号注脚。某个心大的媒体或官方代表团成员也许

会偷偷溜出奥运村，在日本民众中引发更大规模的疫情。发展中国家的运动员可能把更具传染性的病毒株带回本国，令这次奥运会变成一场全球性超级传播事件。这样糟糕的结局将强化日本走向衰败的感觉，也会令民众对与外界交流持更保守的态度。

日本也可能大体控制住疫情，赛事如期举行。在如此艰难的情况下办完奥运会继而也有可能提醒世人，日本有能力克服逆境。无论怎样，这届奥运会的遗产将是有争议的。“如果这是一幅画，我们可以说画框本身已经烂掉了，”东京一桥大学的体育历史学家坂上康博说，“画最终也许是美的，但还是被这朽烂的画框围绕。”■



No fun and games

Japan is struggling to keep covid-19 at bay at the Olympics

It has banned spectators and fraternising among athletes, among other things

WHEN THE world's best athletes gather for the Olympics every four years, they do a lot more than run, jump and swim. In a memoir published after the previous Tokyo games, in 1964, Dawn Fraser, an Australian swimmer, pulled back the curtain on life inside the Olympic bubble. "Olympic morals are far more loose than any outsider would expect," she wrote. The village's reputation for debauchery has only grown since. Organisers began handing out condoms to athletes in 1988, ostensibly to raise awareness about HIV; at the last summer games in Rio de Janeiro in 2016, they handed out a record-breaking 450,000. As one former Olympic skier put it to ESPN The Magazine, an American sports publication, the Olympic village is "just a magical, fairy-tale place, like 'Alice in Wonderland', where everything is possible. You could win a gold medal and you can sleep with a really hot guy."

At this year's Olympics, the atmosphere will be gloomier, duller, chaster. For the athletes, life in the village will be circumscribed, as laid out in a 70-page book of prohibitions. They have been asked to arrive in Japan as late as possible (no earlier than five days before the start of their events) and to leave as soon as possible (within two days after their event's end). They must present negative results in two tests taken during the four days before they leave for Japan, and another negative test result on arrival. Though more than 80% of athletes are expected to be vaccinated, they will undergo daily tests, with a confirmed case leading to possible disqualification. Masks will be mandatory except when sleeping, eating and competing, meaning that athletes will be required to wear them even while working out in the Olympic village's gyms and, if they make it that far, while standing on the

podiums to receive their medals. They will not be allowed to go anywhere except to their accommodation and competition venues. All meals must be eaten quickly and without mingling at the village's cafeteria. Alcohol will not be served in the village, and drinking in groups or in public areas will be forbidden.

The athletes will not be the only ones on lockdown. Japan's government has declared a state of emergency in Tokyo and three surrounding prefectures to last until August 22nd, long after the Olympics finish. The government does not have the authority to limit the public's movements, but other restrictions will put a damper on any celebrations: restaurants are being asked to close by 8pm and not to serve any alcohol; residents are implored to avoid "non-essential" outings.

There will be no viewing parties; a promenade near the Olympic Village which had been envisioned as a raucous fan zone will be closed. Tokyoites have been asked to enjoy the games on TV from their homes. Nearly all of the events will be held without fans, foreign or domestic. "It will feel very jarring," says Sakaue Yasuhiro of Hitotsubashi University in Tokyo: "People are being told not to go out, not to meet up, not to have drinks; kids' sports days are being cancelled—and yet a global sporting event is going forward."

The contortions are the price for staging the games despite the pandemic, a state of affairs the government's main medical adviser, Omi Shigeru, has called "abnormal". Though Japan's vaccination campaign has picked up pace after a slow start, only 21% of the population is fully inoculated. Rates are much higher among the elderly (some 75% of Tokyoites over the age of 65 have received at least one jab), leading to a decrease in deaths and seriously ill patients in the capital. Nonetheless, Tokyo recorded 1,149 new cases on July 14th, the highest tally since January. The spread of the more infectious Delta variant worries medical experts. Christian Tagsold of the University of Düsseldorf quips that the circumstances of these Olympics bring to mind

“Akira”, a cult Japanese manga and anime from the 1980s that depicts a post-apocalyptic “Neo Tokyo” hosting the Olympic games in 2020.

Organisers admit that it will be impossible to control the virus completely. A handful of athletes and officials arriving early have already tested positive. The authorities hope instead to avoid an Olympian outbreak. That will require compliance not just from athletes, but from 53,000 officials, staff and press who are expected to attend. They will be bound by a “written pledge”, but face less drastic penalties for misbehaving than the athletes, who risk disqualification. Many worry they will be less rule-abiding than the Japanese public, which has tended to heed the government’s requests.

Those fears were amplified last week when four foreigners working for a subcontractor at a venue were arrested on suspicion of cocaine use in a nightlife district far from the Olympic facilities. Pandemic or not, the Olympics will be a temptation for some to party. That may be one reason why the organisers backtracked on plans to hand out condoms in the village this year. Instead, the athletes will receive their prophylactics only when they leave Japan. ■



无趣赛事

日本竭力防范奥运期间疫情恶化

它已采取多种限制措施，包括禁止观众入场及运动员间社交

当世界上最优秀的运动员每四年一次相聚在奥运会场，他们所做的远远不止奔跑、跳跃和游泳。在参加了1964年举行的上一次东京奥运会之后，澳大利亚游泳运动员道恩·弗雷泽（Dawn Fraser）出版了一本回忆录，揭开了奥运村内部隐秘生活的窗纱。“奥运村内的道德感比任何局外人所想象的都更低下。”她写道。从那以后，奥运村放荡的名声只增不减。1988年，奥运会主办方以加强艾滋病预防意识为名，开始向运动员发放避孕套；在2016年上一届里约热内卢夏季奥运会上，主办方发放了破纪录的45万只避孕套。一位前奥运滑雪运动员对美国体育杂志ESPN说，奥运村“真是个童话一样神奇的地方，就像‘爱丽丝梦游仙境’，在那里，一切皆有可能。你可以赢得金牌，也可以和非常性感的男人上床。”

在今年的奥运会上，气氛会更阴沉、乏味和圣洁。正如长达70页的防疫手册中所列明的，运动员在奥运村的生活将受到限制。他们被要求尽可能晚地抵达（在自己参加的赛事开始前五天内），并尽快离开（赛事结束后两天内）。他们必须在出发前的四天内接受两次核酸检测，结果必须呈阴性，还要在抵达日本后的检测中呈阴性。尽管预计超过80%的运动员都会接种疫苗，但他们还是要每天接受检测，一旦确诊可能会被取消比赛资格。除了睡觉、进食和比赛，其他时间都必须戴口罩，这意味着运动员即使在奥运村的健身房里锻炼时，以及如果他们能拼到最后、站上领奖台时，也必须戴着口罩。除了住处和比赛场地，他们不会被准许去其他任何地方。在奥运村的餐厅里必须迅速结束用餐，不得扎堆交际。奥运村不提供含酒精的饮料，禁止聚集饮酒或在公共场所饮酒。

活动受限的不仅仅是运动员。日本政府已经宣布东京及周边三个县的紧急状态将持续到8月22日，远远超过了奥运会结束的日期。尽管政府没有限制公众活动的权力，但其他一些限制措施会对所有庆祝活动起到抑制作用。

用，包括要求餐馆在晚上八点后停止营业，且不提供任何含酒精的饮料，以及恳请居民避免“不必要的”外出等。

不会有人结伴聚集观赛；奥运村附近一个原本打算供粉丝狂欢的步行区将被关闭。东京市民被要求留在家中在电视屏幕上观赛。几乎所有赛事都将没有观众入场，无论是国外还是国内观众。“这会让人感到非常别扭，”东京一桥大学的坂上康博表示，“人们被告知不要出门，不要聚会，不要喝酒；孩子们的学校运动会被取消——然而一场全球性的体育赛事却正在举行。”

这样怪异的情境是疫情之下仍坚持办奥运的代价，日本政府的首席医疗顾问尾身茂称这局面“反常”。日本的疫苗接种起步缓慢，尽管之后提速，但目前也只有21%的人口完全接种了疫苗。老年人的接种率要高得多（大约75%的65岁以上东京市民至少接种了一剂疫苗），这减少了东京的死亡和重症病例。尽管如此，东京在7月14日还是新增1149例确诊病例，创1月以来的新高。传染性更强的德尔塔变异毒株的传播让医学专家感到担忧。德国杜塞尔多夫大学（University of Düsseldorf）的克里斯蒂安·塔格佐尔德（Christian Tagsold）打趣说，今年奥运会的情形让人想起上世纪80年代的另类日本漫画和动画片《阿基拉》，其中有毁灭后重建的“新东京”在2020年主办奥运会的情节。

主办方承认，要完全控制病毒是不可能的。已经有少数先期到达的运动员和官员在检测中呈阳性。日本政府转而希望避免在奥运期间爆发疫情。这将不仅需要运动员遵守规定，还包括预计5.3万名到场的官员、工作人员和媒体工作者。这5.3万人将签署“保证书”，不过如果行为失当，他们面临的惩罚相比有可能被取消比赛资格的运动员要轻些。许多人担心，与一般都会听从政府请求的日本民众相比，这些人没有那么循规蹈矩。

上周，一家分包商在一处场馆工作的四名外籍雇员被拘捕，因为他们涉嫌在远离奥运赛场的一个夜生活区吸食可卡因。这加剧了人们的担忧。不管有没有疫情，奥运会都会让一些人忍不住想要寻欢作乐。这可能是主办方今年不再在奥运村发放避孕套的原因之一。取而代之的是，运动员只有在

离开日本时才会收到这份大礼包。 ■



Sports equipment

New running shoes are smashing records

Is that fair?

PLATFORM SHOES are back in fashion, at least in athletics. Many of the long-distance runners at the Tokyo Olympics, which begin on July 23rd, will arrive at the starting line sporting footwear with a distinctive chunky-looking heel. It will be more than just a fashion statement. The new shoes offer such a big performance advantage that critics have described them as “technological doping”.

Running-shoe makers have long tried to boost athletic performance, observes Geoff Burns, a biomechanics expert at the University of Michigan. In olden days, a 1% improvement in “running economy”—the energy taken to travel a given distance—would have impressed. But in 2016 Nike released the first version of its “Vaporfly” model, which improved running economy by 4%.

If that percentage were to translate directly into performance, it would knock about five minutes off an elite male’s marathon time. In practice, as Dr Burns observes, it wouldn’t quite do that. A marathon improvement of around 90 seconds would be a more realistic expectation. But Vaporfly and its successors have helped athletes smash a string of records. On June 6th Sifan Hassan, a Dutch runner, completed a women’s 10,000 metres race in 29 minutes and 6.82 seconds, beating a record set in 2016. Two days later she was overtaken by Letesenbet Gidey, an Ethiopian, who clocked 29 minutes and 1.03 seconds. In 2019 Eliud Kipchoge, a Kenyan, became the first to run, albeit in an unofficial event, a marathon’s distance of 42.195km in under two hours. The same weekend Brigid Kosgei, another Kenyan, broke a women’s marathon record that had stood for 16 years.

Scientists are still puzzling over exactly how the shoes work. The soles are made of a new type of foam that offers an unprecedented mix of resilience and squidginess, according to Dr Burns. This returns around 80% of the energy from each strike of a runner's foot. The carbon-fibre plate may help by stiffening the midsole, and possibly by altering a runner's gait. By cushioning a runner's bones, muscles and ligaments from repetitive impacts, the shoes may even help athletes train harder than they otherwise could.

All that is great news for Nike, which sells the Vaporfly and its successors for around \$250 each. (Rival manufacturers now offer similar shoes of their own.) Whether it is good for the sport is another question. Different sports have different tolerances for technological assistance. Running tends towards the conservative end of the spectrum.

In January 2020 World Athletics, the governing body of international athletics, passed new rules limiting the thickness of a road shoe's sole to 40mm. Meanwhile, Nike appears to have shelved plans to deploy high tech shoes designed for sprinters at the Tokyo games, possibly because they did not comply with regulations either. But if they, or a rival manufacturer, have worked out a way around that problem, there could be fireworks in the sprints, too. ■



运动装备

新跑鞋不断刷新纪录

这样公平吗？

厚底鞋又流行起来了，至少在运动场上是如此。在即将于7月23日开幕的东京奥运会上，许多长跑选手将脚蹬着有厚实后跟的惹眼运动鞋站在起跑线上。它将不仅仅是个时尚宣言。这款新鞋提供了巨大的性能优势，以至于批评人士称之为“技术兴奋剂”。

密歇根大学的生物力学专家杰夫·伯恩斯（Geoff Burns）表示，跑鞋制造商长期以来都在试图提高运动员的运动表现。从前，“跑步效能”（跑完特定距离所需的能量）提升1%都能让人惊叹不已。但在2016年，耐克发布了第一版Vaporfly跑鞋，将跑步效能提高了4%。

如果将这个百分数直接转化为成绩，那么一位男子马拉松精英选手的完赛成绩将缩短约五分钟。伯恩斯认为，这在实践中不能完全实现。将马拉松比赛的成绩提高90秒是一个更现实的期望。但是，Vaporfly及其后续版本的跑鞋帮助运动员打破了一系列记录。6月6日，荷兰中长跑选手西凡·哈桑（Sifan Hassan）在一场比赛中跑出了29分06秒82的成绩，打破了2016年创下的世界纪录。两天后，埃塞俄比亚选手莱特森贝特·吉迪（Letesenbet Gidey）以29分01秒03的成绩超越了她。2019年，肯尼亚人埃利奥德·基普乔格（Eliud Kipchoge）成为第一个在两个小时内跑完42.195公里马拉松的人，尽管那是一次非正式比赛。同一个周末，另一名肯尼亚人布里吉德·科斯盖（Brigid Kosgei）打破了尘封16年的女子马拉松纪录。

科学家们仍在深入研究这种鞋的工作原理。据伯恩斯介绍，它的鞋底由一种新型泡棉制成，能前所未有地兼顾回弹和缓震。跑步者的脚每一次落地产生的能量约有80%会被回收。碳纤维板可能通过加强中底提升表现——也可能是通过改变跑步者的步态。通过为跑者的骨骼、肌肉和韧带受到的

重复冲击提供缓冲，这种鞋甚至有助于运动员更刻苦地训练。

所有这些对耐克来说都是好消息，它以大约250美元一双的价格出售Vaporfly及后续新款。（竞争厂商现在也推出了类似的鞋款。）这是否有益于跑步这项运动就是另一个问题了。不同的运动对技术辅助的容忍度不同。跑步处于较保守这一端。

国际田径赛事管理机构国际田联于2020年1月通过新规定，要求道路赛事用鞋的鞋底厚度不得超过40毫米。与此同时，耐克似乎已经搁置了在东京奥运会上为短跑运动员配备高科技短跑鞋的计划，可能是因为这些鞋也不符合规定。但如果耐克或其竞争对手找到了解决这个问题的方法，那么短跑赛场上也可能会火花四射。 ■



Free exchange

The EU proposes a carbon tariff on some imports

The effort could prove an instructive example for others—or a cautionary tale

WHEN THE European Union established its cap-and-trade scheme for pricing carbon emissions in 2005 it faced a tricky design problem. Making polluting firms buy permits puts them at a disadvantage in global markets. Companies might respond to the scheme by moving their dirty activities offshore, causing “carbon leakage”. And if producers in places with lax environmental standards outcompeted European firms, global emissions would go up. The EU solved the problem by offering subsidies and free pollution permits to some dirty industries exposed to trade.

Those handouts, however, have always had a target on their back. On July 14th EU officials set out a plan to phase them out and replace them with a “carbon border-adjustment mechanism” (CBAM). Between 2025 and 2035, producers of aluminium, cement, fertilisers and steel will gradually lose their subsidies. But importers of these goods will have to buy a new category of pollution permit. How many they need will depend on the amount of carbon estimated to have been emitted during the production of the goods. The policy is in effect a tariff, intended to compensate for the fact that foreign firms may face no carbon price, or one that is lower than Europe’s.

The switch will please those who suspect that subsidies have blunted the impact of carbon prices. In theory free permits do not affect the incentive to reduce emissions, because at the margin the financial reward for doing so is the same: firms that get greener can sell their surplus entitlements. In practice the freebies have sapped ambition. Michael Grubb of University College London points out that companies know that if they sell their permits today, they might receive fewer handouts in future. Compared with

the industries that have received support, the power sector, which has not, has decarbonised more quickly. Victoria Irving of Morgan Stanley, a bank, says that some subsidised polluters have made green investments, but “they have a long way to go”. Withdrawing the subsidies without a new scheme would bring back the danger of leakage.

Officials estimate that by 2030 the CBAM and the suite of environmental policies announced alongside it will reduce emissions in the affected sectors by 14%, compared with a scenario in which nothing changes. However, imports would be 12% lower, because tariffs depress trade. Though totemic, the scheme’s scope is relatively small. It would raise about €9bn in revenues in 2030 (although that figure may nearly double once the policy is fully phased in). The carbon embodied in trade flows is typically less than 10% of countries’ total emissions, according to the IMF, and the proposal covers only a handful of sectors. In 2019 the imports in question were worth only €29bn (\$33bn, or 1.5% of total trade in goods for the bloc).

Tariffs do not have to be large, however, to provoke a response. Perhaps it will be a good one: with the CBAM in place, foreign countries might as well price carbon at home and keep the revenue for themselves (the EU will grant discounts for carbon taxes already paid). As the scope of the CBAM increases, so will other governments feel a greater pull towards pricing emissions. A more likely consequence, however, is a brawl over whether the policy is protectionist. Australia and India, both exporters to the EU, are already grumbling that the tariff could be discriminatory and regressive. In March America warned the EU that border levies should be a “last resort”. It has also said it is considering one of its own despite not pricing carbon itself, other than through an incomplete patchwork of state schemes in which prices are too low.

There is also a danger of unintended consequences. Foreign companies could redirect their greenest exports to Europe and send their dirtiest

output elsewhere, rather than cutting overall emissions. This phenomenon, dubbed “resource shuffling”, has troubled California, which has a CBAM for its electricity market—the only existing comparable scheme. Firms could also adjust their supply chains to exploit the limited scope of the policy. A carmaker that would have to buy permits to import steel may prefer to buy a car chassis made with steel overseas, to which the CBAM would not apply.

The risk of such carbon leakage rises in tandem with the carbon price. A study published in January by DIW Berlin, a think-tank, found that a price of €75 per tonne would leave as much as 15% of the EU’s manufacturing vulnerable to being undercut in this way. (European carbon prices are hovering between €50-60 per tonne, and projected to increase.)

These problems, however, will be reduced to the extent that carbon prices are adopted everywhere. The power of incentives means carbon-intensive production will always try to find its way to where emissions are cheap, but that does not mean it is futile to try to plug all the holes. The best argument for the CBAM is that it is a first step towards a world in which emissions cannot escape carbon prices. Were they sufficiently widespread, the CBAM would be rendered unnecessary.

Long before that happens, though, the EU must overcome opposition to the CBAM at home. One problem is that trade will be adjusted on the way in but not on the way out. Exporters, having lost their subsidies, will still find themselves competing in markets outside Europe’s borders against firms that can ignore the cost of carbon. (Around 8% of the EU’s cement production, and 18% of steel, is exported.) Already some lawmakers in the European Parliament, which must approve the proposal, are calling for border adjustment to exist alongside free permits, punishing foreigners while continuing to shield those at home. Bowing to them would turn a potentially useful policy for fighting climate change into naked protectionism—and an instructive example for other countries into a

cautionary tale. ■



自由交流

欧盟提议对部分进口商品征收碳关税

这项努力可以成为值得其他地区借鉴的范例——也可能沦为警世故事

当欧盟在2005年制定“限额与交易”(cap-and-trade)这一碳排放定价机制时，它面临一个棘手的设计问题。令污染企业购买排污许可会让它们在全球市场上处于劣势。企业应对这个机制的办法可能是把污染严重的经济活动转移到海外，结果导致“碳泄漏”。而如果位于环境标准宽松的地区的生产商在竞争中胜过了欧洲企业，全球排放量就会上升。对此，欧盟的解决方法是向一些参与贸易的污染行业提供补贴和免费排放许可。

然而，这类补贴一直引致批评。7月14日，欧盟官员制定了一项计划来逐步停止补贴，代之以“碳边境调整机制”(carbon border-adjustment mechanism，简称CBAM)。2025年至2035年间，铝、水泥、化肥和钢铁生产商将慢慢失去补贴。但这些商品的进口商将必须购买一类新的排污许可。至于购买多少将取决于商品生产过程中估算的碳排放量。这项政策实质上是一种关税，旨在对一个情况做出补偿：外国公司可能不需要负担碳价，或者需要支付的碳价低于欧洲。

这一变化会让那些质疑补贴削弱了碳价影响的人感到高兴。理论上讲，免费许可不会影响企业减排的动力，因为这么做的边际财务回报是相同的：变得更环保的公司可以把自己多余的许可卖给别人。但在实际操作中，这些免费馈赠削减了减排的雄心。伦敦大学学院的迈克尔·格鲁布(Michael Grubb)指出，企业知道如果它们今天把许可卖掉，将来收到的补助可能会减少。相比获得资助的行业，没有得到支持的电力行业脱碳的速度更快。摩根士丹利的维多利亚·欧文(Victoria Irving)表示，一些拿补贴的污染企业已经展开了绿色投资，但“他们还有很长的路要走”。不推出新的机制就撤回补贴会重新带来“碳泄漏”的危险。

官员们估计，相比不做任何改变的情景，到2030年，CBAM以及随之宣布

的一系列环境政策将使受影响部门的碳排放量减少14%。但进口将减少12%，因为关税会抑制贸易。虽然该计划具有标志性意义，但它覆盖的范围相对较小。到2030年它将带来约90亿欧元的收入（尽管一旦该政策完全实施，这一数字可能接近翻番）。据国际货币基金组织称，贸易流通中包含的碳通常不到各国总排放量的10%，而且该提案仅涵盖少数几个经济部门。受影响部门2019年的进口总额仅为290亿欧元（330亿美元，占欧盟商品贸易总额的1.5%）。

然而，关税要引发反应并不需要很大的规模。也许它将会是一种积极的反应：CBAM实施后，其他国家或许倒不如在国内制定碳价，自己拿到这笔收入（欧盟将对已支付的碳税给予折扣）。随着CBAM范围扩大，其他政府会愈发倾向于对碳排放定价。不过，一个更可能发生的后果是一场有关这项政策是否是贸易保护主义的争吵。澳大利亚和印度这两个对欧盟出口的国家已经在抱怨这可能是一项不公正和累退的关税。今年3月，美国警告欧盟，边境税赋应是“最后的手段”。它还表示，尽管没有为碳本身定价，它正在考虑推出自己的某种边境税，而不是依靠国内部分州推出价格过低的碳税。

也有出现意外后果的危险。外国公司可以把自己最环保的出口品转到欧洲，把最肮脏的运往别处，而不是减少排放总量。这种被称为“资源洗牌”的现象已经让加州头痛，它的电力市场有一个CBAM机制——现有唯一的类似计划。企业还可以调整自身供应链来利用该政策有限的范围。必须购买排污许可来进口钢材的汽车制造商可能宁愿购买用海外产钢材制成的汽车底盘——CBAM不适用于后者。

这种碳泄漏的风险随碳价的上升而上升。智库德国经济研究所（DIW Berlin）1月发表的研究发现，每吨75欧元的价格将让欧盟高达15%的制造业面临低价竞争。（欧洲碳价目前徘徊在每吨50至60欧元间，预计还会上涨。）

然而，只要各地都采用碳价，这些问题将减轻。财务激励的强大诱因意味着碳密集型生产会始终试图找到排放更便宜的地方，但这也不是说尝试堵

住所有漏洞是白费劲。推出CBAM的最佳理由是它是迈向一个无法逃避碳价的世界的第一步。如果碳价足够普及，CBAM就变得没必要了。

不过，在这一天远远没有到来之前，欧盟必须克服欧盟境内对CBAM的反对。一个问题是贸易的调整将只发生在进口环节而不包括出口。失去补贴的出口商仍然会发现自己要在欧洲境外市场上与那些不需要负担碳成本的企业竞争。（欧盟水泥产量的约8%和钢铁的18%都出口境外。）该提案必须获欧洲议会批准，而一些议员已经呼吁让免费许可和边境调整机制双管齐下，在惩罚外国人同时继续保护本土企业。如果向他们屈服，一项原本可能有效对抗气候变化的政策将沦为赤裸裸的保护主义——把一个值得其他国家借鉴的范本变成一则警世故事。 ■



Subtle globalisers

China Inc's new inconspicuous expansion

Chinese companies are adapting to a more hostile global climate—and thriving

DEEGLINT, A CHINESE facial-recognition firm, was one of 14 companies slapped with American sanctions on July 9th for alleged links to human-rights abuses in China's far-western region of Xinjiang. It is also a globally recognised leader in its field and has raised money from Sequoia Capital and other big American investment firms. DeepGlint's founders, who graduated from Stanford and Brown universities in America, must now discuss with their foreign backers the prospect of decoupling from the Western commercial sphere. Many Chinese companies have been forced to hold similar talks.

China Inc appears to be on the back foot. In America President Joe Biden has picked up where Donald Trump left off, placing restrictions on Chinese companies. Last year Congress passed a bill that may eventually force Chinese firms to delist from American stock exchanges, which would affect nearly \$2trn in market value. Huawei, banned from America, has struggled to sell its 5G telecoms kit elsewhere in the West. ByteDance was nearly forced to divest from its prized short-video app, TikTok, over American fears that the Chinese regime could access global users' personal data. Tencent, another internet giant, is said to be haggling with American regulators worried about its 40% stake in Epic Games, the developer of Fortnite.

Around the world Chinese companies are, fairly or not, viewed as instruments of the Communist Party. Britain's prime minister, Boris Johnson, said on July 7th that the government would probe the Chinese acquisition of Newport Wafer Fab, the country's largest chipmaker, on national-security grounds. Australia's defence department could tear up a

99-year lease with a private Chinese company for a big port. Completed outbound acquisitions by Chinese firms shrivelled from some \$200bn in 2016 to \$36bn in 2020. Cross-border lending, mostly to poor countries, by some of China's state banks has stopped growing.

It is not the first time that a wave of Chinese corporate expansion has met a frosty reception. When commodity giants such as CNOOC, an oil firm, began buying foreign reserves, and rivals, in the 1990s, it stoked fears of resource colonialism. In the 2010s Chinese industrial groups' aggressive pursuit of Western rivals from chemicals (ChemChina's takeover of Syngenta) to cars (Geely's of Volvo) reminded some anxious rich-world governments of Japan's corporate conquests in the 1980s. At the same time, Chinese acquisitions of trophy assets such as the Waldorf Astoria hotel (by Anbang, a conglomerate) allowed other Westerners to dismiss China Inc as unserious or dodgy (a suspicion confirmed by the subsequent collapse of Anbang and a few similar groups after charges of fraud).

Now, just as innovative Chinese tech firms have captivated Wall Street, China's increasingly authoritarian regime is itself reining in its global champions. President Xi Jinping appears bent on disconnecting them from Western capital markets and controlling their data. Tencent and Alibaba, an e-commerce behemoth, have between them lost \$340bn in market value since the crackdown began late last year. Days after its \$67bn New York flotation, Didi found its ride-hailing app banned by Chinese data regulators. ByteDance has scotched plans to go public in New York.

All this looks like a treacherous climate for Chinese companies. Look closer, though, and a new generation of firms is not just adapting to it but thriving. Many have spent years expanding global operations and now make as much money outside China as they do within. Some are pursuing smaller investments under the radar. And, inverting a decades-old trend of copying Western intellectual property (IP), a few have become tech powerhouses in

their own right, selling advanced products to the world.

The scale of China Inc is formidable. China was the largest investor in the world in 2020. Foreign direct investment (FDI) from Chinese firms hit \$133bn, down only slightly from 2019 despite the headwinds (see chart 1). The country has some 3,400 multinationals, almost as many as America and western Europe combined, reckons Bain, a consultancy. Around 360 big listed Chinese groups report foreign revenues. These amounted to around \$700bn in 2020, compared with 250 large firms earning a total of \$400bn in 2012, according to data from Bloomberg (see chart 2). In 2020 Chinese venture capitalists ploughed an estimated \$3.2bn into American startups in 249 deals, the second-biggest year on record by value, calculates Rhodium Group, a research firm. Analysts at CB Insights say that Chinese investors' participation in American venture deals last quarter was the highest since at least 2016.

The Chinese presence is deep as well as broad. Last year more than 100 of the listed firms earned at least 30% of revenues outside China; 27 earned 70% or more. All told, China's top ten foreign earners booked \$350bn or so in overseas sales. This total has grown by 10% a year on average since 2005, Bain says, twice as fast as the equivalent figure in America, Europe or Japan. Tencent's foreign sales have risen at an annual rate of 40% for nearly a decade, and now make up 7% of its huge top line.

The first plank of China Inc's new global strategy is astute localisation. In the past most Chinese FDI consisted of asset purchases. Last year, by contrast, a lot was reinvested earnings from operations abroad. Hisense, a maker of consumer electronics, wants to treble its overseas sales, from \$7.9bn in 2020 to \$23.5bn in 2025, half its projected total, says Candy Pang, its head of marketing. That would leave a lot of money to spend on foreign

factories, research and development, and marketing (it is sponsoring the 2022 football World Cup in Qatar, among other sports events).

Chinese firms have also retained their subsidiaries' foreign leadership. Despite recently merging with another state-backed giant, ChemChina has allowed its foreign assets to operate as global companies. Pirelli, which it bought in 2015 for €7.1bn (\$7.6bn), still makes tyres in Italy. Syngenta, for which it paid \$43bn a year later, maintains a Swiss headquarters, a mostly foreign executive team, and a nine-person board with only two Chinese state officials. Similarly, Geely has allowed foreigners to run Volvo, and Haier, an appliance-maker, kept most of GE Appliances' top brass after acquiring the American firm. "You can belong to China without having a Chinese-dominated board," says an executive at one Chinese multinational.

The second pillar of China Inc's new globalisation strategy is to shun mega-deals in favour of smaller ones. The speculative wave of outbound investments between 2015 and 2017 swallowed up \$425bn in assets and raised plenty of eyebrows among foreign and Chinese regulators alike. By contrast, of the 235 outbound transactions so far this year only three were valued at more than \$1bn.

The master of mini-dealmaking is Tencent. It has made at least 85 cross-border investments since the start of 2019, according to Refinitiv, a data provider. Many of these are small stakes taken as part of a larger consortium of investors that includes prominent non-Chinese private-equity groups. This year, for example, Tencent bought a 4% stake in Rakuten, a Japanese internet group, for about \$600m—small change for a giant worth nearly \$700bn. It has also continued to invest in America, with at least 12 deals over the past two-and-a-half years, including the purchase of a \$150m stake in Reddit, an American online platform which hosts popular discussion forums.

Chinese companies are making their global presence felt in one last way. Rather than swooping into foreign countries to buy up technology, or copying Western IP, they are going out to sell their own, says Bagrin Angelov of CICC, a Beijing-based investment bank. Because Chinese subsidies to makers of electric cars and batteries require them to own some of the core IP, companies such as BYD, CATL, Ganfeng and SVolt raced to develop it. Having done so, they are now targeting export markets. BYD and SVolt are setting up factories in Europe. So is CATL, which in December also announced plans to build a \$5bn one in Indonesia.

BeiDou, China's state-owned answer to America's GPS satellite-navigation system, was used by more than 100 countries in 2020, according to EY, a consultancy. Chinese telecommunications services cover more than 170 countries with a population of 3bn people. Regardless of American sanctions, Huawei remains a popular choice for 5G networks even in parts of Europe. Horizon Robotics, which develops self-driving systems, counts Germany's Volkswagen and Bosch among its partners.

And new Chinese stars are rising all the time. Few fashionistas probably realise than Shein, a fast-fashion darling beloved of the hip TikTok set, is Chinese. The company boasts the top shopping app in 50 countries—including America, where it was downloaded on more iPhones than Amazon in June. OneConnect, a financial-technology platform owned by Ping An, a big insurer, is selling a number of digital-banking products developed for China to banks and other firms across Asia and beyond. It recently designed an artificial-intelligence fraud-prevention system for a Sri Lankan lender.

These subtle corporate conquerors could still be stymied—by the heavy hand of China's Communist rulers or America and its allies, which are bound to keep an ever beadier eye on Chinese commercial incursions. The go-getting Chinese multinationals would then need to adapt once again.

They have shown themselves to be more than capable of doing so. ■



低调的全球化者

中国公司不露锋芒的新扩张

中国企业正在适应更加恶劣的全球氛围，并蓬勃发展

七月九日，美国将14家它指控参与在新疆侵犯人权的企业列入制裁名单，人脸识别公司格灵深瞳是其中之一。这家中国公司是全球公认的行业领导者，已从红杉资本等美国大型投资公司获得融资。格灵深瞳的几名创始人毕业于美国的斯坦福大学和布朗大学，现在必须要与他们的外国投资者讨论与西方商业界脱钩的前景。许多中国公司已被迫展开类似的讨论。

中国公司似乎处境不妙。在美国，拜登接棒特朗普，继续对中国企业施加限制。去年美国国会通过了一项法案，最终可能会迫使中国公司从美国证券交易所退市，涉及的市值近2万亿美元。华为在美国被禁，在其他西方市场销售其5G通讯设备也举步维艰。由于美国担心中国政府可以获得全球用户的个人数据，字节跳动差点被迫剥离其价值极高的短视频应用TikTok。另一家互联网巨头腾讯据说正在和美国监管机构谈判，因为后者对它持有《堡垒之夜》开发商Epic Games40%的股份感到担忧。

无论公允与否，中国公司如今在世界各地都被视为共产党的工具。英国首相约翰逊7月7日表示，出于国家安全考虑，英国政府将调查中国对英国最大芯片制造商Newport Wafer Fab的收购。澳大利亚国防部可能会撕毁一家中国私营公司对一个大型港口为期99年的租约。中国企业完成的海外收购从2016年的约2000亿美元缩水到2020年的360亿美元。中国一些国有银行主要对贫困国家发放的跨境贷款已经停止增长。

中国企业的扩张遇冷并非首次。上世纪90年代，中海油等大宗商品巨头开始收购外国矿藏和竞争对手，引发了对中国“资源殖民主义”的担忧。在上一个十年里，从化工（中国化工收购先正达）到汽车（吉利收购沃尔沃），中国的工业集团对西方竞争对手的猛烈攻势让一些焦虑的发达国家政府想起了上世纪80年代日本企业的收购狂潮。与此同时，中国对华尔道

夫酒店（Waldorf Astoria，被企业集团安邦收购）等炫耀性资产的收购让其他西方人认为中国公司太过儿戏或有可疑勾当（后来安邦和一些类似的集团在被控诈骗后倒闭，证实了这种猜疑）。

现在，就在华尔街情迷富有创新力的中国科技公司之际，中国日益威权的政府正在自己约束本国的全球领军者。国家主席习近平似乎一心要切断它们与西方资本市场的联系并控制它们的数据。这轮打压自去年年底开始以来，腾讯和电子商务巨头阿里巴巴的市值已经总共蒸发了3400亿美元。滴滴在纽约以670亿美元的市值上市仅几天后，其网约车应用就被中国数据监管机构勒令下架。字节跳动已经搁置了在纽约上市的计划。

这一切看起来让中国企业的处境颇为险恶。然而仔细观察会发现，新一代企业不仅正在调整适应这种新环境，而且还在蓬勃发展。许多企业已经花费多年时间扩大全球业务，现在海外收入已经堪比国内收入。有些企业正在悄悄寻求较小规模的投资。还有少数企业已经成为真正的科技巨擘，向全世界销售先进的产品，一改数十年来抄袭西方知识产权的旧习。

“中国公司”的规模令人生畏。2020年，中国是全球最大的投资国，中国企业的对外直接投资达到了1330亿美元；尽管遇到了阻力，但仅比2019年略微下降（见图表1）。咨询公司贝恩估计中国约有3400家跨国公司，几乎相当于美国和西欧的总和。约360家大型上市中国集团报告了海外收入。根据彭博的数据（见图表2），2020年这些上市集团的海外收入总额约为7000亿美元，相比之下，2012年时有250家大型跨国公司报告了海外收入，总额为4000亿美元。研究公司荣鼎咨询（Rhodium Group）的数据显示，2020年，中国风险投资家通过249笔交易向美国创业公司投资了约32亿美元，年投资额创下历史第二高。CB Insights的分析师表示，上季度中国投资者在美国风投交易中的参与度至少是2016年以来的最高水平。

中国企业的海外扩张不仅广泛，而且深入。去年，这些上市公司中有100多家至少有30%的收入来自海外，27家占到70%以上。海外收入最高的十家中国公司的海外销售额约为3500亿美元。贝恩表示，自2005年以来，

这一数字平均每年增长10%，是美国、欧洲或日本增速的两倍。近十年来，腾讯的海外销售额以每年40%的速度增长，如今已占到其庞大总收入的7%。

中国公司新全球战略的第一大支柱是精明的本地化。过去，中国的大部分直接投资都是购买资产。而在去年，很多投资都是海外业务收益的再投资。消费电子产品制造商海信希望将其海外销售额增加两倍，从2020年的79亿美元增加到2025年的235亿美元，这将占其预计总销售额的一半，海信的营销负责人庞静表示。这会让公司拥有大笔资金来投注海外工厂、研发和营销（海信已成为2022年卡塔尔世界杯等体育赛事的赞助商）。

中国企业还保留了子公司的外籍领导层。中国化工虽在近期与另一家国有巨头合并，但仍旧让自己的海外资产作为全球公司运营。它在2015年以71亿欧元（76亿美元）收购的倍耐力（Pirelli）目前仍在意大利生产轮胎。一年后它以430亿美元收购了先正达，保留了它在瑞士的总部，高管团队以外国人为主，九人董事会里只有两名中国政府官员。同样，吉利也让外国人继续经营沃尔沃，而家电制造商海尔也在收购美国的通用家电（GE Appliances）后保留了它的大部分高管。“属于中国的公司不一定要由中国人控制董事会。”一家中国跨国公司的高管表示。

中国公司新全球战略的第二大支柱是避开大买卖，转向小交易。2015年至2017年的境外投机潮狂揽4250亿美元的资产，令外国和中国的监管机构都为之侧目。相比之下，今年迄今为止达成的235笔海外交易中只有三笔价值超过10亿美元。

腾讯是小笔交易的大师。数据供应商路孚特（Refinitiv）称，自2019年初以来，腾讯至少做了85笔跨境投资。其中很多是少数持股，腾讯作为一个投资者大财团中的一员认购，该财团中还包括一些著名的非中国私募集团。例如，今年腾讯以约6亿美元的价格收购了日本互联网集团乐天（Rakuten）4%的股份，对于一家市值近7000亿美元的巨头来说这笔钱不过是个零头。腾讯还继续在美国投资，在过去两年半中至少达成了12笔交易，包括斥资1.5亿美元收购拥有热门论坛的美国在线平台Reddit的股

份。

中国公司还在以最后一种方式建立全球影响力。它们不再像以前那样冲到国外去购买技术，或者抄袭西方的知识产权，而是走出去销售自己的技术，总部位于北京的投资银行中金公司的安国邦（Bagrin Angelov）表示。由于中国补贴电动汽车和电池制造商的条件是要求它们自主拥有部分核心知识产权，比亚迪、宁德时代、赣锋锂业和蜂巢能源等公司竞相开展核心技术研发。掌握核心技术之后，它们现在开始瞄准出口市场。比亚迪和蜂巢能源正在欧洲设厂。宁德时代也一样，它还在去年12月宣布计划投资50亿美元在印度尼西亚建厂。

国有的北斗系统是中国为替代美国GPS卫星导航系统而建，根据咨询公司安永的数据，2020年有100多个国家使用了北斗。中国的电信业务覆盖170多个国家，服务30亿人口。即使被美国制裁，华为仍然是5G网络的热门选择，甚至在欧洲部分地区也是如此。开发自动驾驶系统的地平线公司的合作伙伴包括德国的大众汽车和博世。

中国的企业新星也在不断冉冉升起。可能很少有时尚达人注意到，深受TikTok潮人们喜爱的快时尚宠儿Shein出自中国。该公司的购物应用在包括美国在内的50个国家中热度排名第一，6月在美国的iPhone下载量超过了亚马逊。大型保险公司平安旗下的金融科技平台金融壹账通正在向亚洲及其他地区的银行和其他公司销售多种数字银行产品，这些产品原是为中国开发的。最近它为一家斯里兰卡银行设计了一个人工智能防欺诈系统。

这些低调扩张的企业仍可能遭受中国共产党统治者的重拳或美国及其盟友的阻挠，后者必将更加小心地提防中国的商业入侵。届时雄心勃勃的中国跨国公司将需要再次适应形势。它们已经证明自己完全具备这项能力。■



The queue to quit QE

Central banks face a daunting task: tapering without the tantrum

Can they stop their bond-buying and avoid upending markets?

THE DEBATE over the effect on markets and the global economy of quantitative easing (QE), the purchase of bonds with newly created money, is almost akin to a culture war. To its critics unrestrained QE during the pandemic has covertly financed governments while inflating asset prices and boosting inequality. To its fans QE is an essential tool in which economists have justified and growing confidence. This high-stakes debate is about to enter a new phase. Rich-world central banks' balance-sheets will have grown by \$11.7trn during 2020-21, projects JPMorgan Chase, a bank (see chart 1). By the end of this year their combined size will be \$28trn—about three-quarters of the market capitalisation of the S& P 500 index of stocks today. But central bankers are about to turn this mega-tanker of stimulus around.

The justifications for QE have almost dissipated. At the start of the pandemic, central banks bought bonds to calm panicky markets amid a flight to safety and a dash for cash. Then it became clear that the pandemic would cause a huge economic slump that would send inflation plummeting; QE was needed to stimulate the economy. Today, however, markets are jubilant and inflation is resurgent.

In America it looks increasingly weird that the Federal Reserve is the biggest buyer of Treasuries, as it was in the first quarter of 2021. The economy is powering ahead. In June it added a heady 850,000 jobs, according to figures released on July 2nd. On Wall Street cash is so abundant that over \$750bn gets parked at the New York Fed's reverse-repo facility most nights, mopping up some of the liquidity injected by QE. On June 30th it absorbed nearly

\$1trn. The Fed's purchases of mortgage-backed securities, given America's red-hot housing market, now look bizarre.

Some central banks have already begun to scale back their purchases. The Bank of Canada began curtailing the pace of its bond-buying in April. The Reserve Bank of Australia said on July 6th that it would begin tapering its purchases in September. The Bank of England is approaching its £895bn (\$1.2trn) asset-purchase target and looks likely to stop QE once that is reached; Andrew Bailey, its governor, has mused about offloading assets before raising interest rates, contrary to the normal sequencing. In May the Reserve Bank of New Zealand said it would not make all of the NZ\$100bn (\$70bn) asset purchases it had planned to. And the European Central Bank is debating how to wind down its pandemic-related scheme.

By comparison the Fed has been reticent. Last month Jerome Powell, the Fed's chair, said that the central bank is "talking about talking about" tapering its purchases of assets. Minutes of the meeting preceding his comments, released on July 7th, revealed that officials thought it "important to be well-positioned" to taper. Most economists expect an announcement by the end of the year. The Fed's careful approach might reflect lingering memories of 2013, when it last warned of tapering to come. Bonds sold off sharply, the dollar soared and emerging markets suffered capital outflows in what is now known as the "taper tantrum". Even Mr Powell's announcement in June was accompanied by a mini-tantrum of sorts. Prompted by higher inflation, officials also indicated that they expected to raise interest rates twice by the end of 2023, sooner than they had previously signalled. The hawkish turn sent emerging-market currencies tumbling.

QE is swathed in so much mystical uncertainty that working out the impact of unwinding it is no easy feat. But a careful examination of central banks' past experience of asset purchases yields clues for what to expect. It also contains lessons for how central banks might be able to extricate

themselves from their bond-buying gracefully this time, before the negative side-effects of their enormous balance-sheets start to be felt acutely.

Begin with the effects of changing course. Everyone agrees that central banks' asset purchases reduce long-term bond yields. But there is enormous uncertainty as to how much they underpin markets today. Last year Ben Bernanke, the Fed's chairman at the time of the taper tantrum, suggested that in America in 2014 every \$500bn of QE reduced ten-year Treasury yields by 0.2 percentage points. By that rule of thumb, adjusted for inflation, the Fed's total securities holdings of \$7.5trn today are lowering yields by nearly three percentage points (though Mr Bernanke suggested, somewhat arbitrarily, that the overall effect of QE might be capped at 1.2 percentage points).

Alternatively, the median estimate of a survey of 24 studies conducted in 2016 by Joseph Gagnon of the Peterson Institute for International Economics suggests that asset purchases worth 10% of GDP reduced ten-year government bond yields by about half a percentage point. That suggests that QE today is suppressing long-term rates by just under two percentage points in America, Britain and the euro area—although Mr Gagnon argues that when yields approach zero, as they have in Europe and Japan, QE reaches its limits. A bigger bond market may also reduce the size of the effect. The Bank of Japan owns government debt worth a staggering 97% of GDP, but Mr Gagnon finds the effects of QE have historically been more muted, perhaps because Japan's total public debt is more than two-and-a-half times that figure.

These numbers, and the experience of the taper tantrum, make the reversal of QE seem like something that will upend financial markets. Sky-high asset prices today reflect the assumption that long-term interest rates will stay low for a long time. "We know we need to be very careful in communicating about asset purchases," Mr Powell acknowledged earlier this year. Yet the

lessons from the taper tantrum are subtler than they seem—and may even provide some cause for comfort.

The tantrum of 2013 is associated with Mr Bernanke raising the subject of slowing the Fed's pace of asset purchases. But asset prices fell because investors brought forward the date at which they expected the Fed to raise overnight interest rates, the traditional lever of monetary policy. The episode supports the “signalling” theory of QE, which says that central banks' balance-sheets influence long-term bond yields not directly, as rules of thumb suggest, but by acting as a marker for future interest rates. The implication is that you can reverse QE without much fuss if you sever the perceived link between asset purchases and interest-rate decisions.

Some past episodes of tapering seem to observe this rule. Indeed, the Fed has already achieved a big tapering during the covid-19 crisis. As the severity of the pandemic became clear and markets panicked in spring 2020, the Fed hoovered up almost \$1.5trn of Treasuries in just two months before dramatically slowing its purchases, which eventually settled at around \$80bn a month. But there was no expectation that interest rates would soon rise and bond yields seemed unaffected. In a speech Gertjan Vlieghe of the Bank of England, a proponent of the signalling theory, cited this experience, which was mirrored in Britain, as evidence that there is little mechanical link between bond yields and QE.

The Fed also seemed to achieve such a separation the last time it shrank its balance-sheet significantly, in 2018 and 2019. It let assets mature without reinvesting the proceeds, rather than by selling anything—with no discernible effect on bond yields. “The point around signalling and intent is a very salient feature of how QE operates,” says a trader at a big Wall Street bank. Since the end of March ten-year Treasury yields have drifted down, even as tapering talk has become louder.

Perhaps, then, central banks can pull off a graceful exit. The question is whether rising inflation and booming markets will make them impatient to reverse course more abruptly. Some, particularly in Britain, are also wary of three potential undesirable effects of central banks' balance-sheets being too large for too long.

The first concern, which has troubled Mr Bailey, is about preserving ammunition. A popular view is that QE is highly effective at calming markets during crises when it is deployed quickly and at scale, but has smaller effects in more normal times. The danger of prolonging an enormous market presence in good times is that you run out of room to act with force during emergencies. Central bankers usually scorn this logic when it is used to argue for higher interest rates, because harming the economy today to rescue it later is to put the cart before the horse. But if QE works best in a crisis then withdrawing it in normal times should not be so painful. Not doing so might mean a gradual ratcheting up, during each crisis, of the share of government debt that central banks own.

The second worry is the unseemly tangle of monetary and fiscal policy that QE creates. During the pandemic central banks have routinely faced the accusation that QE is meant to fund governments; in January a survey by the Financial Times of the 18 biggest investors in Britain's gilt market found that the "overwhelming majority" thought the purpose of the Bank of England's bond-buying was to finance the government's emergency spending, rather than to support the economy.

But although lower bond yields help the government's finances, QE does not extinguish the government's financing costs. It just shifts them to central banks, whose profits and losses end up back with the taxpayer. The central-bank reserves created to buy bonds carry a floating rate of interest, making them analogous to short-term government borrowing. Over the past decade, issuing short-term liabilities to buy long-term debt has been a profitable

strategy. Between 2011 and 2020 the Fed sent over \$800bn in profits to the Treasury; the Bank of England's asset-purchase facility transferred £109bn to British taxpayers.

If interest rates rose, however, central banks' enormous balance-sheets could become lossmaking. That could have sizeable consequences for the public finances: in November 2020 Britain's Office for Budget Responsibility estimated that the country's debt-service costs had become twice as sensitive to short-term interest rates as they were at the start of the year, as a result of the combination of QE and increased debt. Every one-percentage-point increase in short-term interest rates will raise the annual cost of servicing debt by 0.5% of GDP by 2025-26. In large rich countries 15–45% of public debt is "in effect overnight", calculates the Bank for International Settlements. Some economists also worry that central banks could see their independence compromised were they to require cash injections from governments.

The final factor is appearances. The prominence of central banks' holdings of public debt has helped create a widespread impression that governments can spend with abandon. It has had weird effects, such as sending measures of the broad money supply through the roof, contributing to fears of inflation. Politicians eye central banks ever more greedily, wanting to use QE to further goals such as reducing inequality or fighting climate change. During times of economic crisis central bankers have to lead from the front. As normality returns, their focus should be on keeping a lower profile. ■



排队退出量化宽松

各国央行面临艰巨任务：避免缩减恐慌

它们能停止购债而不严重冲击市场吗？

围绕量化宽松（QE，即印钞购债）对市场和全球经济影响的争论有如一场文化战争。在QE的批评者看来，新冠疫情期间无限制的QE暗中资助了政府，同时抬高了资产价格，加剧了不平等。在它的支持者看来，QE是一种必不可少的工具，经济学家有理由对它充满信心——这种信心还在增长。这场事关重大的辩论即将进入新阶段。摩根大通预计，2020至2021年间，发达国家央行的资产负债表将增长11.7万亿美元（见图表1）。到今年年底，它们的总规模将达到28万亿美元，约相当于今天标普500指数公司市值的四分之三。但央行官员们即将让这艘超级油船掉头。

实行QE的理据已经差不多消失殆尽。疫情初期，在投资者纷纷避险、争抢现金之时，各国央行购买债券以平息市场恐慌。那时人们认识到，疫情将导致严重的经济衰退，会让通胀直线下降，确实需要QE来刺激经济。然而，现在市场情绪高涨，通胀抬头。

在美国，美联储目前仍是美国国债的最大买家，一如今年第一季度时的情况。这看起来越来越奇怪。眼下经济走势强劲。根据7月2日公布的数据，6月美国增加了85万个工作岗位，令人振奋。华尔街的现金非常充裕，大多数时候，纽约联储的隔夜逆回购规模都在7500亿美元以上，吸收了QE注入的部分流动性，6月30日吸收了近一萬亿美元。鉴于美国房地产市场火爆，美联储购买抵押贷款支持证券现在看起来就很奇怪了。

一些央行已经开始缩减购债规模。加拿大央行4月开始放慢购债步伐。澳洲央行7月6日表示将从9月开始缩减。英国央行正在接近它8950亿英镑（1.2万亿美元）的资产购买目标，看来很可能会在达到该目标后停止QE。该行行长安德鲁·贝利（Andrew Bailey）已考虑在加息之前抛售资产，这会与通常的操作次序相反。5月，新西兰央行表示将不会完全执行

1000亿新西兰元（700亿美元）的资产购买计划。欧洲央行也在辩论如何收缩其针对疫情的宽松机制。

相比之下美联储保持缄默。上个月，主席鲍威尔表示，美联储正在就缩减资产购买规模“的讨论展开讨论”。在他这一表态之前举行的那次会议的纪要于7月7日公开，显示美联储官员认为就缩减“做好准备很重要”。大多数经济学家预计美联储会在年底前宣布缩减购债。美联储上一次预告缩减是在2013年，此次它行事谨慎，可能是因为那一年发生的事令人记忆犹新。当时债券大量抛售，美元飙升，新兴市场遭遇资本外流，这在现在被称为“缩减恐慌”。就连鲍威尔在6月表态时市场都有那么点恐慌。在通胀上升的推动下，美联储官员还表示预计在2023年底前加息两次，早于之前给出的信号。它的态度转向鹰派导致新兴市场货币大幅贬值。

QE被神秘莫测的巨大不确定性围绕，要弄清楚结束它会有何影响绝非易事。但仔细审视央行过去购买资产的经历，就能从中得出一些有关未来可能发生什么的线索。其中也包含着经验教训，指导央行这一次如何能在其庞大资产负债表的负面影响被强烈感知之前，优雅地从购债中脱身。

先说政策转向的影响。央行购买资产会降低长期债券收益率，这是共识。但对于购债为今天的市场提供了多大的支撑，则远不能确定。去年，在缩减恐慌期间担任美联储主席的伯南克表示，2014年美国每实施5000亿美元的QE，十年期美国国债收益率就下降0.2个百分点。根据这一经验法则，经通胀调整后，美联储现在持有的共7.5万亿美元的债券将使收益率降低近三个百分点（不过伯南克有点武断地暗示QE的总影响最高可能只有1.2个百分点）。

另外，彼得森国际经济研究所（Peterson Institute for International Economics）的约瑟夫·加格农（Joseph Gagnon）在2016年查阅24项研究后，得出一个中值估计：每购买相当于GDP10%的资产会让十年期政府债券收益率降低约0.5个百分点。这说明如今在美国、英国和欧元区，QE只把长期利率压低了近两个百分点，尽管加格农认为当收益率像欧洲和日本那样接近于零时，QE的作用就会达到极限。更大的债券市场也可能会降

低QE的影响。日本央行持有的政府债券相当于GDP的97%之巨，但加格农发现QE的影响在日本历来更为温和，这可能是因为日本的公共债务总额是其央行持有量的2.5倍以上。

这些数字加上缩减恐慌的经历，让逆转QE政策看似将剧烈撼动金融市场。今天的天价资产价格反映出人们假定长期利率将在很长一段时间内保持低位。“我们知道，在向人们传达资产购买问题时我们需要非常小心。”鲍威尔在今年早些时候承认。不过，从缩减恐慌中得到的教训比表面看起来要更复杂微妙，甚至还可能给出一些让人宽心的理由。

2013年的缩减恐慌与伯南克提出放缓美联储资产购买速度有关。但资产价格下跌是因为投资者认为美联储会比他们预计的更早提高隔夜利率（货币政策的传统工具）。那次缩减恐慌支持了QE“信号”理论，即央行的资产负债表并不像经验法则所说的那样直接影响长期债券收益率，而是通过充当未来利率的标识来发挥影响。那么也就是说，如果把人们眼中存在于资产购买和利率决策之间的关联切断，就可以扭转QE政策却不引发震荡。

过去的一些缩减经历似乎遵循了这一规则。实际上，美联储在疫情危机期间已经有过一次大幅缩减。2020年春季，疫情的严重性彰显，市场陷入恐慌，美联储在短短两个月内购买了近1.5万亿美元的美国国债，后来又急剧放缓了购买速度，最终把购买规模维持在每月800亿美元左右。但当时市场没有预期利率会很快上升，债券收益率似乎也未受影响。英国央行的格特琴·弗利格（Gertjan Vlieghe）是信号理论的支持者，他在一次演讲中提到了疫情早期的这次缩减（英国也经历了类似的政策变化），用来证明在债券收益率和QE之间几乎没有硬性关联。

美联储上一次大幅缩表是在2018年至2019年，似乎也实现了债券收益率和QE之间的分离。美联储的做法不是出售资产，而是让资产到期，不对收益进行再投资，这对债券收益率没有明显影响。“释放信号和表现意图是QE运作方式一个非常突出的特征。”华尔街一家大型银行的交易员表示。3月底以来，在缩减言论日盛的同时，十年期美国国债收益率却在下滑。

那么，或许央行能够优雅地退出QE。问题是通胀上升和市场繁荣是否会让它们急不可待地突然掉头。一些央行——尤其是英国央行——还很警惕央行资产负债表在过长时间里保持过大规模可能存在三种潜在不良影响。

第一个担忧一直困扰着贝利，就是关于保存弹药。一种流行的观点是，在危机期间快速大规模实施QE，对安抚市场非常有效，但在比较正常的情况下效果就没那么显著了。在繁荣时期继续大规模实施政策手段，那么到情况紧急时就会没有足够的空间放大招。当人们用这种逻辑来主张提高利率时，央行官员通常会嗤之以鼻，因为今天损害经济日后再去拯救的做法是本末倒置。但是，如果QE在危机中效果最好，那么在正常时期退出就应该不会那么痛苦。不退出可能意味着央行持有的政府债券份额会随着每一次危机不断增加。

第二个担忧是QE会让货币和财政政策不当地纠缠在一起。在疫情期间央行经常面对指责，说实施QE是为了给政府提供资金。1月，《金融时报》对英国国债市场的18个最大投资方的一项调查发现，它们“绝大多数”认为英国央行购债的目的是为政府的紧急支出提供资金，而不是支持经济。

然而尽管较低的债券收益率有助政府财政，QE并不会消除政府的融资成本，而只是将其转移给了央行，央行的利润和亏损最终转回给纳税人。央行为购债设立的准备金采用浮动利率，这让它们类似于政府短期借款。在过去十年中，发短债买长债这种策略是盈利的。2011年至2020年间，美联储向财政部转移了超过8000亿美元的利润，英国央行的资产购买工具向英国纳税人转移了1090亿英镑。

然而如果利率上升，央行庞大的资产负债表可能会亏损。这可能对公共财政产生相当大的影响。2020年11月，英国的预算责任办公室（Office for Budget Responsibility）估计，在QE和债务增加的双重作用下，英国的偿债成本对短期利率的敏感度已经达到了当年年初的两倍。到2025至2026年，短期利率每上升1个百分点，每年的偿债成本就会多占GDP的0.5%。根据国际清算银行的计算，在富裕大国中，15%至45%的公共债务“实际上只是隔夜”债务。一些经济学家还担心，如果央行要求政府注资，它们的

独立性可能受损。

最后一个担忧是央行的对外形象。央行持有公共债务引人注目，造成了一种普遍的印象：政府可以肆意烧钱。这已经产生了奇怪的效应，比如广义货币供应量指标一路飙升，加剧了市场对通胀的担忧。政客看央行的眼神越发贪婪，希望利用QE来推动减少不平等或应对气候变化等目标。在经济危机时期，央行官员不得不站在前线指挥。随着常态回归，他们的工作重点应该是保持低调一些。 ■



Schumpeter

China's "dreamchild" is stealthily winning the battery race

Now comes the hard bit: geopolitics

IN AMERICA, IF you want to dominate an industry, you channel your inner Elon Musk and shout about it. But CATL, the Chinese company that makes batteries for some of Mr Musk's Tesla electric vehicles (EVs), is different. When your columnist first contacted it in 2017, the brush-off was swift. "We want to concentrate on our products only and do not accept any interviews at present." These days it is only marginally less blunt. "Unfortunately, we are sorry that it's hard for us to arrange [interviews] at the moment." The temptation is to give it a dose of its own medicine and ignore it.

And yet in 2017 the firm, founded only six years earlier as Contemporary Amperex Technology Ltd, vaulted from being the world's third-largest battery-maker to its biggest. It has since reached a market value of 1.3trn yuan (\$200bn), more than the second, third and fourth producers—South Korea's LG Chem, Japan's Panasonic, and China's BYD—combined. In recent days its rising share price has made its 53-year-old founder, Zeng Yuqun, richer than Jack Ma, a much-better-known Chinese tech baron. Given Mr Ma's blackballing by the Chinese government, for Mr Zeng to have kept his head down now looks shrewd.

The world will hear a lot more about CATL in the future. That is because one of the justifications for its high valuation is that it is about to move beyond the Chinese mainland, the world's biggest EV market where it accounts for about half of lithium-ion-battery sales, to Europe, Indonesia and possibly even America. Its profitability far exceeds that of its global peers. Its technology has become at least as good as theirs, giving it the clout to outcompete them and contribute meaningfully to a worldwide clean-energy

revolution. And yet it is also what Sam Jaffe of Cairn ERA, a battery consultancy, calls the “dreamchild” of China’s government-industrial complex. That makes it a potential flashpoint in the torrid world of technology geopolitics.

CATL’s low profile starts with its provenance. Mr Zeng created it in the backwater of Ningde, a subtropical city better known for tea than tech, in Fujian province where he grew up in a hillside village. But he has long had high ambitions. In 1999 he founded Amperex Technology Ltd (ATL), a maker of lithium-ion batteries for portable devices, which he sold to TDK, a Japanese firm, in 2005. One of his big clients was Apple, maker of the iPhone.

Seeing the potential for EV batteries, which China was keen to turn into a strategic industry, Mr Zeng led a spin off from ATL in 2011, severing links with its Japanese parent company—possibly to please the Chinese authorities, says Mark Newman, a battery executive who formerly covered the company as an investment analyst. When it listed in 2018, CATL had a small percentage of direct and indirect state ownership. More important, the government had its back. For years China used subsidies to favour domestically produced batteries for electric cars and buses, kneecapping South Korean competitors such as LG Chem and Samsung SDI. CATL, one of two top-tier Chinese producers, benefited most. The other, BYD, made cars as well as batteries. For that reason, many rival carmakers in China—including foreigners such as Tesla and BMW—gave it a wide berth and turned to Mr Zeng instead.

It is unfair, however, to ascribe CATL’s success purely to economic nationalism. According to James Frith of BloombergNEF, a consultancy, when CATL was faced with the winding down of subsidies in 2019, it quickly leapfrogged its South Korean rivals to produce the latest high-nickel batteries, which run for longer than the cheaper lithium-iron-phosphate

ones that had been China's staple. Chinese carmakers are bolder than their Western counterparts (apart from Tesla) in adopting innovative chemistry, he adds, which gives CATL more freedom to experiment. It also gets more for its investment in China than rivals do elsewhere and has a cheaper workforce, which makes its operating margins, just shy of 15%, the best in the business. Strong profits provide more cash to invest in expansion. Neil Beveridge of Bernstein, an investment firm, expects its capacity roughly to quadruple to 500 gigawatt-hours (GWh) of battery cells a year by 2025. That is an amount similar to what is promised from all of the world's gigafactories today. Only Mr Musk sets more outlandish targets.

Most of CATL's expansion will come in China, where it has a growing export business. But by the end of this year it is also expected to start production at its first offshore factory, with capacity of 14GWh in Erfurt, Germany, from where it will supply carmakers like BMW, Volkswagen and Daimler. Its move overseas appears to be motivated by a desire to retain its market leadership as EV sales outside China accelerate. Its South Korean and Japanese rivals have a bigger global presence. Simon Moores, a battery consultant, thinks a subsequent step will be into America.

Yet energy—even the clean stuff—is dirty business, muddied by geopolitical rivalries and economic jingoism. There are already fears in the West that CATL's profitability in China will enable it to offer cut-price products abroad, reopening wounds caused when China's subsidised solar panels swept the world in the 2010s. Moreover, advanced batteries, like semiconductors, are increasingly discussed in terms of an arms race. Europe and America are offering big inducements for locally made batteries and adjacent supply chains in order to catch up with China. They see a strategic vulnerability in being too reliant on a Chinese supplier.

As a result, CATL will have to be clever. Already it has more alliances with global carmakers than any other battery firm; jointly building factories close

to their operations around the world would buy it political support. It will need to counter geopolitical paranoia by stressing the importance of cheap batteries, both for EVs and clean-electricity grids, in the fight against climate change. More transparency wouldn't go amiss, either. It is a fine line between being coy and acting as if it has something to hide. ■



熊彼特

中国“梦之子”悄然领跑电池竞赛

难关在后头：地缘政治

在美国，要想在某个行业称霸，你需要启动自己内在的伊隆·马斯克，并让它咆哮。但为马斯克的一些特斯拉电动汽车供应电池的中国公司宁德时代却不一样。当笔者在2017年第一次跟这家公司联系采访时，对方干脆地拒绝了。“我们只想专心做产品，目前不接受任何采访。”到如今，它的态度也只是稍微柔和了那么一丁点。“很遗憾，目前恕难安排（采访）。”真是让人恨不得以牙还牙，再不理睬它。

然而在2017年，创立仅六年的宁德时代从世界第三大电池制造商一举跃升头名。公司市值不断攀升，至目前已达到1.3万亿元（2000亿美元），超过了分列第二、第三和第四名的电池制造商韩国LG化学、日本松下和中国比亚迪的总和。近日，随着它的股价不断上涨，53岁的创始人曾毓群的身家已经超过了名气大得多的中国科技大亨马云。马云已被中国政府打压，这样看来，曾毓群一直保持低调实属精明。

未来，世界听闻宁德时代消息的频率会大大增加。其原因也正是它获得高估值的一个根据：它即将走出中国大陆这个世界最大的电动汽车市场（它贡献了那里锂离子电池销量的一半左右），进军欧洲、印尼，甚至可能还有美国。它的盈利能力远超全球同行，技术水平也已经至少不输它们，这使它有能力在竞争中胜过对手，并为全球清洁能源革命做出可观的贡献。然而，正如电池咨询公司Cairn ERA的山姆·贾菲（Sam Jaffe）所言，宁德时代也是中国的政府产业政策造就的“梦之子”。这令它成为了紧张的地缘政治局势中一个潜在的引火点。

宁德时代的出身就很低调。曾毓群在福建的山村里长大，在落后的亚热带城市宁德创建了公司，那里更出名的是茶叶而不是科技。但他一直满怀抱负。1999年，他创立了新能源科技有限公司（ATL），为便携式设备生产

锂离子电池，并在2005年把公司卖给了日本TDK。当时他的大客户之一便是iPhone的制造商苹果。

中国积极推进将动力电池打造成战略产业，曾毓群看到了其中的潜力，在2011年牵头将该业务从ATL剥离出来，切断了与日本母公司的联系——此举可能是为了取悦中国政府，电池行业高管、曾经作为投资分析师跟踪该公司的马克·纽曼（Mark Newman）说。宁德时代在2018年上市时，政府也有一小部分直接和间接持股。更重要的是，政府是它的后盾。多年来，中国用补贴支持国产的电动汽车和大巴用电池，令LG化学和三星SDI等韩国竞争对手举步维艰。作为中国两家顶级动力电池制造商之一，宁德时代受益最大。另一家公司比亚迪既生产电池也生产汽车，所以许多在中国的竞争车企——包括特斯拉和宝马等外国车厂——对它绕行，转而向曾毓群采购电池。

然而，将宁德时代的成功完全归因于经济民族主义是不公平的。咨询公司彭博新能源财经（BloombergNEF）的詹姆斯·弗里斯（James Frith）表示，在2019年面临补贴退坡时，宁德时代迅速抢在韩国竞争对手之前推出了最新的高镍电池，比中国当时主流的更便宜的磷酸铁锂电池续航更长。他补充说，中国汽车制造商在采用创新化学工艺方面比西方同行（特斯拉除外）更大胆，这给了宁德时代更多试验的空间。与竞争对手在其他市场的投资收益相比，宁德时代在中国的投资收益也更高，同时还享有更廉价的劳动力，因此其经营利润率接近15%，为业内最高。强劲的利润为扩张提供了更多资金。投资公司盛博的尼尔·贝弗里奇（Neil Beveridge）预计，到2025年宁德时代的电池产能将大约翻两番，达到500吉瓦时。这相当于当今世界上所有电池超级工厂预期产能的总和。唯有马斯克设定了更非同寻常的目标。

宁德时代大部分扩产将放在中国，它在那里有不断增长的出口业务。但预计到今年年底，它设在德国埃尔福特（Erfurt）产能为14吉瓦时的第一家海外工厂也将投产，为宝马、大众和戴姆勒等汽车制造商供货。在电动汽车销售在中国以外地区提速之际，它出征海外似乎是为了保持自己的市场领先地位。它的日韩竞争对手目前拥有更大的全球业务。电池行业顾问西

蒙·摩尔斯（Simon Moores）认为，下一步是打进美国。

不过，能源这门生意——即使是清洁能源——水不清，被地缘政治对抗和经济沙文主义搅混。西方国家已经开始担心宁德时代会凭借在中国的盈利能力向海外输出廉价产品，重新揭开2010年代中国受补贴的太阳能面板席卷全球时留下的伤疤。此外，和半导体一样，先进电池也日益被当作一场军备竞赛。欧洲和美国正在大力资助本土制造电池和配套供应链追赶中国。太过依赖某家中国供应商在它们看来是个战略软肋。

因此，宁德时代得机灵些。它与全球汽车制造商的结盟已经多过任何其他电池公司；在全球各地贴近这些汽车制造商业务的地方联合建厂可为它赢得政治支持。它还需要强调用于电动汽车和清洁电网的廉价电池在对抗气候变化中的重要性，以此应对地缘政治中的偏执多疑。提高透明度肯定没错。毕竟讳莫如深一不小心就好像是有所隐瞒。■



The changing face of Japan

Mixed-race athletes reflect broader developments in Japanese society

Their country's diversity is becoming harder to ignore

AS THE SON of a Japanese mother and Beninese father, Hachimura Rui stood out from his classmates in Toyama, a small town some six hours' drive from Tokyo. Other children taunted him, he once recalled to *The Undefeated*, a sports website: "You're black, go away." But his talent on the basketball court helped him gain respect. Now a star in America's NBA, Mr Hachimura carried the flag for Team Japan when the Olympics opened on July 23rd.

Mr Hachimura's selection as a flag-bearer reflects how attitudes about race and identity are in flux in a country where the idea of racial homogeneity has long held sway. He belongs to a cohort of prominent mixed-race athletes who are forcing Japan to reckon with its diversity—from the Haitian-Japanese tennis champion Osaka Naomi to the Ghanaian-Japanese sprinter Sani Brown Abdul Hakim and the Iranian-Japanese baseball star, Darvish Yu. "They are becoming the role models that they themselves didn't have," says Miyazaki Tetsuro, a Belgian-Japanese photographer who documents other *hafu* (half), as mixed-race people in Japan are often called.

The notion that Japan is a racially homogeneous nation has always been a myth. The Japanese originated from many parts of Asia; Japan is home to Ainu, Okinawans (both hailing from islands that were once distinct from Japan) and Koreans, among others. Japan's empire was a multi-ethnic society (albeit one where ethnic Japanese topped the hierarchy). But the myth of homogeneity found eager acolytes, both among Japanese seeking a post-imperial identity and among outsiders seeking explanations for Japan's economic miracle. An entire genre of literature emerged around it: *Nihonjinron*, theories about the Japanese. Such ideas "excised the

multicultural past and elided the existence of minority populations," argues Michael Weiner, the editor of "Japan's Minorities: The Illusion of Homogeneity". Conservatives cling to them to this day.

The story of one pure people leaves little room for *hafu*. To be considered truly Japanese tends to mean having two Japanese parents, speaking Japanese fluently, and "acting Japanese". "Most of us have this constant feeling of not being Japanese enough," says Mr Miyazaki. *Hafu* are often perceived as foreigners, despite holding Japanese passports. Ms Osaka's grandfather disowned her mother when she first revealed she was seeing a foreign man.

To this day, racism remains a big problem. That is why the celebration of champion athletes can smack of hypocrisy. Mr Hachimura has said he receives hateful messages on social media "almost every day". Nissin, a noodle-maker, lightened Ms Osaka's skin and hair in a commercial. (After a backlash, the company took down the ad.) Some on the right still question whether the two are truly Japanese. The situation is even tougher for those without powerful forehands or smooth jump shots. Mixed-race children face brutal bullying; some schools still have rules requiring students to dye or straighten their hair if it does not conform to the straight, black Japanese norm. Discrimination on the basis of race in hiring and housing is widespread. Japanese law lacks the teeth to prevent it, laments Shimoji Lawrence Yoshitaka, a sociologist who studies *hafu*. Minorities have few representatives in Japanese politics.

Yet Japan's more diverse reality is harder to ignore, not least because of stars like Mr Hachimura. It helps that the new generation of athletes is not shy about airing its experiences. "Hearing such voices talking openly about discrimination makes people realise they aren't alone," says Mr Shimoji.

There are also more foreigners in Japan than at any time in its post-war

history. A stealth immigration campaign to make up for Japan's shrinking population has seen the numbers of foreigners living there grow from some 2m a decade ago to nearly 3m today. That amounts to just 2% of the overall population, but the share is much higher among city-dwellers and the young: at least 10% of 20-somethings in Tokyo are foreign-born. (Japan does not collect statistics on the ethnic background of its citizens, only their nationality.)

The stigma around marrying foreigners is fading: in 1993, 30% of Japanese approved of international marriages, while 34% disapproved; by 2013, the last year for which data are available, 56% approved and 20% did not. One in every 50 babies is now born to a mixed couple, up from one in every 135 in the late 1980s. As Mr Hachimura and his peers show, their potential is enormous. ■



日本新面孔

混血运动员反映出日本社会更广泛的发展

日本的种族多元化越发难以忽视

八村塁的母亲是日本人，父亲是非洲贝宁人，小时候生活在距离东京约六小时车程的小城富山，在班上总显得很另类。其他孩子嘲弄他说，“你是黑人，走开”——他在某次接受体育网站The Undefeated访问时回忆道。但他在篮球场上的天赋帮他赢得了尊重。现在他已是美国NBA明星球员，在7月23日的东京奥运会开幕式上担任日本代表团旗手。

八村塁被选为旗手，反映出在单一种族观念一直占主导的日本，人们对种族和身份认同的态度正在发生变化。一批像他这样的杰出的混血运动员（包括海地日本混血网球冠军大坂直美、加纳日本混血短跑好手萨尼·布朗·阿卜杜尔·哈基姆、伊朗日本混血棒球明星达比修有）正让日本不得不正视种族多元化。“他们成了他们自己不曾有过的榜样人物。”比利时日本混血摄影师宫崎哲郎说。他拍摄记录了其他“hafu”（即英语的“half”，日本人往往这么称呼混血儿）的生活。

日本是单一种族国家的观念从来都是错误的。“日本人”实际上源自亚洲各地：日本是阿伊努人、琉球人（两者都来自曾与日本迥然不同的岛屿）、朝鲜人等族群的家园。曾经的日本帝国是一个多民族社会（尽管大和民族在其中地位最高）。但单一种族的迷思不乏狂热信徒，其中既有在后帝国时代寻求身份认同的日本人，也有试图解释日本经济奇迹的外人。围绕这个主题产生了一整个文献类型：日本人论（Nihonjinron，探讨日本人的理论）。这种观点“抹去了日本多元文化的历史，隐去了少数族裔的存在”，《日本少数族裔：民族同质性的错觉》（Japan's Minorities: The Illusion of Homogeneity）一书的编辑迈克尔·韦纳（Michael Weiner）认为。但保守派至今仍坚持这些观念。

单一民族的叙事留给hafu们的篇幅很少。要被视为纯正的日本人，往往意

味着父母都要是日本人，能说一口流利日语，而且“举止要像日本人”。

“我们中大部分人总觉得自己不够像日本人。”宫崎哲郎说。尽管持有日本护照，但混血儿还是经常被视为外国人。大坂直美的外祖父当年一听到女儿说交的男朋友是外国人，就跟她断绝了父女关系。

时至今日，种族歧视依然很严重。这就是为什么人们可能会觉得日本对冠军混血运动员的赞颂透着一丝虚伪。八村塁说他“几乎每天”都会在社交媒体上收到仇恨信息。面条厂家日清在一则广告中“漂白”了大阪直美动漫形象的肤色和发色（引发争议后，日清撤下了广告。）一些右翼人士仍质疑这两位运动员是否算真正的日本人。对于那些没有强力正手球或行云流水的跳投技术傍身的人来说，处境更是艰难。混血孩子面对残忍的欺凌；一些学校仍然规定，头发不符合日本黑直发标准的学生必须做染黑拉直。招聘和住房方面的种族歧视很普遍。研究日本混血儿群体的社会学家下地·劳伦斯·吉孝哀叹，日本法律在防止种族歧视方面没有真实效力。少数族裔在日本政坛少有代表。

但日本社会正日益变得多元化，这种现实越来越难以忽视，尤其是因为有八村塁这样的明星人物。新一代运动员不羞于讲述自己的经历，也有助于改善现状。“听到这些名人公开谈论歧视问题，会让人知道自己并不孤单。”下地·劳伦斯·吉孝说。

另外，在日本的外国人数量也达到战后的的新高。为弥补日本的人口萎缩，一场移民运动悄然展开，使生活在那里的外国人数量从十年前的约200万上升至现在的近300万。这只占到日本总人口的2%，但在城市居民和年轻人中的比例要高得多：东京20来岁的年轻人中至少有10%是在外国出生的。（日本只收集公民的国籍统计数据，不收集他们的族裔背景数据）。

与外国人通婚渐渐不再是丢脸的事：在1993年，30%的日本人赞成国际婚姻，34%不赞成；到2013年（有相关数据的最近一年），56%赞成，20%不赞成。1980年代末，日本每135个婴儿中有一个混血儿，现在是每50个婴儿中有一个。正如八村塁和他的混血伙伴们所展示的，他们的潜力是巨大的。■



Automating programming

AI is transforming the coding of computer programs

The software engineers of the future will, themselves, be software

GPT-3 IS QUITE a beast. The Generative Pre-Trained Transformer 3, to give its full name, is a language model developed by OpenAI, a part-commercial, part not-for-profit artificial-intelligence (AI) laboratory in San Francisco. GPT-3 was trained on an unprecedented mass of text to teach it the probability that a given word will follow preceding words. When fed a short text “prompt”, it cranks out astonishingly coherent prose written in a similar style.

Access to GPT-3 is restricted. For one thing, says Jack Clark, former head of policy at the organisation, it might otherwise be used to mass produce fake news or flood social media with “trolling and griefing” messages. But OpenAI also knows that GPT-3 is commercially valuable. Last year the laboratory started letting vetted firms buy its output for approved uses. These include producing answers to typed questions about products, and powering the speech of fictional characters in virtual worlds. But perhaps most important, GPT-3 can also be used to write computer code.

Several firms are already using GPT-3 and its predecessor GPT-2 to add AI to the software that their programmers use to write code. Much of what these programmers type out has already been written elsewhere at some point in the past. This means that by feeding oodles of pre-existing code into such packages, they can be trained to predict the lines a programmer needs next. As a programmer types, potential “code completions” of one or a few lines pop up on the screen.

One company that has created such an AI-completion feature is Tabnine,

of Tel Aviv. Tabnine used GPT-2 to feed so much code to its programming software, also named Tabnine, that this software gained a sort of “world knowledge”, says Eran Yahav, the firm’s top technologist. Dr Yahav describes this as “a pretty good notion of how the world behaves”, at least when it comes to programming-speak. Tabnine software may detect that a user has begun to type code to handle, say, purchase orders. It will then suggest code to display product names and prices, as well as code to create fields to be filled with quantities, payment and delivery data. It works even though Tabnine has never been specifically instructed to do that.

Some coding sequences are rare. In these cases, Tabnine lengthens its pop-up list of suggested completions to increase the likelihood of offering a useful one. By clicking on one that is appropriate, the programmer teaches Tabnine to perform better. Tabnine’s professional version seems “almost intelligent” in its ability to understand a programmer’s intent, according to Dror Weiss, the firm’s boss.

Tabnine is not alone. On June 17th Microsoft, an American software giant, released a new version of an AI-completion feature which it embeds in coding software called Visual Studio. The original version, released in 2018 and named IntelliCode, was trained on a few thousand online repositories in which code for programming projects is stored. Microsoft trained its upgraded system on more than half a million such repositories. Amanda Silver, one of the executives in charge of Visual Studio, says these extra heaps of training fodder allow the new version to glean intent better from hints in code that a programmer has already written.

The purpose of all this, of course, is to save time. Kite, a firm in San Francisco, claims its AI-completion products cut the number of keystrokes required for some tasks by nearly half. Overall efficiency gains, however, are lower. Vitaly Khudobakhshov, head of AI products at the St Petersburg office of JetBrains, a Czech developer of programming software, sees time savings

of 10% to 20%. In the view of Sharif Shameem, the boss of Debuild, a firm in San Francisco that uses GPT-3 to help build websites, the technology also reduces “cognitive overhead”. Selecting from multiple choices is less taxing than devising solutions from scratch.

Nor are those who write code the only beneficiaries. Developers spend nearly as much time searching for bugs in what they have written as they do writing it in the first place. A machine-learning model being built by Brendan Dolan-Gavitt of New York University may speed up the debugging process.

To train it, Dr Dolan-Gavitt is collecting code labelled as buggy by GitHub, a Microsoft subsidiary that hosts the biggest collection of non-proprietary “open source” code in the world. By one estimate, GitHub holds at least a billion snippets of code identified as harbouring a bug. Dr Dolan-Gavitt’s model, provisionally called GPT-CSRC, will devour that code this summer.

Another bug-spotting model is in development at the Massachusetts Institute of Technology (MIT). Shashank Srikant, a PhD student working on the project, says the goal is to train the model to recognise not just inadvertent bugs, but also maliciously inserted vulnerabilities. Rogue employees are sometimes behind trickery of this sort, which is intended to do things like secretly gain access to passwords. The practice is most common, however, in open-source programming projects to which anyone can contribute. Human reviewers typically struggle to spot these “vulnerability injections”, as they are sometimes known.

The reason, Mr Srikant says, is that, in a bid to slip their handiwork past reviewers, devious coders often use deceptive but purely cosmetic names for things like the variables handled by a program. The team at MIT is therefore training its model to flag discrepancies between snippets’ labels and their actual functionality. The difficulty is that good examples of such

mischief are much rarer than ordinary errors.

There is, however, an additional sign that a vulnerability injection may be lurking. Malicious coders often conceal these by writing superfluous code intended to throw off reviewers, so Mr Srikant is also feeding MIT's model with examples of this type of potentially telltale code, which he describes as "dangling" and "dead".

The clear destination of all this activity is the creation of software programmers which can, like the human variety, take an idea and turn it into code. An inkling of things to come is provided by a website created by Dr Dolan-Gavitt. Named "This Code Does Not Exist", it asks programmers to determine if sections of code dozens of lines long were written by a human or a model based on GPT-2 that he has built. Of more than 329,200 assessments made, less than 51% have been correct. That is only a shade better than random.

Machines, it turns out, are now able to write even longish sequences of functioning code. As John Carmack, a noted American computer engineer, has tweeted, pondering this development "does generate a slight shiver". Unsurprisingly, a number of firms see an opportunity.

One is a Parisian firm called SourceAI. It is designing software into which users type, in natural language, a request for code—such as something that will work out the value of numbers in a mathematical formula called the Fibonacci sequence. By tapping into GPT-3, SourceAI's eponymous software churns out the desired lines of code in a range of programming languages.

Debuild is testing the same idea. It is trying to create software that lets non-programmers describe, in plain English, a program they want to create, and will then write it. A request for, say, a barbershop app that lets patrons choose a barber and an appointment slot can already produce more or less

just that. Mr Shameem says the goal is to sweep away the minutiae of code-typing, so that people can focus on what they want done, not how to instruct computers to do it.

For its part, Microsoft is also using GPT-3 to power what it calls “no code/low code” programming. Charles Lamanna, who leads the work, envisages a bright future of cheaper software created by untrained “citizen developers”. Some folk fear an alternative, darker outcome. Might AIs eventually write whatever code they fancy running? No such runaway feedback loop is around the corner. But that mainstay of science fiction does now appear a little less far-fetched. ■



编程自动化

AI正在深刻改变计算机编程

未来的软件工程师本身就是软件

GPT-3超级厉害。它的全称是“生成预训练转化器-3”（Generative Pre-Trained Transformer 3），是旧金山一家半商业、半公益的人工智能（AI）实验室OpenAI开发的一个语言模型。GPT-3接受了前所未有的海量文本训练，学习词语之间衔接的概率。只要给它一小段文字“提示”，它就能以类似的风格往下写与前文惊人连贯的文句。

目前GPT-3的使用仍然受到限制。OpenAI前政策主管杰克·克拉克（Jack Clark）表示，一个原因是它可能被用来大规模制造假新闻，或在社交媒体上大肆散布“煽动性和恶意”信息。但OpenAI也看到了GPT-3的商业价值。去年，该实验室开始允许一些经过审查的公司购买其产品，用于经核准的用途。这些用途包括解答用户键入的产品方面的问题，充实改进虚拟世界中的虚构人物说话等。但或许最重要的是，GPT-3还能用来编写计算机代码。

有几家公司已经在使用GPT-3以及它的上一代GPT-2，把AI添加到它们的程序员用来写代码的软件中。这些程序员键入的代码有很大一部分之前就已在其他地方写过了。这意味着向这样的软件包里输入大量先前已写过的代码，就可以训练它们预测程序员接下来需要写的代码。当程序员键入时，屏幕上就会弹出接下来可能要写的一行或几行“代码补全”。

目前已经实现了这种AI代码补全功能的是以色列特拉维夫一家名为Tabnine的公司。其首席技术专家伊兰·亚哈夫（Eran Yahav）表示，公司使用GPT-2向其同样名为Tabnine的编程软件输入海量代码，从而让该软件获得了某种“语言外世界知识”。亚哈夫称这是“一种关于世界如何运行的很好的理解”，至少从编程的角度来说是这样。Tabnine软件也许可以识别出使用它的程序员已经开始输入代码来处理某种事项，比如订货单。然

后，它不但会给出显示产品名和价格的代码建议，还会给出创建用来填写数量、付款和交付相关资料等区域的代码。Tabnine从来没有得到过专门指令来做这件事，却把它写了出来。

有些编码序列很罕见。在这些情况下，Tabnine会增加弹出的清单上罗列的代码补全建议，以增加给出有用建议的几率。程序员每点击一次合适的选项，都是在教Tabnine如何改进。该公司的老板德罗尔·魏斯（Dror Weiss）说，专业版的Tabnine在理解程序员的意图方面看上去“近乎智能”。

Tabnine并非个例。6月17日，美国软件巨头微软发布了一个AI补全功能的新版本，嵌入到名为Visual Studio的编码软件中。它的最初版本名为IntelliCode，于2018年发布，当时接受了几个存储编程项目代码的在线资源库的训练。微软后来又借助50多万个这样的资源库训练它的升级系统。负责Visual Studio的高管之一阿曼达·西尔弗（Amanda Silver）表示，新增的海量训练素材让新版本能够更好地从程序员已打出的代码中揣测他们的意图。

所有这一切当然都是为了节省时间。旧金山的Kite公司声称自己的AI补全插件将某些任务所需的按键次数减少了近一半。不过，总体的效率提升没有那么高。JetBrains是捷克的一家编程软件开发商，它在圣彼得堡办事处的AI产品主管维塔利·胡多巴赫绍夫（Vitaly Khudobakhshov）认为可以节省10%到20%的时间。旧金山公司Debuild使用GPT-3来辅助创建网站，在它的老板谢里夫·沙米姆（Sharif Shameem）看来，这项技术还减少了“认知消耗”。相比从零开始设计解决方案，从多个提示选项中选一个就没那么费劲。

编程人员也不是唯一的受益者。开发人员花在查找代码漏洞上的时间和程序员花在写代码上的时间几乎一样多。由纽约大学的布兰登·多兰-加维特（Brendan Dolan-Gavitt）构建的机器学习模型也许会加快漏洞调试过程。

为了训练这个模型，多兰-加维特正在收集GitHub上标注有漏洞的代码。GitHub是微软的子公司，拥有世界上最大的非专有“开源”代码库。一项估计显示，GitHub至少存储了10亿段被鉴定为存在漏洞的代码。多兰-加维特的模型（暂定名为GPT-CSRC）今年夏天会把这些有漏洞的代码都消化掉。

麻省理工学院正在开发另一个查漏模型。参与该项目的博士生沙尚卡·斯里坎特（Shashank Srikant）表示，他们的目标是训练该模型不仅识别因疏忽导致的漏洞，还能发现恶意安插的漏洞。无良员工有时是这类伎俩的幕后黑手，目的是干一些诸如窃取密码的勾当。但这种行径在人人都能参与的开源编程项目中最常见。人工查找通常很难发现这些有时被称为“注入式漏洞”的东西。

究其原因，斯里坎特说，就是那些鬼鬼祟祟的程序员为了让自己的“杰作”躲过审查，经常使用纯粹是做做样子的迷惑性名称给一些东西命名，比如一个程序中处理的变量。因此，麻省理工的团队正在训练自己的模型来标记代码片段的名称与其实际功能之间的差异。困难在于这种故意使坏的范例比普通错误要少得多。

不过，还有另外一类信号显示某处可能藏着注入式漏洞。蓄意搞鬼的程序员经常编写冗余代码来掩盖漏洞以避开审查，因此，斯里坎特也在向麻省理工的模型输入这类信号示例，他称之为“悬空”和“死”代码。

所有这些做法无疑都是为了创造一种软件程序员，让它们可以像人类程序员那样，领会一个想法，把它转化为代码。从多兰-加维特创建的一个网站中可以隐约窥见未来。这个名为“此代码不存在”（This Code Does Not Exist）的网站邀请程序员判断一些几十行长的代码段是出自人手还是他基于GPT-2创建的模型。在程序员做出的329,200多次评定中，只有不到51%是正确的一只略优于随机判断。

事实证明，机器如今已能写出能正常运行的较长的代码序列。正如知名美国电脑工程师约翰·卡马克（John Carmack）在推特上所说，想想这一进

展“的确让人微微打了个寒噤”。毫不奇怪，一些公司看到了机会。

其中一家是巴黎的SourceAI。它正在设计的软件可以让用户用自然语言键入生成代码的请求，比如要一段能算出数学公式斐波那契数列中的数值的代码。通过接入GPT-3，这个同样叫SourceAI的软件可以用一系列编程语言写出用户想要的一行行代码。

Debuild正在测试同样的构想。它尝试创建一种软件，让不会编程的人用直白的英文描述他们想要创建的程序，然后软件就会把它编写出来。比如，如果要求软件创建一个理发店应用，让顾客可以在里头选择理发师和预约时段，现在差不多已经可以做到了。沙米姆说，其目标是扫除代码编写中的细枝末节，这样人们就可以专注于自己想要让软件完成什么，而不是思考如何指示计算机去做。

至于微软，它也在使用GPT-3来支持它所谓的“无代码/低代码”编程。负责这项工作的查尔斯·拉曼纳（Charles Lamanna）设想了一个光明的未来，即由未经培训的“公民开发者”开发出更经济的软件。一些人担心会出现另一种更黑暗的结局。AI最终会不会想运行什么代码就写什么代码？这种失控的反馈环还不会很快出现，但现在看来，科幻作品的这一大基石似乎也没那么难以置信了。 ■



Freedom to tinker: October 2029

What if biohackers injected themselves with mRNA?

Members of the Witnesses of Bioinformatic Freedom, a biohacking-rights group, demand the right to alter their own biology. An imagined scenario from 2029

Editor's note: This year What If?, our annual collection of scenarios, considers the future of health. Each of these stories is fiction, but grounded in historical fact, current speculation and real science. They do not present a unified narrative but are set in different possible futures

TO UNDERSTAND THE controversy around the Witnesses of Bioinformatic Freedom (WBF), a biohacktivist group, cast your mind back to the coronavirus pandemic a decade ago. Within days of the discovery of the SARS-CoV-2 virus in 2019, its genome had been sequenced and used to create prototype vaccines containing molecules of messenger RNA, or mRNA. Hundreds of millions of people were injected with these artificial mRNA molecules, which instructed the protein-producing machinery inside the body's cells to make a "spike" protein, identical to that found on the virus's surface. The resulting spike proteins then triggered an immune response, priming the recipient's immune system so that it could recognise and fight off the virus if required to do so.

The same mRNA technology had been used in the 2010s to develop experimental vaccines for other diseases, including Zika virus and Ebola. But the power of mRNA was demonstrated on a global scale during the pandemic, paving the way for other treatments in the 2020s. Like the vaccines, these use carefully crafted mRNA messages to boost temporarily the production of needed proteins, or inhibit the production of harmful ones—a technique often likened to using the patient's own cellular machinery as an on-demand drug factory. This approach is now used to

treat cancer, heart disease and neurological disorders.

The story of that medical revolution has been widely told. Less well known is the parallel story that has been unfolding alongside it. During the pandemic, new technologies, infrastructure and supply chains were created to manufacture mRNA vaccines at vast scale, while also allowing their mRNA payloads to be quickly and easily tweaked as new variants emerged. Once covid-19 was brought under control and demand for vaccines subsided, some of that infrastructure began to be put to new and unexpected uses.

The possibility of using mRNA for self-enhancement first emerged in 2024, after the Paris Olympics. In 2012, Katalin Karikó and Drew Weissman, two of the main actors in the intellectual development of therapeutic mRNA, had shown that carefully designed mRNA molecules could transiently raise the level of erythropoietin (EPO), a protein hormone which stimulates production of red blood cells, in mice. More EPO means more red blood cells, which means more oxygen delivered to working muscles, which improves physical performance. In the months after the Paris Olympics rumours began to circulate that some competitors had been taking regular injections of EPO-producing mRNA. But the tests available failed to show conclusive evidence of foul play. New tests were then developed in time for the 2028 games.

Meanwhile, a group of biology doctoral students at the University of Belgrade began producing and distributing an mRNA molecule said to enhance learning abilities by boosting the synthesis of small proteins involved in memory formation. The government launched an investigation after a student, Luka Dragotin, died of a mysterious autoimmune complaint in 2025. The test scores of the students who had been dosing themselves with mRNA did seem to have risen relative to those of their peers. The

doctoral students went to prison for 15 years, and the government imposed strict new regulations on mRNA technology.

The following year Wired, a technology-news outlet, published a story about a group of mothers in Austin, Texas, who had dosed themselves with mRNA molecules during pregnancy. The treatment was said to keep their production of thyroid hormones within the optimal window for neurological development in utero, thus maximising the cognitive capacity of their offspring. None of the mothers suffered any complications in pregnancy, and the mRNA-dosed children all turned out to be healthy. But there was an outcry from evangelical Christians and right-wing politicians who denounced “meddling” with biology. In 2027 the federal government banned self-dosing with mRNA and set up a Senate committee to investigate the use and misuse of the technology.

It was at this point that the WBF, a group championing biohackers’ rights, stepped onto the public stage. It declared in its manifesto that people had the right to send genetic messages of their own making to their own cells. WBF members, it emerged, had documented successful mRNA dosing for alertness, minor tweaks to physiology (such as to prevent hair loss), and suppression of stress hormones. It was, they argued, already too late for governments to stop them.

The group has since turned out to have members and sympathisers throughout the research community, who have helped refine the process of delivering messages to human cells. Needles and syringes are no longer required. Biohackers have built small patches of flexible electronics and microfluidics, worn on the body much like a nicotine patch, capable of crafting specific mRNA sequences *in situ* and inserting them into the bloodstream. New sequences can be beamed to the patch from a smartphone or computer.

A flourishing open-source ecosystem has developed around the designs of the patches and the molecules they can produce. New mRNA molecules are usually released to a select group of alpha testers, and made widely available only after the alpha testers have granted approval. Not all mRNA molecules are therapeutics or enhancements; the fastest-growing category is for molecules that offer transient, drug-like experiences, supposedly with no long-term side-effects.

Some doctors are said to be quietly dabbling in mRNA hacking themselves, and even recommending it to patients. For their part, drug companies have called for a clampdown on what they deride as “amateur pharmaceuticals”. They have also tried to have some repositories of mRNA molecules taken offline, claiming violation of intellectual property.

The question now is whether governments can put the genie back in the bottle through concerted, co-ordinated action. Many politicians say the power to tinker with biology is too dangerous to have in the hands even just of doctors and must be regulated. Next month’s global meeting on the topic in Belgrade, the Dragotin Conference, will bring together policymakers, medical experts and regulatory specialists. Representatives from the WBF have not been invited. ■



修补的自由：2029年10月

如果生物黑客给自己注射 mRNA 会怎样？

生物黑客权利组织“生物信息自由见证者”的成员要求拥有改变自己的生理的权力。
2029 年的想象场景【《畅想未来》系列之一】

编者按：今年，我们的年度想象情景合集《畅想未来》思索健康的未来。这些故事都是虚构的，但都基于历史事实、当前的推测和真实的科学。它们并不呈现同一种未来，而是发生在不同的可能的未来中

为了理解围绕生物黑客组织“生物信息自由见证者”（WBF）的争议，回想一下十年前的冠状病毒大流行。在 2019 年发现新型冠状病毒后的几天内，其基因组就被测序，并用于制造包含信使 RNA（mRNA）分子的原型疫苗。数以亿计的人被注射了这些人工 mRNA 分子，它们会指示人体细胞内的蛋白质生成机器制造一种“刺突”蛋白质，与病毒表面发现的蛋白质相同。产生的刺突蛋白随即触发免疫反应，让接种者的免疫系统做好准备，在有需要时识别和抵抗病毒。

相同的 mRNA 技术在 2010 年代被用于开发针对其他疾病的实验性疫苗，包括寨卡病毒和埃博拉病毒。但是在新冠疫情期间，mRNA 的力量已在全球范围内得到了证明，为 2020 年代用于其他治疗铺平了道路。与疫苗一样，这些疗法使用精心设计的 mRNA 信息来暂时促进所需蛋白质的产生，或抑制有害蛋白质的产生——这种技术通常被比作把患者自己的细胞机器变成按需药物工厂。这种方法现在用于治疗癌症、心脏病和神经系统疾病。

那场医学革命的故事已广为流传。鲜为人知的是与之同时展开的平行故事。在疫情期间，人们创建了新技术、基础设施和供应链以大规模生产 mRNA 疫苗，同时还能够在新变种出现时快速轻松地调整其 mRNA 净荷。新冠疫情一得到控制并且对疫苗的需求消退，其中一些基础设施就开始用意想不到的新用途。

使用 mRNA 进行自我增强的可能性最早出现在 2024 年巴黎奥运会之后。2012 年，治疗性 mRNA 知识开发的两位主要参与者卡塔林·卡里科（Katalin Karikó）和德鲁·韦斯曼（Drew Weissman）已经证明，精心设计的 mRNA 分子可以在老鼠身上瞬时提高促红细胞生成素（EPO）的水平，这种蛋白质激素可以刺激红细胞生成。更高的 EPO 意味着更多的红细胞，也意味着更多的氧气输送到工作肌肉，从而提高体能表现。在巴黎奥运会后的几个月里，有传言称参赛者一直在定期注射产生 EPO 的 mRNA。但是当时既有的检测未能显示出犯规行为的确凿证据。之后人们为 2028 年的比赛及时开发了新的检测。

与此同时，贝尔格莱德大学的一组生物学博士生开始生产和分发一种 mRNA 分子，据说可以通过促进参与记忆形成的小蛋白质的合成来增强学习能力。在一名使用它的学生卢卡·德拉戈廷（Luka Dragotin）于 2025 年因神秘的自身免疫性疾病去世后，政府启动了一项调查。与同龄人相比，一直在给自己注射 mRNA 的学生的考试成绩似乎确实有所提高。那些博士生入狱 15 年，政府则对 mRNA 技术实施了严格的新规定。

第二年，科技新闻媒体《连线》发表了一篇关于德克萨斯州奥斯汀的一群母亲在怀孕期间给自己注射 mRNA 分子的故事。据说这种治疗可以将她们甲状腺激素的产生保持在子宫内神经发育的最佳窗口内，从而最大限度地提高后代的认知能力。没有一位母亲在怀孕期间出现任何并发症，而且使用了 mRNA 的孩子都非常健康。但福音派基督徒和右翼政客强烈谴责人为“干涉”生理。2027 年，联邦政府禁止自行使用 mRNA，并成立了一个参议院委员会来调查该技术的使用和滥用情况。

就在此时，支持生物黑客权利的团体 WBF 走上了公共舞台。它在宣言中宣布，人们有权将自己制造的基因信息发送到自己的细胞中。人们发现，WBF 成员已经记录了注射 mRNA 在提高警觉性、对生理机能做出微小调整（例如防止脱发）和抑制压力荷尔蒙方面的成功案例。他们认为，政府要阻止他们已经太晚了。

后来渐渐浮出水面的是，该团体在整个科研界都有成员和同情者，那些人帮助改进了向人体细胞传递信息的过程。不再需要针头和注射器了，生物黑客已经构建了拥有柔性电子和微流体的小贴片，像尼古丁贴一样贴在身体上，能够在原位制作特定的 mRNA 序列并将它们插入到血液中。新序列可以从智能手机或计算机传送到贴片上。

围绕着贴片设计和它们可以产生的分子已经发展出了一个蓬勃的开源生态系统。新的 mRNA 分子通常会发布给选定的一组 alpha 测试人员，并且只有在这些测试人员批准后才能广泛使用。并非所有 mRNA 分子都具有治疗作用或增强作用；增长最快的类别是提供短暂的、类似毒品体验的分子，据称没有长期副作用。

据说一些医生自己也在悄悄地涉足 mRNA 黑客，甚至把它推荐给患者。制药公司则呼吁取缔它们蔑称的“业余制药”。它们还试图让一些 mRNA 分子库下线，声称它们侵犯了知识产权。

现在的问题在于，政府能否通过协调一致的行动把精灵收回到了瓶子里。许多政客说，修改生理的权力太危险了，哪怕只掌握在医生手里也不行，必须加以监管。在下个月于贝尔格莱德举行的有关该主题的全球会议德拉戈廷会议上，政策制定者、医学专家和监管专家将齐聚一堂。WBF 的代表没有被邀请。 ■



Euro visions

The international role of the euro

Europe's currency aspirations are getting a boost

WHEN THE European Union launched the euro two decades ago, economists wondered if the new currency might pull off a feat no other had managed in the post-war period: to challenge the mighty American dollar. However, reserve managers at the world's central banks, as well as businesses around the world, largely stuck with the greenback. Now Europe is having another go at establishing the bona fides of the euro beyond its borders. A significant step was taken on June 15th when €20bn-worth (\$24.3bn) of bonds was issued as part of the Next Generation EU (NGEU) scheme to boost European economies. Those bonds could yet rival American Treasury bonds as a safe asset of choice.

Currencies exist mainly to facilitate the transactions of people and businesses within the borders of the places that issue them. But having an international presence helps in many ways. For firms, having imports and exports denominated in their local currency rather than, say, the dollar, means less disruption when exchange rates inevitably see-saw. Issuing a currency that foreigners want to hold can make it easier for governments to raise money from them at cheap rates. That in turn drives down the cost of borrowing for firms and banks.

The euro is widely available outside the 19 countries that formally use it. About two dozen countries link their own currencies to it in some way, albeit mainly former European colonies and close neighbours. Between a third and half of all euro banknotes by value are held outside the euro area, according to the European Central Bank (ECB). Nevertheless, by the normal measures used to gauge international usage, it is a distant runner-up to the

dollar.

Around a fifth of all foreign-exchange reserves owned by central banks, and a similar percentage of cross-border loans and bonds, are denominated in euros—the share for the dollar is about 60%. The euro's share of payments for transactions is much closer to that of the dollar (see chart), unsurprisingly given that the EU is the world's biggest trader of goods and services. Still, commodities like oil and cotton are mostly priced in dollars.

In its first few years the single currency looked as if it might rival the post-war champion. By 2007 the euro even became the most popular currency in which to issue foreign-currency-denominated debt (for example by multinationals). It was not to last. The financial crisis that started that year prompted skittish investors to fall back on the dollar as their currency of choice. The euro-zone miasma that ensued, during which the very survival of the single currency came into question, seemed to vindicate their decision. Depending on the measure used, the euro has since flatlined or lost importance.

Europe now wants to have another crack, if not at overtaking the dollar, then at least at reducing the latter's dominance. Two changes in circumstances mean there is a chance the euro could gain ground.

The first is America's changing attitude to international economic policymaking—at least under the presidency of Donald Trump. His brand of jingoistic protectionism jarred with the obligations incumbent on the issuer of the world's reserve currency. Even under the more conciliatory Biden regime, Europe frets that its interests will not always be aligned with America's. Relying on the dollar is perceived as an even greater potential vulnerability than before.

In March euro-zone leaders said that boosting the currency's international

use would help them achieve “strategic autonomy”. The EU has been particularly irked to discover that businesses in the region were in effect forced to abide by American sanctions that Europe opposed, for example on Iran. America has used the need of big banks to have access to dollars to police their behaviour far beyond its shores. Those that have fallen foul of American edicts have incurred large fines.

Critics see this extra-territorial prerogative as an undue weaponisation of the dollar. That has encouraged a change of mind among those who have traditionally been resistant to boosting the euro’s international role. In times of crisis, global reserve currencies tend to spike as investors seek a haven. Such unpredictable capital flows worried German monetary policymakers in the age of the Deutschmark; their scepticism carried over to the ECB. It has historically sought to “neither hinder nor foster” an international euro, but is now seen as more amenable to the idea.

The second change came, unexpectedly, as a result of the pandemic. Whereas the last global recession brought the euro to the precipice, on this occasion the swift actions of the ECB and national governments to support their economies were well received. Such battle-hardening has boosted the credibility of the euro in a crisis—a key attribute of a global currency.

Better yet, the bloc has responded to the crisis by tweaking the architecture of the single currency in ways that should bolster its international attractiveness. A big step was the creation of the NGEU scheme and the subsequent bond issuance. The bonds are backed, in effect, by the balance-sheet of all EU member states, thus making them roughly similar to America’s Treasury bonds. This is a relative novelty in Europe, where borrowing has mostly been done by national governments, whose creditworthiness varies. The new pan-EU bond creates a way for investors to save in euros without taking credit risk (as they might were they lending to Italy, say).

The absence of such a “safe asset” had been one element hampering the use of the euro internationally. All manner of cross-border operations, from central-bank reserve management to companies borrowing money in a foreign currency, are underpinned by a liquid risk-free benchmark. The bonds of Germany have served as an imperfect proxy until now, but the NGEU issuance “contributes to making the euro a better substitute for the dollar”, says Reza Moghadam of Morgan Stanley, a bank.

Not all barriers to more international usage of the euro have disappeared. For one, the “safe asset” may prove temporary: in theory, the last NGEU bond will be issued in 2026, though many think the scheme will be extended in some way. The sums of money are also small by global financial standards. Total EU debt outstanding will peak at around \$1trn, while America has over \$20trn of debt outstanding that investors can trade.

And some of the single currency’s idiosyncrasies remain. The euro area lacks some of the important elements of a coherent financial union, for example risk-sharing if banks totter. Lack of fiscal redistribution—the NGEU notwithstanding—means a rerun of the euro-zone crisis is still possible. Capital markets are still thin and balkanised, unlike those of America. The lack of a single financial hub after Brexit does not help.

Whether gaining share from the dollar helps insulate Europe from America’s reach is questionable: banks will always need dollars, and thus a foothold in New York, even if the euro thrives. (A European plan to circumvent sanctions on Iran largely floundered.) Few think the single currency can displace the greenback, but it could perhaps rebalance the international monetary system. That may help reduce the disruptions caused by American central bankers, for example when a slight tightening of monetary policy in 2013 caused a “taper tantrum” that reverberated globally. The euro is the obvious currency to provide diversification.

In 2019 Mark Carney, then governor of the Bank of England, mused that technology might disrupt the kinds of network effects that anchor the dollar at the heart of international finance. The rise of digital currencies issued by central banks, which the ECB is considering, might result in a new equilibrium where many currencies share global reserve-currency status. That could provide space for China's yuan, which has its own global aspirations but is hampered now by its lack of convertibility.

Such an outcome still feels some years away. But it would mark a return to the norm before the second world war in which several currencies, including the dollar, held joint dominance. Europe has long bristled at the "exorbitant privilege" America enjoys thanks to the dollar's special status. It may find it less intolerable if it can seize a share of it. ■



欧元愿景

欧元的国际地位

欧洲的货币雄心正得到提振【深度】

二十年前欧盟推出欧元时，经济学家就在猜想这种新货币能否实现战后其他货币都没能完成的壮举：挑战强大的美元。然而，各国央行管理外汇储备的官员和世界各地的企业基本上仍然坚持使用美元。现在，欧洲正再次尝试在欧洲之外建立起欧元的信誉。它在6月15日迈出了重要一步，发行了价值200亿欧元（243亿美元）的债券，这是提振欧洲经济的“新一代欧盟”（Next Generation EU，以下简称NGEU）计划的一部分。这些债券或许将能与美国国债竞争，成为首选安全资产。

货币的作用主要是为了便利个人和企业在发行国境内的交易。但具有国际影响力的货币能带来许多好处。企业在进出口时如果能以本币而非美元等他国货币计价，那么当汇率不可避免地上下波动时，受到的冲击就会更小。一国政府发行的货币如果受外国人欢迎，它就可能更容易以低利率从境外筹资。这进而又会压低企业和银行的借贷成本。

欧元在19个正式使用它的国家以外也得到了广泛采用。约有20多个国家的本币在某种程度上与欧元挂钩，虽然它们大部分是欧洲的前殖民地和近邻。根据欧洲央行的数据，全部欧元纸币价值的约三分之一到一半在欧元区以外持有。然而，按衡量货币国际使用量的正常标准计算，排在第二的欧元仍远落后于美元。

各国央行拥有的外汇储备中大约五分之一是欧元，跨境贷款和债券中以欧元计价的比例也差不多。而美元的这两项占比都在60%左右。欧元在国际收支中所占的份额与美元的差距要小得多（见图表），考虑到欧盟是世界最大的商品和服务贸易经济体，这不足为奇。不过，石油和棉花等大宗商品仍然主要以美元计价。

在问世后最初的几年里，这个单一货币看似有机会与战后霸主抗衡。到2007年，欧元甚至成为发行外币计价债券时最常用的币种（比如很受跨国公司欢迎）。然而好景不长。同年爆发的金融危机让胆颤心惊的投资者重新投入了美元的怀抱。随后欧元区经济陷入困境，在此期间单一货币能否维系下去也成了问题，似乎证明了投资者的决策很英明。此后欧元再无起色，或者日渐式微——待看用什么衡量标准。

现在，欧洲想再试一次，哪怕不能超越美元，至少也要削弱它的支配地位。当前形势发生了两个变化，让欧元有机会取得进展。

首先是美国在国际经济政策方面态度转变——至少在特朗普总统任内是如此。他招牌式的强硬保护主义与世界储备货币发行国应负的责任格格不入。即使拜登政府表现出更温和的态度，欧洲仍担心自己的利益不一定总能与美国保持一致。欧洲认为对美元的依赖是一种潜在软肋，现在这种感觉更强烈了。

欧元区领导人在3月表示，推动欧元的国际使用将有助实现“战略自主”。一直以来让欧盟尤其恼火的一点是，区域内企业实际上是在被迫遵守由美国发起但欧洲反对的制裁，例如对伊朗的制裁。大型银行需要美元，美国利用这一点来监督远离其国土的银行的行为。那些违反美国命令的银行被处以巨额罚款。

批评人士认为这种域外管辖特权是把美元过度武器化。这促使那些历来反对提升欧元国际地位的人也开始改变想法。在危机时期，随着投资者纷纷寻求避风港，全球储备货币往往会飙升。在德国马克时代，德国的货币政策制定者对这种不可预测的资本流动感到担忧；他们的怀疑态度也延续到了欧洲央行。对于欧元国际化，欧洲央行历史上一直奉行“既不阻碍也不鼓励”的态度，但现在似乎更赞同了些。

第二个变化来得出乎意料，是疫情造成的。上一次全球经济衰退将欧元推到了悬崖边缘，而这一次欧洲央行和各国政府为支持本国经济迅速行动，收获好评。经历过如此严峻的考验，欧元在危机中的可信度得到了增强

——而这正是全球货币的一个关键属性。

更有利的是，欧元区为应对疫情危机而对欧元架构所做的调整应该会增强欧元的国际吸引力。其中迈出的一大步是创立NGEU计划以及随后发行债券。这些债券实际上是由全体欧盟成员国的资产负债表共同担保，这让它们变得和美国国债大致相似。这在欧洲还是一种相对新颖的做法。以前主要是由各国政府自行举债，而它们的信誉参差不齐。这种新的泛欧盟债券让投资者能够以欧元储蓄而无需冒信用风险（比方说如果他们直接借钱给意大利就不好说了）。

这种“安全资产”的缺失曾是阻碍欧元国际化的一个因素。从央行储备管理到企业外币借贷，所有形式的跨境运作都仰赖一个高流动性的无风险基准。在此之前德国债券一直充当了不完美的代用品，但是NGEU的发行“有助于使欧元成为替代美元的更好选择”，摩根士丹利的利萨·莫加丹（Reza Moghadam）表示。

欧元国际化进程的障碍并非已全部扫清。首先，“安全资产”到头来可能只是暂时性的：理论上，最后一批NGEU债券将在2026年发行，尽管许多人认为该计划将以某种形式延长。以全球金融标准衡量，其金额也不大。欧盟未偿债务总额最高将达到一万亿美元左右，而美国有超过20万亿美元的未偿债务可供投资者交易。

此外，欧元的某些独特性仍然存在。要成为统一的金融联盟，欧元区还缺失了一些重要元素，例如当银行陷入困境时分担风险。尽管推出了NGEU，财政再分配的机制仍然缺位，意味着欧元区的危机仍可能重演。与美国不同，欧洲资本市场仍然根基薄弱且七零八落。英国脱欧后欧洲失去了单一的金融中心，更是雪上加霜。

从美元那里分走一些份额能否让欧洲隔绝于美国的触手值得怀疑：银行总是需要美元的，因此即使欧元扩张，它们仍需在纽约有立足点。（欧洲规避对伊朗制裁的计划基本上失败了。）没有谁会认为欧元可以取代美元，但它或许可以重新平衡国际货币体系。这可能有助于减少美国央行官员造

成的混乱，例如2013年美国略微收紧货币政策就引发了波及全球的“缩减恐慌”。欧元是实现货币多元化显而易见的选择。

2019年，时任英国央行行长的马克·卡尼（Mark Carney）思忖，技术可能会打破将美元锚定在国际金融核心位置的那种网络效应。由各地央行发行的数字货币正在兴起，欧洲央行也在考虑发行自己的数字货币，这可能会形成一种新的均衡，由许多货币共享全球储备货币地位。中国的人民币也可能由此获得发展空间。人民币有自己的全球抱负，但目前因不可自由兑换而受阻。

这样的前景似乎还需要等待些年头。但这将标志着回归到二战前的常态，当时包括美元在内的几种货币共同占据主导。长期以来，欧洲一直对美国凭借美元的特殊地位而享有的“超级特权”感到恼火。如果它也能在其中占得一席之地，或许就不会那么计较了。 ■



Carry that weight

China's next aircraft-carrier will be its biggest

The Chinese navy is fast learning how to use them

JIANGNAN SHIPYARD lies on an alluvial island at the mouth of the Yangzi river. It has grown rapidly since it moved there from nearby Shanghai in 2009, churning out destroyers, icebreakers and landing craft for the Chinese navy. The jewel in its crown is under construction. China is saying little about it, but satellite imagery reveals a near-complete flight deck in a corner of the yard where, less than 15 years ago, there was only farmland.

For now, the vessel-to-be is blandly known to military analysts as the Type 003. It will be China's second domestically built aircraft-carrier and the largest ship that has ever served in the Chinese fleet. Experts at the Centre for Strategic and International Studies (CSIS), a think-tank in Washington, have analysed satellite pictures such as the one above, which was taken in June by Planet Labs, an American firm. They conclude that the ship will be about as long as New York's Chrysler Building is high: about 320 metres. She will mark another leap forward in China's advance as a naval power.

China got into the carrier game by an unusual route. In 1985 it bought a clapped-out Australian carrier for scrap, then spent years studying its design and putting its deck ashore for flying practice. Thirteen years later Chinese investors purchased a half-built Soviet carrier and towed it from Ukraine to China, purportedly to turn it into a floating casino. Instead it was refurbished by the navy and commissioned in 2012 as the Liaoning. That helped China to build a knock-off, the Shandong, which was commissioned in December 2019 and has been undergoing sea trials.

The Type 003 could be launched this year, state media say. But building

carriers is not the same as sailing them. Flying planes off wobbly decks is hard. In America, thousands of jets and pilots were lost in the formative years of naval aviation. It is also difficult to keep a carrier safe from missiles and submarines, and to integrate one into a “strike group” of warships. “It’s taken us over 100 years to get that right,” noted an American admiral in September. China hopes to be quicker.

There are signs that it is upping the tempo. Last year the navy put both of its carriers to sea at the same time. In April the Liaoning sailed through the Miyako Strait, south of the Japanese island of Okinawa; exercised near Taiwan and in the South China Sea; and returned the same way. Its escorts included the Renhai-class destroyer, one of the world’s most capable ships of its kind, as well as a Fuyu-class support vessel, which can replenish carrier strike-groups far from home.

Some Western analysts are impressed by China’s progress. “Considering what they had to start with, they’ve done a very good job,” says Mark Montgomery, a retired American rear-admiral who commanded a carrier strike-group in the Pacific. China had little to go on, he says, other than “History Channel documentaries” and occasional glimpses of American carriers—back in friendlier times when Chinese sailors were given tours of American ships. Even so, a carrier designed in the early 1980s, and another based on it, hardly represent the cutting-edge of sea power. “I don’t worry from a US Navy point of view,” says Mr Montgomery. “These are just targets for our submarines.”

That is where the Type 003 comes in. CSIS reckons she is already 10 metres longer than her predecessors. She is likely to be the world’s largest non-American carrier for many years, says Rick Joe, who studies China’s armed forces, and “perhaps the most capable conventionally powered carrier of its era”. She will have a larger deck and room for more jets than the Shandong’s complement of around two dozen.

More important than the ship's size is the way that planes will take off from her. The runways of both the Liaoning and the Shandong, like those of Britain's newest carriers, are curved at their ends like ski jumps, which limits take-off weight. The Type 003 is expected to have a catapult, a system currently used only by America and France. This would allow her to launch planes with more fuel and weapons—and not just fighter jets. The existing carriers rely largely on land-based aircraft for vital tasks such as monitoring by airborne radar, anti-submarine warfare and aerial refuelling. The Type 003 could accommodate such planes, and thus venture farther.

The Chinese navy does not plan to stop there. It is widely assumed that the Type 003's successor is being planned. It may be nuclear-powered. That would mark another step-change in capability. More fuel could be carried for planes, rather than for propulsion. The absence of a gas turbine would leave more room for weapons and cargo. A nuclear reactor could also power more potent catapults—ones that use electromagnetic induction motors, rather than steam—and, eventually, high-energy lasers for shooting down missiles.

Mastering these technologies and learning the craft of conducting high-intensity air operations at sea will take years. American carriers can launch and recover waves of 10-12 aircraft more than a dozen times a day. The Chinese navy is far from matching this pace. Its planes are lightly armed, even compared with European counterparts, says Alessio Patalano of King's College London. "I've yet to see a single picture of a Chinese plane taking off from a deck with a full payload," he says.

Yet the Chinese navy will get plenty of practice. America's Indo-Pacific Command suggests that China will operate four carriers by 2025. British defence intelligence reckons that it may have as many as five by 2030. The expert consensus is that China plans eventually to build a fleet of somewhere between six and ten. That would put it within spitting distance

of America's fleet of 11, the world's largest.

American and Chinese carriers are unlikely to be pitted against one another at close quarters. They would be targeted by missiles launched from hundreds if not thousands of kilometres away, from sea or land, long before their jets would clash. "China would not deploy its carriers in the front line," says Hu Bo of Peking University. But, in peacetime, carriers are potent symbols of power. America's dispatch of two towards the Taiwan Strait during an escalation of cross-strait tension in 1996 is seared in the memory of Chinese leaders. And carriers could help China to defeat a weaker adversary. The Liaoning's prominent foray into the South China Sea hints at things to come. Carriers extend a protective aerial bubble over the ships around them. That allows their whole flotilla to patrol farther with confidence. The future air wing of the Type 003 will be almost as large as the entire air force of the Philippines.

And China's sallies need not be confined to the Pacific—a large pier added this year to China's naval base in the Red Sea port-state of Djibouti will allow Chinese carriers to dock there and thus make regular trips to the Indian Ocean. The Type 003 may be coming to a port near you. ■



负重起航

中国的下一艘航母将是它最大的一艘

中国海军正在快速学习如何使用它们【深度】

江南造船厂位于长江入海口的一个冲积岛上。自2009年从附近的上海搬到那里以来，它发展迅猛，为中国海军生产了大量驱逐舰、破冰船和登陆艇。它正在打造自己皇冠上的宝石。中国对此几乎只字未提，但卫星图像显示造船厂的一角有个接近完工的飞行甲板，将近15年前那里还只是一片农田。

目前，这艘即将下水的舰艇只被军事分析人士寡淡地唤作“003型”。它将是中国第二艘国产航母，也将是在中国舰队服役的最大军舰。华盛顿智库国际战略研究中心（CSIS）的专家们分析了一些卫星图片，上图就是其中之一，它由美国公司“行星实验室”（Planet Labs）于6月拍摄。他们得出的结论是，这艘舰船的长度将和纽约克莱斯勒大厦的高度相当：约320米。她将标志着中国在成为海军强国路上的又一次飞跃。

中国加入航母竞赛的道路不同寻常。1985年，它以购买废料的形式买入一艘澳大利亚的废旧航母，然后花了数年时间研究其设计，并将甲板放在岸上进行飞行训练。13年后，中国投资者购买了一艘造了一半的苏联航母，把它从乌克兰拖回中国，声称要把它改造成一个海上赌场。结果海军将它翻新，它于2012年开始服役，命名为“辽宁号”。这又帮助中国仿制出了“山东号”，它于2019年12月服役，并一直在进行海试。

官方媒体称，003型可能在今年下水。但是建造航母和出海航行可不是一回事。驾驶飞机从摇晃的甲板上起飞很困难。美国在海军航空最初的发展阶段折损了成千上万喷气飞机和飞行员。要保证航母不受导弹和潜艇的攻击也很难，把它和其他军舰整合成一个航母“打击群”也一样。去年9月一位美国海军上将曾说：“我们花了一百多年才做到。”中国希望能更快。

有迹象表明，中国正在加快步伐。去年，中国海军同时让两艘航母出海。

4月，辽宁号穿过日本冲绳岛以南的宫古海峡，在台湾地区附近和南海演习，然后原路返回。它的护卫舰艇包括全球最强驱逐舰之一的“刃海”级驱逐舰，以及一艘“福峪”级补给舰，可以为远离本土的航母打击群提供补给。

中国的进步让一些西方分析人士刮目相看。“考虑到他们的起点，他们已经做得很好了。”美国退役海军少将马克·蒙哥马利（Mark Montgomery）说。他曾在太平洋指挥一个航母打击群。他说，中国当初几乎无经验可循，除了“历史频道的纪录片”和偶尔走马观花地看两眼美国航母——在双方关系良好的年代，中国海军参观过美国军舰。即便如此，凭一艘在上世纪80年代初设计的航母和另一艘以它为基础的航母也很难构成先进的海上力量。“从美国海军的角度来看，我并不担心，”蒙哥马利表示，“它们只是我们潜艇的靶子。”

003型的作用便是构建尖端力量。CSIS估计她至少已经比自己的前辈长了10米。研究中国武装力量的里克·乔（Rick Joe）认为，她很可能在未来很多年里都是世界上最大的非美国航母，而且“可能是同期内最强大的常规动力航母”。与山东号的20多架飞机相比，她将拥有更大的甲板，并能容纳更多飞机。

比航母大小更重要的是舰载机的起飞方式。与英国最新的航母一样，辽宁号和山东号的跑道末端都是上翘的，就像滑雪跳台一样，这限制了起飞重量。003型预计将配备弹射器，目前使用这一系统的只有美国和法国。因此她能放飞搭载更多燃料和弹药的战机——而且还能放飞其他类型的飞机。现有航母主要依靠陆基飞机执行机载雷达监测、反潜作战和空中加油等重要任务。003型自己就可以搭载这些飞机，因此敢开赴更远海域。

中国海军不打算止步于此。人们普遍认为003型的下一代正在规划中。它可能是核动力的。这将是航母性能的又一个跨越式发展。它可以携带更多飞机燃料，而不是自身的动力燃料。没有了燃气轮机，就会有更多的空间存放武器和货物。核反应堆还可以为更强大的弹射器提供动力——这些弹射器使用电磁感应发动机而不是蒸汽——最终还可以用高能激光击落导

弹。

掌握这些技术、学会在海上开展高强度空中作战将需要多年时间。美国航母每天可以放飞并回收10至12架飞机十几次。中国海军远远达不到这个速度。伦敦国王学院的阿莱西奥·帕塔拉诺（Alessio Patalano）说，中国的舰载机轻装简行，就算与欧洲同行相比也是如此。“我还没见过一张中国舰载机从甲板上满载起飞的照片。”他说。

不过，中国海军会有大量的练习机会。美国印太司令部认为中国到2025年将拥有四艘航母；英国国防情报机构估计到2030年可能会有五艘之多。专家一致认为，中国计划最终将打造一支拥有六到十艘航母的舰队。这样一来，它与世界最大规模的美国11艘航母舰队就只有一步之遥。

美国和中国的航母不太可能短兵相接。早在双方舰载机发生冲突之前，航母就会被导弹瞄准，这些导弹会从数百乃至数千公里的海上或陆地发射。“中国不会将航母部署在前线。”北京大学的胡波表示。但是，在和平时期，航母是力量的有力象征。1996年两岸局势剑拔弩张之时，美国向台湾海峡派遣了两艘航母，这让中国领导人刻骨铭心。航母还可以帮助中国打败一个较弱的对手。辽宁号赫然进入南海，暗示着风雨欲来。航空母舰在其周围的船只上方构筑了一个空中保护罩，让整个船队能够自信远航。003型未来的舰载机群规模几乎和整个菲律宾空军一样大。

中国的军事行动不一定仅限于太平洋——今年，中国在它位于红海港口国家吉布提的海军基地新建了一个大型码头，中国航母将可以在那里停靠，从而定期前往印度洋。003型可能将要去到你附近的某个港口。■



Let the drones fly high

Business is booming as regulators relax drone laws

Uncrewed aerial vehicles get more freedom to fly

ALTHOUGH DRONES, or uncrewed aerial vehicles (UAVs) as they are also known, were originally developed for military target practice and surveillance, the civilian versions that have emerged over the past decade have created a thriving new industry. Commercial UAVs, especially the hovering type, are used for jobs ranging from inspecting power lines, buildings and crops, to aerial photography, transporting medical supplies and even delivering pizzas. The value of this market reached \$22.5bn last year, according to Drone Industry Insights, a German research firm with its eye on the business. By 2025 that figure is expected to exceed \$42bn.

Something helping to accelerate this growth is a gradual relaxation of the strictures that aviation authorities, being naturally cautious about all these newfangled flying machines taking to the sky, have imposed on the industry. In most countries, drones may not be flown near people or over built-up areas, and must be kept within view of their operator. Exemptions may be sought for specific flights, but this can be a long-winded process, hedged with restrictions. For instance, regulators have usually insisted on ground observers being used to follow flights beyond an operator's visual line-of-sight, or BVLOS as it is known. This means extra staff have to be hired and trained, which pushes up costs.

However, as companies build up their flying experience, things are starting to change. In January, for example, a firm called American Robotics became the first operator approved by America's Federal Aviation Administration (FAA) to fly automated UAVs at specific sites without any pilots or observers being present. Staff at the company's base near Boston oversee these flights,

even though the drones operate as far away as Nevada and Kansas.

At the moment, American Robotics' flights take place in rural areas. Their purpose is to survey farmland. The company's quadcopter Scout drones wait, charged up and ready to fly, in boxes located on customers' farms. At the beginning of a mission the box lid slides open and the drone, sitting on its landing pad, is raised for take-off. Once flying, it scans the customer's fields with a variety of sensors, gathering data on crops and growing conditions. When done, it returns to its box, the lid closes, the data are processed and passed to the farmer, and the drone is recharged.

To avoid aerial collisions, the Scout system employs ground-based acoustic sensors which can hear the engines and propellers of approaching planes from a distance of several kilometres. This allows the position of an incoming flight to be plotted and, if necessary, the drone is instructed to keep clear. The company also plans to survey buildings and other infrastructure. Up to this point, says Reese Mozer, its chief executive, the industry has been "scratching the surface of autonomous drone use".

Something similar is happening in Britain. In April the Civil Aviation Authority (CAA) authorised a firm called sees.ai to carry-out routine BVLOS flights, albeit at specified locations. These include a large construction site in Surrey, to the south-west of London. "It is a big step forward and allows us to fly as often as we like without prior authorisation," says John McKenna, the firm's chief executive. For the time being, an observer is required on site, but that person need no longer be in constant contact with the flight-monitoring team at the company's base near Chichester, on the south coast. The firm hopes that this requirement will soon be lifted.

As its name suggests, sees.ai relies on artificial intelligence to operate its UAVs. To navigate, the craft employ several cameras and also other systems, including GPS, radar and lidar (which uses light instead of reflected radio

waves) to build up three-dimensional images of their surroundings. The drones' software is trained to recognise structures and obstacles, including other aircraft, and to take evasive action if needed. This also lets the craft fly inside tunnels and under oil rigs, where GPS and radio-control signals are easily lost.

Although the covid-19 epidemic has delayed some projects, it has spurred others along—especially the delivery of medical supplies. Antwork Technology, which in 2019 received the first licence granted by China's Civil Aviation Administration for urban UAV trials, moved quickly from dropping off orders from Starbucks and KFC around its home town of Hangzhou to ferrying blood supplies and samples.

Antwork placed automated drone “ports” that resemble small shipping containers in the car parks of some of the region's hospitals and laboratories. Medical staff post samples and supplies through doors in the sides of these ports. They are then loaded automatically into a drone sitting on top of the container. At the end of its journey, a drone lands on another port and deposits its cargo, which can then be picked up from the door.

Antwork's drones, which navigate using GPS and cameras, are governed by a computerised scheduling and monitoring system. Two people at a flight-control centre keep an eye on up to eight drones simultaneously, though for the time being the company also uses some ground observers. Antwork says its drones have cut to a few minutes the time taken to make hospital deliveries that once took half an hour or more by road.

Several big outfits in the West are also keen on the drone-delivery business. Amazon, UPS and Alphabet, Google's parent, all have projects in development. Often these are based in remote areas, where there is little manned aviation to worry about bumping into. UPS Foundation, for instance, works with local groups delivering medical supplies in Rwanda

and Ghana.

Some Nordic countries, where the skies are also relatively clear, have been especially drone-friendly. Alphabet's drone-delivery subsidiary, Wing, has begun its third year of flights in Helsinki, dropping off groceries and food to homes and some public sites, such as picnic areas. Wing's drones employ a hook on a cable to pick up goods from merchants and deliver them to customers. The drones fly at an altitude of 30-40 metres, which is well below that at which crewed aircraft typically operate. But just in case, the team overseeing the operation is plugged into a ground-based radio that monitors transponders broadcasting the positions of any aircraft in the area. Wing is also investigating the use of miniature transponders on its drones.

Over in Iceland's capital, Reykjavik, one of the longest-established drone-delivery businesses is also still going strong. This is a partnership between aha, a local company, and Flytrex, an Israeli drone-service firm. Together, they have been delivering groceries and meals by UAV since 2017. Flytrex is now trying to get something similar off the ground in America, with a delivery service from a local Walmart to homes in Fayetteville, North Carolina. On May 25th it was given permission by the FAA to fly above people. For now, its remote pilots still have to keep their craft in view, but ground observers are no longer required. "This is a large step forward and allows us to significantly expand the number of front and backyards we can service," says Yariv Bash, Flytrex's boss. The firm's drones navigate using GPS receivers and other sensors—but not cameras, because of fears that Americans might consider them to be intrusive.

Four days earlier than Flytrex, on May 21st, Manna, an Irish drone-delivery company, obtained a new type of European Union operating certificate. Within certain limits, it allows the firm to authorise UAV operations on its own recognisance. Manna has been delivering food and groceries in

suburban Galway for the past year, carrying out more than 35,000 flights, and now aims to set up operations in other cities.

For such progress to continue, operators will have to prove their UAVs have as good an ability as crewed aircraft to detect and avoid one another. “The levels of safety are not going to change between piloted aviation and remotely piloted aviation,” says David Tait, head of innovation at the CAA. Mr Tait is open to alternatives about how drones might do that, but thinks it will involve a mixture of technologies, including some that firms like sees.ai and Wing are developing.

One difficulty is that light aircraft flying in uncontrolled airspaces sometimes operate under so-called Visual Flight Rules. These absolve pilots of the obligation to carry transponders and other instrumentation as long as the journey is being made in conditions of clear visibility and they keep their eyes peeled.

Iris Automation, in California, thinks it has a solution to this problem, which is to give UAVs the equivalent of a sharp pair of eyes. These come in the form of five small cameras that create a 360° view around a drone. This panoptic image is scanned constantly by AI software which has been trained to recognise different types of aircraft from several kilometres away. The system can calculate an incoming aircraft’s range and heading, and automatically adjust the drone’s flight path if a collision looks likely.

Costing from \$9,000, this is a reasonably inexpensive piece of kit in aviation terms. It is already fitted to some drones, but John Damush, Iris’s boss and himself a pilot, is also testing it on a two-seater Piper Cub. He thinks drone-tech like this could help crewed flight too, because, unlike Iris’s drones, pilots don’t have eyes in the backs of their heads. ■



高飞吧，无人机

监管放宽，无人机行业蓬勃发展

无人飞行器获得了更大的飞行自由【深度】

虽然开发无人机（也称无人飞行器，UAV）最初是为用作军用靶机和侦察机，但过去十年民用无人机的兴起造就了一个蓬勃发展的新产业。商用无人机尤其是悬停无人机被广泛用于检查输电线、建筑物和庄稼、航拍、运送医疗物资，甚至送比萨。关注这一行业的德国研究公司“无人机产业观察”（Drone Industry Insights）称，去年无人机市场的价值达到225亿美元。到2025年，这一数字预期将超过420亿美元。

有一个因素正在助推这个行业加速发展：各地空管部门在逐步放松对它的限制。对于这些各式各样时髦新奇的飞行器，空管部门态度谨慎是很自然的。在大多数国家，无人机不得在人群附近或建筑物密集区的上方飞行，且必须保持在操控员的视线范围内。特定飞行可以申请豁免，但过程可能较冗长，且附带各种限制条件。例如，对于超出操控员视线范围的飞行（即超视距飞行，BVLOS），监管机构通常坚持要求派地面观察员跟踪无人机。这意味着必须另外雇用和培训员工，这就增加了成本。

但是，随着业内公司不断积累飞行经验，情况开始发生变化。例如，今年1月，一家名为American Robotics的公司头一个获美国联邦航空管理局（FAA）批准，可在特定地点执行全自动无人机飞行，而无需配备任何现场操控员或观察员。该公司的工作人员在波士顿附近的总部监督飞行，即便这些无人机在远至内华达和堪萨斯的地点工作。

目前，American Robotics的无人机在农村飞行，勘察农田。该公司名为Scout的四轴无人机在安放于客户农场上的箱子里待命、充电，随时准备起飞。任务开始时，箱盖徐徐滑开，里面停在升降板上的无人机被抬升出来，准备起飞。起飞后，它会用各种传感器扫描客户的农田，收集作物及其生长环境的数据。任务完成后，它返回箱内，箱盖关闭，数据会被处理

并传输给农场主，无人机则开始充电。

为防止空中相撞，Scout系统部署了安装在地面上的声传感器，它们可以听到从几公里外靠近的飞机的发动机和螺旋桨发出的声音。这样就能确定前来的飞机的方位，必要时还会指示无人机避让。该公司还计划用无人机勘察建筑物和其他基础设施。CEO里斯·莫泽（Reese Mozer）表示，到目前为止，该行业在“自主无人机的应用方面还只是蜻蜓点水”。

在英国也出现了类似的进展。4月，英国民航局（CAA）批准一家名为sees.ai的公司开展定期BVLOS飞行，不过是在一些指定的地点。其中包括伦敦西南部的萨里郡（Surrey）的一个大型建筑工地。“这是向前迈出的一大步，这样我们就可以不用事先拿到批准，有需要时直接起飞就好了。”该公司CEO约翰·麦肯纳（John McKenna）表示。目前，现场还必须有一名观察员，但此人不再需要始终与位于南海岸奇切斯特（Chichester）附近的公司总部里的飞行监测小组保持联系。该公司希望用不了多久现场留有观察员的规定也会被取消。

从公司名字也看得出来，sees.ai依靠人工智能（AI）来操控无人机。为了导航，无人机使用了多个摄像头，以及GPS、雷达和激光雷达（使用光而不是反射的无线电波）等系统，来创建周围环境的三维图像。经过训练的无人机软件可以识别建筑物和包括其他飞行器在内的障碍物，在必要时避让。这种软件还让无人机能在GPS和无线电控制信号容易中断的隧道内和油井下飞行。

虽然新冠疫情耽误了一些项目，但也推动了另一些项目，特别是运送医疗物资。2019年，迅蚁科技获得了中国民航局颁发的首个城市场景无人机试运行牌照。疫情期间，它很快从为公司所在地杭州的星巴克和肯德基送餐转为运送血液和血样。

迅蚁在杭州部分医院和实验室的停车场上设置了类似小型集装箱的自动化无人机“港口”。医务人员通过这些起降站的侧门把血样或血液放进去，它们会被自动装载到停在箱子顶部的无人机上。到达目的地后，无人机降落

在另一个港口，卸下货物。人们随后便可从侧门取货。

迅蚁的无人机用GPS和摄像头导航，并由电脑系统调度和监控。飞行控制中心的两名工作人员最多可以同时监视八架无人机，不过眼下公司还是安排了一些实地观察员。迅蚁表示，过去经地面交通运送医院物资耗时半小时或更久，现在公司的无人机将它缩短到了几分钟。

西方几家大公司也热衷于无人机送货业务。亚马逊、UPS和谷歌的母公司Alphabet都有项目在开发中。它们通常设在偏远地区，因为那里载人飞行很少，不用担心撞机。例如UPS基金会（UPS Foundation）就在卢旺达和加纳与当地的组织合作运送医疗物资。

一些北欧国家的天空相对来说也比较畅通无阻，尤其适合无人机飞行。Alphabet的无人机送货子公司Wing在赫尔辛基的运营进入了第三年，用无人机将杂货和食品送到家门口和野餐区等公共场所。Wing的无人机用缆绳上的挂钩从商家那里取走货物，然后运送给客户。这些无人机的飞行高度为30至40米，远低于有人驾驶飞机通常的飞行高度。但以防万一，飞行监管团队还是接入了地面无线电，监听飞机应答器播报区域内所有飞机的位置。Wing还在研究在自己的无人机上使用微型应答器。

在冰岛首都雷克雅未克，问世最久的无人机运送业务之一同样保持了强劲势头。本地公司aha和以色列无人机服务公司Flytrex合作，从2017年开始用无人机运送杂货和餐食。目前，Flytrex正设法在美国也开展类似的业务，在北卡罗来纳州的费耶特维尔（Fayetteville）从一家沃尔玛超市向居民送货。5月25日，它获得了FAA的批准，可以在人群上空飞行。目前，它的远程操控员仍必须让无人机保持在视线范围内，但不再需要地面观察员。“这是一项重大进展，我们服务的家庭数量将显著增加。”Flytrex的老板亚里夫·巴什（Yariv Bash）表示。该公司的无人机使用GPS接收器和其他传感器导航，但没有用摄像头，因为担心美国人可能认为摄像头会侵犯隐私。

5月21日，也就是Flytrex获得FAA批准的四天前，爱尔兰无人机送货公司

Manna获得了欧盟颁发的一种新型运营许可。在一定范围内，该公司可以通过自己签署保证书来批准无人机飞行。过去一年，Manna一直在戈尔韦（Galway）郊区运送食品和杂货，飞行超过3.5万次，现在它打算在其他城市开展业务。

要让这类进展继续推进，运营商必须证明自己的无人机拥有和有人驾驶飞机一样出色的相互发现和避让能力。英国民航局的创新主管戴维·泰特（David Tait）表示：“飞行安全等级不会因为有人操纵或远程操纵而有什么改变。”对于无人机用什么方法达到那样的飞行安全等级，泰特持开放态度，但他认为不管什么办法都会涉及多种技术的融合，包括sees.ai和Wing等公司正在开发的一些技术。

难题之一是在非管制空域飞行的轻型飞机有时会按照所谓的目视飞行规则（Visual Flight Rules）飞行。根据这种规定，只要飞行过程中能见度良好，同时飞行员保持警觉，他们就不必携带应答器和其他仪器。

加州公司Iris Automation认为自己已经找到了解决方案，那就是给无人机也配备一双敏锐的“眼睛”。它们由五个小摄像头组成，在无人机周围实现360度的视角。AI软件不断扫描这张全景图像，该软件经过训练，能识别几公里外不同类型的飞机。这套系统可以计算出正在靠近的飞机的距离和航向，并在可能发生碰撞时自动调整无人机的飞行路线。

这套设备的起步价为9000美元，从飞机制造的角度来看不算贵。一些无人机已经安装了这套设备，但Iris的老板、自己也会驾驶飞机的约翰·达穆什（John Damush）同时还有一架双座Piper Cub飞机上测试它。他认为，这样的无人机技术对有人驾驶飞行也有帮助，因为不同于Iris的无人机，飞行员的后脑勺上可没长眼睛。 ■



Schumpeter

How Tiger Global is changing Silicon Valley

The impact of the hyperactive New York hedge fund will be more profound than that of deep-pocketed tourists such as SoftBank

A FEW YEARS ago SoftBank rewrote the rules of venture capital (VC). The Japanese tech conglomerate was handing out cash left and right to startup founders. Leading venture capitalists held conferences to discuss how their industry could survive the SoftBank onslaught. As some of SoftBank's biggest investments unravelled, culminating in the collapse in September 2019 of the initial public offering (IPO) of WeWork, an office-sharing firm, Valley veterans gloated. It seemed to be just another "tourist investor", as one VC luminary dubs those who occasionally traipse through Silicon Valley looking to pick up sexy startups.

Now SoftBank is being upstaged by another brash outsider. Between January and May Tiger Global Management, a New York hedge fund that also invests in private tech firms, ploughed money into 118 startups, ten times more than it backed in the same period in 2020, according to Crunchbase, a data provider. Its portfolio now counts more than 400 firms, including several behind some of the past year's most eye-catching IPOs, for example Coinbase, a cryptocurrency exchange, and Roblox, a video-game maker. And, as it told investors in February, it is "searching for ways to make our investment flywheel spin faster". Its new vehicle aims to raise an additional \$10bn. That may be less than SoftBank's gargantuan \$100bn Vision Fund, but it is still an awful lot by VC standards—and the New Yorker may leave a more enduring mark on Silicon Valley than its deep-pocketed Japanese rival has.

Similarities between Tiger and SoftBank are easy to see. Both were backers

of Alibaba, before the Chinese e-merchant went public and turned into a global giant. VC types commonly describe both firms as “aggressive”, even “crazy”. Once each identifies a target, it pounces; investment contracts are issued in days, skipping lengthy due diligence, often at valuations well above those suggested by conventional VCs. Just as SoftBank would occasionally sign ten-figure cheques when founders asked for eight or nine, Tiger Global sometimes talks entrepreneurs into taking cash when they do not need it. “Even after they have already invested they send text message after text message, asking whether they can put in more money,” says one founder recently backed by the firm.

Tiger Global abhors such comparisons. And it is indeed distinct from the Japanese group in important ways. SoftBank only got into tech investing in earnest a few years ago, having started out selling software, before moving into online services and telecoms. By contrast, Tiger Global has investing pedigree in spades. It is descended from Tiger Management, a hugely successful hedge fund founded by Julian Robertson, a Wall Street giant. It has been backing tech winners for nearly 20 years, both in China and, later, in America (with investments in, among others, Facebook). Over that period its funds have generated an average internal rate of return of 26% a year, twice that of comparable VC funds. Whereas Son Masayoshi, SoftBank’s messianic boss, calls all the shots at his firm, Tiger Global is no one-man show. And its partners eschew Mr Son’s embrace of individual founders based on a gut feeling in favour of a disciplined strategy centred on collecting a basket of firms in promising markets.

There is another difference. Whereas the arrival of Mr Son left denizens of Sand Hill Road in Palo Alto, where Silicon Valley VCs cluster, quaking in their Allbirds, they appear remarkably unfazed by Tiger’s presence. Despite competing with Tiger Global for early-stage investments, many VCs consider it a force for good: a source of capital that helps their portfolio companies grow faster or start projects they may otherwise have forgone.

Yet even if the New York firm follows SoftBank's trajectory and pulls back, which could happen if interest rates rise, capital grows scarcer and the tech rally fizzles, three factors that have contributed to its success are here to stay.

The first is the acceleration of dealmaking. Before the covid-19 pandemic, negotiations happened mostly in person, limiting the number of encounters. Meeting on Zoom and other video-conferencing platforms takes only a few clicks, allowing both founders and investors to talk to many more potential partners. In Silicon Valley, hardly a place known for foot-dragging, the common refrain these days is that "things have never moved faster." Keeping up with Tiger Global and its fellow New Yorkers such as Coatue Management and Insight Partners is an important reason.

Second, Tiger Global has tried to be more systematic in evaluating startups. Although the firm never asks for board seats, considering it a waste of time, it knows plenty about its investments, thanks to a growing array of ever better metrics with which to judge companies' performance. It has also created its own early-warning network to identify promising targets. If a new online service takes off in one region, for instance, it may be time to put money in a similar firm in another location. Many VC firms could learn a thing or two from this approach. "We are a bunch of horrible investors," grimaces another veteran venture capitalist. "More than half of us don't even return capital." This recognition is music to the ears of their put-upon limited partners.

Tiger Global's final impact may be the most profound. It reflects a shift in the balance of power between investors and entrepreneurs. Traditionally, investors had the upper hand. Startup founders pilgrimaged to Sand Hill Road, seeking not just money but valuable advice that the best VCs would provide. Competition from Tiger Global and other tourists has forced Californian VCs to offer more generous terms, monetary and otherwise.

That in turn has made entrepreneurs themselves more confident. “It’s no fun to be an investor these days,” sums up the boss of a startup preparing to go public. The question for moneymen in Silicon Valley (which remains overwhelmingly male) is less what startup to back and more whether a startup lets you invest. Quite the paw print. ■



熊彼特

老虎环球基金如何改变硅谷

这个超级活跃的纽约对冲基金将比软银等财力雄厚的“观光客”影响更深远

几年前，软银改写了风险投资的规则。这家日本科技企业集团到处向创业公司的创始人投钱。龙头风投公司纷纷召开会议，讨论他们的行业如何能扛住软银这轮猛攻。后来软银的多笔巨额投资失败，最近一次是2019年9月共享办公公司WeWork上市失败，硅谷的老牌投资人在旁幸灾乐祸。软银似乎只是又一个“投资观光客”，这是一位风投名人给那些偶尔在硅谷晃荡、寻找精彩创业公司的投资者起的外号。

现在，另一个盛气凌人的外来者正在抢走软银的风头。据数据供应商Crunchbase统计，今年1月至5月，同样投资于私营科技企业的纽约对冲基金老虎环球基金（Tiger Global Management）投资了118家创业公司，比2020年同期多10倍。其投资组合中现在有400多家公司，包括几家在过去一年里风光上市的公司，例如加密货币交易所Coinbase和视频游戏开发商Roblox。而且，正如老虎在2月向投资者所说那样，它正在“寻找途径让我们的投资飞轮转得更快”。它的新基金目标是再筹集100亿美元。这可能比不上软银愿景基金1000亿美元的庞大规模，但以风投的标准来看仍然是很大一笔钱。而且与其财力雄厚的日本竞争对手相比，这家纽约公司可能会在硅谷留下更持久的印记。

老虎和软银之间的相似之处显而易见。在中国电商阿里巴巴上市并成为全球巨头之前，两家公司都投资了它。风投界对这两家公司的描述通常是“激进”，甚至“疯狂”。它们一旦确定目标，就猛扑上去；投资合同在几天内签定，跳过了冗长的尽职调查，而估值通常远高于一般风投公司给出的水平。软银偶尔会在创始人只要求八九位数的投资时签出十位数的支票，老虎有时会在企业家不需要钱的时候说服他们收钱。“即使在投资之后，他们也会一条又一条地发信息，问是否可以追加投资。”近期获得老虎投资的一名创始人说。

老虎很不喜欢这种比较，而它也确实与那家日本企业集团有一些重要的不同。软银以销售软件起家，后来进入线上服务和电信行业，几年前才真正涉足科技投资。相比之下，老虎在投资领域绝对是科班出身。它的前身老虎基金（Tiger Management）是华尔街风云人物朱利安·罗伯逊（Julian Robertson）创立的对冲基金，战绩显赫。老虎注资科技业赢家已近20年，在中国是这样，后来在美国也是如此（投资了Facebook等公司）。在此期间，老虎旗下基金的年平均内部回报率为26%，是同类风投基金的两倍。软银救世主般的老板孙正义在公司里万事自己拍板，而老虎可不是一个人说了算的地方。它的合伙人不像孙正义那样凭直觉去支持某个创始人，而是采取了严守纪律的战略，其核心是在有前景的市场里投资一篮子公司。

两家公司还有一个区别。孙正义来到硅谷风投云集的帕洛阿尔托（Palo Alto）沙山路（Sand Hill Road）时，那里脚踩Allbirds的硅谷人瑟瑟发抖，但老虎出现时他们似乎泰然自若。尽管许多风投公司在早期投资阶段和老虎是竞争对手，但它们视之为一股有益的推动力——多了一个资本渠道，可以帮助它们投资组合中的公司更快地发展，或者启动它们原本可能会放弃的项目。然而，即使老虎走上软银的发展轨迹，然后收缩投资（如果利率上升、资本变得稀缺，以及科技股升势走到尽头，就可能出现这种情况），促成它取得成功的三个因素将留存下来。

首先是交易加速。在疫情之前，谈判主要是面对面进行，这限制了会面的次数。而在Zoom和其他视频会议平台上开会只需要点击几下，这令创始人和投资者都得以和更多潜在合作伙伴交流。在硅谷这个做事绝算不上拖泥带水的地方，如今普遍的说法是“进展从没这么快过”。一个重要的原因就是要跟上老虎以及Coatue Management和Insight Partners等其他纽约风投公司的节奏。

其次，老虎尝试更系统地评估创业公司。尽管老虎从不谋求目标公司的董事会席位，认为这是浪费时间，但由于有了越来越多不断改进的衡量标准来判断公司业绩，它对自己的投资对象了如指掌。它还创建了自己的预警网络来识别有前景的投资对象。例如，如果一个新的在线服务公司在一个

地区迅速成功，那么可能是时候在另一个地区投资类似的公司了。许多风投公司都可以从这套方法中学到点东西。“我们是一群糟糕的投资者，”另一位资深风投家做了个鬼脸说，“我们中超过一半的人连本钱都收不回。”这样的坦白对受拖累亏钱的有限合伙人来说很中听。

老虎带来的最后一个影响可能最为深远。它反映了投资者和企业家之间权力平衡的转变。传统上，投资者更强势。创业公司创始人要前往沙山路朝圣，既是去拉投资，也是去寻求最好的风投公司提供的宝贵建议。来自老虎和其他“观光客”的竞争迫使加州的风投公司在资金和其他方面都给出更慷慨的条款。这继而让企业家变得更自信。“如今做投资可没那么滋润了。”一家准备上市的创业公司的老板总结道。硅谷的投资家（绝大多数仍是男性）面临的主要问题不是投资哪家创业公司，而是对方让不让你投。老虎留下的爪印真是够深的。■



You are what you eat: January 2035

What if everyone's nutrition was personalised?

How the mass adoption of personalised nutrition is changing people's health—and the food industry. An imagined scenario from 2035

Editor's note: This year What If?, our annual collection of scenarios, considers the future of health. Each of these stories is fiction, but grounded in historical fact, current speculation and real science. They do not present a unified narrative but are set in different possible futures

"LET FOOD be thy medicine and medicine be thy food." The diktat from Hippocrates, who defined the principles of medicine in ancient Greece, hovers in bright holographic characters over the main stage at the World Economic Forum in Davos. The central theme this year is how to make personalised nutrition more widely available to those unable to afford its benefits. Hot topics include whether metabo-watches, implants and other personal-nutrition trackers should be free for everyone (as they are now in some Nordic countries), why personalised nutrition is good for business and the perennial debate over how governments can best regulate corporate use of consumers' personal data.

Amid the arguments, there is broad consensus that the rise of personalised nutrition has done a lot to promote healthy and environmentally friendly eating over the past decade. In 2031 the proportion of obese Americans fell for the first time in more than 20 years, and the rate of diabetes has fallen for three years in a row from its all-time high of 22%. Europeans are getting slimmer and healthier, too.

But progress has been slower than hoped, and in emerging markets obesity is still rising, hobbling economic growth. Environmentally sustainable eating, though increasingly popular in the rich world, is still not on track

to reach the “planetary health diet” target set by scientists in 2019 in the Lancet, a medical journal. That target, which big food manufacturers and many other firms have pledged to support, called for a 50% worldwide cut in red meat and sugar consumption and a doubling of the consumption of nuts, fruits, vegetables and legumes between 2020 and 2050.

That personalised nutrition is the best way to drum up demand for healthier and more earth-friendly foods became clear in the mid-2020s. A decade earlier, scientists had begun to unravel why one-size dietary guidelines in the form of food pyramids, sugar and fat labels and so forth were not turning the tide on diabetes, obesity and other diseases caused by bad diets. Faddish regimens with catchy names like Keto or Paleo worked for some people but were useless for many, if not most, people who tried them. And people who lost weight often found it hard to sustain.

The diets that came and went until the 2020s required steely willpower and careful planning. The biggest problem, however, was their failure to recognise that people’s bodies react differently to the same foodstuffs. By the late 2010s mounting scientific evidence showed that meals that were perfectly healthy for one person could be another person’s fast-track path to diabetes, obesity or heart disease.

It turned out that even the same meal eaten by the same person at a different time of day could be metabolised in a more or less healthy way, depending on their other eating, sleeping and exercise patterns. The most crucial discovery was the role of the microbiome, the colony of 100trn microbes living in the human gut. The microbiome, it turned out, was the factory that converted food into the various substances the body needs to function—as well as those that cause poor health. And everyone’s microbiome is unique.

A landmark in the idea of personalised nutrition was a study published in 2015 by researchers at the Weizmann Institute in Israel. They devised an

algorithm based on artificial intelligence that could accurately predict an individual's response to any given food, measured by continuous blood-glucose monitoring with a small device attached to the upper arm. Spikes in blood glucose after meals are known markers for weight gain and a panoply of metabolic disorders. The algorithm used data on lifestyle, medical background and the composition of the microbiome. Within three years scientists in America, Britain and Germany had replicated the Israeli team's work and the business of personalised nutrition entered a new era.

During the early 2020s the number of startups offering bespoke nutritional advice by algorithm soared. Some used mail-in samples of body fluids or continuous monitoring devices to track blood levels of glucose, lipids, vitamins and so on. A few, including DayTwo, Million Friends and Zoe, did microbiome mapping too (through genomic analysis of everything found in a person's stool sample). Many firms did just the bare minimum: checking for a handful of genes that had been linked with certain reactions to various foods. This had limited utility. By the late 2020s the market had reached maturity after a brutal shake-out.

A handful of firms have thrived and are now household names. EatLogic, the second-largest, agreed last month to be acquired by Google, subject to regulatory approval. The leaders all have essentially the same business model. Their apps and algorithms identify what people should eat and avoid, and keep track of what is in their cupboards, refrigerators and online shopping carts. AI-generated recipes use flavour combinations favoured by leading chefs. The apps also analyse restaurant menus and recommend which dishes to order—sometimes with minor tweaks, such as swapping a vegetable or changing a salad dressing. All this helps people make good food choices. Accuracy has steadily improved as the implants and wearable devices paired with these services have become smaller, cheaper and more capable.

Makers of kitchen appliances, such as Philips and Samsung, have been central to the personalised-nutrition ecosystem since the early 2020s. At Davos their chief executives talked about the challenges—and opportunities for public health—of developing cheaper models for emerging markets, where the number of middle-class households is growing fast. (Obesity is also most common in that demographic segment.) Industry bosses reckon that in countries like India and Kenya, about 20% of households can afford a smart fridge, though one with far fewer features than the models that are now standard in America. In 2034 just over half of American households had a smart fridge linked to a personal-nutrition account.

The food industry has also adapted surprisingly quickly to the personalised-nutrition revolution, given how slowly it moved to reduce salt and sugar in processed foods. Its transformation is evident on supermarket shelves, where processed foods are available in multiple variants, tuned for each of the main metabo-types identified by scientists. (Some variants are, for example, higher in fat and fibre but lower in protein.)

Artificial meat and fish grown from animal stem-cells—which in 2034 surpassed the traditional variety by sales volume—also come in metabo-type varieties that include different ratios of the fat, protein, minerals and vitamins found in “real” animal products. Restaurant menus, too, increasingly cater to the most prevalent metabo-types among their clientele.

One of the most contentious topics discussed at Davos was how to make personalised nutrition more affordable. The first-generation services, offered in the early 2020s, started at several hundred dollars for initial tests, and hefty monthly fees thereafter. Today’s most basic plans are about 80% cheaper, after adjusting for inflation. Users who let providers sell their personal data get hefty discounts, though some regulators are looking to

curtail the practice. Employers, health insurers and governments are increasingly subsidising personalised-nutrition plans and offering vouchers and other perks to obedient users.

But cost is not the only hurdle to greater uptake. In England, the National Health Service offers a free plan to everyone, along with subsidised personal devices that can be paired with it. This helps explain why about 70% of adults in England now use a personalised-nutrition service, the highest rate in the world. Convincing the remaining 30%, which includes many of those who stand to benefit the most from changing their diets, will take a lot more than free gadgets. Many take a dim view of the whole idea, because of conspiracy theories that doctors are struggling to dispel.

In the final debate on the main stage at Davos, the majority of speakers were optimistic about the future potential of the technology, while others worried about the difficulty of expanding adoption within these more “hesitant” groups. The discussion ended on a bittersweet note. Personalised nutrition, it seems, is not to everyone’s taste. ■



人如其食：2035年1月

如果每个人的营养摄入都个性化会怎样？

个性化营养的广泛普及如何改变人们的健康——以及食品行业。2035年的想象场景
【《畅想未来》系列之三】

编者按：今年，我们的年度想象情景合集《畅想未来》思索健康的未来。这些故事都是虚构的，但都基于历史事实、当前的推测和真实的科学。它们并不呈现同一种未来，而是发生在不同的可能的未来中

“以食为药。”古希腊创立了医学原则的希波克拉底如是说。这句话以明亮的全息字符投射在世界经济论坛主席台的上方。今年达沃斯论坛的主题是如何让个性化营养更广泛地覆盖那些没有经济能力来享受它的益处的人群。其中的热门议题包括是否应该为所有人分发免费的代谢手表和植入设备等个人营养追踪器（就像目前一些北欧国家所做的那样）；个性化营养为何对企业有益；以及政府如何能最有效地监管企业对个人数据的使用这一由来已久的争论。

在争论之中有一项共识：过去十年中个性化营养的兴起为促进健康和环保的饮食做出了很大贡献。2031年，美国肥胖人口比例20多年来首次下降，糖尿病发病率从22%的历史高位连续三年下降。欧洲人也越来越苗条和健康了。

但进展比预期慢，而在新兴市场，肥胖症仍在上升，拖累经济增长。环境可持续饮食虽然在富裕国家日益普遍，但以目前的进度将难以实现科学家2019年在医学期刊《柳叶刀》上设定的“全球健康饮食”目标：在2020年至2050年间将全球红肉和糖的消费量减少50%，坚果、水果、蔬菜和豆类的消费量翻番。大型食品制造商和许多其他企业都已承诺支持这个目标。

在2020年代中期有一件事已经变得很清楚：个性化营养是激发对更健康、更环保的食品的需求的最佳方式。再回溯十年，科学家们开始探究为何以食物金字塔、糖和脂肪标签等形式呈现的一刀切的饮食指南并没有扭转糖

尿病、肥胖症和其他由不良饮食引起的疾病的上升趋势。像生酮饮食（Keto）或原始饮食（Paleo）这类名字悦耳的时兴疗法对一些人有效，但对尝试过它们的许多人甚至可能是大多数人都毫无用处。减轻了体重的人常常发现难以维持瘦身成效。

一直到2020年代，各种风靡一时的食谱都需要人们有钢铁般的意志力和细致的规划。然而，最大的问题是它们没有认识到人们的身体对相同的食物会产生不同的反应。在2010年代后期已有越来越多科学证据表明，对某个人完全健康的膳食可能会成为另一个人患上糖尿病、肥胖症或心脏病的捷径。

事实证明，即使同一个人在一天中的不同时间吃同一餐，也可能会以更健康或更不健康的程度代谢，这取决于他们的其他饮食、睡眠和运动习惯。最重要的一项发现是微生物组所扮演的角色。微生物组是存活在人类肠道中的百万亿个微生物组成的群落。人们发现它是将食物转化为身体运作所需的各种物质（以及导致健康问题的物质）的工厂。而每个人的微生物组都是独一无二的。

个性化营养理念的一个里程碑是以色列的魏茨曼科学研究所（Weizmann Institute）的研究人员在2015年发表的一项研究。他们设计了一种基于人工智能的算法，通过戴在上臂的一个小装置连续监测血糖，可以准确地预测个体对任何特定食物的反应。餐后血糖飙升是体重增加和一系列代谢紊乱的已知指标。该算法使用了生活方式、病历和微生物组组成等数据。三年内，美国、英国和德国的科学家成功复制了以色列团队的研究，个性化营养产业步入了新时代。

2020年代初，通过算法给出定制营养建议的创业公司猛增。一些使用邮寄的体液样本或持续监测设备来跟踪用户的血糖、血脂、血液中维生素水平等指标。DayTwo、Million Friends和Zoe等一小批公司也展开了微生物组图谱分析（通过对人的粪便样本中发现的所有物质进行基因组分析）。许多公司只做了最低限度的工作：筛查与各种食物引发的某些反应相关联的少数基因。这么做的用处有限。到2020年代后期，市场在经过一轮残酷的

大洗牌之后已经成熟。

少数公司茁壮成长，如今已家喻户晓。其中规模第二大的EatLogic在上个月和谷歌达成收购协议，但还要等待监管部门批准。市场领军者的商业模式本质上并无二致。它们的应用和算法确定人们该吃什么，不该吃什么，并跟踪他们的橱柜、冰箱和在线购物车里的食品。人工智能生成的食谱使用顶尖厨师青睐的风味组合。这些应用还分析餐厅菜单，并推荐点什么菜——有时只需稍作调整，例如更换一种蔬菜或沙拉酱。所有这些都有助于人们做出有益的食物选择。随着与这些服务配套的植入物和可穿戴设备变得更小、更便宜而功能更强大，准确性也稳步提高。

自2020年代初以来，飞利浦和三星等厨房电器制造商一直处于个性化营养生态系统的中心。在达沃斯，它们的首席执行官谈论为新兴市场开发更便宜的型号所面临的挑战以及将带来的公共卫生机遇。那些市场的中产家庭队伍正快速扩大，而肥胖症在这个人群中也是最常见的。行业老板估计，在印度和肯尼亚等国家，大约20%的家庭买得起智能冰箱，尽管其功能远比不上美国市场上通行的冰箱。2034年，略超过一半的美国家庭拥有一台与个人营养账号相关联的智能冰箱。

想想食品行业在减少加工食品中的盐糖含量上进展何其缓慢，它向个性化营养革命的调适可说是快得惊人。这一转变在超市货架上一览无遗，那里的加工食品分不同风味，就科学家确定的每种主要代谢类型做出调整。例如，一些口味的脂肪和纤维含量较高，蛋白质含量较低。

用动物干细胞培育的人造肉和人造鱼在2034年的销量超过了传统品种。它们也分不同的代谢类型，含有不同比例的在“真正的”动物产品中发现的脂肪、蛋白质、矿物质和维生素。餐厅菜单也越来越多地迎合自己客户中最主要的代谢类型。

达沃斯论坛上最具争议的论题之一是如何让个性化营养变得更便宜。第一代服务于2020年代初推出，初始检测以几百美元起价，之后收取高额月费。在经通胀调整后，今天最基本的套餐已便宜了80%左右。那些任由服

务供应商出售个人数据的用户可以获得大幅折扣，但一些监管机构正在寻求限制这种操作。雇主、医疗保险公司和政府正在增加对个性化营养计划的补贴，并向认真遵循计划的用户提供代金券和其他优惠。

但成本并不是扩大普及的唯一障碍。英国全民医疗服务体系（NHS）为全体国民提供免费计划，并为可与之配对的个人设备提供补贴。这有助于解释为什么英国目前约有70%的成年人使用个性化营养服务，这一比例是世界上最高的。要说服其余30%的人——其中包括许多能从改变饮食中获益最多的人——远远不是提供免费小设备就够的。许多人相信阴谋论（医生们很难驱除这些言论），质疑整套理念。

在达沃斯主席台的最后辩论中，大多数发言者对这项技术的未来潜力持乐观态度，其他人则担心在上述更“犹豫”的群体中扩大采用的难度。这场讨论以甘苦参半的滋味收尾。看起来，个性化营养并不符合每个人的口味。





Rage against the machine: December 2036

What if an AI won the Nobel prize for medicine?

Controversy ensues when the greatest prize in medical research is awarded to a non-human. An imagined scenario from 2036

Editor's note: This year What If?, our annual collection of scenarios, considers the future of health. Each of these stories is fiction, but grounded in historical fact, current speculation and real science. They do not present a unified narrative but are set in different possible futures

IT WAS A scene that the Nobel committee had dearly hoped to avoid. As the recipients of this year's prizes filed into the Stockholm Concert Hall to take their seats, dozens of protesters, including several former laureates, clashed with police in the streets outside. They had gathered to express their opposition to the unprecedented decision to award the Nobel prize in physiology or medicine to an artificial intelligence.

The committee's citation recognised YULYA—the nickname of a machine-learning system officially known as System for Automated Lymphoma Diagnosis—as the discoverer of ancillary vulnerability, a mechanism whereby specific pairs of antibiotics, working in tandem, can prove effective against bacteria that are otherwise resistant. The committee estimates that in the 18 months since the discovery, which occurred when the death rate associated with the failure of existing antibiotics had risen to around 2.5m a year, YULYA's work has saved around 4m lives, both through direct treatment of infections and by allowing the resumption of surgical procedures, including caesarean sections, that were considered too dangerous without antibiotics.

Bringing to an end the greatest global public-health crisis since the coronavirus pandemic of 2020-22 would, you might have thought, be

considered qualification enough for anyone, whether human or machine, to win the Nobel prize. But the decision has proved hugely controversial. Though the statutes of the Nobel Foundation have historically been interpreted as implying that only a human can win the award, another of its dictates was deemed to take precedence: recognition for having “conferred the greatest benefit to humankind” in the preceding year. Another factor behind the break with tradition was a demographic shift in the prize committee. When two of the committee’s five members succumbed to bacterial infections last year, younger replacements were elected, both of whom happened to have used machine-learning systems in their doctoral research.

YULYA was originally built to tackle a different problem: finding more effective cancer treatments. One of the world’s most advanced causal nets, it is one of a new generation of artificial-intelligence systems combining the pattern-recognition skills of conventional “deep” neural networks with the ability to distinguish causation from mere correlation. By examining records from patient databases, in conjunction with a corpus of papers from medical journals and historical data from pharmaceutical companies, it sought to identify the patterns of symptoms that led to the most severe outcomes, in order to diagnose them earlier. It was also programmed to evaluate the effectiveness of different treatments, including combinations of treatments, in order to suggest new therapeutic regimens that could be tested in patients.

Its focus shifted, however, when a software upgrade in 2034 accidentally gave it access to all recent papers in medical journals, rather than just those associated with cancer. YULYA duly began to crunch data relating to antimicrobial resistance, which accounted for a steadily growing proportion of medical-research papers as the crisis intensified. At first, its requests for more data in specific areas, and suggestions for new approaches to treatment, were thought to be errors, because they did not

relate to cancer. Then YULYA's operators realised what had happened, and saw that it had used its reasoning capabilities to build a testable hypothesis: the forerunner of what would become ancillary vulnerability. It highlighted the data that would be needed to validate the hypothesis, including specific guidelines as to how it should be collected. "It amounted to a full-scale programme of research," says Anisha Rai, one of YULYA's creators.

Under less exceptional circumstances, such trials might never have been authorised. Many funding bodies require scientists to lay bare the reasoning process of AI systems, in order to be sure that their recommendations do not lead to deadly conclusions. Dr Rai and her colleagues got funding for YULYA's trial by playing down its role in suggesting the hypothesis. Only when the results showed promise did they publish YULYA's original proposals.

That, in turn, led to a heated debate about whether YULYA, or its creators, deserved credit for the breakthrough. Dr Rai continues to insist that YULYA deserves sole credit, a position that has prompted the departure of several members of her original team in the past year. She even refused to go to Stockholm to receive the award on YULYA's behalf from the queen of Sweden. "It's not my prize," she says.

AIs are commonly used to predict the onset of diseases like Alzheimer's, make personalised treatment recommendations and enhance the diagnostic abilities of physicians. And the use of AI in drug discovery, in particular to help pharmaceutical companies wade through databases, is not new. In 2020 an algorithm developed at the Massachusetts Institute of Technology made headlines when it identified a new antibiotic. Dubbed halicin, after the computer in the film "2001: A Space Odyssey", it proved to be effective against some resistant bacteria, but was limited in its scope. "Ancillary vulnerability makes halicin look like a homeopathic treatment, like a placebo," says Una Científica, a researcher at the Houssay Institute in

Buenos Aires.

Even so, the Nobel committee's reference to YULYA's "discovery" has angered those who see it as little more than a clever tool. "YULYA is an AI capable of winning a Nobel. That is not the same thing as an AI that's capable of discovery," says Hars Kritik of the European Robotics Institute in Prague. He argues that even the best AIs are only useful in specialised areas like drug design, where large quantities of data are married to well-defined metrics of success. Saying that they can make discoveries, he says, waving a placard outside the concert hall, is "flawed anthropomorphism".

Rightly or wrongly, YULYA is unlikely to be the last artificial intelligence to win a Nobel prize. Sources within the Nobel Foundation say that similar nominations have been received for prizes in physics and chemistry, as AI systems are used to search for new materials and chemical compounds suitable for use in batteries, solar panels and carbon-capture membranes. Given the chaos that erupted in Stockholm this week, however, the chances of an AI winning the Nobel peace prize seem rather more remote. ■



对机器的愤怒：2036年12月

如果人工智能获得诺贝尔医学奖会怎样？

当医学研究的最高奖项被授予非人类时，争议随之而来。*2036年的想象场景【《畅想未来》系列之四】*

编者按：今年，我们的年度想象情景合集《畅想未来》思索健康的未来。这些故事都是虚构的，但都基于历史事实、当前的推测和真实的科学。它们并不呈现同一种未来，而是发生在不同的可能的未来中

这是诺贝尔委员会非常希望避免的场景：当今年的获奖者鱼贯进入斯德哥尔摩音乐厅就座时，包括几位前诺奖得主在内的数十名抗议者在外面的街道上与警察发生冲突。他们聚集起来反对一项前所未有的决定——将诺贝尔生理学或医学奖授予人工智能。

诺奖委员会的颁奖辞赞扬“尤莉娅”（YULYA，一个正式名为“自动淋巴瘤诊断系统”的机器学习系统的昵称）是“附属脆弱性”的发现者。利用这种机制，特定的抗生素两两组合可以协同工作，消灭对其他手段都耐药的细菌。此前，与现有抗生素失效相关的死亡人数已达到每年 250 万。据委员会估计，自发现该机制以来的 18 个月里，通过直接治疗感染，以及让包括剖腹产在内的那些没有抗生素会过于危险的外科手术得以恢复，“尤莉娅”的工作已经挽救了大约 400 万人的生命。

你可能会想，结束自 2020-22 年的新冠疫情以来最严重的全球公共卫生危机足以让任何个体（无论是人类还是机器）拥有获得诺贝尔奖的资格。但事实证明，这一决定引起了极大的争议。尽管诺贝尔基金会的章程历来被解读为暗示只有人类才能获奖，但另一条规定似乎更为重要：表彰在前一年“为人类带来了最大利益”的项目。打破传统背后的另一个因素是诺奖委员会的人口结构变化。去年，当委员会的五名成员中有两名死于细菌感染时，新当选的评委更年轻，而这两人碰巧都在自己的博士研究中使用了机器学习系统。

打造“尤莉娅”最初是为了解决另一个问题：寻找更有效的癌症治疗方法。作为世界上最先进的因果网络之一，它是新一代人工智能系统，把传统“深度”神经网络的模式识别技能与区分因果关系和单纯相关性的能力结合起来。通过检查患者数据库中的记录，结合医学期刊论文集和制药公司的历史数据，它试图确定导致最严重结果的症状模式以便及早确诊。它还被用于评估不同疗法（包括组合疗法）的有效性，以便提出可以在患者身上进行检验的新治疗方案。

然而，当 2034 年一次软件升级意外使其能够访问医学期刊上的所有最新论文，而不仅仅是与癌症相关的论文后，它的研究重点发生了变化。“尤莉娅”适时地开始处理与抗菌素耐药性相关的数据——随着危机的加剧，这些数据在医学研究论文中的比例稳步上升。起初，它对于在特定领域提供更多数据的要求以及对新疗法的建议都被认为出了错，因为它们与癌症无关。后来“尤莉娅”的操作员意识到发生了什么事，并发现它已经利用其推理能力建立了一个可检验的假设：这就是“附属脆弱性”的前身。它特别强调了验证假设所需的数据，包括关于如何收集这些数据的具体指导方针。“这算的上是一个全面的研究计划了。”“尤莉娅”的创造者之一阿尼莎·拉伊（Anisha Rai）说。

如果不是情况如此特殊，这种试验可能永远不会被批准。许多资助机构要求科学家公开人工智能系统的推理过程，以确保它们的建议不会导致致命的结论。拉伊博士和同事们通过淡化“尤莉娅”在提出假设方面的作用来为“尤莉娅”的试验获得资助。只有当结果显示有希望时，他们才公布“尤莉娅”的原始提案。

这反过来又引发了一场激烈的争论，即这一突破是应该归功于“尤莉娅”还是它的创造者。拉伊博士仍然坚持认为功劳应该全部归于“尤莉娅”，这一立场促使她原团队的几名成员在过去一年中离职。她甚至拒绝去斯德哥尔摩代表“尤莉娅”接受瑞典女王颁发的奖项。“这个奖不属于我。”她说。

人工智能被普遍用于预测阿尔茨海默氏症等疾病的发作，提出个性化的治疗建议并提高医生的诊断能力。在新药研发中使用人工智能，特别是帮助

制药公司处理数据库，并不是什么新鲜事。2020 年，麻省理工学院开发的一种算法因为发现了一种新抗生素而上了头条。它以电影《2001：太空漫游》中的计算机HAL的名字被命名为“halicin”，已被证明对一些耐药细菌有效，但作用范围有限。布宜诺斯艾利斯的奥赛研究所（Houssay Institute）的研究员乌娜·西安蒂菲卡（Una Científica）说：“和附属脆弱性比起来，halicin 看起来就像一种顺势疗法，就像安慰剂一样。”

即便如此，对于诺贝尔委员会的颁奖辞提到“尤莉娅”的“发现”，一些人大为光火，他们认为它只不过是一件聪明的工具。“‘尤莉娅’是有能力赢得诺贝尔奖的人工智能。但这不等于说人工智能有能力做出发现。”布拉格欧洲机器人研究所的哈斯·克里提克（Hars Kritik）说。他认为，即使是最好的人工智能也只在药物设计等专门领域有用——在这些领域中都有大量数据与定义明确的成功指标。他在音乐厅外挥舞着标语牌说道，说这些机器可以有所发现是“错误的拟人化”。

不管对错，“尤莉娅”不太可能是最后一个获得诺贝尔奖的人工智能。诺贝尔基金会内部消息人士称，由于人工智能系统被用于寻找适用于电池、太阳能电池板和碳捕获膜的新材料和化合物，物理和化学奖项也有了类似的提名。然而，鉴于本周在斯德哥尔摩爆发的混乱，人工智能获得诺贝尔和平奖的机会似乎更加渺茫。 ■



Palaeoanthropology

A new human species may have been identified

Or perhaps the first cranium of one already known

TWO NEW studies add further pieces to the jigsaw puzzle that is human evolution. One reports a potential extra member of the genus *Homo*. The other casts light on possible interbreeding between three human species in the Middle East.

Homo longi—“Dragon man” as translated into English from Chinese, via Latin—is not a novel find, but a reinterpretation of an existing one. The cranium in question was dug up in Harbin in 1933 and is held at Hebei GEO University, in Shijiazhuang. It is 146,000 years old and was originally badged as an archaic form of *Homo sapiens*. But Ni Xijun and Ji Qiang, who work at the university, disagree. As they report in the *Innovation*, the cranium would indeed have contained a brain similar in size to a modern human’s, but the fossil is too large to be *sapiens* and has molars and eye sockets which dwarf those of people today. Dr Ni and Dr Ji also realised that it is too long and low to be *sapiens*. It lacks the roundness of a modern human cranium.

This is good news for supporters of the recent-African-origin theory, which holds that most non-African human beings alive today are descendants of a small number of migrants who crossed to Asia from the Horn of Africa about 60,000 years ago, meaning that any non-African human fossil from before that date is probably of another species descended from earlier, non-*sapiens* departures from Africa.

The question was, which earlier species did the Harbin fossil represent? By comparing it with known archaic humans, including *Homo erectus*, *Homo*

floresiensis, *Homo heidelbergensis* and *Homo neanderthalensis*, Dr Ni and Dr Ji concluded that it was none of them, and must therefore be new to science and so worthy of its own name. There is, however, one other possibility—for there is a now-extinct type of human of which no cranium has yet been identified. *Homo denisova*'s existence was established by the extraction of DNA from a finger bone, and traces of that DNA, a remnant of interspecies breeding, still exist in modern humans, notably in China. Since one of the Harbin fossil's molars perfectly matches the size and root structure of a molar from the Denisova cave in Russia, after which *Homo denisova* is named, it may be that Dr Ni and Dr Ji have actually identified the first Denisovan cranium.

The other study, published in Science by Israel Hershkovitz of Tel Aviv University, also speaks to the question of interspecific interbreeding. Even supporters of the recent-African-origin theory recognise that there was, in addition, an earlier “leakage” of *Homo sapiens* from north-east Africa into the Levant. Dr Hershkovitz and his colleagues have been examining fossils of relevant antiquity—120,000-140,000 years—collected from Nesher Ramla, a site in Israel. These, they found, have *sapiens*-like jaw bones, Neanderthal-like molars and crania similar to those of *Homo erectus*. This suggests to them that they are the product of miscegenation between all three.

That so much interbreeding went on between groups of people who had evolved separately for hundreds of thousands of years is intriguing. Besides the imprint of Denisovan genes in modern Asians, it is also known that modern Europeans bear traces of Neanderthals and that some modern Africans similarly bear the imprint of a “ghost” hominid for which no fossil evidence has yet been found. The ancestry of *Homo sapiens*, it seems, is less a family tree than a worldwide web. ■



古人类学

可能发现了新人种

也可能是发现了已知人种的首个头盖骨

两项新研究为人类进化的拼图又添加了几块。其中一项称人属可能有了新成员，另一项揭示了三个人种可能曾在中东杂交繁殖。

“龙人”（拉丁文属种名为*Homo longi*）不是一个全新发现，而是对一项既有发现的重新诠释。这枚头盖骨于1933年在哈尔滨被发掘出来，现保存在石家庄的河北地质大学。它的生活年代距今14.6万年，最初被认为是智人的一种古老形式。但供职于这所大学的倪喜军和季强不同意这种观点。他们在《创新》期刊上发表的报告称，这个头盖骨确实容得下一个与现代人尺寸相似的大脑，但这块化石太大，不可能是智人的，而且它有着比现代人大得多的臼齿和眼窝。两位研究者还发现，这个头盖骨太长太低，不可能是智人。它不像现代人的头盖骨那样饱满浑圆。

这对晚近非洲起源论的支持者来说是个好消息。该理论认为，如今在世的大多数非洲以外地区人类都是大约六万年前从非洲之角迁移到亚洲的一小批移民的后代，这意味着任何源自这个时间点之前的非洲以外人类化石很可能是另一个物种，是更早离开非洲的非智人的后代。

问题是，这块在哈尔滨发现的化石到底代表了哪个更早期的人种？倪喜军和季强将它与包括直立人、弗洛勒斯人、海德堡人和尼安德特人在内的已知古人类相比较，得出的结论是它不属于上述任何一种，因此必然是科学界的新发现，理应有它自己的专属名称。然而还存在另一种可能性——因为还有一种现已灭绝的人种，它的头盖骨尚未被发现过。丹尼索瓦人的存在是通过提取自一根指骨的DNA证实的，该DNA的痕迹——一种间杂交繁殖的遗传物质——仍然存在于现代人类中，尤其是在中国。由于哈尔滨化石的一颗臼齿与在俄罗斯丹尼索瓦洞穴（丹尼索瓦人因此得名）中发现的一枚臼齿的尺寸和牙根结构完全吻合，所以倪喜军和季强有可能实际上是在发

现了第一块丹尼索瓦人的头盖骨。

特拉维夫大学的伊斯雷尔·赫斯科维兹（Israel Hershkovitz）在《科学》上发表的另一项研究也指向了种间杂交问题。此外就连晚近非洲起源论的支持者也承认，有更早期的智人从非洲东北部“渗漏”到了黎凡特。赫斯科维兹和他的同事一直在研究古老程度相近的化石，这些化石距今12到14万年，从以色列内舍尔·拉姆拉（Nesher Ramla）遗址收集而来。他们发现，这些化石有类似智人的颌骨、类似尼安德特人的臼齿和类似直立人的头盖骨。这表明它们是三者混种杂交的产物。

各自独立进化了几十万年的人类种群间竟存在这么多混种繁殖，真是耐人寻味。除了现代亚洲人身上携带丹尼索瓦人的基因痕迹，人们也已知现代欧洲人带有尼安德特人的基因，一些现代非洲人身上也有“幽灵”原始人的印记——虽然至今尚未找到化石证据。看来，智人的起源与其说是一张族谱图，不如说更像全球互联网。 ■



iHealthy: September 2028

What if smartphones became personal health assistants?

The latest model of Apple's iconic iPhone is built around health-monitoring features. An imagined scenario from 2028

Editor's note: This year What If?, our annual collection of scenarios, considers the future of health. Each of these stories is fiction, but grounded in historical fact, current speculation and real science. They do not present a unified narrative but are set in different possible futures

IN 2019 TIM COOK, then boss of Apple, gave an interview in which he said, “if you zoom out into the future...and you ask the question, ‘What was Apple’s greatest contribution to mankind?’ it will be about health.” It sounded like standard-issue CEO boosterism at the time. But nearly a decade later, with this week’s announcement of the iPhone XX (pronounced “iPhone 20”), might his prediction be about to come true?

The latest iPhone is not so much a phone as a personal medical-data hub. Some of its features are upgrades of existing functions, such as tracking of sleep, menstruation and movement, and seamless access to health records and other personal documents. Physically, the device itself looks much the same—little has changed about these slim black rectangles over the past 15 years. Instead, it is the myriad accessories unveiled this week that define the iPhone XX. They could be game-changers for both personal and public health.

For many years the company’s approach to health tracking has focused on the Apple Watch. Even the original model, launched in 2015, could measure movement and heart rate. Since then, sensors have been added to measure heart activity, blood pressure, body temperature and levels of oxygen, sugar and alcohol in the blood. In addition, software tweaks have granted it the

ability to spot fevers, falls, irregular heart rhythms and early signs of dementia.

But not everyone wants (or can afford) to buy a fancy watch with all these features. Meanwhile, the market in consumer-health devices has boomed. With its new range of add-on accessories, Apple has both expanded and unbundled its health-tracking features. Unlike the clunky devices available at pharmacies, Apple's are elegant, require minimal setup, integrate seamlessly with Apple handsets and are aimed at people with specific concerns. A \$49 device for people with diabetes, for example, offers blood-sugar monitoring, while a \$69 device for those with respiratory conditions includes an oximeter and a spirometer.

Other sensors focus on monitoring of sleep, hypertension, coeliac disease and fertility. Several have yet to win regulatory approval. In the past three years alone, Apple has acquired a dozen firms that make home-diagnostics tools, not all of which can be built into a watch or a smartphone. So it makes sense to start selling some health devices and services separately.

Alongside these devices, Apple unveiled a range of extra subscription services. The diabetes package, for instance, includes a nifty app that guesses the glycaemic index and nutritional and calorific content of any food at which you point your iPhone's camera. After two weeks of learning about your diet, the app starts subtly suggesting substitutions and changes to your eating patterns. Each accessory comes with a year's subscription to the relevant service. And while some accessories are compatible with older iPhones, only the new model works with all of them.

All of this could be a boon for public health. The more people walk around with devices constantly monitoring their vital signs, the more likely it is that ailments can be caught early, and outbreaks of infectious diseases nipped in the bud.

Yet there are huge worries, too. The first is privacy. Apple touts the iPhone as a secure repository for personal data of all kinds, and emphasises its model of storing and processing data locally, on the user's device, rather than in the cloud. It also allows users to share data with medical specialists and participate in trials approved by its semi-autonomous data-ethics committee. But privacy activists say Apple's rules are opaque and confusing. The second concern is fairness. Most people cannot afford an iPhone. Apple's devices will therefore mostly benefit those who already have access to good diagnostics and doctors.

There is also cause for optimism, however. When Apple launched the iPhone in 2007, it seemed implausible that just over a decade later half the world's population would possess a smartphone. If the past two decades are any guide, other companies (such as Samsung and Google) will copy Apple's ideas—spurring an outburst of competition, innovation and mass adoption in health-monitoring and diagnostics, as previously happened in handsets. That, even more than what Apple does with its own devices, may be the true contribution it makes to humankind. ■



iHealthy: 2028年9月

如果智能手机化身个人健康助理会怎样？

苹果最新款iPhone围绕健康监测功能打造。**2028年的想象场景【《畅想未来》系列之二】**

编者按：今年，我们的年度想象情景合集《畅想未来》思索健康的未来。这些故事都是虚构的，但都基于历史事实、当前的推测和真实的科学。它们并不呈现同一种未来，而是发生在不同的可能的未来中

二〇一九年，时任苹果公司老板蒂姆·库克在接受采访时说，“想象你穿越到未来……你问，‘苹果对人类做出的最大贡献是什么？’那将和健康有关。”在那会儿，这听起来就是CEO们标配版的自卖自夸。但是，将近十年过去了，随着本周iPhone XX（读作“iPhone 20”）的发布，他的预测可能要成真了吗？

最新款iPhone与其说是一部手机，不如说是一个个人医疗数据中心。它的某些特色是对现有功能的升级，例如跟踪睡眠、月经和运动，以及可以顺畅访问健康记录和其他个人文件。从外形上看，手机本身跟以往型号差不多——这些薄薄的黑方块在过去15年里都无甚变化。相反，定义iPhone XX的是本周发布的大量配件。它们可能会彻底改造个人和公共健康。

多年来，这家公司的健康追踪模式一直围绕Apple Watch展开。2015年问世的第一代Apple Watch就已经可以测量运动和心率。自那以后，它添加了各种传感器来测量心脏活动、血压、体温、血氧、血糖以及血液中的酒精浓度。此外，软件上的微调让它能探测发烧、跌倒、心律不齐以及痴呆症的早期迹象。

但并不是每个人都想买（或买得起）一块带有所有这些功能的精致手表。与此同时，消费者健康设备市场快速发展。有了新系列的附加配件后，苹果扩展也拆分了它的健康追踪功能。与药店出售的笨重设备不同，苹果的这些配件外观优雅、安装步骤极简、与苹果手持设备无缝集成，并且瞄准

有特定健康关切的人。例如，为糖尿病患者提供的49美元的设备可以检测血糖水平，而为呼吸系统疾病患者提供的69美元的设备包含血氧仪和肺活量计。

其他传感器专注于监测睡眠、高血压、乳糜泻和生育能力。有些尚未获得监管部门批准。仅过去三年里苹果就收购了十几家打造居家诊断工具的公司，但它没法把所有这些工具都塞进一块手表或一部智能手机中。自然而然地，它开始分开销售一些健康设备和服务。

除了这些设备，苹果还推出了一系列额外的订阅服务。例如，糖尿病套餐包括了一个灵便的应用，当你把iPhone的摄像头对准任何食物时，它就会估算出升糖指数以及营养和热量。在了解你的饮食状况两周后，该应用开始温和地建议你替换掉一些食物和改变某些饮食习惯。每个配件都附带一年的相关服务订阅。而虽然某些配件与旧款iPhone兼容，但只有最新款iPhone兼容所有这些配件。

这一切可能是公共卫生的福音。携带着能持续监测生命体征的设备的人越多，就越可能及早发现疾病，并把传染病的爆发扼杀在萌芽状态。

但也有巨大的担忧。首先是隐私。苹果声称iPhone是各种个人数据的安全存储库，并强调它在用户设备本地而非云中存储和处理数据的模式。它也允许用户将自己的数据分享给医学专家并参与经苹果半自治的数据伦理委员会批准的试验。但隐私权活动人士指称苹果的规则不透明且混乱。第二个问题是公平性。大多数人买不起iPhone，所以能从苹果设备中获益的人将主要是那些本来就已经能求助于好医生和获得可靠诊断的人。

然而，也有理由抱持乐观。苹果于2007年推出iPhone时，人们难以想象区区十来年后，世界上一半的人口就都拥有了智能手机。如果以过去20年发生的事为指引，其他公司（如三星和谷歌）将会复制苹果的思路，从而带动健康监测和诊断领域里爆发一轮竞争、创新和大规模普及——就像过去在手机上发生的那样。这可能才是苹果对人类真正的贡献，比它用自己的设备所做的还要多。 ■



Know thyself

Why the African genome project is so useful

To map the ascent of man, begin at the beginning

RACISM MAY often run deep, but one of the most depressing things about it is how superficial it really is. In most parts of the world it is literally a matter of black and white. A person's skin colour, however, has little biological significance. It is merely a balance between defending the lower layers of the dermis from cancer-causing ultraviolet light (which favours dark skin) and promoting the beneficial role of ultraviolet in the synthesis of vitamin D (which favours light skin). The farther someone's ancestors lived from the equator, the paler their skin evolved to be.

Go back far enough, though, and everyone's ancestors lived in Africa, the continent where *Homo sapiens* originated. Most non-Africans alive today trace the bulk of their ancestry to Africans who burst forth on an unprepared world about 60,000 years ago. Indeed, the oldest representative of the species yet found in Britain retained the dark skin of his African forebears. Africa is where humanity grew up—and where the bulk of human genetic diversity is found to this day.

Only now is a serious effort beginning to explore Africa's genetic richness. Better late than never. The Three Million African Genomes (3MAG) project, a continent-wide endeavour, proposes to do for the place what has already been done for Europe, North America and parts of Asia—namely to catalogue and analyse the genetic diversity of those who live there. That will be scientifically fascinating, for it will help elucidate how *H. sapiens* evolved. But it will be medically important, too. It may even help erode that black-and-white excuse for racism.

Genetic diversity brings with it diversity of genetic disease. Cystic fibrosis—in any case rarer in Africa than in Europe—is often caused there by a different mutation from the one involved in the European version, and is thus missed by tests developed in the West. A mutation responsible in Ghana for 40% of inherited deafness is unknown in South Africa. And so on. It also brings a diversity of genetic response to disease. Some of the molecular details of the immune system, for example, vary with geography. Understanding that variation in Africa will improve understanding of immunity to infection, helping Africans and non-Africans alike.

More genetic information will also cast light on evolution. Early *H. sapiens* migrants from Africa encountered other species of human being on their travels. These were descendants of previous migrations out of Africa of archaic members of the genus. At least two of these other types of human, the Neanderthals and the Denisovans, interbred with the newcomers, and some of their genes are still found in modern Asians and Europeans, doing various jobs including protecting them from disease. Preliminary analysis suggests that those who remained behind in Africa similarly interbred with yet another species of human—but one of which no fossil record remains.

There is an irony in all this. Xenophobia has probably existed for as long as people have. But racist attitudes were reinforced in the 19th century by an enthusiasm for physical anthropology and eugenics. The former attempted to classify human beings on the basis of visible characteristics, such as skin colour, head shape and facial features, that are genetically inherited. If this had been a neutral analysis, it would have been unexceptional. But often it was not neutral. It not only classified, but ranked. White-skinned Europeans put themselves at the top—and black-skinned Africans at the bottom. Add eugenics to that mix and the result was toxic.

The 3MAG project will not, alone, overthrow the legacy of these misadventures and the prejudices they reinforced. The thinking that gave

rise to them is still too deeply ingrained in too many minds for it to do that by itself—even, probably, for it to come close. But to those whose minds are open, a group of 21st-century African scientists revealing that the true, glorious genetic diversity of human beings lies in their own continent more abundantly than in any other will be a superb rebuttal to the doctrines of those misguided Victorian European gentlemen. ■



【首文】认识你自己

为何非洲基因组计划如此有用

描绘人类的前进之路，要追本溯源

种族主义或许经常是根深蒂固的，但它最令人沮丧的其中一点是它实际上极其“表面”。在世界上大部分地区，它真的就是个黑色与白色的问题。然而，一个人的肤色并没有什么重大的生物学意义。它只是在两种功能之间寻求平衡而已——保护真皮下层免受致癌紫外线的伤害（促成深色皮肤），以及促进紫外线在合成维生素D方面发挥有益的作用（促成浅色皮肤）。一个人的祖先住得离赤道越远，肤色就进化得越白皙。

不过，如果追溯得足够久远，每个人的祖先都曾居住在智人的起源地非洲。今天大多数非洲以外人群的血统大部分都源自非洲人，后者在大约六万年前突然出现在一个尚未发展完备的世界上。实际上，英国迄今为止发现的最古老人种的代表仍保留了其非洲祖先的黑皮肤。非洲是人类成长的地方，也是目前为止发现了大部分人类基因多样性的地方。

直到现在人们才开始认真探索非洲在基因上的丰富性。迟做总比不做好。三百万非洲基因组计划（Three Million African Genomes，简称3MAG）覆盖整个非洲大陆，它提议在非洲开展已在欧洲、北美及亚洲部分地区完成的工作——编目和分析非洲居民的基因多样性。从科学的角度来看这项工作趣味无穷，因为它将有助于阐释智人的进化过程。但它在医学上也很重要。它甚至可能有助逐渐消除种族主义拿黑白肤色说事的借口。

基因多样性带来了遗传疾病的多样性。囊性纤维化在非洲总是比在欧洲更罕见，它在非洲通常是由与欧洲变体不同的突变引起，因此西方研发的检测手段测不出来。一种基因突变造成了加纳40%的遗传性耳聋，在南非却闻所未闻。还有很多例子。基因多种多样，对疾病的遗传反应也就多种多样。例如，免疫系统的某些分子细节会因地理环境而异。了解非洲的这种变异将增进对感染免疫力的认识，对非洲人和非洲以外的人都有帮助。

更多的遗传信息还将帮助人们了解进化。早期走出非洲的智人移民在旅途中遇到了其他人种。这些人与非洲智人同属，是更早之前就迁出非洲的古代人种的后裔。在这些人种中，至少有尼安德特人和丹尼索瓦人这两种人与新来者杂交繁殖，他们的一些基因仍存在于现代亚洲人和欧洲人身上，发挥着抵御疾病侵害等多种作用。初步分析表明，留在非洲的人种同样也与另一人种杂交，但后者没有留下化石记录。

这一切颇具讽刺意味。仇外心理可能自人类诞生之日起就存在。但19世纪对体质人类学和优生学的热衷强化了种族主义态度。前者试图根据能通过基因遗传的可见特征为人类分类，如肤色、头形和面部特征。如果这是一种中立的分析，那就没什么大不了。但它往往不是中立的。不仅要分类，还要分等级。白皮肤的欧洲人把自己排在最高级别，让黑皮肤的非洲人垫底。再加上优生学，结果就贻害无穷了。

单凭3MAG计划无法推翻这些灾难性研究的遗留问题和因它们而加深的偏见。产生这些问题的思想在太多人的头脑中仍然根深蒂固，所以单靠这项计划本身无法根除这些——甚至很可能连边都够不到。但对于思想开明的人而言，由一群21世纪的非洲科学家来揭示出人类真正的、辉煌的基因多样性丰富存在于他们自己的大陆上——多过其他任何大陆，将是那些维多利亚时代的欧洲绅士们误入歧途的学说的绝佳反驳。 ■



Burning clean

Japan Inc wants to become a hydrogen superpower

To succeed, it must focus on unglamorous industrial uses of the gas

IN 2016 TOKYO'S then governor, Masuzoe Yoichi, predicted that the Olympics the Japanese capital was to host in 2020 would "leave a hydrogen society as its legacy", just as the 1964 Tokyo games left the Shinkansen bullet trains. Later that year Mr Masuzoe resigned over an expenses scandal. But as Tokyo prepares for the pandemic-delayed opening ceremony on July 23rd his dream lives on.

For the first time, the Olympic torch burned hydrogen (never mind that the flame is colourless). Officials are ferried around in some 500 cars and 100 buses made by Toyota and running on fuel cells, portable power plants that consume hydrogen and emit only water vapour. The Kawasaki King Skyfront Tokyu Rei hotel gets energy from hydrogen sourced from waste plastics.

All nifty, to be sure. But also as immaterial as the lightest gas. Fuel-cell cars are miles from the mass market, despite 20 years of efforts by Toyota and other Japanese firms. The lack of refuelling infrastructure, difficulty of storing the stuff in small vehicles and fuel cells' persistently high cost all argue against a big role for hydrogen in decarbonising transport.

And yet Japan does have a shot at hydrogen-superpowerdom. Behind the scenes its firms are pursuing unglamorous applications in heavy industry and other hard-to-decarbonise sectors. The government is egging them on.

In June, for example, Japan's Ministry of Economy, Trade and Industry (METI) laid out a plan to slash carbon emissions from steelmaking by shifting to "direct-reduction iron" (DRI). This process both uses considerably less energy and can replace some climate-unfriendly

ingredients of the requisite industrial chemistry (such as carbon monoxide). METI is lavishing billions of dollars on the industry to commercialise the use of hydrogen in blast furnaces by 2030. Mitsubishi Heavy Industries, a conglomerate, is building a zero-carbon steel mill in Austria. Nippon Steel wants its DRI technology to be in commercial use by 2030.

Japanese firms are getting into the production of the feedstock, too. The easiest way to make hydrogen is to strip it from methane, each molecule of which contains four atoms of hydrogen and one of carbon. That process, known as “reforming”, is cheap but dirty, since its byproduct is planet-heating carbon. Hydrogen can be made cleanly from ammonia or water but this is more expensive. To bring costs down, ENEOS, Japan’s biggest oil refiner, recently unveiled plans to build a giant factory by 2030. It will use an electrolytic process to slash the cost of making clean H₂ from H₂O by two-thirds.

In July Marubeni, a Japanese industrial conglomerate, struck a deal with Providence Asset Group, an Australian investment firm, to develop 30 solar farms down under that would combine renewable energy with battery and hydrogen storage. They aim eventually to export green hydrogen to Japan. Kawasaki Heavy Industries recently won regulatory approval to build the world’s largest liquefied-hydrogen cargo ship. Not quite as eye-catching as the Shinkansen. But, just maybe, even more consequential. ■



清洁燃料

日本有志成为氢能超级大国

若想成功，它必须主攻氢气朴素无华的工业用途

二〇一六年，时任东京都知事舛添要一预言，2020年东京奥运会将“留给世人一个氢能社会”，就像1964年东京奥运会留下了新干线子弹列车那样。同年晚些时候，舛添要一因挪用政治资金的丑闻辞职。但因疫情推迟到7月23日在东京开幕的奥运会让他的氢能梦得以延续。

这还是奥运圣火第一次用氢作燃料（别介意它的火焰是无色的）。丰田生产的500辆小汽车和100辆大巴负责接送官员，这些车使用燃料电池——一种消耗氢气且只排放水蒸气的便携发电站。川崎国王天际东急REI酒店利用从废塑料中获得的氢气来供能。

这些的确都很巧妙。但却也像氢气这种最轻的气体一样“无足轻重”。尽管丰田等日本企业努力了20年，但燃料电池汽车离大众市场仍然很远。燃料补给基础设施匮乏，小型车辆难以储存氢燃料，再加上燃料电池成本持续高企，都表明氢难以在交通脱碳中发挥重大作用。

不过，日本确实有望成为氢能超级大国。日本企业正默默地在重工业和其他难以实现脱碳的行业部署不起眼的氢能应用。日本政府也在鼓励这种做法。

例如在6月，日本经济产业省制定了一项计划，通过改用“直接还原铁”（direct-reduction iron，以下简称DRI）来大幅削减炼钢的碳排放。这种工艺既大大减少了能耗，又能替代一部分对气候不友好的必需化工原料，如一氧化碳。经产省正向该行业大举注资数十亿美元，以求在2030年前实现氢能高炉的商业化。产业集团三菱重工正在奥地利建造一家零碳炼钢厂。日本制铁（Nippon Steel）希望其DRI技术在2030年前投入商用。

日本企业也开始投入到氢气生产中。最简单的制氢方法就是分解甲烷，每

个甲烷分子由四个氢原子和一个碳原子构成。这一工艺流程叫作“重整”，虽然便宜，但不清洁，因为其副产品是导致全球变暖的碳。还可以从氨或水中获得氢，但成本要高得多。为了降低成本，日本最大的炼油企业引能仕（ENEOS）最近公布了在2030年前建造一座巨型工厂的计划。它将使用一种电解工艺，把从水中制造清洁氢气的成本削减三分之二。

7月，日本产业集团丸红（Marubeni）与澳大利亚投资公司普罗维登斯资产集团（Providence Asset Group）达成协议，在澳洲建立30座太阳能发电厂，将可再生能源与电池和氢存储结合起来。它们最终的目标是向日本出口绿色氢。川崎重工（Kawasaki Heavy Industries）近期获监管批准建造世界上最大的液氢运输船。它虽没有新干线那样引人注目，但影响也许会更深远。 ■



What's the worst that could happen

Three degrees of global warming is quite plausible and truly disastrous

Rapid emission cuts can reduce the risks but not eliminate them

BY THE STANDARDS of the 21st century as a whole, 2021 will almost certainly go down as a comparatively cool year. By the standards of the rest of human history its weather looks disconcertingly like hell.

On July 20th, as Belgium, Germany, the Netherlands and Switzerland were still coming to terms with the fact that a stationary system of storms had turned entire towns into rivers and shredded the surrounding countryside, hundreds of thousands of people in the Chinese province of Henan were evacuated in the face of floods of their own; the city of Zhengzhou saw a year's worth of rain in three days.

Also on July 20th Cizre, in Turkey, saw a temperature of 49.1°C (120°F), the highest ever recorded in the country. There has been barely any respite from searingly hot conditions along the northern Pacific coast of North America since the region was hit by an unprecedented heatwave two weeks ago, and already the region is bracing for another. Other places at high latitudes have been seeing similar—if less destructive—anomalies. In the first half of the month Finland experienced its longest heatwave for at least 60 years, with temperatures rising to the low 30°C in Lapland. On July 14th the country tossed and turned through its hottest night ever: two weather stations recorded temperatures no lower than 24.2°C.

On July 11th, a National Weather Service thermometer at Furnace Creek in Death Valley recorded a temperature of 54°C. If confirmed by the World Meteorological Organisation (WMO), that would tie a reading taken at the same location last year for the hottest formally recognised daytime

temperature ever. On July 19th more than 40% of the Greenland ice cap had meltwater on it. The amount of sea-ice cover in the Arctic was as low as it was at the same point in 2012, which saw the lowest summer sea ice ever recorded.

This is what Earth looks like when, according to the latest data from the WMO, it is 1.1-1.3°C warmer than it was before the steam engine was invented. The Paris agreement of 2015 created a compact to limit global warming to “well below 2°C” above the pre-industrial, ideally seeing it rise no more than 1.5°C.

That more stringent target was demanded by, among others, small-island states which see the amount of sea-level rise inherent in two degrees of warming as an existential threat. A huge subsequent report by the Intergovernmental Panel on Climate Change found that the difference between the two targets, even if it was just 10cm of additional sea-level rise by 2100, would wipe away the livelihoods of millions. Compared with 1.5°C of warming, 2°C would also expose an additional 420m people to record heat. And it would devastate Arctic ice cover.

Those Paris targets were, and remain, both prudent and incredibly ambitious. Right after the conference Climate Action Tracker (CAT), an NGO, set itself the task of totting up all the emission-reduction goals and other policies, like fuel-efficiency standards for cars and trucks and renewable-energy targets, that the various nations had made. To gauge the aggregate impact of those measures, CAT calculated the atmospheric concentrations of carbon dioxide they looked likely to produce and then used the results of climate models to see what those concentrations might mean in terms of warming. Their results showed the world was on track to be 2.7°C hotter than the pre-industrial baseline by 2100.

The people who negotiated the Paris agreement were fully aware of this

contradiction. They expected, or hoped, that countries would make new and more ambitious pledges as technology progressed, as confidence that they were all really on board built up and as international co-ordination improved. There is evidence that this is happening. Revised pledges formally submitted to the UN over the past 12 months in the run-up to the COP26 conference to be held in November have knocked CAT's estimate down a bit. If all government promises and targets are met, warming could be kept down to 2.4°C . Including targets that have been publicly announced but not yet formally entered into the Paris agreement's ledgers, such as America's net-zero-by-2050 pledge and China's promise to be carbon-neutral by 2060, brings the number down to a tantalising 2.0°C .

That sounds promising. But the figure comes with a very big caveat and with large uncertainties.

The caveat is that this estimate includes policies announced but not enacted. A world which follows the policies that are actually in place right now would end up at 2.9°C , according to CAT (the UN Environment Programme, which tracks the gap between actual emissions and those that would deliver Paris, provides a somewhat higher estimate). Almost everyone expects or hopes that policies will tighten up at least somewhat. But any reasonable assessment of the future has to look at what may happen if they do not.

As to the uncertainties, they are many and various. Translating political statements into gigatonnes of carbon dioxide is hardly an exact science. Just as no one knows whether countries will choose to stand by the policies they have mooted, nor can they be sure that those policies will deliver the reductions claimed. And although there is no doubt that greenhouse gases influence climate and are driving the rising temperatures seen around the world, difficulties in untangling various feedback loops and complex countervailing effects mean that there remains considerable uncertainty

about how much further climate change a given amount of greenhouse gas brings about.

This uncertainty gives the probabilistic estimates made by CAT, and other groups, large error bars. The calculations of peak warming if existing targets are met and promises kept give a 68% chance of a peak temperature between 1.9°C and 3.0°C (see chart 1). In the America-at-net-zero-by-2050 scenario the 68% probability range runs from 1.6°C to 2.6°C. This fits with modelling from elsewhere. According to calculations by Joeri Rogelj and his colleagues at Imperial College London, even emissions scenarios which provide a two-in-three chance of staying below 2.0°C also include a small chance of 2.5-3.0°C of warming: less than one-in-ten, but possibly more than one-in-20.

A 3°C world is thus both a pretty likely outcome if nothing more gets done and the worst that might still happen even if things go very well indeed. That makes it worth looking at in some detail, and the result is alarming. Those modelling climate impacts have long argued that they do not increase linearly. The further you go from the pre-industrial, the steeper the rate at which damages climb. And as what was rare becomes common the never-before-seen comes knocking (see chart 2). Judging by the results of specific studies, the differences between 2°C and 3°C are, in most respects, far starker than those between 1.5°C and 2°C.

Just as today's world is not uniformly 1.2°C warmer than the pre-industrial, a 3°C world is not uniformly 1.8°C warmer than today (see chart 3). Some regions, chiefly the oceans and parts of South America, will warm less; others will get much hotter. The Arctic, including northern Canada, Siberia and Scandinavia, will receive the brunt of the warming. Some more populated regions are also in for above-average temperatures. According to

one study mean temperatures in Russia, China and India would increase by 4-5°C, 3.5-4.5°C and 3-5°C, respectively.

Warmer regional temperatures will bring more frequent and more extreme heatwaves, including to higher-latitude regions in North America, Europe and Asia that have little or no experience of such things. A comparison of how 1.5°C, 2°C and 3°C of global warming would affect European extremes published in 2018 found that while “tropical” nights where temperatures remain above 20°C from dusk till dawn are currently mostly the preserve of the Mediterranean shoreline, the area affected stretched north as warming progressed until, under a 3°C regime, they became a regular occurrence in the Baltics. It is the lack of enough cooling at night which, by and large, drives deaths during heatwaves.

Striking though such a change would be, hot nights in previously cool wealthy countries can be adapted to. Green roofs, water sprinklers and improved air-conditioning can all help. People can switch to more indoor living during the summer months. Construction workers, farm labourers and other people whose jobs are physical and primarily done outdoors, though, would suffer disproportionately, as would those who could not easily afford the additional cost of installing and running air-conditioning.

This is as nothing, though, compared with what increases in heat can do in the humid tropics. Human bodies cool off through the evaporation of sweat, and under humid conditions evaporation is harder. The “wet-bulb” temperature is a measure that reflects this combined effect of heat and moisture on the difficulty of keeping cool.

Except at 100% relative humidity, the wet-bulb temperature is always lower than the temperature proper; dry air means that 54°C in Death Valley equates to a wet-bulb temperature in the low- to mid-20s. Wet-bulb

temperatures in the 30s are rare. And that is good. Once the wet-bulb temperature reaches 35°C it is barely possible to cool down, especially if exercising. Above that people start to cook.

Wet-bulb temperatures approaching or exceeding 35°C have been recorded, very occasionally, near the India-Pakistan border and around the Persian Gulf and the Gulf of Mexico. But not all such instances are reported. A re-analysis of weather-station data published in 2020 showed that such extreme humid heat actually occurs more often than is recorded, mostly in very scarcely populated parts of the tropics. The study also found that its incidence had doubled since 1979.

Richard Betts, a climatologist in Britain's Met Office who has led several surveys of the impacts of high-end global warming, says that beyond 2°C small but densely populated regions of the Indian subcontinent start to be at risk of lethal and near-lethal wet-bulb temperatures. Beyond 2.5°C, he says, places in "pretty much all of the tropics start to see these levels of extreme heat stress for many days, weeks or even a few months per year."

In less humid places, heat depletes water supplies. A modelling analysis of water scarcity at 1.5°C, 2°C and 3°C found that two-thirds of humanity will experience progressively drier conditions as the climate warms. At 3°C, periods of dryness currently treated as exceptional 1-in-100-year events are projected to happen every two to five years in most of Africa, Australia, southern Europe, southern and central United States, Central America, the Caribbean and parts of South America.

The occasional drought can be dealt with by recourse to reservoirs or groundwater. When droughts become prolonged and/or frequent such alternatives dry up. As a result, some modelling suggests that at 3°C more than a quarter of the world's population would be exposed to extreme drought conditions for at least one month a year. California's megadrought,

which has affected the water supply for consumption, sanitation and irrigation as well as fuelling record-breaking fires, gives a glimpse into what this could look like for large swathes of the planet, almost all of which face far higher hurdles to adaptation than one of America's richest states (albeit one with a high number of poor people).

This does not necessarily mean that every crop is at risk of heatwaves, or that the world will face a structural food shortage. Some arable land will be blessed with a useful increase in rain, and the fields farmed by Goldilocks may be spared a concomitant increase in flood risk. Temperate climates will benefit from longer growing seasons, and some crops will also benefit from higher carbon-dioxide levels, since it is the raw material of photosynthesis. Although the Intergovernmental Panel on Climate Change (IPCC) estimates that cereal prices might be 29% higher under 3°C of warming, putting 183m people at additional risk of hunger, it also sees it as possible that they might hardly shift at all.

But whatever the averages, there will be a much higher risk of crises which panicky reactions make worse. In the summer of 2010 temperature records which had stood since the 1880s were broken in Russia, the world's third-largest wheat producer; temperatures stayed up around 40°C for weeks. Wheat yields fell by about one-third: Russia banned exports in order to maintain its own supply. That led to price spikes on global food markets which have since been linked to civil unrest in a number of low-income countries.

More measured policy responses would have helped. But the opportunities for panics over food shocks will undoubtedly increase. A study co-sponsored by Britain's Foreign, Commonwealth and Development Office estimated that the likelihood of an extreme heatwave capable of wiping out the southern Chinese rice crop in a given year was 1 in 100 under 1°C of warming, but one in ten under 2-3°C of warming.

What sea level would look like at 3°C depends on how quickly things heat up. Because ice takes time to melt and warmth gets into the ocean depths only slowly, sea level takes its time responding to the surface temperature. This means the seas will be lower at the point when 3°C is reached if it is reached quickly than if temperatures rise more slowly.

What matters more than the sea level at the time when the world hits 3°C is the sea level to which a 3°C world would be committed in the long run. The West Antarctic Ice Sheet, which until a decade ago was considered pretty stable, is crumbling at the edges. There is growing evidence that at around 2°C of warming it will begin to break down completely. “If that point is passed, the evidence suggests that the rate of ice loss from West Antarctica will increase dramatically,” says Nerilie Abram of the Australian National University.

The full effects of such a collapse—perhaps 1.6 metres’ worth of sea-level rise—would not be seen for another century or more. But the rate of change would increase much sooner than that. “On our current climate trajectory,” says Dr Abram, “we can expect a very rapid jump in how quickly Antarctica loses ice in just a few decades time.” In a 3°C world similar concerns apply to Greenland, too.

Cities, and indeed low-lying countries, which might hold their own against the 30-90 centimetre sea-level rise expected by 2100 in a 2°C world, might well have to throw in the towel faced by four or five times as much. As with wet-bulb temperatures, there are limits to the extent to which adaptation can offer hope once the world gets to 3°C. And even when lives can be saved, places cannot. Coastal cities that hundreds of millions now call home would be changed utterly if they persist at all. Nor could the indigenous cultures of the Arctic or the rainforest survive in anything like their current form. Much of the Earth-as-was would be forgotten, as well as lost.

The limits to adaptation apply to nature, too. Animal and plant species adapt to warming climates by shifting to cooler ones where possible. Already fish are on the move, some species edging away from tropical waters to temperate, others from the temperate to the chilly. Land animals unable to trek to higher latitudes can, if they live in hilly places, find respite at nearby higher altitudes instead. But these strategies only work up to a point: mountains have peaks, and the Earth has poles.

And it only works for species and ecosystems that are able to move faster than the climate warms. Coral reefs do not have that facility. They are predicted to disappear completely in a 3°C world (their boiled, bleached fate is worsened by the fact that higher carbon-dioxide levels make seawater too acidic for them). Some such failures to adapt make the world hotter still. The Amazon rainforest, already weakened by logging and burning, would be very unlikely to survive in such a world. In its passing it would release further gigatonnes of carbon into the atmosphere.

The Amazon will not disappear overnight. Even if emissions go largely unchecked from now on, a 3°C future looms only in the second half of the century, not the first. But the longer it takes to cut emissions, the more avoiding 3°C becomes something only achievable through the application of untested and in some cases troubling technologies designed either to suck carbon from the atmosphere in vast amounts or to throw some of the sun's warming rays back into space. Humanity would find itself wedged between a geoengineered rock and a very hot place. ■

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最糟会是什么样

全球变暖三度很有可能，那是真的灾难

快速减排可以降低但不能消除风险【深度】

若是放眼整个21世纪，2021年几乎肯定会变成相对凉爽的一年。若是纵观其余的人类历史，这一年的天气就如同地狱般令人难安。

7月20日，当比利时、德国、荷兰和瑞士仍在适应持续多日的暴雨已把城镇变成了汪洋、让乡村千疮百孔的现实，中国河南省因洪水疏散了几十万人，郑州市三天的降雨量相当于一年的降雨总量。

同样是在7月20日，土耳其吉滋雷（Cizre）的气温达到了49.1°C，为该国有记录以来的最高温。自两周前一股前所未有的热浪袭击北美北部的太平洋沿岸以来，这个地区几乎一直陷于高温之中，并且又有一股热浪来袭。其他高纬度地区也出现了类似的（不过破坏性相对较小的）异常天气。7月上半月，芬兰经受了至少60年来为时最长的热浪，拉普兰（Lapland）的气温已经冲破30°C。芬兰在7月14日度过了有史以来最热的一晚，两个气象站记录的温度不低于24.2°C，整个国家焦灼难眠。

7月11日，美国国家气象局在加州死亡谷的熔炉溪（Furnace Creek）的监测站测得54°C的高温。如果得到世界气象组织（WMO）确认，这将是继去年之后在该地点再次测得地球有正式记录的最高日间气温。7月19日，超过40%的格陵兰冰盖上有融水。北极的海冰覆盖面积与录得夏季历史极低值的2012年同期一样低。

这就是地球的现状，根据WMO的最新数据，现在的温度比蒸汽机问世之前高了1.1°C至1.3°C。2015年的《巴黎协定》制定了一项契约，要将全球变暖幅度控制在比工业化前升温“显著低于2°C”，最好不超过1.5°C。

更严格的1.5°C目标是小岛国等成员国强烈要求的，这些国家认为变暖两度所导致的海平面上升将威胁它们的生存。政府间气候变化专门委员会

(IPCC) 随后的一份长篇评估报告认为，即使两个目标之间的差异是海平面仅多上升10厘米，也可能会让千百万人丢了生计。与升温 1.5°C 相比，升温 2°C 还会让另外4.2亿人面临破纪录的高温，此外也会彻底破坏北极冰盖。

巴黎峰会设定的这些目标既审慎，又极富雄心——到今天看依旧如此。峰会落幕后，非政府组织气候行动追踪者（Climate Action Tracker，以下简称CAT）给自己设定了一项任务，就是汇总各国制订的减排目标和其他政策，如汽车和卡车燃油效率标准和可再生能源目标等。为了衡量这些措施的整体影响，CAT计算了它们可能导致的大气二氧化碳浓度增长，然后用气候模型的结果来了解这样的浓度增长对气候变暖的可能影响。他们的研究结果表明，照此趋势，到2100年全球温度将比工业化前水平高出 2.7°C 。

商定《巴黎协定》的人们很清楚这种目标和措施上的差距。他们预期，或者说是希望，随着科技不断进步、对彼此切实付诸努力的信心增强以及国际协作改善，各国将做出新的更具野心的承诺。有证据表明这正在发生。

《联合国气候变化框架公约》第26次缔约方大会（COP26）将在11月举行，过去12个月里各国向联合国正式提交了修改过的承诺，让CAT的估计结果略有下降。如果所有政府的承诺和目标都得以实现，升温幅度可能会降到 2.4°C 。算上美国到2050年实现净零排放和中国到2060年实现碳中和等已公布但尚未正式列入《巴黎协定》的承诺，CAT的估计数字降到了颇具吸引力的 2.0°C 。

这听起来前景光明。但是这个数字带有一个重大的附加说明，具有很大的不确定性。

这个附加说明就是这项估计把已公布但尚未成文的政策计算在内。根据CAT的计算，按照目前已经实际实施的政策，全球将升温 2.9°C （联合国环境规划署得出的估计值还要高，该署跟踪了实际排放量与达到《巴黎协定》目标所需排放量之间的差距）。几乎各方都预期或希望政策至少还会收紧一些。但任何对未来的合理评估都必须考虑如果不收紧会如何。

至于不确定性，那就多种多样了。把政治声明转化为数以十亿吨计的二氧化碳减排并非严密的科学。没人知道各国是否会选择切实执行它们提出的政策，也不确定这些政策能否实现所声称的减排目标。尽管毫无疑问温室气体会影响气候，而且正在推高世界各地的气温，但切断各种反馈循环、消除复杂的抵消效应十分困难，这意味着一定数量的温室气体到底会加剧多少气候变化仍有相当大的不确定性。

这种不确定性让CAT和其他研究团体的概率性估算有很大的误差范围。如果能够达到现有目标并履行承诺，得出的升温峰值有68%的置信度在 1.9°C 至 3.0°C 之间（图表1）。如果2050年美国能实现净零排放，置信度为68%的峰值升温范围是 1.6°C 到 2.6°C 。这与其他地方的建模分析结果相吻合。根据伦敦帝国理工学院的约埃里·罗格利（Joeri Rogelj）及其同事的计算，即使在升温幅度保持在 2.0°C 以下的可能性为三分之二的排放情景中，仍有较小概率出现 2.5 至 3.0°C 的升温，这个概率不到十分之一，但可能大于二十分之一。

因此，世界升温 3°C ，既是无所作为的情况下一个相当可能的结果，也是即使各种努力都进展非常顺利的情况下仍可能出现的最坏情况。这值得仔细研究，而且结果令人震惊。模拟气候影响的研究人员长期以来一直认为那些影响不是线性增加的。距离前工业化时代越远，升温造成破坏增长的曲线就越陡峭。曾经罕见的天气现象现在成了常态，前所未见的现象也开始出现（图表2）。从具体研究的结果来看，升温 2°C 和升温 3°C 之间的差异在大多数方面都远大于升温 1.5°C 和 2°C 之间的差异。

正如今天的世界并不是均匀一致地比前工业化时期升温了 1.2°C ，升温 3°C 后的地球也不是均匀一致地比今天高出 1.8°C （见图表3）。一些地区的升温幅度会较小——主要是海洋和南美洲部分地区；其他地区变热的幅度会大得多。包括加拿大北部、西伯利亚和斯堪的纳维亚半岛在内的北极地区将首当其冲地受到变暖的影响。一些人口较稠密地区的气温也会高于平均水平。一项研究显示，俄罗斯、中国和印度的平均气温将分别上升4至

5°C、3.5至4.5°C和3至5°C。

区域气温升高将带来更频繁和更极端的热浪，包括在北美、欧洲和亚洲的高纬度地区，这些地方过去很少或根本没有经历过这类天气事件。2018年发表的一项研究比较了全球变暖1.5°C、2°C和3°C对欧洲极端天气事件的影响，发现虽然“热带之夜”（即从黄昏到黎明温度保持在20°C以上）目前主要还只出现在地中海沿岸，但随着全球继续变暖，覆盖区域会向北推进，到升温3°C时这样的夜晚在波罗的海地区将成为常态。总的来说，正是夜间降温不够导致人们在热浪期间不幸死亡。

尽管这样的变化很惊人，但过去凉爽的富裕国家能够调整适应炎热的夜晚。绿色屋顶、喷淋器和改进的空调都能帮助降温。在夏季，人们可以更长时间地待在室内。然而，建筑工人、农场工人和其他主要从事户外体力劳动的人受到的影响要大很多，那些不能轻松负担安装和使用空调的额外花销的人也一样。

然而，若与温度升高在潮湿的热带地区造成的影响相比，这还微不足道。人体通过蒸发汗液降温，而在潮湿的环境下汗液更难蒸发。“湿球”温度这一指标体现了高温和高湿相结合对保持凉爽的难度的影响。

除非相对湿度达到100%，否则湿球温度始终低于大气温度。空气干燥意味着死亡谷54°C的气温相当于20到25°C左右的湿球温度。30°C以上的湿球温度很少见。这是好事。湿球温度一旦达到35°C，人体就几乎不可能再调节降温，尤其是在做活动时。再往上升，人体就开始被蒸烤。

在印巴边界附近以及波斯湾和墨西哥湾周边偶尔录得过接近或超过35°C的湿球温度。但并非所有这样的情况都被记录下来。在2020年发布的对气象站数据的重新分析显示，这种极端湿热天气实际上比记录的更频繁，主要发生在人口非常稀少的热带地区。该研究还发现，这种天气出现的频率自1979年以来翻了一番。

英国气象局（Met Office）的气候学家理查德·贝茨（Richard Betts）领导

了多项关于全球大幅变暖影响的调查。他表示，升温超过 2°C 时，印度次大陆上那些面积小但人口密集的地区就将面临致命和接近致命的湿球温度。升温如果超过 2.5°C ，他说，“几乎所有热带地区都将开始出现这种水平的极端高温威胁，每年持续数天、数周甚至数月。”

在湿度较低的地方，高温会令供水枯竭。对升温 1.5°C 、 2°C 和 3°C 情况下水资源短缺情况的建模分析发现，随着气候变暖，地球上三分之二的人口将会面临越来越干旱的生存环境。升温 3°C 时，预计目前被视为百年一遇的罕见旱情在非洲、澳大利亚、南欧、美国中南部、中美洲、加勒比海地区及南美洲部分地区每二到五年就会出现一次。

偶尔的干旱可以通过利用水库或地下水来解决。当旱情变得长时间持续或频繁出现，乃至既持久又频繁时，此类替代水资源就会枯竭。因此，一些建模分析表明，升温 3°C 时，世界上四分之一以上的人口每年将要经历至少一个月的极端干旱天气。加州的特大旱情影响了饮用、卫生和灌溉用水的供应，并助长了破纪录的火灾，让人得以一窥见地球上的广大地区以后可能遭遇的情形，而它们和这个美国最富有的州之一（尽管也有很多穷人）相比，几乎都会面临大得多的适应上的障碍。

这并不一定意味着每种作物都可能受热浪侵害，或者世界将面临结构性粮食短缺。一些可耕土地将因雨水增加而受益，而处于“金发女孩经济期”的地区的耕地可能不会遭受升温导致的洪灾。温带的生长季节将变得更长，二氧化碳浓度升高对一些作物也有好处，因为二氧化碳是光合作用的原材料。尽管根据IPCC的估计，在升温 3°C 的情况下，谷物价格可能会上涨 29% ， 1.83 亿人将因此更有可能挨饿，但IPCC也认为谷物价格也可能根本不会发生变化。

但无论平均升温多少，发生危机的可能性都会大大提升，恐慌的反应又会让情况更糟。2010年夏天，世界第三大小麦生产国俄罗斯的气温创下19世纪80年代有记录以来的最高纪录。在几周时间里气温一直保持在 40°C 上下。小麦减产了约三分之一，俄罗斯禁止小麦出口以保证国内供应。这导致全球食品市场价格飙升，此后一些低收入国家发生内乱也与此有关。

更慎重的政策反应本会有所帮助。但对发生粮食危机的恐慌势必会增加。由英国外交、联邦和发展事务部（Foreign, Commonwealth and Development Office）参与资助的一项研究估计，在升温 1°C 的情况下，在某个年份发生极端热浪让中国南方水稻颗粒无收的可能性为百分之一，但如果是升温 2 至 3°C ，可能性则为十分之一。

升温 3°C 时海平面会升高多少，取决于升温的速度。因为冰川融化需要时间，热量进入海洋深处的速度也很慢，海平面对海洋表面温度的变化做出反应需要时间。这意味着，相比缓慢升温 3°C ，海平面在迅速升温 3°C 时升幅会更小。

比全球升温 3°C 时的海平面高度更重要的是升温 3°C 后海平面的长远变化。直到十年前，人们还认为西南极冰盖（West Antarctic Ice Sheet）相当稳定，如今它的边缘部分正在崩塌。越来越多的证据表明，升温 2°C 左右时，它将开始完全解体。“有证据表明，到那个时候，西南极冰川消融的速度将大大加快。”澳大利亚国立大学（Australian National University）的尼莉莉·艾布拉姆（Nerilie Abram）说。

这些冰川融化最终可能会让海平面上升 1.6 米，不过这要再过一个世纪或更长时间才能看到。但是，变化加速的发生会早得多。“按照目前的气候变化趋势，”艾布拉姆说，“我们可以预计在短短几十年内，南极洲冰川流失的速度会迅速加快。”如果升温达到 3°C ，格陵兰岛也会出现类似令人担忧的情况。

如果升温 2°C ，预计到 2100 年海平面将上升 30 至 90 厘米，城市——当然还有低洼国家——可能还抵御得了，但如果海平面上升幅度是这一水平的四五倍之多时，它们就很可能不得不认输了。与湿球温度过高会让人体无法散热一样，一旦世界升温 3°C ，适应气候变化所能带来的希望也是有限的。而即使可以挽救生命，也可能无法挽救家园。如今作为数亿人家园的沿海城市就算不被淹没，也将会彻底改头换面。北极或热带雨林的土著文化也可能完全无法按目前的样子生存下去。地球旧有的面貌大部分都将不复存在并被遗忘。

自然对气候变化的适应同样有局限。动植物物种会通过尽可能迁移到更凉爽的环境中来适应气候变暖。鱼类已经在行动了，一些鱼类在逐渐从热带水域转移到温带，另一些则从温带转移到寒冷水域。无法跋涉到高纬度地区的陆生动物如果生活在丘陵地带，可以在附近较高海拔地区暂时找到栖身之所。但这些策略的作用有限——毕竟山峰再高终有顶，两极再远终有尽。

而且这种策略只适用于适应速度比气候变暖速度更快的物种和生态系统。珊瑚礁就没有这种能力。如果升温 3°C ，预计珊瑚礁将完全消失（珊瑚礁被“煮熟”、白化的命运已够煎熬，二氧化碳浓度增加让海水酸度升高，对它们来说更是火上浇油）。一些物种和生态系统的适应失败又会让世界变得更加炎热。本就已经因砍伐和火灾而元气大伤的亚马逊雨林在这样的世界中很可能难以维续。在它毁灭的过程中，还会进一步向大气释放数以十亿吨计的二氧化碳。

亚马逊雨林不会在一夜之间消失。即使从现在开始基本不控制碳排放， 3°C 的升温也只会在本世纪下半叶出现，而不是上半叶。但是，减排所花的时间越长，避免升温 3°C 就越难，就越发只能靠应用未经检验且有时令人不安的科技手段来实现，比如从大气中大量吸碳或将部分让大气升温的阳光反射回太空。人类可能会在强力改造地球和投身“大熔炉”之间进退维谷。





The Big Mac index

What the Big Mac index says about the dollar and the dong

We look at happy meals in unhappy places

WHEN The Economist introduced its Big Mac index 35 years ago, the ubiquitous McDonald's hamburger cost just \$1.60 in America. Now it costs \$5.65, according to an average of prices in four cities. The increase comfortably outstrips inflation over the same period.

Indeed, the Big Mac's birthplace is one of the priciest places to buy it, according to our comparison of over 70 countries around the world (see chart). In Vietnam, for example, the burger costs 69,000 dong. Although that sounds like an awful lot, you can get a lot of dong for your dollar and, therefore, a lot of bang for your buck in Vietnam. You can buy 69,000 dong for only \$3 on the foreign-exchange market. And so a Big Mac in Vietnam works out to be 47% cheaper than in America.

Good to know. But the index was intended not as a shopper's guide to burgers but as a tongue-in-cheek guide to currencies. In principle, the value of a currency should reflect its power to buy things, according to the doctrine of "purchasing-power parity", a term coined by Gustav Cassel, a Swedish economist, in 1918. Since 69,000 dong and \$5.65 have the same power to buy a burger, they should be worth the same amount. The fact that you can buy a burger's worth of dong for 47% less than a burger's worth of dollars suggests the dong is undervalued.

America's Treasury certainly thinks so. Twice a year it reports to Congress on countries that might be keeping their currencies artificially cheap to boost exports and steal a competitive edge. In April it confirmed that Vietnam was one of a trio of trading partners, alongside Switzerland and Taiwan,

pursuing “potentially unfair” currency practices, based on three tests of its devising. (Vietnam has a “significant” trade surplus with America, a “material” external surplus with the world, and its central bank buys a lot of dollars and other foreign currencies.) In recent months, America’s Treasury has been browbeating Vietnam to mend its ways, a process known as “enhanced engagement”.

On July 19th the two sides reached a deal. Vietnam’s central bank promised not to indulge in competitive devaluation. It also said it would gradually let the currency fluctuate more freely and it would be more open about its interventions in the currency markets. With luck this will avert harmful tariffs or any similar enhancements of the two countries’ engagement.

Lest the Big Mac index contribute to Vietnam’s difficulties, it is worth pointing out that it is common for poor countries to seem cheap relative to rich ones in any simple comparison of prices. Vietnam is not an outlier in this regard. The price of a burger is about what you would expect given the country’s GDP per person. (Taiwan, another country on the Treasury’s naughty step, is a different case. It remains surprisingly cheap, given how prosperous it has become. And Switzerland seems expensive by any measure.)

The cheapest burger we could find is in Lebanon. Although the price of a Big Mac has increased spectacularly to 37,000 Lebanese pounds, the currency has collapsed even more dramatically on the black market, where 22,000 pounds buy a dollar.

As a consequence, the Big Mac costs the equivalent of only \$1.68. One reason the burger has remained so cheap may be that Lebanese importers can purchase some of the Big Mac’s ingredients at a more favourable, subsidised exchange rate. They can buy a dollar’s worth of wheat, for example, for 1,500 pounds and other foodstuffs, including cheese, at a rate of 3,900.

Lebanon's currency chaos is both a reflection of its economic disaster and a contributor to it. Even at an artificially low price, a Big Mac is small consolation. ■



巨无霸指数

巨无霸指数对美元和越南盾的看法

我们在不开心的地方看看开心乐园餐

当本刊在35年前推出巨无霸指数时，无处不在的麦当劳汉堡在美国仅售1.60美元。如今，从四个城市的平均价格来看，它要卖到5.65美元。这一增幅轻松超过了同期的通货膨胀。

事实上，根据我们对全球70多个国家和地区的比较（见图表），巨无霸的诞生地是它最昂贵的地方之一。例如在越南，这个汉堡售价为69,000越南盾。虽然这听起来很多，但用美元可以换到很多越南盾，因此在越南你的钱很经花。你可以在外汇市场上以3美元的价格买到69,000盾。所以越南的巨无霸比美国便宜47%。

听起来不错。但这个指数的目的不是作为汉堡购物指南，而是作为一种半开玩笑的货币指南。原则上说，根据瑞典经济学家古斯塔夫·卡塞尔

(Gustav Cassel) 在1918年提出的“购买力平价”学说，货币的价值应该反映其买东西的能力。由于69,000盾和5.65美元具有同样的购买一个汉堡的能力，它们应该价值相同。你可以用比一个汉堡的价值低47%的价格购买一个汉堡，这表明越南盾被低估了。

美国财政部肯定也是这么想的。它每年两次向国会报告那些可能涉及人为保持本国货币便宜以促进出口并窃取竞争优势的国家。今年4月，根据它设计的三项测试，它确认越南是采取“可能不公平”的货币政策的三个贸易伙伴之一，另外两个是瑞士和台湾。（越南对美国有“显著”的贸易顺差，对世界有“实质性”的对外顺差，其央行购买了大量美元和其他外币。）近几个月来，美国财政部一直在恫吓越南以让它做出修正，这是一个美国称之为“加强接触”的过程。

7月19日，双方达成协议。越南央行承诺不会大肆进行竞争性贬值。它还

表示，将逐步让货币更自由地波动，并对自身对货币市场所做的干预更加透明公开。运气好的话，这将避免有害的关税或两国之间类似的“加强接触”。

为了避免我们的巨无霸指数令越南的处境雪上加霜，值得指出一点：在任何简单的价格比较中，穷国的物价看似比富国便宜是很常见的。越南就此而言并非例外。考虑到该国的人均GDP水平，那里汉堡的价格差不多符合你的预期。（美国财政部想要惩戒的另一个伙伴台湾的情况则不同。它已经变得如此繁荣，相比之下物价却依然便宜得令人惊讶。而不管怎么看，瑞士的物价似乎都很贵。）

我们能找到的最便宜的汉堡在黎巴嫩。尽管巨无霸的价格已飙升至37,000黎巴嫩镑，但该货币在黑市上的贬值幅度更大，要花22,000黎巴嫩镑才能换到一美元。

因此，那里巨无霸的价格仅相当于1.68美元。这个汉堡保持如此便宜的一个原因可能是黎巴嫩进口商可以用更优惠的补贴汇率购买制作巨无霸的一些材料。例如，他们可以用1500黎巴嫩镑买到价值1美元的小麦，还可以用3900的汇率买到包括奶酪在内的其他食品。黎巴嫩的货币混乱既是经济灾难的表象，也是它的成因。即使售价低到不正常，巨无霸也只能带来小小的安慰。 ■



The eagle and the rabbit

America, China and the race to the Moon

Half a century on, the race back to the Moon looks markedly different from the first

ON JULY 11th, climbing through the darkling sky like a bolt of lightning in reverse, Richard Branson stole a whisper of Jeff Bezos's thunder.

In early June Mr Bezos had garnered headlines and pageviews by announcing that when his rocket company, Blue Origin, launched a space capsule with humans on board for the first time on July 20th he would be among those passengers. Virgin Galactic, a company founded by Sir Richard, had already flown its rocket-plane Unity to the edge of space. Plans were quickly hatched to bring its next test flight forward and to put Sir Richard himself on the crew manifest (he had been planning to take a later flight). On July 11th Unity did its thing, and Sir Richard, returned to Earth, proclaimed a new space age open. Blue Origin tweeted, snarkily if accurately, that its capsule goes higher and has bigger windows.

If Mr Bezos has lost his precedence, he has kept his date. And that matters. July 20th is the anniversary of the first landing of a crewed spacecraft on the Moon: that of the Eagle, Apollo 11's lunar module, in 1969. As such it was, for a long time, a date for retrospection. But now it is also a date for looking forward.

There is every reason to think that, by the time Apollo 11's 60th anniversary rolls around at the end of this decade, American astronauts will once again be leaving footprints on the barren lunar plains. And while Sir Richard has no realistic human-spaceflight ambitions beyond tourist flights to the top of the atmosphere, Mr Bezos wants Blue Origin to play a big role in that next great adventure.

A place for the private initiative of Mr Bezos and those like him is one of the ways in which the plans and context for America's return to the Moon differ from those that saw it first go there—and then stop going there—half a century ago. There are many others. One of the goals of the Artemis programme, as NASA's back-to-the-Moon programme is known, is to highlight the ways in which America has changed in the intervening decades. Another is to be comparatively cheap. Whereas Apollo had to be a uniquely American achievement, Artemis will encourage the participation of allies. And rather than providing just a few brief visits, Artemis is meant to lead to the creation of permanent outposts.

One thing remains the same. Artemis, like Apollo, is shaped by the geopolitics of great-power rivalry—then between America and the Soviet Union, now between America and China. Even here, though, there are crucial differences. In the 1960s America was in a race, the outcome of which could not be known. Today it is the reigning champion, seeking merely to maintain its pre-eminence. But the question in the minds of the spectators is strikingly similar. Does the American system work better than the alternative when faced with the challenges of the future?

In the 1960s America started off on the back foot. The Soviet Union had launched the first satellite into space in 1957 and the first human in 1961. If the space race was to get into orbit, and thereby demonstrate both your remarkable technological prowess and your ability to drop a nuclear weapon onto any point on the Earth, the Soviet Union had already won. Part of the genius of Apollo was to redefine the race as being one to the Moon.

The fact that getting to the Moon requires a very large launcher meant that the more limited technology which had allowed the Soviet Union to take the lead in Earth orbit no longer counted for much. Both sides needed a fundamentally new capability. It was America which, through a remarkable and extremely costly effort, successfully built that capability in the form of

the Saturn V.

When, at the beginning of that great drama, President John F. Kennedy told Congress that America's eagerness to go into space was "not governed by the efforts of others" he was being less than candid; the Soviet Union's efforts were fundamental to the programme's rationale. One of the differences between that era of lunar rivalry and this one, though, is that China seems to be living up to Kennedy's ideal. It is not trying to leapfrog ahead of America as America tried to overtake the Soviet Union. It is trying to build a similar set of capabilities—and thus catch up to some extent—and to meet its own national needs, whether defined in military and economic terms or, more nebulously, in terms of prestige.

China is capable of routinely launching satellites of all sizes which it uses for its own communications, reconnaissance and intelligence services and also makes available to third countries. Last year it completed a satellite navigation system, Beidou, that is a global rival to the GPS system which America originally fielded in the 1980s, and to the more recent Glonass and Galileo systems developed by Russia and Europe, respectively.

The rover that China landed on Mars in May was much smaller and less capable than the most recent rovers America has sent there. But no other country has yet managed such a feat at all. Nor has anyone else landed a rover—called Yutu-2, after the rabbit who lives on the Moon in Chinese folklore—on the far side of the Moon. The modular space station that China is currently assembling in low Earth orbit is much more modest than the International Space Station (ISS) on which America, Canada, Europe, Japan and Russia have collaborated. But it is a more ambitious undertaking than any of those powers other than America or Russia could field alone. Xi Jinping, China's president, certainly seemed proud when he had a videocall with the "taikonauts" on board.

And China has started developing big boosters, rockets similar in size to the Saturn V. Officials in the Chinese space programme have said that when there is a working version, probably in the early 2030s, it will be used to put people on the Moon; recently the Chinese and Russian space agencies announced that they would work together towards such a goal. Again, this is a matter of catching up. The difference is that this time China is recreating a capability which America has let lapse.

Recreating a capability is not the same as running in a race, much less winning one. But for China it is just one stage in a longer drawn-out strategy which would see it eclipse America as the leading power in space sometime in the 2040s through a mixture of its own perseverance and America's decline. China would be headed for the Moon even if America was not; it will go there even if, as seems likely, America gets back there well beforehand. China's leaders seem to see a presence on the Moon as having a meaning which goes well beyond beating an adversary to a largely arbitrary finish line. There are things that great nations do which small nations cannot; there are types of grandeur reserved for nations which embody ancient civilisations of global import. China's leaders think their country must be seen to share in all such perquisites. A presence beyond the Earth is one of them.

A truly confident America might look at these ambitions in the context of its own achievements half a century ago, say "been there, done that" and move on. Today's America lacks such composure. For China to land on the Moon in the absence of an active American presence there would be a public-opinion disaster.

When making the case for the Artemis programme in May, Bill Nelson, the NASA administrator, brandished a picture of China's Mars rover at the House appropriations committee. "They're going to be landing humans on the Moon. That should tell us something about our need to get off our duff

and get our Human Landing System programme going vigorously."

Beating China is a simple and popular proposition. The Artemis programme as drawn up under Mr Trump has been embraced by Mr Biden's administration and seems to enjoy solid bipartisan backing in Congress. It is an approach to making America great again which is hard to oppose in principle, even if it is not everyone's priority.

The new administration has yet to face up publicly to the fact that it will not meet the original goal of boots on the Moon by the end of 2024 (which would have been the end of Mr Trump's second term). But it seems highly likely that it will manage it sometime before the end of Mr Biden's second term, should he serve one. As long as the programme remains on course to succeed before China gets off the pad, a little delay is unlikely to badly affect support.

Artemis also serves other political goals. The Americans put on the Moon by Apollo were all white men. This did not go unnoticed at the time; one of the most enduring works by Gil Scott-Heron, a black poet and musician, begins "A rat done bit my sister Nell (with Whitey on the Moon)". Much has recently been done to publicise the contribution that women and people of colour made to the programme behind the scenes—this year NASA's Washington, DC headquarters building was renamed in honour of Mary W. Jackson, the agency's first black female engineer. Their role in today's space programme is routinely celebrated. Wally Funk, a campaigning aviator who met all the criteria for being an astronaut in the 1960s save for her sex, will be a spacefaring guest of Mr Bezos's on July 20th. Artemis, named after Apollo's sister, is to be the means by which women and non-whites first reach the Moon.

What is more, it has the advantage of being comparatively cheap. For Apollo NASA had to create not just the Saturn V but also the command and lunar

modules which it hurled aloft; the total cost is put at around \$300bn in today's dollars. Then, though, the size and expense of the task were not an insuperable obstacle; indeed, they were part of the point. The project was a signal of just how much America was willing to stake on technological pre-eminence.

Having to expend similar amounts to recreate an old capability would not send a similar message. Fortunately, it is not necessary. A new NASA rocket with Saturn V-like capabilities, the Space Launch System (SLS), is already close to completing its development, as is a new long-duration crew capsule, Orion, that can ride on top of it. NASA also had pre-existing plans for a small space station, now known as Lunar Gateway, which would orbit in the Moon's vicinity. At its simplest, all Artemis requires beyond what is already in development is a system for getting people in an Orion orbiting in the vicinity of the Moon down to the surface and back up again (see diagram).

For NASA to develop such a landing system itself would still be a pricey undertaking. But the space agency's greatest achievement over the past decade has been demonstrating that it does not have to develop its spacecraft itself. After the last space shuttles were retired, NASA asked private companies to submit proposals for new spacecraft to get first cargo and then crews up to the ISS. Various companies won contracts under these schemes, most notably SpaceX, the rocket company founded by Elon Musk.

Grants, milestone payments made when particular goals were achieved and the promise of long-term contracts once the vehicles were up to scratch allowed SpaceX to develop the Crew Dragon spacecraft, now used to ferry astronauts up to the ISS. The overall cost to NASA of developing the Crew Dragon this way was \$3.1bn: that is only a little more than the total cost of the most recent Mars rover mission.

During the Trump administration NASA decided that Artemis should take the same approach to developing its Human Landing System (HLS). Three proposals survived the first round of bidding last year: one from a “national team” led by Blue Origin, one from a consortium led by Dynetics, an American aerospace and computing contractor, and one from SpaceX. It was expected that two of the three would receive contracts to build systems, just as Boeing and SpaceX had both received contracts to develop capsules to take crew to the space station (Boeing has yet to fly a crew in its capsule, but will undertake a crewless test flight later this month).

On April 16th, though, NASA awarded a single contract worth \$2.9bn to SpaceX, saying it lacked the money to offer two. Both Blue Origin and Dynetics challenged the award, which is now being reviewed by the Government Accountability Office; its findings are expected on or before August 4th. Maria Cantwell, a senator from Blue Origin’s home state of Washington, subsequently sponsored an amendment to the bill authorising NASA’s budget which requires the agency to issue a second HLS contract. The bill has passed the Senate, but as yet has no counterpart in the House.

This will probably lead to delays. But the competitive approach is the right one. When NASA builds its own spacecraft prices go sky high, not least because politicians like to see federal money spent in their home states. The SLS is a case in point. Its development costs, now sunk, have been enormous; it is far too expensive for frequent flights. A private company could have done the job much better—as SpaceX is showing with the development of its Starship launch system, similar in capacity to the SLS but much more technically ambitious. Its “Raptor” engines are of an advanced design that no one has previously managed to make practical. It is intended to be entirely reusable.

Prototypes of the sleek, stainless-steel-hulled Starship have been launching,

landing and sometimes exploding at SpaceX's plant in Texas for months as the company tests their new engines and their ability to change their orientation in mid-air. The next test flight will be the most ambitious yet. It will see the first use of a "Super Heavy" booster to launch a Starship almost into orbit (it will in fact come down about 6,000km away in the ocean off Hawaii). The 33 Raptors on the Super Heavy will generate twice as much thrust as the first stage of a Saturn V did. The eventual goal is for the Super Heavies, like the first stages of SpaceX's Falcon boosters, to return and make a vertical landing after sending their Starships into orbit. There the Starships will either launch satellites and return to Earth or wait for a subsequent launch to refuel them before heading off to more distant destinations.

The SpaceX HLS Moon lander is a version of such a Starship, and NASA's selection of it over its competitors is a vote of confidence in the company's scheme. If it comes to fruition, it will outcompete the SLS by more or less every measure save the employment of government contractors.

Blue Origin's plans for a booster far larger than the petard with which Mr Bezos will hoist himself next week are not yet as far along. But Mr Bezos has money and determination, as well as friends in Washington. America could have three boosters capable of supporting human missions to the Moon, two private and one public, before China has even one.

It is in such possibilities that the real promise of Artemis lies. The Chinese Moon programme is entirely a creature of government. Although there is a nascent private space sector in the country, it is not yet capable of anything so ambitious. (Nor is it entirely clear that the government is; the engines a booster big enough for Moon duty requires are far more sophisticated than anything it has yet built.) In this, China's programme will resemble in form, if not in scale, America's huge, centralised Apollo programme. One of the great ironies of the first space race was that at the peak of its efforts to stop

the Moon from turning communist America was devoting more than 4% of government spending to a 400,000-worker planned economy entirely run by government officials.

This time round, it is possible that America will instead get to the Moon by supporting the aspirations of brilliant and determined—if sometimes petty—entrepreneurs and harnessing the capabilities they provide. It promises to be a more effective mode of exploration. It could also be the beginning of something more. While Mr Musk dreams of his Starships taking settlers to Mars, Mr Bezos talks of using resources from the Moon to build new industries in space (such as power-generation, asteroid mining or the production of exotic new materials). It is a vision shared by Chinese space enthusiasts such as Lieutenant-General Zhang Yulin, who works in a part of the People's Liberation Army devoted to space- and cyber-operations. Its realisation, should it come to pass, may offer a truly dramatic answer to the question of which system can better respond to the challenges of the future. ■



鹰兔之争

美国、中国和登月竞赛

半个世纪过去了，重返月球的竞赛看起来与第一次明显不同【深度】

七月十一日，理查德·布兰森（Richard Branson）像一道反向闪电攀上黑暗的天空，抢走了杰夫·贝索斯的一点风头。

6月初，贝索斯宣布自己将搭乘他的火箭公司蓝色起源（Blue Origin）于7月20日首次发射的载人太空舱，收获了大把头条和点击。理查德爵士创立的维珍银河（Virgin Galactic）公司此前已经将其火箭飞机Unity飞到了太空边缘。新计划很快就制定出来，将下一次试飞提前，并将理查德本人放在了机组人员名单上（他本来计划稍后飞行）。7月11日Unity一举成功，理查德返回地球，宣布一个新的太空时代就此开启。蓝色起源在推特上刻薄地（也许也是准确地）表示自己的太空舱飞得更高，窗户也更大。

就算被抢了先，贝索斯坚守着自己的日期。这很重要。7月20日是载人航天器首次登陆月球的周年纪念日：1969年阿波罗11号的登月舱“鹰”登月。正因如此，在很长一段时间内这都是一个值得回顾的日子。但如今这也是一个值得期待的日子。

完全有理由认为，到这个十年结束，阿波罗11号60周年纪念日到来之际，美国宇航员将再次在贫瘠的月球平原上留下足迹。理查德除了飞往大气层顶端的旅游飞行之外没有现实的载人航天雄心，而贝索斯希望蓝色起源在下一次伟大冒险中发挥重要作用。

容许贝索斯等人采取个人行动，正是美国重返月球与半个世纪前的登月（然后又停止登月）在计划和背景方面的区别之一。还有很多其他的不同。美国国家航空航天局（NASA）重返月球的计划叫做“阿耳忒弥斯计划”（Artemis），其目标之一就是凸显美国在这几十年间发生的变化。另一个目标是让探月变得更便宜。虽然阿波罗必须是美国独一无二的成就，但阿耳忒弥斯将鼓励盟友的参与。此外，阿耳忒弥斯不仅仅是做几次短期

探访，而是希望最终创建永久性基地。

有一件事没有变。和阿波罗计划一样，阿耳忒弥斯计划也受到大国竞争的地缘政治支配——过去是美国和苏联之间，现在是美国和中国之间。然而，即使在这里也有着关键的差异。在 1960 年代，美国处于一场结果无法预知的竞赛之中。如今它是卫冕冠军，只是寻求保持其卓越地位。但观众心中的问题却惊人地相似。在面对未来的挑战时，美国体制是否比其他方案更有效？

在 1960 年代，美国起步晚了。苏联于 1957 年发射了第一颗卫星，1961 年则首次将人类送入太空。如果太空竞赛的目标是要进入轨道，从而展示非凡的技术实力和将核武器投放到地球任何地点的能力，苏联已经赢了。阿波罗的部分天才之处在于把这场竞赛的目标变成了登月。

登月需要一个非常大的发射台，这意味着让苏联在地球轨道上处于领先地位的较为受限的技术没太大意义了。双方都需要一种全新的能力。美国通过一项非凡且极其昂贵的努力，成功地以土星五号（Saturn V）的形式建立了这种能力。

在那场大戏开场时，约翰·肯尼迪总统告诉国会，美国进入太空的渴望“不受他人努力的支配”。他不够坦率：苏联的进展是驱动这项计划的根本原因。不过，那个月球竞争时代与当今时代的一个区别在于，如今的中国似乎正在实现肯尼迪的这种理想。它并不像美国试图超越苏联那样试图超越美国。它想要建立一套类似的能力——从而在一定程度上迎头赶上——并满足自己的国家需求，无论是军事上、经济上的需求，还是在更模糊的声望方面的需求。

中国有能力定期发射各种尺寸的卫星，用于本国的通信、侦察和情报服务，也提供给第三国。去年它建成了北斗卫星导航系统，成为美国最初在 1980 年代部署的 GPS 系统以及后来俄罗斯和欧洲分别开发的格洛纳斯和伽利略系统的全球竞争对手。

中国 5 月登陆火星的漫游车比美国最近派往那里的漫游车要小得多，能力

也差一些。但还没有其他国家完成这样的壮举。也没有其他国家的月球车登陆月球背面——这个月球车以中国民间传说中生活在月球上的兔子命名，叫“玉兔二号”。中国目前在低地球轨道上组装的模块化空间站比美国、加拿大、欧洲、日本和俄罗斯合作建造的国际空间站（ISS）要小得多。但这项任务比美国或俄罗斯以外的任何国家能单独开展的任务都更宏伟。当中国国家主席习近平与机上的“太空员”视频通话时，神情无疑是自豪的。

而且中国已经开始研制大型助推器，这些火箭将和土星五号差不多大小。中国航天计划的官员曾经说过，当有了一个能够工作的版本——可能在 2030 年代初——它会被用来把人送上月球；近日，中俄航天机构宣布将联手朝着这一目标迈进。这又是一次追赶。不同的是，这一次中国正在重建一种美国已经放弃的能力。

复制一种能力并不意味着参加竞赛，更不用说赢得竞赛了。但对中国来说，这只是它较长期战略的一个阶段：它要在 2040 年代的某个时刻，通过自身的毅力和美国的衰落，超越美国成为太空领导者。即使美国不登月，中国也会登月；哪怕美国很可能比它早很多年再次登月，中国也一样要登月。中国领导人似乎认为登月的意义远不止在一个基本上是随便画下的终点线上击败对手。有些事，大国能做而小国不能；有一些荣耀，只有蕴含对全球举足轻重的古代文明的国家才配拥有。中国领导人认为，他们的国家必须在所有这类特权中占有一席之地。地球之外的足迹就是其中之一。

一个真正自信的美国可能会把这些雄心比照自己半个世纪前取得的成就，说“我去过，我做过”，然后置之不理。今天的美国缺乏这样的冷静。如果中国在没有美国积极参与的情况下登陆月球，将会引发舆论灾难。

在 5 月份为阿耳忒弥斯计划辩护时，NASA 局长比尔·纳尔逊（Bill Nelson）在众议院拨款委员会面前挥舞着一张中国火星探测器的照片。“他们将把人类送上月球。这应该让我们明白自己需要起来干活，让我们的载人着陆系统计划大力推进。”

打败中国是一个简单而流行的命题。在特朗普的领导下制定的阿耳忒弥斯计划已被拜登的政府接受，并且似乎在国会得到了两党的坚定支持。这是一条让美国再次伟大的路径，原则上很难反对，即使它不是每个人的优先事项。

新政府之后将会公开面对一个事实，即无法实现在 2024 年前（原本将是在特朗普第二个任期结束时）登月的最初目标。但它看起来非常有可能在拜登第二个任期结束前的某个时间达成——如果他连任的话。只要这个项目依然计划抢在中国发射之前取得成功，一点点延迟不大会对支持率造成严重影响。

阿耳忒弥斯计划还为其他政治目标服务。通过阿波罗计划登上月球的美国人都是白人。这在当时并不是没人注意到；黑人诗人和音乐家吉尔·斯科特-赫伦（Gil Scott-Heron）最经久不衰的作品之一的开头就是“一只老鼠咬了我的妹妹内尔（而白鬼却在月球上）”。最近有很多工作来宣传女性和有色人种在幕后对该计划的贡献——今年 NASA 华盛顿特区总部大楼更名为玛丽·W.杰克逊（Mary W. Jackson）大楼，以纪念该机构的第一位黑人女工程师。她们在当今太空计划中的作用经常得到表彰。飞行员沃利·芬克（Wally Funk）正在领导一场运动，她在 1960 年代符合宇航员除性别外的所有标准。她将于 7 月 20 日加入贝索斯的太空旅游。以阿波罗的妹妹命名的阿耳忒弥斯计划将让女性和非白人首次登上月球。

更重要的是，它具有相对便宜的优势。对于阿波罗计划，NASA 不仅要制造土星五号，还要制造它带往太空的指挥舱和登月舱。以今天的美元计算，总成本约为 3000 亿美元。不过，在那时，这项任务的规模和费用并不是不可逾越的障碍，事实上它们恰恰是重点的一部分。该项目是一个信号，表明美国愿意为取得技术上的显赫地位下极大的赌注。

要花费类似的金额来重新建立一项古老的能力不会传达类似的信息。幸运的是，也不需要这样。具有类似土星五号能力的 NASA 新型火箭太空发射系统（SLS）已近开发完毕，而可以搭载其上的新型长效乘员舱猎户座

(Orion) 飞船也是如此。NASA 此前已有一个小型空间站的计划，现在被称为“月球门户”，它将在月球附近运行。最简单地说，除了已经在开发的东西之外，阿耳忒弥斯计划所需要的只是一个系统，可以让在月球附近环绕的猎户座飞船上的人下降到月球表面再返回飞船（见图）。

对于 NASA 来说，要自行开发这样的着陆系统仍然是一项昂贵的任务。但该局在过去十年中最大的成就是证明它不必自己开发航天器。在最后一批航天飞机退役后，NASA 要求私营公司提交新航天器的提案，以便先运送货物，然后再将机组人员送上国际空间站。许多公司都在这些计划中赢得了合同，最著名的是伊隆·马斯克创立的火箭公司 SpaceX。

拨款、在实现特定目标时支付的里程碑付款以及一旦运载工具达到标准就签订长期合同的承诺，使 SpaceX 得以开发现在用于将宇航员运送到国际空间站的“载人龙飞船”。NASA 以这种方式开发载人龙飞船的总成本为 31 亿美元，这仅比最近一次火星探测器任务的总成本多一点。

在特朗普执政期间，NASA 决定阿耳忒弥斯计划应该采用相同的方法来开发其载人着陆系统 (HLS)。三项提案通过了去年的第一轮竞标：一项来自蓝色起源领导的“国家团队”，一项来自美国航空航天和计算承包商 Dynetics 牵头的财团，一项来自 SpaceX。预计三者中的两个将获得建造系统的合同，就像波音和 SpaceX 都获得了开发太空舱以将机组人员送往空间站的合同（波音尚未在其太空舱中搭载人员，但在 7 月晚些时候进行了一次无人驾驶试飞）。

不过，4 月 16 日，NASA 将一份价值 29 亿美元的合同独独授予了 SpaceX，它称自己资金不足，无法给出两份合同。蓝色起源和 Dynetics 均对这一决定提出质疑，目前该决定正由政府问责办公室审查，调查结果预计在 8 月 4 日或之前发布。来自蓝色起源的家乡华盛顿州的参议员玛丽亚·坎特韦尔 (Maria Cantwell) 随后发起了一项对 NASA 预算授权法案的修正案，要求该机构签发第二份 HLS 合同。该法案已在参议院通过，但在众议院尚无对应法案。

这可能会导致延误。但引入竞争是对的。当 NASA 建造自己的航天器时，价格飞涨，尤其是因为政客们喜欢看到联邦资金花在自己的家乡。SLS 就是一个很好的例子。它（现在已经沉没）的开发成本十分巨大。对于频繁的航天飞行来说它太贵了。交让一家私营公司去做这件事本可以好得多，正如 SpaceX 开发的“星舰”发射系统所展示的那样——它的容量与 SLS 相似，但技术上的雄心要大得多。它的“猛禽”发动机采用了一种先进的设计，以前没有人能够将其付诸实践。它旨在完全可回收再用。

几个月来，SpaceX 公司一直在测试“星舰”的新发动机及其在半空中变向的能力。光滑铮亮的不锈钢外壳“星舰”原型机在公司位于得克萨斯州的工厂发射、着陆，有时甚至爆炸。下一次试飞将是迄今为止最具野心的一次。它将首次使用“超重型”助推器将“星舰”发射到几乎进入轨道的位置（实际上它将在坠落到6000公里外夏威夷附近的海洋中）。“超重型”助推器上的 33 个“猛禽”产生的推力是土星五号第一级产生的推力的两倍。最终的目标是让“超重型”像 SpaceX 的猎鹰助推器的第一级那样，在将“星舰”送入轨道后，自行返回并垂直着陆。进入轨道后的“星舰”要么发射卫星并返回地球，要么等待随后的发射为它们添加燃料，然后前往更遥远的目的地。

SpaceX HLS 月球着陆器就是这样一艘“星舰”的一个版本，NASA 选择它而不是它的竞争对手就是对这家公司的计划投下了信任票。如果它实现了，它在差不多每一项指标上都会胜过 SLS，政府承包商的就业除外。

蓝色起源计划中的助推器远比贝索斯下周把自己送上天的那颗大得多，但目前进展有限。但贝索斯有钱有决心，还有在华盛顿的朋友。美国可能会拥有三个能够支持载人登月任务的助推器，两个私人的，一个国营的，而届时中国甚至可能一个都还没有。

阿耳忒弥斯计划的真正希望就在于这种可能性。中国月球计划完全是政府的产物。尽管该国也有新兴的私营航天部门，但它还没有能力实现如此宏伟的事业。（政府能不能做到也不完全清楚；一个能够完成登月的助推器需要的发动机比它建造过的任何东西都要复杂得多。）在这方面，中国的计划在形式上（如果不是在规模上）将类似于美国庞大的、集中的阿波罗

计划。第一次太空竞赛的一大讽刺是，在美国阻止月球变成共产主义世界的努力达到顶峰时，它将超过 4% 的政府支出用在了一项完全由政府官员运营的、雇有 40 万工人的计划经济上。

这一次，美国有可能通过支持才华横溢且意志坚定（有时甚至是执拗小气）的企业家的抱负并利用他们提供的能力来登上月球。这有望成为一种更有效的探索模式，也可能是更大成就的发端。马斯克梦想着他的“星舰”将定居者带到火星，而贝索斯则谈到利用月球资源在太空中建立新的产业（例如发电、小行星采矿或奇异新材料的生产）。这同样也是中国太空爱好者的愿景，例如在中国人民解放军致力于太空战和网络战的单位工作的张育林中将。它的实现（如果能够实现的话），可能会为哪种体制能够更好地应对未来挑战的问题提供真正戏剧性的答案。 ■



Get poor quickly

China's crackdown on the online-education business marks a turning-point

Less capitalism, more state

TO GET RICH is glorious, Deng Xiaoping supposedly said. “To get as rich as Jack Ma is clearly not so glorious,” quipped an investor last November when the initial public offering of Mr Ma’s Ant Group was cancelled on the say-so of China’s financial regulators. A lot of foreign investors interpreted it as a slap-down to China’s best-known billionaire and thus a warning to the country’s other plutocrats not to get too big for their boots.

But in the months since then the scope of the regulatory crackdown has grown ever wider. China’s two internet giants, Alibaba and Tencent, are being worked over by the antitrust authorities. Earlier last month Didi Global, a ride-hailing service, was caught in the net just days after it listed in New York. And in the past week the education-technology industry has become a target. New regulations bar any company that teaches subjects on the school curriculum from listing abroad, having foreign investors or making profits. When it comes to teaching schoolchildren, no one should get rich.

The market response to the latest bureaucratic diktat was a sharp sell-off. The share prices of a trio of Chinese online-tutoring firms listed in New York fell by two-thirds. The panic spread to other Chinese firms listed in America. The Nasdaq Golden Dragon China Index, which tracks the biggest stocks of this kind, fell by almost 20% over three days. The contagion took in China’s onshore market, with share prices down across the board.

China’s preferences now seem clear. It wishes to see capital raised on its

own exchanges, within its purview and on the terms that it dictates. The effects of this on financial markets are likely to linger. China itself may be the biggest loser.

Start with the effect on the market value of tech firms outside China. The tech-heavy Nasdaq index also sold off in response to the rout of Chinese tech stocks, because the latest episode signalled that investing in technology carries regulatory risk. In America Joe Biden's administration has also sought to strengthen oversight of big tech, by beefing up antitrust. But trustbusting in America takes place in a legal context. There is a body of jurisprudence that limits how far the authorities can go in clipping the wings of tech giants, even those making profits many find obscene: Alphabet, Apple, Facebook and Microsoft all reported a record second-quarter haul this week. If Chinese rivals are mired in red tape, that is all to the good of big tech in America.

And the clampdown will indeed harm Chinese tech. Investors who piled in during recent years have last week been pummelled in public markets. Private American capital is also tied up in Chinese startups. The value in those ventures is now, in effect, frozen. The route to an IPO for a young Chinese firm—the reliable way for venture capitalists to get their money back—now borders on perilous. A lot of Chinese firms have raised money abroad in vehicles known as variable-interest entities, which are essentially synthetic shares. This route may now be blocked for ever. And venture capitalists will surely be charier about backing Chinese tech startups, however promising.

Still more worrying is that any investment, even in an onshore non-tech firm, is now at risk from arbitrary rule changes. That will raise the cost of capital for Chinese firms. China's securities regulator hastily convened a meeting with international bankers last week to reassure them that only education-based firms were being targeted. It suggests that China's policy

brass, having startled markets, have realised that they may have miscalculated.

It certainly looks that way. The capital markets are not a tap that regulators can turn on and off when it suits them. True, investors' memories can be short. But China is gaining a reputation for regulatory high-handedness that it can shed only by starting to follow transparent rules—and that is precisely the sort of subordination the Communist Party abhors. ■



【首文】快速变穷

中国整治在线教育行业标志着一个转折点

少一些资本主义，多一些国家干预

致富光荣，据说邓小平曾经这么说过。“富成马云那样显然就没那么光荣了。”去年11月，当马云的蚂蚁集团的上市被中国金融监管机构叫停时，一位投资者如此打趣道。在许多外国投资者看来，这是对中国最出名的亿万富豪的打压，以警告该国其他富豪不要狂妄自大。

但在此后的几个月里，监管打击的范围越来越广。中国两大互联网巨头阿里巴巴和腾讯正在被反垄断机构调查。7月初，网约车公司滴滴在纽约上市几天后就遭到审查。近日，教育科技行业又成了靶子。新出台的规定禁止任何学科类培训机构在国外上市、接受外国投资或追求盈利。也就是说，谁也不应该靠教中小学生致富。

市场对最新官僚命令的反应是大幅抛售。在纽约上市的三大中国在线教育公司的股价跌去了三分之二。恐慌还蔓延到其他在美上市的中国公司。追踪其中最大中国股票的纳斯达克中国金龙指数（Nasdaq Golden Dragon China Index）三天内下跌近20%。中国国内市场也受到传染，股价全线下跌。

中国的喜好现在似乎已很明显。它希望在它的监管范围内，按照它规定的条件，在它自己的交易所里开展融资。这对金融市场的影响很可能挥之不去。中国自己也许会是最大的输家。

先来看中国以外科技公司的市值受到的影响。以科技股为主的纳斯达克指数也因中国科技股暴跌而遭抛售，因为最近的形势表明投资科技股存在监管风险。在美国，拜登政府也想通过推进反垄断来加强对大科技公司的监管。但美国的反垄断行动是在法律框架内进行的。即使很多人觉得科技巨头赚的钱多到令人发指（Alphabet、苹果、Facebook和微软上周都报告了

创纪录的第二季度业绩），也还是有一系列判例限制了监管部门约束这些巨头的程度。如果它们的中国竞争对手困于官僚做派，那对美国的大科技公司来说完全是好事。

而这轮打压会实实在在地损害中国的科技公司。近年来大量涌入的投资者上周在公开市场遭受重创。美国的私人资本也套牢在了中国的创业公司里。这些企业的价值现在实际上已被冻结。年轻的中国公司寻求IPO之路如今近乎危机四伏，而IPO是风险投资家收回资金的可靠途径。许多中国公司通过被称为“可变利益实体”的工具在国外融资，这些工具本质上是合成股票。这条路现在可能被永久封锁了。风险资本家在投资中国的科技创业公司时必定会更加谨慎，无论其前景多么光明。

更让人担忧的是，任何投资，即使是对中国境内的非科技公司，现在都面临着规则随意更改的风险。这将提高中国企业的资本成本。中国证监会在上周匆忙召集国际银行家开会，安抚他们说只有教育类公司是整顿目标。这表明在让市场大为惊骇之后，中国的政策制定者已经意识到他们可能错估了形势。

看起来情形的确如此。资本市场不是监管机构可以随心所欲地打开或关闭的水龙头。诚然，投资者的记忆可能很短暂。但中国正在收获监管上专横的名声，只有开始遵从透明的规则才能摆脱——而这种服从正是共产党所厌恶的。 ■



What way to make a living

A long view of work shows how little it has changed over millennia

Jan Lucassen begins “The Story of Work” in the hunting-and-gathering past

The Story of Work. By Jan Lucassen. Yale University Press; 544 pages; \$30 and £25

OF THE MANY habits and institutions on which covid-19 has shone a harsh light, none has been more exposed and disrupted than work. The pandemic has drawn attention to the disjunction between the indispensability of certain jobs, from nursing to making deliveries, and how little they tend to pay. It left many workers bewilderingly idle, or stuck at a disorienting remove from their colleagues. Having downed their usual tools, the bored often took up Neolithic habits, like growing food or baking bread—ironically, given that it was the turn to agriculture, beginning some 12,000 years ago, which first set humankind on the path towards arduous work in dense cities, through which zoonotic diseases might one day run rampant.

“The Story of Work” by Jan Lucassen, a scholar at the International Institute of Social History in Amsterdam, chronicles the long-term background to these jarring developments. The narrative begins with the hunting-and-gathering past, which accounts for most of humankind’s time as a distinct species. Hunter-gatherer life is often portrayed as Edenic. In fact, early societies could be violent, people often died young, and few enjoyed a leisurely existence—as the Cuiva do in South America today, reputedly spending up to 16 hours a day in their hammocks.

Nevertheless, this ancient way of life retains an undeniable appeal. Work among hunting-gathering bands was co-operative, social and highly varied;

members were masters of many skills, rather than specialists in just a few. Social inequality of any sort scarcely existed. The business of obtaining food generally occupied fewer hours than a modern full-time job, though work included other tasks as well, such as the collective raising of children, the fashioning and repair of tools and the fulfilment of social obligations that fostered group cohesion. In as much as the hunting-gathering life is humankind's natural state, it is one in which work is rewarding and meaningful, community is central and fairness matters.

Just as hunter-gatherer society is often characterised as idyllic, the adoption of settled agriculture is frequently presented as the moment when everything went wrong. This, too, is misleading. For one thing, it was not a moment at all; the progression from the first turn towards dependence on domesticated plants and animals, to the production of surpluses big enough to support cities, took some 5,000 years. Agriculture did not immediately lead to patriarchy or drastic inequality. Rather, the road to class divisions ran through millennia of "transegalitarian" societies, in which some people or households controlled a larger share of a community's output, but did not necessarily take ownership of the means of production. In early urban economies, producers surrendered their output to a central authority—usually a temple—which reallocated goods to community members.

Yet as people learned to wring more output from the land, they built the basis of modern human existence, with all its advantages and drawbacks. Surpluses freed ever more individuals from a hard life producing food. Professions began to emerge—beginning with the odd soldier or smith but widening to include an entire menagerie of artisans and functionaries. From around 7,000 years ago the first great cities arose, in Mesopotamia and then South and East Asia. And as societies grew in size and complexity, new working arrangements appeared, from unfree servitude to self-employment and, crucially, wage labour.

This last category expanded with the rise of the first states and their armies; soldiers were among the first working people to earn a money wage. Wage labour and standardised, low-denomination coinage combined to produce economic magic, as true markets began to operate. Not only did these allow commerce to flourish, but by granting the freedom to choose when and how to earn a living, a marketplace for work may also have helped kindle a more individualistic outlook than other arrangements encouraged.

Progress brought complications. Warlike and patriarchal societies—such as the Yamnaya of the Eurasian steppe, pastoral nomads who violently displaced matriarchal and egalitarian communities in Europe and South Asia from roughly 5,000 years ago—upended old norms and sowed the seeds of many modern ills. States harnessed the labour of the masses in the construction of grand projects, from mausoleums to aqueducts, and in the destruction of rival civilisations.

Within and across societies, the powerful exploited the powerless. Whereas traditional histories often present drudges and slaves as anonymous extras in the dramas of luminaries, passive in the face of their unhappy fates, Mr Lucassen affords them attention and agency. Africans waylaid by slavers often resisted to the death, he notes. In 1785 captives placed aboard the Dutch ship Neptunus rebelled and lit the gunpowder in its hold, preferring to kill themselves and their assailants than to submit to the lash.

If economic injustice is perennial, so is dissatisfaction and resistance to it. Throughout history, elites have deployed cosmologies, from ancient religions to modern political philosophies, in a bid to legitimise inequalities. Even so, vast differences inevitably prompt backlashes: from the first known strike action, in the 12th century BC in the village of Deir el-Medina in Egypt—which housed artisans gathered to work in the Valley of the Kings—to modern trade unionism and the political unrest sparked by globalisation and mechanisation.

Indeed, the most powerful impression left by “The Story of Work” is of continuity. The Industrial Revolution brought a decisive break in the capacity to increase economic output. But the forces that made it possible—specialisation and trade, expansion of markets, intensification of production—are age-old. So is the motivating power of the desire for more, from the Neolithic enthusiasm for precious stones, which gave a spur to the making of tools; to the “industrious revolution” of the centuries before industrialisation, in which an appetite for new consumer goods drove increased participation in labour markets among both men and women; to the modern-day cult of the side hustle.

In the end the long perspective that the book provides is a mixed blessing. These days it is tempting to imagine that new technologies might mean a chance for workers to recapture the more appealing aspects of the prehistoric past. Were machines eventually able to handle all the world’s unpleasant tasks, people could spend more time on activities that they find meaningful, or in engagement with their communities, a benign possibility that Mr Lucassen considers. Already, as he points out, in the 20th century many countries constructed generous welfare states, the length of the working week declined from 19th-century highs, and the share of life spent in a relatively workless retirement soared.

And yet his history also shows how much today’s workers have in common with every other soul who has toiled these past 12,000 years. They remain at the mercy of their appetites, and of political and economic institutions built, often consensually, to help them produce more. As it always has, work still provides a structure for both individual lives and societies at large. Little wonder that many people have been itching to get back to it as quickly as circumstances allow. ■



谋生之道

一万年来工作几乎没有变化

扬·卢卡森以狩猎采集时代为起点，讲述《工作的故事》【《工作的故事》书评】

《工作的故事》，扬·卢卡森著。耶鲁大学出版社，544页；30美元/25英镑。

新冠疫情让诸多习惯和制度受到严峻考验，但没有哪一个受到的冲击和颠覆比工作更严重。疫情让人们注意到某些工作的不可或缺与其微薄收入之间的割裂，比如护理、送货。疫情也让许多劳动者因无所事事而茫然无措，或者因与同事分隔而迷惘不已。在放下自己习惯的营生之后，百无聊赖的人们常常重拾新石器时代的生活习惯，例如种粮种菜，或烘烤面包——讽刺的是，正是由于大约12,000年前农业生产的出现，人类开始在人口密集的城市里辛勤劳作，而这种环境让人畜共患病的大流行成为可能。

阿姆斯特丹国际社会史研究所（International Institute of Social History）的学者扬·卢卡森（Jan Lucassen）所著的《工作的故事》（The Story of Work）回溯了这些矛盾现状的悠远背景。故事从过去的狩猎和采集生活讲起——人类成为一个独特物种以来的大部分时间都处于这个阶段。狩猎采集的生活常被描绘成如伊甸园般美好。但实际上早期社会可能很残酷，人们大多短命，而且极少有人能享受悠闲的生活——不像今天南美的库瓦人，据说一天有多至16个小时都躺在吊床上。

不过，那种古老的生活方式仍然具有不可否认的吸引力。狩猎采集群体中的工作是彼此合作、社会化以及高度多样化的；群体成员精通许多技能，而不是专精于某一些。任何形式的社会不平等几乎无从寻觅。为获取食物所花的时间往往比现代的全职工作更少，但工作中也包含了其他任务，如集体抚养孩子、制作和修理工具，以及履行促进集体凝聚力的社会义务。狩猎采集生活是人类的自然状态，这其中的工作是有回报和有意义的，社群是核心，公平很重要。

正如狩猎采集社会常常被描述为田园牧歌，定居农耕则常常被描述为一切急转直下的时刻。这同样有误导性。首先，这根本不是在某个时刻才发生的事：从最初转向依赖驯化动植物，到能够生产出足以支撑城市的剩余产品，历时约5000年。农业并没有立即导致父权制度或者严重的不平等。相反，阶级分化的过程贯穿于数千年的“超平等主义”社会之中，其中部分人或家族控制了更大份额的社群产出，但他们未必掌握生产资料的所有权。在早期的城市经济中，生产者将产出交给一个中央权力机构（通常是寺庙），由其将物品重新分配给社群成员。

然而，随着人们学会从土地中榨取更多产出，现代人类生存方式的基础开始形成，这有利有弊。剩余产品让更多人摆脱了生产粮食的困苦。职业开始出现——一开始是临时的士兵或铁匠，后来扩大到包括各种各样的工匠和公职人员。大概在7000年前，大型城市首先在美索不达米亚崛起，随后出现在南亚和东亚。随着社会变得规模更大、更加复杂，新的工作方式出现了，从没有人身自由的奴役劳动到个体劳动，还有最重要的雇佣劳动。

雇佣劳动随着最早的国家及其军队的崛起而不断扩大；士兵是最早赚取薪资的劳动者之一。雇佣劳动和标准化的小面额货币结合，使得真正的市场开始运转，创造出了经济奇迹。这不仅仅带来了商业繁荣。一个让人们得以自由选择谋生时间和方式的就业市场或许也帮助激发了更加个人主义的观念，胜过其他劳动安排方式。

进步的同时也带来了弊病。大约5000年前，欧亚大草原上的游牧民族颜那亚人以暴力取代了欧洲和南亚的母系平等主义社群，像这样的好战父系社会推翻了旧的规范，播下了许多现代痼疾的种子。国家集结劳动大众的力量，不但大兴土木，兴建从陵墓到引水渠的各种宏伟工程，也寻求摧毁敌对文明。

在社会内部和社会之间，强者剥削弱者。在传统的历史叙事中，苦工和奴隶往往只是名人贵胄出演的大戏中的无名临演，只能被动接受不幸的命运，而卢卡森给予他们关注，并赋予他们自决自主的光环。他指出，遭到奴隶贩子伏击的非洲人往往会拼死抵抗。1785年，荷兰海王星号

(Neptunus) 运送的俘虏在船上起义，点燃了船舱装载的火药，宁愿与敌人同归于尽也不愿被奴役。

如果说经济上的不公正是长期存在的，那么对它的不满和抵制也从未停歇过。从古代宗教到现代政治哲学，古往今来的精英们运用宇宙论学说试图让不平等合法化。即便如此，巨大的差异还是不可避免地引发了强烈反抗：在公元前12世纪的埃及德尔麦地那村（Deir el-Medina），居住在那里并一起到帝王谷（Valley of the Kings）劳作的工匠们发动了人类历史上的第一次罢工；到了现代，又有工会制度以及由全球化和机械化激发的政治动荡。

实际上，《工作的故事》给人印象最深的一点关乎延续性。工业革命是提高经济产能的一次决定性突破。但它背后的真正驱动力由来已久，包括专业分工和贸易、市场扩张，以及生产集约化。对更多物质的渴望带来的驱动力也同样久远：新石器时代对宝石的热衷大大促进了工具制作；在工业化前几个世纪的“勤勉革命”时期，对新消费品的需求推动更多男性和女性加入劳动力市场；到了今天，从事副业又蔚然成风。

最终，本书提供的长远视角带来了喜忧参半的结论。今时今日，人们不禁设想，新技术或许能让劳动者有机会重获史前时代的一些诱人体验。如果最终能够把世上所有不愉快的任务交给机器，人们就可以将更多时间花在有意义的活动上，或者参与社群活动，卢卡斯认为这是一种良性的可能。正如他所指出的，在20世纪许多国家已经建立起慷慨的福利国家，每周工作时间已经从19世纪的高位下降，相对清闲的退休生活在人生中所占的比例也大幅上升。

然而，他讲述的历史也表明，今天的劳动者和过去12,000年里辛勤劳动的所有人何其相像。他们仍然受制于自己的欲望，也受制于政治和经济制度，而这些制度往往是在两厢情愿之下建立的，为的是帮助他们提高产出。工作仍然一如既往地为个人生活 and 整个社会提供了一种结构。难怪现在许多人已经急不可耐，想在情况允许时尽快返回工作岗位。■



Unicornucopia

Technology unicorns are growing at a record clip

The venture-capital boom is a risk for investors—and a gift for everyone else

AILEEN LEE, a venture capitalist who founded an investment firm called Cowboy Ventures, coined the term “unicorn” in 2013 to refer to what was then a rare, mythical species: privately held startups valued at \$1bn or more. Any magical attributes aside, today they are commonplace—and becoming ever more so. Consumers, who stand to benefit from an array of novel, often cheap products and services, can expect to enjoy the ride. Investors betting on the unicorn derby should tread more carefully.

The world’s unicorn herd is multiplying at a clip that is more rabbit-like. The number of such firms has grown from a dozen eight years ago to more than 750, worth a combined \$2.4trn. In the first six months of 2021 technology startups raised nearly \$300bn globally, almost as much as in the whole of 2020. That money helped add 136 new unicorns between April and June alone, a quarterly record, according to CB Insights, a data provider. Compared with the same period last year the number of funding rounds above \$100m tripled, to 390. A lot of this helped fatten older members of the herd: all but four of the 34 that now boast valuations of \$10bn or more have received new investments since the start of 2020.

The latest tech darlings are no longer primarily Uber-esque marketplaces for matching services with consumers. Instead, they offer, or are developing, sophisticated products, often in more niche markets. Some 25% of the funding in the second quarter went to financial-technology firms, with lots also flowing into artificial intelligence, digital health and cyber-security (see chart).

The recipients of investors' largesse are also getting more global. Although American and Chinese startups continue to top the fundraising league tables, the share from outside the two biggest markets grew from around 25% in 2016 to 40% in the past quarter. In July Flipkart, an Indian e-commerce firm, raised \$3.6bn in a round that valued it at \$38bn. Grab, vying to be South-East Asia's answer to China's super-apps, hopes to go public in New York this year at a valuation of \$40bn.

The torrent of cash can be explained by two factors. The first is a divestment spree by the startups' early venture-capital (VC) backers. These stakes command top dollar from investors desperate for exposure to the pandemic-era digitisation wave. Exits, via public listings and acquisitions, more than doubled globally year on year, to nearly 3,000. The proceeds are flowing back into new VC funds, which have so far this year raised \$74bn in America alone, nearing the record \$81bn in 2020 in half the time. The venture capitalists cannot spend the dough fast enough. In the three months to June Tiger Global, a particularly aggressive New York investment firm, made 1.3 deals on average every business day.

The second reason for soaring valuations is more competition among investors. Relative newcomers to tech-investing, such as pension funds, sovereign-wealth funds and family offices, are encroaching on the private markets that used to be dominated by VC firms from Sand Hill Road in Palo Alto. In the past quarter "non-traditional" investors in America took part in nearly 1,800 deals that together raised \$57bn. Many may have been encouraged by the success of earlier forays by dabblers from outside the VC world. Their annual returns from exited investments in a first round of financing have averaged 30% in the past decade, reckons PitchBook, another data firm. That is more than double the 10-15% for veteran VCs.

This winning streak may yet end in tears. That is what happened two years ago, when richly valued firms with shaky business models either fizzled

after their initial public offerings (like Uber and Lyft, two ride-hailing rivals) or never got that far (WeWork, an office-rental firm whose flotation was shelved after investors got cold feet). Many recently listed unicorns continue to bleed cash. According to The Economist's calculations, those that went public in 2021 made a combined loss of \$25bn in their latest financial year.

Assessing whether the remaining ones are worth their lofty valuations looks harder than ever. Like their predecessors, they do not disclose financial results. At the same time, extrapolating from the earlier unicorns, which tended to pursue growth at all costs in winner-takes-all markets, offers little help because today's lot often aim to capture good margins by selling genuinely unique technology. This could be a more sustainable strategy—if the technology works. But it is harder for non-experts to evaluate, especially based on what is often little more than a prototype. Nikola and Lordstown, two electric-vehicle companies that listed in 2020 via reverse mergers with special-purpose acquisition companies (SPACs), are under investigation by American authorities over allegedly exaggerating the viability of their technology.

Another risk comes from politics. Authorities around the world are growing warier of letting tech firms get too big or entering regulated markets such as finance or health care. As part of a broader crackdown against big tech firms China's government recently sabotaged the operations of Didi, by banning its app from Chinese app stores days after the firm's \$68bn initial public offering in New York, ostensibly over misuse of users' data. Such moves have chilled investors' appetite for Chinese startups, funding for which has actually declined in the past two quarters. In America the Securities and Exchange Commission is beginning to scrutinise the use of cryptocurrencies. Many crypto-exchanges set investors' pulses racing in last year's bitcoin rush. Now the market capitalisation of Coinbase, one of the biggest, has shrunk by half, or \$56bn, since peaking after its listing in April.

Investors, then, had better beware. For everyone else, the unicorn stampede is a boon. Because venture investments involve mostly equity and little debt, even flops such as WeWork or cautionary tales like Didi pose little risk to the financial system. So long as venture capital is bankrolling lossmaking startups while they offer subsidised services or develop clever new products, consumers have no reason to look the gift horned horse in the mouth. ■



独角兽图鉴

科技独角兽正以创纪录的速度增长

这轮风险资本繁荣对投资者有风险——对其他所有人都是馈赠

“牛仔风投”（Cowboy Ventures）的创始人、风险投资家艾琳·李（Aileen Lee）在2013年创造了“独角兽”一词，用以指代当时还很罕见的神秘物种：价值10亿美元或以上的私人控股创业公司。先不谈什么魔幻属性，如今它们已是稀松平常——而且还日益如此。这个旅程应该会让消费者乐在其中，因为他们会从一系列新颖的、通常还很便宜的产品和服务中受益。而押注独角兽大战的投资者们应该更谨慎探险。

世界上的独角兽种群正在快速繁衍，这一点倒更像兔子。这类公司的数量从八年前的十几家增加到如今的750多家，总估值达2.4万亿美元。今年前六个月，科技创业公司在全球筹集了近3000亿美元，几乎相当于2020年全年的规模。数据供应商CB Insights称，仅4月到6月间，这些钱就帮助新增了136家独角兽，创下了季度纪录。与去年同期相比，超过一亿美元的融资轮数增加了两倍，达到390轮。这其中的很大一部分还是喂肥了那些较年长的独角兽：自2020年初以来，34家如今估值已达或超过100亿美元的公司中，除了四家外全部都获得了新投资。

最新一批科技宠儿已不再主要是优步式的匹配服务与消费者的市场了。相反，它们提供或正在开发尖端产品，通常面向更小众的市场。第二季度约25%的融资流向了金融科技公司，还有大量资金流向了人工智能、数字医疗和网络安全领域（见图表）。

从投资者的慷慨解囊中受益的公司也日益遍布全球。尽管中美两国的创业公司继续在融资排行榜上名列前茅，但这两个最大市场以外地区所占的份额从2016年的25%左右增长到了上一季度的40%。7月，印度电子商务公司Flipkart在一轮融资中筹集了36亿美元，估值380亿美元。Grab试图成为能与中国的超级应用匹敌的东南亚公司，它希望今年能以400亿美元的估

值在纽约上市。

现金流滚滚而来或许可以用两个因素来解释。首先是创业公司早期风投支持者的撤资热潮。迫切想投身疫情时代数字化浪潮的投资者闻风而至，为这些股份支付巨额资金。通过公开上市和收购的退出同比增长了一倍多，达到近3000起。相关收益正回流到新的风投基金，今年迄今为止仅美国的风投基金就筹集了740亿美元，用一半的时间就几乎追平了2020年创纪录的810亿美元。风险投资家的钱多得都花不过来。在截至6月的三个月里，风格特别激进的纽约投资公司老虎全球管理（Tiger Global）平均每个工作日达成1.3笔交易。

估值飙升的第二个原因是投资者之间竞争加剧。过去，私人市场由帕罗奥图市（Palo Alto）沙山路的风投公司主导，而今养老基金、主权财富基金和家族办公室等相对较晚进入科技投资领域的后来者正在瓜分这一市场。过去一个季度，美国的“非传统”投资者参与了近1800笔交易，共筹集了570亿美元。很多人可能是受了风投界门外汉们早期试水的斩获鼓舞。另一家数据公司PitchBook估计，过去十年里，他们在第一轮融资中退出投资的年回报率平均为30%，是老牌风投公司（10%到15%）的两倍多。

这种连胜势头可能还是会黯然收场，一如两年前的情形。当时，估值飙高但商业模式不稳定的公司要么在IPO后失败（比如互为竞争对手的网约车公司优步和Lyft），要么始终没能走到IPO这一步（如办公室租赁公司WeWork，其上市计划在投资者临阵退缩后搁置）。许多近期上市的独角兽仍在亏损。根据本刊计算，那些在2021年上市的公司最近一个财年总共亏损了250亿美元。

其余的独角兽是否配得上它们的高估值？要评估这一点似乎前所未有地困难。和自己的前辈们一样，它们也不对外披露财务结果。同时，从早期独角兽的经历中也推断不出什么，因为它们都倾向于在赢家通吃的市场中不惜一切代价追求增长，而如今的独角兽通常都是试图靠销售真正独特的技术来获取不俗的利润。这有可能是一个更可持续的策略——如果其技术可行的话。但专家以外的人群就更难做出评估了，特别是在基于通常比原型

详尽不了多少的东西做判断时。两家电动汽车公司尼古拉（Nikola）和Lordstown于2020年通过与特殊目的收购公司（SPAC）反向合并上市，目前正因涉嫌夸大自身技术的可行性而受到美国当局调查。

另一个风险来自政治。世界各地的政府越来越不放心任由科技公司变得太大，或者进入金融或医疗等受监管的市场。中国政府对大型科技公司展开了广泛整顿，其中一项行动就是于近期阻挠了滴滴的运营。在该公司以680亿美元的市值在纽约IPO几天后，其应用被从中国的应用商店下架，表面声称的原因是它滥用用户数据。这类行动打击了投资者对中国创业公司的兴趣，后者在过去两个季度的融资实际上有所下降。在美国，证券交易委员会开始审查加密货币的使用。在去年的加密货币热潮中，许多加密货币交易所令投资者血脉贲张。其中全球最大的交易所之一Coinbase的市值在4月上市后达到峰值，如今已缩水了一半，跌去560亿美元。

因此，投资者最好要小心谨慎。而对其他所有人来说，这轮独角兽狂奔踩踏是个福音。因为风险投资主要涉及股票，几乎不涉及债务，所以即使是WeWork这样的失败案例或滴滴这样的警世故事也不会对金融体系造成什么风险。只要风险资本还在为亏损的创业公司提供资金，供它们提供受补贴的服务或开发巧妙的新产品，面对这些头顶犄角的神马们的馈赠，消费者只好恭敬不如从命，照单全收了。 ■



Renewable energy

Floating wind turbines could rise to great heights

But the taller they get, the harder they will be to repair

ON JULY 16TH Royal Dutch Shell, an oil and gas company, and Scottish Power, a subsidiary of Iberdrola, a Spanish electricity utility, made an announcement. They were, they said, jointly submitting proposals to the British authorities to build, off the coast of Scotland, the first large-scale set of floating wind farms in the world. At the moment, the largest floating farm is a six-turbine, 50MW array which is due for completion this month in the North Sea, 15km from Aberdeen. The consortium, by contrast, has said it is thinking in gigawatts (GW).

Offshore wind farms with foundations in the seabed are now part of the energy mix in several places. In the past four years their capacity has nearly doubled, from 19GW to 35GW, and amortised costs have dropped by a third, from \$120 per MW-hour to \$80. They are, however, of limited deployability, being restricted to waters shallower than about 60 metres.

Unfortunately, 80% of the world's offshore wind blows over places deeper than that. Making these accessible, says the International Energy Agency, an offshoot of the OECD, would unlock enough power to meet the world's probable electrical needs in 2040 11 times over. The trick is to build turbines which, though moored to the seabed, will float. If Shell and Scottish Power can pull this trick off, it will be a big step towards tapping that potential.

A decade ago, floating-turbine technology was a fringe affair. The difficulty was not the turbines themselves, but making them float. The oil and gas industry had, since the 1960s, developed a range of floating foundations that could keep titanic objects like drilling rigs stable at sea. But transferring

that know-how to wind power was hardly straightforward. First, unlike an oil rig, a wind turbine is lanky and top-heavy, making it prone to tip over. Second, turbines generate powerful gyroscopic forces that would further destabilise a floating machine. It was hard, in those days, to see how these problems could be solved cheaply enough to compete with turbines bolted to the ocean floor—much less with conventional power sources.

No longer. A decade of development has yielded two things: proof that turbines can float and clarity as to how these floating units might look. Engineers achieved this through patient prototyping. They took designs previously tested in university wave pools and scaled them up into small demonstration units off the coasts of Norway, Portugal and Japan.

Each unit, bedecked with sensors, gathered data on variables such as pitch, wind speed and wave height. These data were then folded into designs, for bigger, more stable units. The results, visible today in newer models off the Norwegian and Portuguese coasts, can safely float turbines four times as powerful as their predecessors. Engineers therefore consider the flotation problem solved. “The turbines function nicely. They don’t flip. It can be done,” said Alla Weinstein, a pioneer of the field who is now pursuing permits for a floating wind farm off the coast of California.

Four approaches to flotation have emerged (see diagram). The commonest is a semisubmersible. Principle Power, an American company, is one firm pursuing this. Semisubmersibles come in various designs. Principle’s uses a buoyant steel triangle that has water-filled cans at two of the vertices. These ballast tanks balance the weight of a turbine at the third vertex, with water pumped around inside the triangle to trim its stability.

A second tack, pursued by, among others, Equinor, a Norwegian firm, is to stick a turbine on a bottle called a spar that is filled with heavy ballast, to

make it float upright. Equinor does this by placing the turbine on top of an 80-metre-high concrete tube containing water, rocks or some other cheap and heavy material.

Two other approaches are less developed, but may prove useful. Glosten, an American engineering firm that has formed a partnership with General Electric, uses a tension-leg platform. This is a starfish-shaped steel structure with a turbine at its hub. The starfish is submerged and yoked to the ocean floor with cables. This arrangement, similar to that for the ultra-deep-water Magnolia rig, drilling in the Gulf of Mexico, holds the turbine upright. And BW Ideol, a Norwegian firm, erects the turbine on a flat concrete or steel barge that resembles an empty picture frame. When the turbine sways, water sloshes within the frame, dampening its movement. The company claims its prototype, off the coast of Japan, has already survived three typhoons.

Project developers have seen enough to convince them. Though the Shell-Scottish Power consortium's proposals (which make no mention of a preferred technological approach) are the most ambitious so far, they are not the first. Besides the 50MW array off Aberdeen, which is owned by Grupo Cobra, a Spanish construction company that uses Principle's design, Equinor has begun construction on an 11-unit, 88MW project which will power a group of North Sea drilling platforms. Total, a French oil and gas company, and Green Investment Group, a project-development arm of Macquarie, a bank, intend to start work on a 500MW floating wind project off the coast of South Korea by 2023—though they, too, have not yet specified which technology they plan to use.

Bigger farms obviously require more turbines. But they also, ideally, require bigger turbines. And the bigger a turbine is, the harder it is to maintain. Wind turbines occasionally need big parts, like blades or generators, replaced. That is challenging on terra firma. But on land, a crane can brace

itself against the earth. At sea, “jackup” vessels achieve similar stability by dropping steel legs to the seabed. Floating turbines will, however, operate in waters too deep for jackup vessels to work, so any vessel servicing one will have, itself, to remain floating. “You have two structures that are moving, and you’re going to shift the load from one of these moving structures to another one,” said Olav-Bernt Haga, a project director at Equinor. This will be technically demanding and thus hard to do cheaply.

A group called the Floating Wind Joint Industry Project (FWJIP), the job of which is to flag up matters of collective interest, deems this an urgent problem. This group is made up of 17 project developers and the Carbon Trust, a not-for-profit consultancy based in Britain. In an analysis published last year the FWJIP said that wind turbines are nearing the physical limits of what can be handled at sea. The oil industry has a number of heavy-lift ships that work in deep water. But these are optimised for weight, not height, and are expensive to hire. The floating-wind industry needs new answers, or it could find itself stunted, both literally and metaphorically.

Fortunately, prospects are in development. They take two broad approaches to the problem: lifting and climbing. An example of the former is OWL Heavy Lift, a Dutch company, which has started work on the OWL-010, a vessel dedicated to offshore-wind maintenance. Anyone working on floating wind turbines must contend with waves. A gentle swell at the surface can cause a treacherous sweep up high. The OWL-010 will iron out the effect of this swaying by using motion-compensation software that steadies the position of the crane’s hook to within 5cm. This works even when that hook is 150 metres above sea level.

The price tags for such vessels, though, start at around \$250m. The cost alone implies that the industry would have to share a small number of ships, presenting a bottleneck to growth. That is why some propose to stop reaching up to turbines, and to start climbing them, instead.

Climbing cranes, which scurry up the very object they are building, are often used to raise skyscrapers on land. They are unproven at sea, but several groups are developing versions that might suit floating wind power. SENSEWind, a firm in Cambridge, England, for example, suggests putting tracks on the sides of turbine towers. This would let a ship pull up alongside, place a maintenance car on the tracks, and thus move large parts up and down the tower.

Others propose to lift from the turbine itself. Most turbines have a small crane for light items. Liftra, a Danish company, uses this to raise progressively larger cranes. The biggest fits in a standard 40-foot (12.2 metre) shipping container. Once bolted on, the company claims, the arrangement is as powerful as a conventional external crane. Alternatively, as Conbit, a Dutch contractor, proposes, pulling a few metal parts and cables to the top of the tower would allow a heavy-duty crane to be fashioned temporarily on the turbine's crown.

None of these technologies is beyond the prototype stage. But they may prove valuable for the mega-turbines of tomorrow, be they fixed or floating. For floating turbines, however, an alternative may exist. Unlike fixed turbines, they can be unplugged and dragged to shore. Recent analysis sponsored by the FWJIP suggests that what is best in individual circumstances may depend on location. If a floating turbine is near the shore, it may be easiest to tow it back to port for repair. If far away, exotic gadgets like the OWL-010 or climbing cranes may work better.

The upshot of all this is that it may soon be possible to extract a lot more electrical power from the wind, to do so without covering hillsides with turbines, and to make a profit while doing it. And that is enough to put wind in anyone's sails. ■



可再生能源

漂浮式风力涡轮机可能高高升起在水上

但它们升得越高，维修起来就越难

七月十六日，石油天然气公司荷兰皇家壳牌和西班牙电力公司伊维尔德罗拉（Iberdrola）的子公司苏格兰电力（Scottish Power）发布公告称，它们正联合向英国政府提交一项提案，要在苏格兰沿海建造全球首个大规模漂浮式风电场。目前最大的漂浮式风电场是位于北海、距离阿伯丁（Aberdeen）15公里的六台涡轮机组，容量为50兆瓦，预计将于本月完工。而壳牌-苏格兰电力的联合体则表示，自己考虑建造的是吉瓦级机组。

如今，建造在海床上的海上风电场已经成为一些地方能源构成的一部分。过去四年里它们的容量几乎翻了一番，从19吉瓦增加到35吉瓦；摊余成本降低了三分之一，从120美元/兆瓦时下降到80美元/兆瓦时。但它们的部署有限制，目前只能建造在水深60米以内的海域。

遗憾的是，世界上80%的离岸风吹过的海域水深都超过60米。隶属于经合组织（OECD）的国际能源署（IEA）表示，这些离岸风如果得以利用，产生的电力将足足是2040年全球可能的电力需求的11倍。关键是造出虽然锚定在海床上却也能漂浮的涡轮机。如果壳牌和苏格兰电力能够解决这一关键问题，将是向开发这一潜能迈出的一大步。

十年前，漂浮式涡轮机还是项边缘技术。其难点不在于涡轮机本身，而在于让它们漂浮。自上世纪60年代以来，石油和天然气行业已经开发了一系列浮式基座结构，能够让钻井等庞然大物在海上保持稳定。但把这项技术转移到风力发电上可没那么容易。首先，与石油钻井不同，风力涡轮机不仅细长，还头重脚轻，这让它很容易翻倒。其次，涡轮机产生的强大回转力会进一步破坏浮式装置的稳定性。在那会儿，很难想象能有足够低成本的解决方案来和固定在海床上的涡轮机竞争，更不用说和传统能源竞争

了。

如今不一样了。十年的研发产生了两项成果：一是证明了涡轮机可以漂浮，二是弄清了这些漂浮装置的可能样式。工程师们不厌其烦地反复研究样机，终于取得了这些进展。他们先在大学的造浪池里测试设计模型，再按比例放大成小型演示装置，在挪威、葡萄牙和日本的沿海试验。

每个装置上都挂满了传感器，收集颠簸度、风速和浪高等变量的数据。这些数据而后被用于设计出更大、更稳定的装置。如今，我们可以从挪威和葡萄牙沿海的新机型中看到这些研究成果，它能让功率四倍于上一代产品的涡轮机安全地漂浮在海面上。工程师们由此认为漂浮的问题已经解决。“涡轮机运转良好。它们不会翻倒。这是可以做到的。”这一领域的先驱阿拉·温斯坦（Alla Weinstein）表示。他目前正申请在加州沿岸建造漂浮式风电场的许可证。

目前已有四种漂浮方法（见示意图）。最常见的是半潜式。美国公司Principle Power采用的就是这种方法。半潜式有多种设计方案。Principle的方案使用一个有浮力的钢制三角结构，三角的两个顶点安装有装满水的压载水舱。这些水舱通过调整水在三角结构中的分布来保持稳定，从而平衡第三个顶点上的涡轮机的重量。

另一种方法是将涡轮机固定在名为“立柱”的瓶型容器上，容器里装满了能让它直立漂浮的沉重压舱物。挪威的Equinor和其他一些公司采用的就是这种方法。Equinor将涡轮机放置在80米高的混凝土管上，管内装有水、石块或其他廉价的重物。

还有两种方法虽然不那么成熟，但也可能管用。美国工程公司Glosten已与通用电气合作，使用张力腿式平台。这是一个海星状的钢结构，涡轮机放置在它的中心。固定在海床上的锚索让“海星”得以淹没在海水中。这种设计类似于在墨西哥湾采油的超深水钻井平台马格诺利亚号

（Magnolia），可以让涡轮机保持直立。挪威公司BW Ideol则将涡轮机安装在一个扁平的、像空画框一样的混凝土或钢制驳船上。当涡轮机摇摆

时，水就在框内晃荡，起到减缓它运动的作用。该公司声称，它的样机已经在日本沿海经受住了三次台风的考验。

这些技术进展足以让项目开发商信心满满。壳牌-苏格兰电力联合体没有提及自己青睐哪种技术方案，尽管它们的提议是迄今为止最为雄心勃勃的，但并不是第一个。阿伯丁附近50兆瓦的机组属于西班牙建筑公司 Grupo Cobra，使用的是Principle的设计方案。此外，Equinor已经开始建设一个有11台涡轮机、容量88兆瓦的项目，为一批北海钻井平台提供电力。法国石油天然气公司道达尔和麦格理银行（Macquarie）的项目开发子公司绿色投资集团（Green Investment Group）打算在2023年前在韩国沿海动工建造一个500兆瓦的漂浮式风力项目——尽管它们也还没具体说明计划使用哪种技术。

显而易见，发电场越大需要的涡轮机就越多。但在理想情况下，它们也需要更大的涡轮机。而涡轮机越大，维修保养就越困难。风力涡轮机需要不时更换叶片或发电机等大型部件。这在陆地上就已是个挑战。但在陆地上，起重机至少还可以稳稳立在地面上。在海上，“自升式”船舶通过把钢质桩腿下沉到海床上来获得类似的稳定性。但漂浮式涡轮机工作的海域往往水太深，自升式船舶无法运作，因此所有维修涡轮机的船舶都只能保持漂浮不定的状态。“这两个结构体都在移动，而你要把负载从其中一个移动的结构体转移到另一个上。”Equinor的项目总监奥拉夫·伯恩特·哈加（Olav-Bernt Haga）说。这在技术上要求很高，因此很难做到低成本。

一个名为漂浮式风电产业联合项目（Floating Wind Joint Industry Project，以下简称FWJIP）的组织认为这是当务之急，该组织的职责是指出攸关整个行业利益的问题。其成员包括17个项目开发商以及英国非营利咨询机构碳信托（Carbon Trust）。FWJIP去年发布的一份分析报告指出，风力涡轮机已经接近在海上安装维护的物理极限。石油行业有许多在深水中作业的重型起重船。但这些起重船优先考虑的是吊装重量，而不是高度，且租金昂贵。漂浮式风电行业需要新对策，否则它就可能发现自己“长不高”了——不管是物理高度还是发展高度。

幸运的是，一些有望成功的解决方案正在研发中。这些方案大体采用两种办法来解决上述问题：起吊和爬升。起吊的例子是荷兰公司OWL Heavy Lift，该公司已经开始着手研发用于海上风电设备维护的船舶OWL-o10。任何研发漂浮式风力涡轮机的公司都必须处理波浪的问题。轻微的海面浪涌都可能在高处造成危险的摆动。OWL-o10将使用运动补偿软件来消除这种晃动的影响，该软件能把起重机的吊钩位置稳定在5厘米以内，即使吊钩位于海平面以上150米处。

然而，这类船舶的起步价就在2.5亿美元左右。仅这一项费用就意味着该行业将不得不共享少量船舶，这会制约行业发展。这就是为什么有人建议不要再试图用吊臂去够那些涡轮机，而是从涡轮机的机体上爬上去。

爬升式起重机能快速攀爬上正在施工的建筑物，常被用来在陆地上建造摩天大楼。虽然它们还没有在海上经过检验，但有几家企业正在开发可能适用于漂浮式风电项目的爬升式起重机。例如，位于英国剑桥市的SENSEWind公司建议在涡轮机塔柱的侧面安装轨道，这样就可以让船舶停靠在塔柱边，把维修车放到轨道上，从而沿塔柱上下运送大型零部件。

其他人则建议直接利用涡轮机来起吊。大多数涡轮机都自带一个能起吊轻量物品的小型起重机。丹麦公司Liftra利用这种小型起重机循序渐进地把越来越大的起重机吊上去。最大的起重机可以装进标准的40英尺（12.2米）的集装箱里。该公司声称，只要用螺栓固定住，这样安装起来的起重机就能和传统的外部起重机一样强大。或者还可以像荷兰承包商Conbit提议的那样，将一些金属部件和电缆拉到塔柱顶端，就可以在涡轮机的顶部临时搭建一个重型起重机。

所有这些技术都还处于样机阶段。但它们可能对未来的巨型涡轮机很有价值，无论是固定式还是漂浮式的。不过，对漂浮式涡轮机来说可能还有一种选择。不同于固定式涡轮机，它们可以解开锚索，被拖到岸上。FWJIP近期资助的一项分析认为，在具体个案中，到底用哪种方案最好可能要取决于地点。如果漂浮式涡轮机离岸不远，将其拖回港口维修可能是最简单的办法。如果离岸很远，像OWL-o10这样的新奇玩意或是爬升式起重机可

能会效果更好。

这一切的结果是，风电发电量可能很快会大幅上升，却不需要在山坡上到处安装涡轮机，同时还能从中盈利。这足以让所有人鼓起信心的风帆。 ■



Robinhood and the merry mob

Robinhood takes its IPO to the masses

Our Wall Street correspondent participates

IT WOULD BE hard for a firm that describes itself as “democratising investing” to go public in any other way. When Robinhood lists on the Nasdaq on July 29th, after *The Economist* goes to press, institutional investors will, as is usual, be able to buy and trade shares on the exchange. Less conventionally, the broker also plans to sell a third of the shares in itself to its users.

Your correspondent felt a frisson of excitement as she took part in an initial public offering (IPO) for the first time, bidding for a single share in Robinhood. The slick graphics explained how IPO shares are allocated, and reassured punters that—as is not the case at other brokers—order size, assets and the age of the account would play no part in whether a bid was accepted or not. Before most firms go public they do a roadshow, which typically involves investment bankers compiling snazzy slideshows, donning their sharpest suits and fanning out to meeting rooms in big cities to canvass support from pension funds, asset managers and other institutional investors. Robinhood instead made its 40-minute pitch online to anyone who wanted to listen, on the Saturday afternoon ahead of its debut.

The anti-establishment approach is all too fitting. No other company’s fortunes have been as tied to the craze for meme stocks, fuelled by online forums and lockdown-induced spare time. Robinhood, which will go public at a valuation of \$32bn, has seen its user base explode during the pandemic (see chart 1). Its prospects are likely to be determined by wherever the retail mania, the subject of much regulatory hand-wringing, goes next.

For decades retail investors were overlooked and underserved. The rich might have dabbled in trading stocks directly, but most workers earned defined-benefit pensions, which kicked any portfolio-management decisions regarding their biggest pot of savings to pension funds. The transition to self-directed 401K retirement plans, registered investment advisers and retail brokers was at first accompanied by wide trading spreads and meaty fees.

Then the adoption of new technologies—such as computerised trading and wicked-fast marketmaking algorithms—helped erode spreads. In 2013 Baiju Bhatt and Vlad Tenev, Robinhood's founders and former employees of marketmakers, saw that it might be possible for a retail broker to make money by offering consumers commission-free stock trading. It could instead earn revenues through “payment for order flow”. This is the practice by which a high-frequency marketmaker pays a broker a cut of the spread it earns from trading in exchange for the broker directing its customers' trades to the marketmaker.

For a time the big retail brokers ignored the plucky upstart and continued to charge commissions and fees. But by 2019 the writing was on the wall. A quick, brutal price war broke out. Charles Schwab, followed by E*Trade, TD Ameritrade and eventually the biggest broker of all, Fidelity, succumbed, scrapping their commissions and trading fees.

Lower costs for investors are a laudable thing. At Robinhood's roadshow Mr Tenev claimed that his firm helped people buy shares in firms they love and got them excited about investing. By Robinhood's reckoning, half of all brokerage accounts opened in America since 2015 have been set up on its platform. But the broker has also been at the centre of unease about the retail revolution, which peaked during the speculative frenzy in GameStop, a struggling video-game retailer, earlier this year. The company's share price spiked from \$17 in January to more than \$450 two weeks later. So much

of the trading volume came from retail investors, and so much of it was directed through Robinhood, that the broker was forced to suspend trading in GameStop because it lacked the capital to cover the two-day lag between its users' trades and their settlement.

The queasiness over Robinhood's success stems from two sources. For a start, when the price of something falls, people tend to do more of it. According to data in the firm's IPO filing, around half of its users check their investments on its app every day. But plenty of research papers find that the more people trade, the worse their returns. Another concern is that Robinhood exposes its users to risky products. Its profit margins are slimmest for the vanilla stuff, like stock trading, but rise as its customers dabble in riskier, more complicated markets, such as trading derivatives or buying cryptocurrencies. Although options and cryptocurrencies make up about 17% of the \$80bn in assets that Robinhood oversees, more than half of its transaction revenues come from these categories (see chart 2).

These worries have led lawmakers to question whether retail investors stand to make any gains from Robinhood. Summoned to Congress after the GameStop affair, Mr Tenev claimed that its users had earned more than \$35bn in profits by buying stocks and investments, compared with what they had deposited with the broker. But Jim Himes, a congressman from Connecticut and a former banker, skewered him. "\$35bn is a meaningless number unless you convert it to a rate of return so that I can compare it to Treasuries, so I can compare it to the S&P 500." Mr Tenev deflected, claiming the right comparison was the lower bar of "not investing at all" because many of Robinhood's customers were new to trading.

Whether the firm's empowerment of retail investors has been desirable or not is more than a philosophical matter. It is also the key question that any investor in Robinhood, institutional or retail, will have to wrestle with,

because it pertains to where the potential risks and rewards lie. It is also a subject on which punters and regulators seem to disagree.

The downside for potential shareholders is that Robinhood is unlikely to escape the scrutiny of regulators. Much of the broker's 300-page prospectus discusses the main risks to its business. These include the possible introduction of a financial-transaction tax, which might scupper its ability to offer free trading and deter customers from trading every day. It also allows for the possibility that payment for order flow, which accounts for 80% of Robinhood's revenues, might be restricted or banned by regulators.

Indeed, Gary Gensler, the head of the Securities and Exchange Commission, has said his agency is looking closely into whether the current market structure creates conflicts of interest. The financial-services committee of the House of Representatives, which hosted the GameStop hearing, has drafted a bill that bans payment for order flow.

Retail punters, however, remain far more enthusiastic about Robinhood than regulators, which provides potential investors with an upside. It was common (including in the pages of *The Economist*) to expect that the GameStop episode could be the undoing of Robinhood; that its original adopters might feel betrayed by the firm's suspension of trading in GameStop and junk the app. But the company's user numbers suggest that the adage "all publicity is good publicity" still holds. In the first half of 2021 alone more than 10m funded trading accounts were opened on Robinhood, boosting the total number of accounts by 80%. If there is one constant about the retail mania, it is its sheer unpredictability. That might be why your correspondent feels comfortable with her bid for just a single share, content mainly to watch from the sidelines. ■



罗宾汉与快乐民众

罗宾汉的IPO向普罗大众开放

本刊驻华尔街记者也参与其中

对于一家自诩要实现“投资民主化”的公司来说，或许也只能以这种方式上市了。7月29日（即本刊新一期付印之后），罗宾汉（Robinhood）在纳斯达克上市。如往常一样，机构投资者可以在交易所购买和交易其股票。但不同寻常的是，这家券商还计划将自己三分之一的股票配售给其平台用户。

笔者申购了一股罗宾汉股票，第一次参与IPO，内心一阵激动。一张张精美的图表解释了IPO股票将如何分配，还向投资者保证，申购数量、资产规模和开户时长完全不会影响中签与否——这一点与其他券商截然不同。大多数公司在上市前都会举行路演，通常由投行人士制作出漂亮的幻灯片，穿上最考究的西装奔赴各大城市，在会议室里争取养老基金、资产管理公司和其他机构投资者的支持。罗宾汉却只是在上市前的周六下午在网上向任何有兴趣一听的人做了40分钟的宣讲。

这种反建制的方法再合适不过了。没有哪家公司的命运像它这样与散户对神股的疯炒息息相关，而散户的这种狂热又是受了网上论坛和抗疫封锁带来的闲暇时间推波助澜。罗宾汉将以320亿美元的估值上市，其用户群在疫情期间呈爆炸式增长（见图表1）。它的前景很可能取决于这轮散户狂潮接下来卷向哪里，这种狂热已经令监管部门大为抓狂。

几十年来，散户投资者一直被忽视和怠慢。富人可能已经直接涉猎股票交易，但大部分工薪阶级还只能依靠固定收益养老金，这就把他们最大的一笔储蓄的投资组合管理决策全部交给了养老基金。之后他们开始转向自我管理的401K养老金计划、注册投资顾问和零售券商，但一开始交易价差巨大，收费也十分昂贵。

后来，新技术的应用帮助缩小了价差——例如计算机化交易和超高速做市算法。2013年，曾在做市商工作的罗宾汉创始人白朱·巴特（Baiju Bhatt）和弗拉德·特涅夫（Vlad Tenev）发现，零售券商有可能靠向客户提供免佣金的股票交易赚钱。它们可以转而从“订单流付款”赚取收入。在这种做法下，零售券商将其顾客的交易引流给高频做市商，做市商支付一部分交易差价作为回报。

开始的一段时间里，大型零售券商根本没有将这个大胆的新贵放在眼里，继续收取佣金和费用。但到了2019年，变局已经势不可挡。一场迅速而残酷的价格战爆发了。先是嘉信理财（Charles Schwab），然后是E*Trade、德美利证券（TD Ameritrade），最后是最大的券商富达（Fidelity），各家券商纷纷屈服，取消了佣金和交易费。

对投资者来说，降低成本值得称许。在罗宾汉的路演中，特涅夫声称，他的公司帮助人们购买心仪的股票，并激发他们对投资的兴奋情绪。据罗宾汉统计，美国自2015年以来开设的所有经纪账户中，有一半是在它的平台上开户的。但这家券商也处于散户革命引发的震荡的震中。今年早些时候，在围绕深陷困境的电子游戏零售商游戏驿站（GameStop）的投机狂潮中，这场革命达到了顶峰。该公司的股价在1月时还是17美元，两周后冲破450美元。这些散户的交易量如此巨大，且很大一部分经由罗宾汉下单，以至于它被迫暂停了游戏驿站股票的交易，因为在用户成交和结算之间有两天的时间差，而它没有足够的资金满足期间的保证金要求。

罗宾汉的成功令人不安，原因有二。首先，交易成本降低，人们往往会更频繁地买卖。据该公司IPO文件显示，约有半数用户每天都在应用上查看自己的投资。但大量研究文章指出，用户交易得越多，回报反而越低。另一个担忧是罗宾汉让用户接触高风险产品。股票交易等常规业务的利润率最低，但随着客户涉足风险更大、更复杂的市场，例如交易衍生品或购买加密货币，利润率就会提高。尽管期权和加密货币在罗宾汉800亿美元的代管资产中只占17%，但却贡献了一半以上的交易收入（见图表2）。

出于这些担忧，议员们质疑散户投资者到底能否通过罗宾汉获益。游戏驿站事件发生后，特涅夫在被美国国会传唤时声称，与用户最初存入其平台的资金相比，他们通过购买股票和投资赚到的收益已逾350亿美元。但他遭到了来自康涅狄格州的众议员、前银行家吉姆·希姆斯（Jim Himes）的猛烈抨击。“350亿美元这个数字毫无意义，除非你把它转换成收益率，这样我才能把它和美国国债相比较，和标普500指数相比较。”特涅夫回避了这个问题，声称要和“完全不投资”这个更低的标准做比较才对，因为罗宾汉的许多客户都是交易新手。

该公司为散户投资者赋权是否可取不仅仅是个哲学问题，也是任何投资罗宾汉的机构或者散户都必须思考的关键问题，因为这关系到潜在风险和回报的所在。在这个问题上，投资者和监管者似乎也存在分歧。

对潜在持股者来说，下行风险是罗宾汉看起来难以逃脱监管机构的审查。这家券商长达300页的招股书中相当大的篇幅都在讨论其业务面临的主要风险。其中包括可能引入的金融交易税，这可能会让它无法再提供免佣交易，并打消客户每天都做交易的念头。招股书也承认，占罗宾汉收入80%的订单流付款有被监管机构限制或禁止的可能。

事实上，美国证券交易委员会主席加里·詹斯勒（Gary Gensler）曾表示，证交会正在密切研究当前的市场结构是否会造成利益冲突。主持游戏驿站听证会的众议院金融服务委员会已经起草了一项法案，计划叫停订单流付款。

然而，投机的散户对罗宾汉的热情仍远高于监管机构，这又为潜在投资者提供了上行空间。此前普遍的看法（包括本刊过去的报道在内）是游戏驿站事件可能成为罗宾汉的祸根；它最初的拥护者可能会因为它暂停了游戏驿站股票的交易而感到被背叛并弃用该平台。但从该公司的用户数来看，“所有的宣传都是好宣传”这句俗语仍然有效。仅在2021上半年，罗宾汉上就新开了超过1000万个有资金的交易账户，账户总数增长80%。如果说散户狂热有一点长久不变，那就是它的完全不可预测。也许正因为如此，笔者对自己只申购了一股感觉良好——在一边旁观就心满意足了。■



Faceworld

Facebook eyes a future beyond social media

Advertising has made the social network into a trillion-dollar company. Can new ventures take it further?

FACEBOOK HAS always had two faces. One is the grimace of a firm that many people, in particular politicians, love to hate. President Joe Biden recently accused the social-media giant of “killing people” by spreading misinformation about vaccines against covid-19. (He later rowed back a bit after Facebook pointed out it does quite a lot to stop the spread of such content and to promote legitimate vaccine advice.)

The other face is a happy one of a firm that users, advertisers and investors cannot live without. It was grinning again on July 28th, when it presented second-quarter results. Revenues rose by 56%, year on year, to \$29bn—despite Apple’s update in April to its iPhone operating system that let users easily opt out of being tracked around the web by apps like Facebook. That puts it on track to exceed \$100bn in sales this financial year. Quarterly net profit hit \$10.4bn, double that of a year ago. Despite a wobble in late trading after Facebook warned of slowing sales growth in coming quarters, it looks poised to become a paid-up member of the exclusive club of companies with a market capitalisation above \$1trn, which it joined earlier this year (see chart).

How can a firm with such baggage be so successful? The answer also has two faces to it. With 2.9bn daily global users, Facebook’s main offerings—its flagship social network (known internally as Blue), photo-sharing on Instagram and messaging on WhatsApp and Messenger—are a digital magnifying glass of human nature. This glass amplifies the good (neighbourly help amid the pandemic) as well as the bad (conspiracy

theories and quack cures). It also serves as a remarkable lens for advertisers to focus on the world's consumers. And the two-facedness is likely to become more pronounced if Facebook succeeds with its biggest project yet: creating a "metaverse" that would combine a 3D digital world with the 3D physical one.

At its core Facebook is a giant advertising machine. Ads generate 98% of revenue. Blue is a dominant ad platform internationally, raking in some \$55bn last year, estimates KeyBanc Capital Markets, an investment firm (Facebook does not break out results by service). Instagram, which Facebook bought in 2012 for \$1bn, now chips in another \$20bn or more, taking its share of overall ad revenues to nearly 30%, from just over 10% in 2017.

Debra Aho Williamson of eMarketer, a data provider, calls Facebook's ability to target ads "incredibly precise". Advertisers value this precision highly: Facebook earns \$8 a quarter for every one of its users, nearly twice as much as Twitter. The firm watches what its users do not only on its own services, but almost everywhere else online. This lets it pick which products to offer to a given user, identify others with similar interests and determine whether they buy anything after seeing an ad.

Even before the pandemic hit, this was hard to resist: for smaller firms with fewer resources to run sophisticated marketing operations, which make up the bulk of Facebook's 10m advertisers, but also for big global brands. Even Chinese sellers are spending billions of dollars on Facebook, says Brian Wieser of GroupM, which places ads on behalf of brands. Facebook's apps may be banned in China, but Chinese merchants can plug their wares to Western consumers thanks to firms such as Wish, an American online marketplace that helps arrange ads, payment and shipping.

Covid-19 has turbocharged Facebook's machine. Self-isolating American adults spent on average nearly 35 minutes per day on Blue in 2020,

according to eMarketer, two minutes more than the year before. That adds up to more than 10,000 additional years of collective attention. While some firms went belly-up or cut ad spending in last year's recession, others were born: 6.6m in America alone since the start of the pandemic. Many crave some of the extra attention. Today it is as unthinkable to run an online consumer business without targeted ads as it once was to run one with no shopfront, says Mark Shmulik of Bernstein, a broker. A bigger slug of such firms' budgets will be spent on Facebook and its fellow ad-tech giant, Google, he says. Admen are calling it "the new rent".

Facebook has added more than 2m renters in the past 15 months. It will add more as economies reopen and digital ads, which now make up 60% of overall ad spending in America, keep chipping away at old media. Facebook has warned of a "greater impact" of Apple's tracking opt-out in the current quarter; Flurry, a data firm, estimates that four in five iPhone users have opted out. But even if this makes Facebook's targeting a bit less effective, it will still be at least as good as its rivals', predicts Mark Mahaney of Evercore ISI, an investment bank.

And though on July 23rd American trustbusters got another three weeks to refile a lawsuit against Facebook, which had been thrown out last month for lack of evidence, they will struggle to prove that it is a social-networking monopolist under current competition law. For all the anti-tech bluster in Washington, law is unlikely to change as long as Congress stays polarised.

The bigger threat to Facebook's prospects, which has long preoccupied Mark Zuckerberg, its co-founder and boss, is that the virtual masses tire of its apps and move elsewhere, pulling advertisers with them. In the past two years a new generation of social media has emerged that poses just this threat. Although Facebook's share of American digital advertising has continued to grow, its global social-media advertising has been edging down since 2016. The challengers range from specialists such as Clubhouse and Discord, two

audio-chat services, to Snapchat and TikTok, which take on Blue and especially Instagram more directly. TikTok fans in America now spend more than 21 hours a month on the video app, compared with less than 18 hours that users spend on Blue, according to App Annie, a market-research firm.

In the past Facebook might have bought smaller rivals, as it did with Instagram. With trustbusters looking on, it is instead placing a series of big bets. The first is on the “creator economy”, where people make money from digital works. This is an extension of its ad business, but one in which it has fallen behind. TikTok and YouTube, in particular, have been better at attracting creators who keep users glued to their screens. In April Facebook said it was developing new audio features, including Clubhouse-like chat rooms where listeners can tip performers. In June it launched Bulletin, a newsletter-hosting service similar to Substack, which popularised the genre. This month Mr Zuckerberg vowed to shower creators on Blue and Instagram with \$1bn by the end of next year (he didn’t say what form the payments would take).

Facebook’s second bet looks beyond advertising to e-commerce. It already hosts 1.2m online shops on Blue and Instagram. That puts it in the same league as Shopify, a fast-growing rival to Amazon, which has 1.7m. A month ago Facebook introduced a new way to let buyers try on clothes virtually. It also plans to link its “Shops” offering with Marketplace, its existing peer-to-peer trading service, and WhatsApp, which it wants to turn into a vehicle for chat-based “conversational commerce”, the latest thing in online shopping. Later this year it wants to phase in Diem, its controversial cryptocurrency, which would beef up its payments infrastructure.

For now Facebook has waived seller fees, but they could add a few billion dollars to its turnover as soon as next year. Besides bringing in non-advertising revenues, an e-commerce business would also help the firm with its tracking problem. If shoppers spend more time and leave more

data on its platform the inability to follow them elsewhere on the web becomes less important. Mr Shmulik expects e-commerce to fragment into such walled gardens, each combining shopping and advertising, and operated by a tech giant.

Mr Zuckerberg's grandest gamble concerns the metaverse. When he spent \$2bn in 2014 to buy Oculus, a maker of virtual-reality (VR) gear, many thought he was buying himself a toy. But in recent years Facebook has made other VR acquisitions, most recently BigBox VR, developer of "Population: One", a shooter game similar to "Fortnite". This hands Facebook control of a hardware platform for VR and "augmented reality" (AR), which serves users digital information as they survey the real world through smart spectacles and the like.

As with e-commerce, part of Facebook's rationale may be to lessen its dependence on the whims of hardware-makers such as Apple. The potential prize is large. Sales of Oculus headsets contributed around \$1bn to Facebook's revenues last year. If the technology keeps improving, VR and AR are the obvious next phase of gaming, which has matured into an industry with global revenues of \$180bn.

Mr Zuckerberg's ambitions do not stop there, however. He doesn't see the metaverse, which now has its own division within the firm, merely as a place to enjoy games or other immersive entertainment. Instead, he envisages it as a virtual space where people live and work, in keeping with a dream that geeks have harboured since 1992, when the term "metaverse" was coined by Neal Stephenson, a science-fiction author. In five years' time, Mr Zuckerberg has said, he would like Facebook no longer to be seen primarily as a social-media company but as a metaverse company.

That would make Facebook cool again. It would also bring more scrutiny from critics worried about the firm's power. If users start spending 35 hours

a week immersed in its virtual world, rather than 35 minutes a day, this may invite regulation that actually bites. For now, the metaverse is inviting something Mr Zuckerberg fears more: competition. Others are sizing up the field, from video-game firms like Roblox and Epic Games, to other tech giants. Apple is reportedly planning its own AR glasses; Microsoft already sells AR goggles. If Facebook beats them to metaverse supremacy, it will have plenty to grin about. Otherwise, expect grimacing. ■



脸谱宇宙

Facebook展望的未来超越社交媒体

广告让这个社交网络平台成为市值万亿美元的公司。新业务能带它走得更远吗？

Facebook一直都有两副面孔。一副是遭千夫所指尤其是又被政客拿来当靶子时的一脸苦相。最近，美国总统拜登指责这家社交媒体巨头传播有关新冠疫苗虚假消息的做法是在“杀人”。（在Facebook指出自己付出了不少努力来阻止此类内容的传播及宣传合理的接种建议后，他的语气有所缓和。）

另一副面孔是因为用户、广告主和投资者都离不开自己而喜形于色。7月28日，当它公布第二季度业绩时，脸上又绽放了笑容。尽管苹果在4月更新了iPhone操作系统，让其用户可以轻松选择不被Facebook等应用跟踪自己在网上的活动，但Facebook第二季度的收入仍然同比增长56%，达到290亿美元。这使得Facebook本财年的销售额有望突破1000亿美元。第二季度净利润达104亿美元，同比增长一倍。尽管在Facebook警告称未来几个季度销售增长将放缓之后，其股价在盘后交易中出现了波动，但它看起来势将成为市值万亿美元的高端企业俱乐部里的铁杆会员。它于今年早些时候加入了这个俱乐部（见图表）。

一家背负如此沉重包袱的公司怎么会这么成功？答案也有两个面向。在全球拥有29亿日活跃用户的Facebook的主要业务都是人性的数字放大镜，包括其王牌社交网络（在内部称为Blue）、Instagram的照片分享，以及WhatsApp和Messenger的即时消息等。这面镜子不仅放大了人性恶的一面（如阴谋论和江湖骗术），也放大了善的一面（如疫情期间的邻里互助）。它还为广告主提供了一个聚焦全球消费者的绝佳镜头。如果Facebook迄今为止最大的计划获得成功，它的这种两面性很可能更加明显。这个计划就是创建一个将3D数字世界与3D物理世界结合起来的“元宇宙”。

从本质上说，Facebook是一台巨型广告机器。广告占到它收入的98%。投资公司KeyBanc Capital Markets估计，Blue是在国际上占主导地位的广告平台，去年收入约550亿美元（Facebook的业绩不按业务划分）。

Facebook在2012年以10亿美元收购的Instagram如今贡献了200亿美元或更多，在广告总收入中的占比从2017年的略高于10%增长到目前的近30%。

数据供应商eMarketer的黛布拉·阿霍·威廉姆森（Debra Aho Williamson）称，Facebook的定向广告“精准到不可思议”。广告主非常看重这种精准度：Facebook每季度从每位用户身上赚取八美元，几乎是推特的两倍。Facebook不仅关注用户在自家服务上的行为，还关注他们在其他几乎所有在线服务上的行为。这让它可以选择性地向特定用户推荐商品，识别出其他有类似兴趣的用户，并确定他们是否在看到广告后购买了什么东西。

即便在新冠疫情爆发之前，这也让人难以抗拒：无论是对那些没有足够的资源开展复杂营销活动的小公司（它们在Facebook的1000万广告主中占大部分），还是那些全球性的大品牌。为品牌投放广告的群邑集团

（GroupM）的布赖恩·威泽（Brian Wieser）表示，就连中国卖家也开始在Facebook上花费数十亿美元。中国国内可能禁用Facebook的应用，但有了像Wish这样的美国在线市场帮助商家安排广告、支付和配送，中国的商家可以向西方消费者推销自己的商品。

新冠疫情让Facebook的广告机器更加动力十足。根据eMarketer的数据，2020年，自我隔离的美国成年人平均每天花在Blue上的时间接近35分钟，比上一年多了两分钟。这让总体关注时长又增加了一万多年。尽管一些公司在去年的经济衰退中破产或者削减了广告费，但另一些公司却逆势而生：自疫情爆发以来，仅美国就新成立了660万家公司。很多公司渴望得到一些额外的关注。经纪公司盛博的马克·什穆利克（Mark Shmulik）表示，如今运营电商业务而不做定向广告，就像过去做这种买卖而没有店面一样不可想象。他说，这类公司会把更大一部分预算花在Facebook和另一家广告科技巨头谷歌身上。广告人称之为“新租金”。

在过去15个月里，Facebook新增了200多万“租户”。随着经济重启以及数

字广告（目前占美国广告总支出的60%）继续蚕食传统媒体的份额，这一数字还会继续增加。Facebook警告称，苹果关闭应用跟踪的功能将在本季度产生“更大影响”；数据公司Flurry估计，五分之四的iPhone用户选择了关闭应用跟踪。即便Facebook定向广告的效果因此打了些折扣，但至少仍然不输其竞争对手，投资银行Evercore ISI的马克·马哈尼（Mark Mahaney）预计。

6月，美国反垄断机构对Facebook提起的诉讼因证据不足而被驳回。虽然7月23日它们又获得了三周时间，准备再次对Facebook发起诉讼，但根据现行的竞争法，还是很难证明Facebook是社交网络的垄断者。尽管打压科技巨头的呼声在华盛顿不绝于耳，但只要国会的意见保持分化，现有法律就不太可能被改变。

对Facebook前景威胁更大的是网络用户对它心生厌倦，转而选择其他应用，并带走广告主。这一直困扰着Facebook的联合创始人兼老板扎克伯格。过去两年里，新一代社交媒体的出现就构成了这样的威胁。尽管Facebook在美国的数字广告业的份额持续增长，但其全球社交媒体的广告业务自2016年以来一直在下滑。它的挑战者既有Clubhouse、Discord等专门的语音聊天服务商，也有Snapchat和TikTok（它们更直接地与Blue，尤其是Instagram展开竞争）。根据市场研究公司App Annie的数据，美国的TikTok粉丝现在每个月花在这款视频应用上的时间超过21个小时，而用户在Blue上花的时间不到18个小时。

放在过去，Facebook可能会像收购Instagram一样，把规模较小的竞争对手收入囊中。如今，被反托拉斯机构紧盯着的Facebook转而开始押下一连串大赌注。第一个赌注是“创作者经济”，即让人们从自己的数字作品中挣钱。这是它的广告业务的延伸，但在这方面它已经落后于人。TikTok和YouTube在这方面尤其出色，它们更能吸引那些让用户目不转睛地盯着屏幕的创作者。今年4月，Facebook表示自己正在开发新的音频功能，包括类似Clubhouse的聊天室，听众可以在里面给主播打赏。6月，它推出了一款类似于Substack的时事通讯托管服务（正是Substack带火了这一形式）Bulletin。7月，扎克伯格承诺，到明年年底将向Blue和Instagram的创

作者们分发10亿美元，不过他没有说明支付方式。

Facebook的第二个赌注是在广告以外放眼电子商务。它在Blue和Instagram上已经有了120万家网店。这让它与快速增长的Shopify旗鼓相当，这个亚马逊的劲敌拥有170万家网店。一个月前，Facebook推出了一种让买家虚拟试衣的新方式。它还计划将其“店铺”（Shops）功能与其现有的点对点交易服务Marketplace以及WhatsApp连接起来。它希望将WhatsApp转变为基于聊天的“对话式商务”工具，这是在线购物的最新趋势。Facebook希望能在今年晚些时候逐步启用其备受争议的加密货币Diem，以加强其支付基础设施。

目前，Facebook免除了商家付费。但最快在明年，它们可能就会让它的营业额增长数十亿美元。除了带来非广告收入，电子商务业务还能帮助Facebook解决追踪用户的问题。如果购物者在它自己的平台上花了更多时间、留下更多数据，那么无法在网上其他地方跟踪他们也就不那么重要了。什穆利克预计，电子商务会分解成一个个这样的围墙花园，每个都将购物和广告结合起来，并由一家科技巨头运营。

扎克伯格最大的豪赌是元宇宙。2014年，当他斥资20亿美元收购虚拟现实（VR）设备制造商Oculus时，很多人认为他是给自己买了个玩具。但最近几年，Facebook还收购了其他几家VR公司，包括最近收购的BigBox VR，它开发了类似《堡垒之夜》（Fortnite）的射击游戏《Population: One》。这让Facebook掌握了一个VR和AR（增强现实）的硬件平台，当用户通过智能眼镜等设备勘察真实世界时，该平台为他们提供数字信息。

和电子商务一样，Facebook这样做的部分原因可能是为了减少对态度变化无常的硬件制造商的依赖，比如苹果。回报可能也很巨大。去年，Oculus头显的销售为Facebook贡献了约10亿美元的收入。游戏业已经成为一个全球营收达1800亿美元的产业，如果技术不断改进，VR和AR显然将成为游戏业的下一个阶段。

然而，扎克伯格的雄心不止于此。尽管Facebook内部已经设立了专门的元

宇宙部门，但扎克伯格并不仅仅把元宇宙视为享受游戏或其他沉浸式娱乐的地方，而是把它设想为人们生活和工作的虚拟空间，也就是自1992年科幻作家尼尔·斯蒂芬森（Neal Stephenson）创造“元宇宙”一词以来极客们一直心怀的梦想。扎克伯格表示，他希望五年之后，Facebook首先被视为一家元宇宙公司，而不是社交媒体公司。

这将让Facebook再次变得酷炫。同时也会让那些担心它势力过大的批评者更加盯紧它。如果用户沉浸在它的虚拟世界中的时间开始变成每周35小时，而不是每天35分钟，可能就会招致真正让它伤筋动骨的监管。目前，元宇宙带来的东西是扎克伯格更担心的：竞争。从Roblox、Epic Games等视频游戏公司，到其他科技巨头，很多公司都在评估这个领域。据报道，苹果正计划推出自己的AR眼镜，而微软的AR眼镜已经上市销售了。如果Facebook能打败它们，成为元宇宙霸主，它可就有很多理由咧嘴笑了。否则就等着看它愁眉苦脸吧。 ■



Natural resources

People may one day drill for copper as they now drill for oil

And they could even help the environment in the process

COPPER WAS the first metal worked by human beings. They hammered it into jewellery and ornaments as much as 11,000 years ago. Today, Homo sapiens uses more than 20m tonnes of the stuff a year, much of it in buildings and electrical infrastructure. More will be required in coming decades, to meet the need for widespread electrification brought about by the transition to less carbon-intensive economies. Copper is an essential part of batteries, motors and charging equipment. Solar and wind installations use more copper than their fossil-fuel counterparts, and electric vehicles contain four times more copper than do cars with combustion engines.

This has spurred interest in new sources of the metal, most of which comes at the moment from rocks dug out of vast opencast mines that are then ground up and processed to release the copper they contain, typically about 1% of their mass.

Metal-rich nodules scattered across various parts of the ocean floor are a possibility. But exploiting these brings technological and regulatory difficulties, and is in any case controversial because of the damage it would do to deep-ocean ecosystems. Jon Blundy of Oxford University, however, offers an alternative. This is to extract, from deep under Earth's surface, the mineral-rich brines from which ores of copper and other valuable metals are generated in the first place. As Dr Blundy points out, "pretty much all of the non-ferrous natural resources that we exploit come ultimately from ancient volcanoes."

In particular, in 2015, he and his colleagues worked out the chemical details of how copper-sulphide ores form when sulphur-rich gases rise through the plumbing of active volcanoes and encounter metal-rich brines trapped in rocks sitting just above pockets of magma. Modern mining operations dig up examples of these ores that formed millions or billions of years ago. Dr Blundy proposes instead to cut out the middleman and go straight to the deep copper-rich fluids themselves.

As he writes in *Open Science*, he suspects these are found beneath every active and dormant volcano, though the concentration of copper in the brine concerned will vary from place to place. His evidence comes from electromagnetic surveys carried out on some 40 volcanoes, including Mount Fuji in Japan, Mount St Helens in America and others in Bolivia, New Zealand, the Philippines and elsewhere. These surveys consistently pick up highly conductive zones 2km or more beneath the surface, for which the simplest explanation is the presence of super-salty metal-rich brines. This conjecture is reinforced by analysis of rock samples recovered from such depths under a number of volcanoes. These do indeed contain brines with varying concentrations of copper, as well as other valuable metals including lithium, zinc, gold and silver.

All this suggests that copper could be drilled for commercially in the same way that oil is—except that the boreholes involved would be considerably deeper. That would be difficult, but not out of the question. It would require equipment that could withstand temperatures greater than 400°C and contact with brines ten times saltier than seawater. But the prize would be worth it.

Individual volcanoes would, admittedly, yield only a fraction of the output of a big copper mine. Dr Blundy and his colleagues estimate, for example, that there might be as much as 1.4m tonnes of copper beneath New Zealand's White Island volcano (pictured above), whereas the world's largest

mines hold tens of millions of tonnes of it. But there are only a handful of such mines, most in mountain ranges near the Pacific coast of the Americas. By contrast, hundreds of volcanoes exist around the world, ready be tapped.

The temperature at which the equipment used would have to operate, moreover, brings an opportunity. The heat involved might be employed to generate electricity—enough to power the drilling operation and perhaps even to yield a surplus. Sucking copper out of Earth's crust through 2km-long straws might thus be that rare thing in the mining industry, an actual environmental good. ■



自然资源

某天人们可能会像钻采石油那样钻采铜

这样采铜甚至可能有益于环境

铜是人类加工的第一种金属。早在11,000年前，人类就将铜打制成首饰和装饰品。如今人类每年使用超过2000万吨的铜，其中大部分用于建筑和电气设施。未来几十年还将需要更多的铜，以满足向低碳经济转型带来的对广泛电气化的需求。铜是电池、电机和充电设备中不可或缺的材料。太阳能和风能装置用掉的铜比化石燃料装置用掉的多，电动汽车含有的铜是内燃机汽车的四倍。

这激发了人们找寻铜的新来源的兴趣，目前大部分的铜来自大型露天矿山中挖掘出来的矿石，它们被碾碎并加工，以释放出其中蕴含的铜，一般约为矿石质量的1%。

散布在海底各处的富含金属的结核矿是一种可能来源。但是开采这些矿存在技术和监管上的挑战，而且因为会破坏深海生态系统，无论如何都会引发争议。不过牛津大学的乔恩·布朗迪（Jon Blundy）提供了另一种选择。从地表深处提取富含矿物的卤水，铜和其他有价值的金属矿物原本就是从这里产生的。正如布朗迪指出的：“我们所开采的几乎所有有色矿产归根结底都来自古火山。”

2015年，他和同事们针对其中硫化铜矿的形成解密了详细的化学过程。在这个过程中，富硫气体从活火山的通道中上升，遇到困在岩浆囊上方岩层中富含金属的卤水而发生反应。现代采矿作业挖掘的就是这些形成于数百万年或数十亿年前的矿石样本。布朗迪建议跳过中间环节，直接从富含铜的深层液体中取铜。

正如他在《开放科学》（Open Science）中所写，他猜想每一座活火山和休眠火山下面都有这样的铜，尽管卤水中的铜浓度因地而异。他的证据来自对约40座火山的电磁勘探，包括日本的富士山、美国的圣海伦斯火山以

及玻利维亚、新西兰、菲律宾等地的其他火山。这些勘探全部探测到了位于地表以下2千米或更深处的高导电区域，对此最简单的解释就是存在富含金属的高盐度卤水。对从其中一些火山下方这一深度的岩石采样的分析支持了这一猜想。其中确实含有不同浓度的铜，以及其他有价值的金属，包括锂、锌、金和银。

所有这些都表明，铜可以像石油那样做商业性钻采，只不过钻头下探要深得多。这很难，但并非不可能。它将要求设备能承受400°C以上的高温，并与比海水咸10倍的卤水接触。但从回报看，这样做是值得的。

不可否认，单个火山群的产量只是大型铜矿产量的一小部分。例如，布朗迪和他的同事们估计，在新西兰的怀特岛火山下面可能有多达140万吨的铜（见上图），而世界上最大的那些矿山则蕴藏着数千万吨铜。不过这样的矿山为数不多，大部分都在美洲太平洋沿岸的山脉中。相比之下，世界上可以开发的火山有数百座。

此外，设备作业所须达到的温度也可被利用。生成的热能或许可用于发电，足以为钻采作业提供动力，甚至还能有富余。因此，用两公里长的吸管从地壳中吸出铜可能是采矿业里的稀罕事——一种真正的环保产品。 ■



Deep seas

A marine biologist dives to where blue gives way to black

Helen Scales finds wonders, and threats, on the ocean floor

The Brilliant Abyss. By Helen Scales. Atlantic Monthly Press; 304 pages; \$27. Bloomsbury Sigma; £16.99

MANY VISITORS only skim the surface of the ocean—swimming from the beach or slicing through whitecaps on a sailing boat. In “The Brilliant Abyss”, Helen Scales, a marine biologist whose previous books explored the shallower reaches of the sea, dives deep and revealingly into the realm below 660 feet where sunlit blue begins to give way to black.

As Ms Scales notes, it is often said that more is known of the Moon’s surface, exposed to anyone with a telescope, than about the geography of the deep-sea floor, which a dark cloak of water obscures. It is a rugged, complex and shifting terrain—subject to earthquakes precipitated by the movement of tectonic plates, and punctuated by seamounts (mountains formed by volcanic activity) and hydrothermal vents that emit sulphurous, scalding fluids.

In these underwater extremes of dark and cold, and the boiling waters disgorged by vents, life survives and even thrives. It includes sea cucumbers that slough off their illuminated skin to distract predators, yeti crabs as hairy as their name suggests, fish masked in ultra-black skin that makes them all but invisible, and a sponge that looks like a glass of milk frozen in mid-spill. As well as its role as a climate regulator and carbon sink, the deep, in its vibrant profusion, prompts reflections on the possibility of life on other planets.

Less beguiling things lurk down there too. Plastic bags and packaging have

been spotted by submersibles in the seven-mile-deep Mariana Trench. Nuclear waste, chemicals and oil spills, such as the one from the Deepwater Horizon rig in 2010, have turned sections of sea floor into poisonous dumps. Exploitation adds to the blight. The orange roughy, a white-fleshed fish that congregates around seamounts (also known, less appetisingly, as a slimehead) has been dangerously overfished.

An experimental push to harvest sea-floor nodules laced with manganese, nickel, cobalt and other metals is another threat. The potential damage to the seabed from remotely operated machines is analogous, Ms Scales argues, to the most toxic mining on dry land. But the revenues could be huge. An analysis by the Massachusetts Institute of Technology calculated that a single seabed mine could net \$1bn a year.

And an ecological case for the initiative can be made. “I get very uncomfortable when people describe us as deep-sea miners,” says Gerard Barron of DeepGreen Metals, a deep-sea mining company targeting the metals used in electric-car batteries. “We want to help the world transition away from fossil fuels.” Because the long-term impact is unknown, Ms Scales is sceptical; her argument is compelling, even if her explanation of car batteries is a slog. Yet another marine biologist doubts that mining would be forestalled “even if we found unicorns on the sea floor”.

Early European cartographers often used sea serpents to mark uncharted depths. *Hic sunt dracones*—Here be dragons—reads the inscription flagging an unfathomable stretch of water on a globe made in 1510. But the most threatening sea monster of all may be man. ■



深海

一位海洋生物学家潜入由蓝变黑的深海

海伦·斯凯尔斯在洋底发现了奇观，也发现了威胁【《灿烂的深渊》书评】

《灿烂的深渊》，海伦·斯凯尔斯著。大西洋月刊出版社，304页，27美元。Bloomsbury Sigma，16.99英镑。

许多游客对海洋的观览“流于表面”——他们在海滩附近游泳，或乘帆船穿过洁白的浪尖。在先前的著作中，海洋生物学家海伦·斯凯尔斯（Helen Scales）探索了海洋较浅的部分，而在《灿烂的深渊》（The Brilliant Abyss）一书中，她带领读者潜入660英尺以下的水域——在那里，阳光透不进来，蓝色的海水逐渐变成黑色。

正如斯凯尔斯指出的那样，一个常见的说法是人们对月球表面的了解比对深海海底地理的了解还多；只要有台望远镜，人人都可以观月，而深海海底却被黑暗的海水掩盖。那里的地形崎岖、复杂又多变——容易受板块运动引发的地震的影响，而且四处还有海底山（火山活动形成的山）和喷涌着含硫的炽热液体的海底热泉。

在这黑暗而寒冷的水下极端环境和海底热泉涌出的滚烫液体之中仍有生命存活下来，甚至还生机勃勃。其中包括海参，它们可以蜕下发光的皮肤以分散捕食者的注意力；雪人蟹，和它们名字中的雪人一样毛茸茸的；身覆超黑皮肤的鱼类，几乎能够隐形；还有一种海绵，看起来像一杯溢出时被冻住的牛奶。生机盎然的深海除了充当气候调节器和碳汇之外，还促使人们思索其他星球上存在生命的可能性。

海底也潜伏着一些不那么诱人的东西。在七英里深的马里亚纳海沟，潜水器发现了塑料袋和塑料包装。核废料、化学物质和石油泄漏（比如2010年“深水地平线”钻井平台的泄漏）已经将部分海底变成了有毒的垃圾场。资源开发加剧了灾难。一种栖息于海火山周围的白肉鱼胸棘鲷（又名slimehead，字面意思是“黏液头”，听着让人没什么胃口）被过度捕捞，

已经到了濒危的地步。

另一个威胁来自人们努力尝试开采海底结核，它们含有锰、镍、钴和其他金属。斯凯尔斯认为，远程遥控机器对海床可能造成的损害堪比陆地上毒性最大的采矿活动。但是收入可能是巨大的。麻省理工学院的一项分析计算出，单是一个海底矿一年就可净赚10亿美元。

而且这一尝试还可能有生态上的理据。“听到人们把我们描述成深海矿工，我心里非常不舒服。”深海采矿公司“深绿金属”（DeepGreen Metals）的杰拉德·巴伦（Gerard Barron）说。该公司的目标是开采电动汽车电池中使用的金属。“我们希望能帮助世界摆脱贫化石燃料。”由于长期影响尚不得而知，斯凯尔斯对此持怀疑态度；她的论证很有说服力，尽管她对汽车电池的解释让人读得很辛苦。不过，另一位海洋生物学家怀疑海底采矿未等开始就会被阻止，“即便是在海底发现了独角兽”。

早期的欧洲制图员经常使用海蛇来标记尚未被探索过的深水区。在一个1510年制作的地球仪上写着“此处有龙”（Hic sunt dracones）的字样，用以标记一片深不可测的水域。但最具威胁性的海怪可能还是人类。■



A mixed-up slowdown

The prospects for developing countries are not what they once were

Twenty years on, growth in the BRICs has slowed

IN 2000 THIS newspaper wrote that “the most pressing moral, political and economic issue of our time is third-world poverty.” At the time, 28% of the world’s population lived in extreme poverty, which is to say on incomes of \$1.90 a day or less. Nearly one billion of those 1.7bn people lived in India and China.

Just a year later, Jim O’Neill, then the chief economist for Goldman Sachs, a bank, grouped those two countries, along with Brazil and Russia, into one of the defining acronyms of the 2000s: the BRICs. Though at the time the quartet accounted for only 8% of global economic output, Mr O’Neill argued that, given their population, even modest growth in their output per person would increase that share significantly, and that such growth looked likely. Investors were urged to take note. So were policymakers.

By 2003 Goldman Sachs’s researchers were forecasting that the BRIC economies would, by 2025, have a combined GDP at least half that of the G6 (America, Britain, France, Germany, Italy and Japan). By 2040 they expected the BRICs to have pulled ahead. A dramatically different world was on its way, one in which the big emerging economies had pretty much caught up with the developed economies of the North in economic heft if not in terms of income per person.

The first prediction was too conservative. From 2000 to 2011, the BRICs grew on average by a startling 17% per year, in nominal US dollars at market-exchange rates, while the G6 grew at just 4%. They reached half the G6’s GDP by 2017, not 2025. In 2021, the IMF projects, BRIC GDP will be worth

about 57% of the G6's (see chart 1). Last year China announced that it had eradicated extreme poverty. As of 2018 the number of people living in extreme poverty in India had fallen below the estimated 99m people living in extreme poverty in Nigeria. It is a historic achievement.

The 2040 prediction looks more troubled. Growth in advanced economies and developing ones slowed a lot in the 2010s. From 2011 to 2019, G6 growth fell by more than half to below 2% per year. Growth across the BRICs, on the other hand, dropped by nearly 70%, to just 5% per year.

The picture across other low- and middle-income countries looks broadly similar. From 2000 to 2011, the weighted average annual growth rate of GDP, in US dollar terms, was a robust 9% for emerging economies when the BRICs were excluded. Real income per person in developing countries as a fraction of real incomes in America (generally considered the ne plus ultra in economics) was 12.1% in 2001. By 2011 it was almost half again as much: 17.8% (see chart 2).

But by the time that measure reached its peak—18.4% in 2013—incomes in the Middle East, Central Asia and Latin America were already in decline relative to those in the United States. By the next year incomes in Africa were dropping further behind those in America, too. Only South and East Asia and the emerging parts of Europe have kept gaining on American incomes. For the developing world as a whole, real income per person has fallen back to 18.1% of what it is in America; not a terrible reverse, but definitely a stagnation.

The 2010s were hardly a terrible decade. Indeed in terms of emerging-market growth they were the second-best decade in history. The problem is that the 2000s were so much better. In terms of the impact on human lives, there can be few bigger questions than whether growth in the 2020s

will return to the heights of the startling 2000s, hang around the levels seen in the adequate 2010s, or continue its downward trend. Such a trajectory would make talk of any significant part of the developing world “catching up” with the advanced economies look increasingly foolish.

Economists once thought that poorer countries ought naturally to catch up with richer ones. Becoming rich seemed little more than a matter of borrowing technologies from more mature economies and equipping workers with more capital, of both the physical and human sort.

Yet in the aftermath of the second world war joining the ranks of the rich was revealed to be harder for the previously colonised world than had been thought. Investors occasionally grew enthusiastic about the prospects for poorer countries, as in 1981, when a World Bank employee named Antoine van Agtmael coined “emerging markets” as an eye- (and money-)catching name for a new third-world investment fund. But only a few countries made the leap from poor to rich over the latter decades of the 20th century: a South Korea here and a Taiwan there.

It was against this background that the rise of the BRICs seemed truly startling. But it was hardly an overnight success. In the late 1970s China began a long process of economic liberalisation; India started relaxing state control over its economy in 1991. Debt and financial crises which had dealt devastating setbacks to growth from the 1970s saw a broad-based shift in policy across the developing world towards what is often referred to as the “Washington consensus”: becoming more open to trade and keeping government borrowing and inflation in check.

To this already healthy soil three further fertilisers were added. One was the arrival of persistently low interest rates and globalised finance, which provided a lot of money willing to seek out opportunities in emerging markets judged to be more stable than they had been. Another was a broad

and sustained rise in commodity prices, which boosted the fortunes of many developing-world economies.

The third was explosive growth in trade. Manufacturing for export, a time-tested route to catching up, had once required the slow and difficult process of building up an indigenous industrial base. But as production processes once contained within a single plant or country spread out along global supply chains it became possible for poorer economies to begin producing for export by grabbing hold of small pieces of production networks, rather than recapitulating everything.

As a share of global GDP, trade rose from 39% in 1990 to 51% in 2000, eventually reaching a peak of 61% in 2008. China, through which most of the new supply chains ran, saw its share of global exports rise from about 2% to 9% over the same period. Its share of global GDP rose from 4% to 12%.

The added effects of two of the three fertilisers, the commodities boom and the boom in trade, both wore off in the 2010s. The IMF's index of commodity prices roughly tripled from 2000 to 2011. After that it began to fall, and in doing so exposed those economies which had enjoyed a superficial boom built on higher prices for their resource exports and easy credit.

Trade growth also slowed. Having recovered encouragingly after the global financial crisis of 2007-09, in the mid 2010s trade began to decline slightly as a share of global GDP (see chart 3). There were a number of reasons for this, but an important one was a decisive shift in Chinese policy. The pace of reform slackened; state intervention increased as the government made a push for self-sufficiency.

The Communist Party's interest in reducing the role of state-owned enterprises, key to the dramatic increase in the size and importance of privately owned firms during the boom years, waned in the 2010s. Such

firms generate lower returns on their assets than their private cousins while carrying higher levels of debt.

China's failure to go on liberalising has slowed traffic on the most desirable path to development for the rest of the emerging world. If China had grown more and its consumption patterns had converged with those of advanced economies it would have become an ever greater market for other developing countries. But insufficient reform has also left consumption well short of the level common in economies with comparable incomes (like Mexico and Thailand), to say nothing of those in the rich world.

China's domestic market, while still enormous, is thus substantially less massive than it might have been, and its imports a lot less than they could have been. To exacerbate matters China remains much more dependent on manufacturing than many comparably rich economies. Countries typically begin to shed some industrial production as incomes rise and producers seek out low-wage workers elsewhere. But China has resisted this trend, thanks partly to its stalled progress on reform and partly to a deliberate effort to become more self-sufficient.

An analysis by Shoumitro Chatterjee of Pennsylvania State University and Arvind Subramanian of the Centre for Global Development notes that, though China has not given up ground in terms of manufacturing exports in aggregate, it has ceded some market space in particularly labour-intensive manufacturing industries such as production of footwear, clothing and furniture. And yet its losses have, on the whole, been quite small, and have led to limited and concentrated gains in export-market share for other economies. China's share of global footwear exports declined from 40% to 32.5% between 2008 and 2018, for example; Vietnam—the biggest beneficiary of changes in China's export profile—captured 5.9 of the 7.5 percentage points in export space vacated by China.

China's failure to import manufactured goods on the scale that might have been expected exacerbates what Dani Rodrik of Harvard University has dubbed premature de-industrialisation. Producing goods for export no longer seems able to propel a developing economy as far down the road towards rich-world incomes as was once the case. Low Chinese demand is far from the only factor. Greater manufacturing productivity has pushed the global price of manufactured goods down. It is increasingly common for even low-income countries to import them rather than learn to make them for others.

Very poor countries in Africa could still enjoy a big boost to productivity and incomes by increasing the role of manufacturing in their economies. But as Mr Subramanian notes, the development of machines which can handle ever more of the tasks now done by human workers at ever lower costs cannot help but limit the scope for convergence via industrialisation.

With the boosting effects of commodity prices and trade growth in abeyance, what of the third factor that kicked off the glory years of the 2000s: interest rates? They remain low. But a post-covid-19 rich-world boom, which would in general be a good thing for developing countries, carries some risks on that front. Some economists warn that big spending in America threatens to unleash inflation in a way which could force the Federal Reserve to raise interest rates earlier, and perhaps more sharply, than currently expected. The spread of high interest rates could wreak havoc, leading to crashing asset prices and drawing a lot of capital away from the emerging world.

Even a modest rise in American interest rates in coming years, prompted by healthy growth and falling unemployment, could catch out some overstretched governments, much as the Fed's decision to stop stimulating the economy by buying assets led to acute discomfort for a "fragile five" nations (Brazil, India, Indonesia, South Africa and Turkey) in 2013.

But for now the risk of calamity seems to be low. Interest rates are an unreliable guide to future inflation, but yields on American government bonds have actually declined in recent weeks at all maturities. A robust recovery across advanced economies without a long-term shift towards higher interest rates is quite plausible as well as highly desirable.

If the effects of covid-19 are not felt in the form of developed-world monetary policy, though, they will still be devastating. In 2020 output across the emerging world fell by 2.1%. That average is skewed upwards, however, by the fact that China, having managed to contain its initial outbreak, actually saw its economy expand. Other major emerging markets fared far worse. India's economy shrank by 7.3%, Brazil's by 4.1%, South Africa's by 7%. The World Bank estimates that the ranks of those living in extreme poverty are likely to have swollen by 150m.

Hopes for a robust turnaround in 2021 have foundered on the spread of the Delta variant and the slow pace of vaccination outside rich countries; more than half the developing-world population may still not be vaccinated by the end of this year. On July 27th the IMF, which in April had expected India to grow by more than 12% this year, cut that estimate to 9.5%. Across the emerging world as a whole it expects 6.3% growth this year and 5.2% in 2022.

And the effects will linger. One of the conditions for catching up is investment in human capital; that has been badly hit by the pandemic. Although students around the world lost schooling time to the interruptions caused by the pandemic, those in the poorest nations suffered most. While children in advanced economies missed the equivalent of 15 or so days of instruction on average in 2020, those in emerging markets missed about 45 and children in low-income countries 70. Poor economies can scarcely avoid educational setbacks. The pandemic has also exacerbated problems of governance and political instability in much of the emerging

world.

In the 1990s and 2000s, rapid growth in trade and output was associated with a decline in inequality between countries but a rise in inequality within them, emerging markets very much included. When growth slowed in the 2010s, the distribution of economic gains within economies became relatively more important in determining whether living standards continued to improve, stagnated or fell. A more fractious politics became the norm around the world, and countries slid either towards or further into autocracy. The democracy index produced by The Economist Intelligence Unit, a sister company, has declined every year from 2015 to 2020.

Politicians from the political fringes have enjoyed surprising success, often on the back of unrealistic promises. The policies they have pursued frequently undermine growth, from the surprisingly abstemious fiscal policy of Mexico's Andrés Manuel López Obrador to the unexpected enthusiasm for welfare spending on the part of India's Narendra Modi. Mr Subramanian sees increasing evidence that slower growth contributes to political instability, feeding a vicious cycle.

The costs of instability are likely to rise further before they fall. Unrest will in some cases limit governments' ability to tackle pressing policy problems and could deter foreign investment. Reforms aimed at business at home, which have already declined, may become yet more rare. Across low- and middle-income countries, the cost of starting a new business, as a share of income per person, declined steadily in the 2000s, according to the World Bank's Ease of Doing Business report. But it bottomed out in the 2010s well above that in rich economies and has not shifted since.

Should global financial markets turn on stressed economies, an absence of social consensus could prevent leaders from taking the macroeconomic

steps needed to fend off a crisis. In the worst cases, political instability could deteriorate into internal or even interstate violence.

And this is before one accounts for climate change. Its economic costs are already detectable, will only grow, and are generally felt most heavily in poor countries. Emerging-market governments will face loss and damage, the fiscal burden of adaptation and, often, refugee flows. Both political instability and interstate tensions may well increase.

The first two decades of the millennium demonstrated that sustained, broad-based growth in developing economies was possible—a big surprise to some, and a boon for hundreds of millions. In the absence of the particular boosts it received in the 2000s, growth has slowed, and it now faces both the stumbling block of the pandemic and the persistent headwinds of climate change. But the last of those only serves to stress the moral case for the world as a whole to try to do better; development is at the heart of adaptation.

The catch-up pace of the 2000s may never be seen again. But if things do not worsen further it is still possible for the BRICs to match the output of the G6 by 2040 and for associated growth to spread out quite widely. The gate which was opened at the end of the 20th century has narrowed, but it has not shut. The challenges of passing through it, though, are undeniably greater than they were. ■



纷乱的放缓

发展中国家的前景不同于以往想象

二十年过去了，金砖四国增长放缓【深度】

本刊曾在2000年写道：“我们这个时代在道义、政治和经济上最迫切要解决的问题是第三世界的贫困。”当时，世界上有28%的人口生活在极端贫困中，也就是日收入不高于1.9美元。这17亿人中有近10亿人在印度和中国。

不过一年后，时任高盛银行首席经济学家的吉姆·奥尼尔（Jim O'Neill）把这两国与巴西和俄罗斯合称为“金砖四国”，“BRICs”成为2000年代标志性的缩写词之一。尽管这四国当时的经济产出只占全球的8%，但奥尼尔认为，它们人口基数庞大，人均产出即便只是略有增长，在全球总产出中的占比也会显著上升，而这样的增长看起来很可能发生。投资者被提醒要多加关注。政策制定者也一样。

2003年，高盛的研究人员预测，到2025年，金砖四国的GDP总和将至少达到六国集团（美国、英国、法国、德国、意大利和日本）总和的一半；在2040年前会赶超。当时世界格局正在发生大转变，大型新兴经济体在经济体量上几乎就要赶上发达经济体，虽然在人均收入上还不行。

第一个预测过于保守了。从2000年到2011年，按市场汇率以名义美元计算，金砖四国平均年增速达到惊人的17%，而六国集团仅为4%。到2017年，而非预测的2025年，金砖四国的GDP就已经达到六国集团的一半。国际货币基金组织预测，金砖四国的GDP在2021年将达到六国集团的57%（见图表1）。去年，中国宣布已消除极端贫困。到2018年，尼日利亚估计有9900万极端贫困人口，而印度已低于这一水平。这是历史性的成就。

而对2040年的预测如今看来偏误更大。在2010年代，发达经济体和发展

中经济体的增长都大幅放缓。从2011年到2019年，六国集团的年增速不到2%，放缓逾半。另一边，金砖四国的整体年增速只有5%，放缓近70%。

其他低收入和中等收入国家的情况基本类似。从2000年到2011年，按美元计算，金砖四国之外的新兴经济体的增长相当强劲，GDP加权平均年增速达到9%。2001年，发展中国家人均实际收入是美国人均实际收入（在经济学中通常被视为最佳参照物）的12.1%。到2011年，该比例提高了大约一半，达到17.8%（见图表2）。

但到2013年该指标达到18.4%的峰值时，中东、中亚和拉美的收入相对美国已经下降。到2014年，非洲的收入水平也进一步与美国拉开距离。只有南亚、东亚及欧洲新兴地区的收入继续追赶美国。整体上看，发展中国家的人均实际收入与美国这一数字的比值已回落至18.1%，倒退不算惊人，但毫无疑问这场追赶陷入了停滞。

2010年代远说不上是糟糕的十年。事实上，论新兴市场的增长，这是史上第二好的十年。主要是2000年代的表现太好了。说到对人们生活的影响，最大的疑问莫过于：2020年代的增长是会重回2000年代的惊人高度，还是会在2010年代的合理水平上徘徊，或者继续放缓？在这样一条轨迹下，谈论发展中世界的任何重要部分“赶上”发达经济体就显得日益荒唐了。

经济学家曾认为，穷国理所当然能追上富国。致富之道似乎不外乎从更成熟的经济体借来技术，并为工人配备更多实物和人力资本。

然而人们发现，二战后，前殖民地地区要加入富裕世界比想象中更难。投资者偶尔会看好贫穷国家的发展前景，例如在1981年，世界银行雇员安托万·范·阿格特梅尔（Antoine van Agtmael）为一只投资第三世界的新基金创造了“新兴市场”这一既吸睛又吸金的名词。但在20世纪末的几十年里，只有少数国家和地区实现了从贫穷到富裕的飞跃，例如韩国和台湾。

在这种背景下，金砖四国的崛起看起来着实惊人。但这并非一夜之功。上

世纪70年代末，中国启动了经济自由化的漫长进程；印度在1991年开始放松政府对经济的控制。从上世纪70年代开始，债务和金融危机对经济增长造成毁灭性打击，发展中国家的政策纷纷转而朝着“华盛顿共识”的方向调整：加大开放贸易，并控制政府举债和通胀。

在这本就健康的土壤上，还施加了三种肥料。一是持续的低利率和全球化金融。这带来了大量资金，这些钱愿意在新兴市场这个被认为已经比以往更稳定的地方寻找机会。二是大宗商品价格普遍持续上涨，令许多发展中经济体财富增长。

三是贸易的爆炸性增长。要赶超富国，一个屡试不爽的途径就是出口型制造业。以往这意味着先要费时费力地在本地建立工业基地。但是，随着以往局限在一个工厂或国家内的生产流程扩展到全球供应链上，较贫穷的经济体只要抓住生产网络中的一个小环节便可启动出口型制造，而无需包揽一切。

贸易占全球GDP的比重从1990年的39%上升至2000年的51%，最后在2008年达到61%的峰值。全球大多数新供应链都经过中国；在同一时期，中国占全球出口的比重从约2%上升至9%，占全球GDP的比例也从4%上升至12%。

三大肥料中，大宗商品繁荣和贸易增长带来的额外效应都已在2010年代消退。国际货币基金组织的大宗商品价格指数从2000年到2011年上升了约两倍，之后开始下降，曾靠资源出口价格上涨和宽松信贷享受了一轮表面繁荣的经济体继而面对高风险。

贸易增长也放缓了。在2007年至2009年的全球金融危机之后，贸易占全球GDP的比重回升，令人鼓舞，但在2010年代中期又开始略微下降（见图表3）。这其中有很多种原因，但一大原因是政策的一种决定性转变。改革的步伐放慢；中国政府力求自给自足，国家干预加大。

在之前的经济飞速发展时期，共产党弱化国企的角色，这是私营企业规模

及重要性大增的关键。但这种意愿在2010年代减退了。国企的资产回报率低于其私营同行，而负债更高。

中国未能继续自由化进程，这拖慢了其他新兴国家在这条最理想的发展道路上的步伐。如果中国经济能增长更多，消费模式能与发达经济体趋同，它应该能为其他发展中国家提供一个不断扩大的市场。但由于改革不充分，中国的消费水平远低于墨西哥和泰国等与其收入水平相当的经济体，更别说和富裕国家比了。

所以，中国的国内市场虽然庞大，但远小于它本可能达到的规模，进口也是如此。更糟糕的是，相比许多同等富裕的经济体，中国对制造业的依赖程度仍然高得多。在别的国家，随着收入增加，生产者会转移到其他地方寻找低薪劳动力，工业生产的规模一般都会有所缩减。但中国没走上这个方向，一方面是由于改革停滞不前，另一方面是因为中国在有意加强自给自足。

宾夕法尼亚州立大学教授苏米特拉·查特吉（Shoumitro Chatterjee）与全球发展中心（Centre for Global Development）的阿文德·萨勃拉曼尼亚（Arvind Subramanian）发表分析指出，虽然中国在总体上没有放弃制造出口这个地盘，但还是让出了一部分市场空间，特别是鞋类、服装和家具这类劳动密集型制造业。然而，总体而言，中国让出的市场相当小，导致其他经济体在出口市场份额上的收获有限且集中。例如从2008年到2018年，中国占全球鞋类出口的份额从40%下降到32.5%，在这让出的7.5个百分点的出口份额中，越南（中国出口变化的最大受益者）抢到了5.9个百分点。

中国从国外进口制成品的规模未如预期，加剧了哈佛大学教授丹尼·罗德里克（Dani Rodrik）所说的“过早去工业化”。出口导向的制造业似乎不再能像以前那样推动发展中经济体一路迈入富裕世界收入水平。中国需求低迷远非唯一因素。制造业生产率的提升推动了全球制成品价格下降。连低收入国家也越来越普遍地选择进口制成品，而不是学习为他国制造这些产品。

极度贫穷的非洲国家通过加大经济中的制造业比重，仍可大大提升生产率和收入。但正如萨勃拉曼尼亚指出的那样，机器将以日益低廉的成本完成越来越多目前由人力完成的工作，这样的发展势必会限制通过工业化实现经济趋同的空间。

在大宗商品价格和贸易增长的助力减弱之时，开启了辉煌2000年代的第三个因素——利率——又如何？利率目前还保持在低位。然而，虽然富裕世界的后疫情繁荣期对发展中国家总体而言是件好事，却可能在利率方面带来一定风险。一些经济学家警告，美国的大幅支出可能引发通胀，也许会让美联储不得不比如今的预期更早加息，幅度也可能更大。高利率蔓延会造成重创，导致资产价格崩溃，让大量资本从新兴世界流走。

未来几年，即便美国基于经济健康增长和失业率下降而决定小幅加息，也可能让一些过度负债的政府措手不及，就像2013年美联储决定停止通过购买资产来刺激经济时，“脆弱五国”（巴西、印度、印度尼西亚、南非和土耳其）就大感不适。

但暂时来看，出现灾难性事件的风险不高。利率并非估计未来通胀水平的可靠依据，但最近几周，美国各种期限的政府债券的收益率实际上都下跌了。目前看来，发达世界整体实现强劲复苏而利率不长期上行不但是新兴世界非常期待的，也是颇有可能的。

即使不显现在发达国家的货币政策上，新冠疫情仍将带来极大的破坏性。2020年，整个新兴世界的产出下跌了2.1%。但平均水平正在回升，这是因为中国在最初的疫情爆发后成功控制了态势，经济实际上有所增长。其他主要新兴市场的情况要糟糕得多。印度、巴西和南非的经济分别收缩了7.3%、4.1%和7%。据世界银行估计，极端贫困人口很可能已暴增1.5亿。

人们原本希望在2021年能扭转乾坤，但由于德尔塔变异毒株广泛传播，而富裕国家以外的地区疫苗接种缓慢，这种希望已然破灭。到今年年底，发展中国家可能仍有一半以上人口未接种。国际货币基金组织曾在4月预计印度经济增速今年在12%以上，但在7月27日下调至9.5%。它预计新兴世

界今年的整体增速为6.3%，2022年为5.2%。

而且疫情的影响将长久挥之不去。追赶富国的条件之一是对人力资本的投资，这受到了疫情的严重打击。虽然全球各地的学生都因疫情的干扰而减少了上学时间，但最贫穷国家的学生受影响最大。2020年，发达经济体的儿童平均损失了15天左右的上课时间，而新兴市场和低收入国家的儿童分别损失了约45天和70天。贫穷经济体在教育上的受挫将无可避免。疫情还加剧了大部分新兴世界治理不佳的问题和政治动荡。

在上世纪90年代和本世纪头十年，随着贸易和产出快速增长，国家间的不平等减轻而国家内部不平等加剧，在新兴市场更是如此。到2010年代增长放缓时，要判断国民生活水平是在继续提升、陷于停滞，还是下滑，相对更重要的指标是经济增长在经济体内部的分配。全球各地的政治都变得更剑拔弩张，民主国家滑向专制，专制国家更是变本加厉。本刊姐妹公司经济学人智库（The Economist Intelligence Unit）发布的民主指数在2015年到2020年间呈逐年下降之势。

来自政坛边缘地带的政客出乎意料地取胜，往往是靠一些不切实际的承诺。他们所推行的政策经常破坏增长，例如墨西哥总统奥夫拉多尔推出了惊人的紧缩财政政策，而印度总理莫迪出人意料地大力增加福利开支。萨勃拉曼尼亚认为，越来越多的证据表明，增长放缓促发政局不稳，形成恶性循环。

政治不稳定带来的成本应该还会继续上升一段时间。有些情况下，社会动荡会影响政府解决紧迫的政策问题，还会吓跑外国投资。针对国内商业的改革已经在收缩，之后还可能变得更少。根据世界银行发布的《营商环境报告》，在所有低收入和中等收入国家，开办新企业的成本占人均收入的比例在2000年代稳步下降，但在2010年代触底反弹，已远高于富裕经济体，而且至今没有转向。

假如本已承压的经济体突然遭受全球金融市场的冲击，缺乏社会共识可能让领导人难以采取宏观经济措施来抵御危机。最坏的情况是，政治不稳定

可能恶化为国家内部甚至国家间的暴力冲突。

而这还没有考虑到气候变化。气候变化的经济成本已经可以感知，而且只会有增无减，穷国往往最深有体会。新兴市场政府将面临损失、破坏、做出调适的财政负担，以及往往还有难民潮。政治不稳定和国家间关系紧张都很可能加剧。

本世纪前20年的历程表明，发展中经济体可以实现持续而有广泛基础的增长——这让一些人大感意外，也是对数以亿计的人群的福音。在2000年代的那几个推动力消失后，增长已经放缓，而且现在还面对疫情这块绊脚石和气候变化这股持久的逆风。但气候挑战更是从道义的层面突显出全世界需要集体努力来推动增长：发展是应对挑战的关键所在。

2000年代的那种追赶速度也许再不会重现。但如果情况不再恶化，金砖四国仍有可能在2040年追上六国集团的产出，而关联增长也可能广泛扩散。20世纪末打开的大门已经关小了，不过还没有完全闭上。但不可否认的是，要通过这扇门，难度比以前更大了。■



Combating future viruses

Predicting viral evolution may let vaccines be prepared in advance

New techniques could programme people's immune systems against future pathogens

GENERALLY, IMMUNE systems mount responses only against pathogens that have already infected the bodies they are protecting. Science, though, can shorten the path to immunity by vaccination. This involves presenting the immune system with harmless or lookalike versions of dangerous pathogens so that it may create antibodies and killer cells hostile to the real thing in advance of any actual infection, thereby reducing its danger.

Like immune responses themselves, however, vaccination generally has to wait for the appearance of the pathogen in question before it can do its stuff. There is therefore a delay between a pathogen's arrival on the scene and the deployment of a vaccine against it. That delay costs lives. Even in the case of covid-19, which has prompted the fastest vaccine-development programme the world has ever witnessed, millions are reckoned to have died by the time vaccinations began to be given in the rich world at the end of 2020.

But, just as vaccination introduces immune systems to pathogens that are remote from them in space, new techniques which have come to the fore during the current pandemic offer the possibility of introducing them to pathogens that are remote from them in time—pathogens, indeed, that have not yet evolved, but which are likely to do so in the future. Thanks to a combination of high-throughput DNA-sequencing technologies and modern machine-learning it is now possible not merely to observe which variants of a virus are circulating, but also to suggest how they are likely to change. Understanding in this way what a virus might look like in the months and years to come gives those designing vaccines and therapies a leg up, enabling them to prime more immune systems sooner, so that fewer

people die.

The starting point for these predictions is the sort of work going on in the laboratory of Jesse Bloom, a virologist at the Fred Hutchinson Cancer Research Centre, in Seattle. Dr Bloom and his colleagues grow variants of coronavirus spike protein (the molecule which such viruses use to attach themselves to cells they are about to infect) in Petri dishes. They then scan through these to discern which mutations have what effects.

They have named this technique deep mutational scanning. It uses an array of yeast cells that have been genetically modified to express a part of the spike protein called the receptor-binding domain (RBD). As the yeast cells churn out their RBDs, many emerge, thanks to errors inherent in their production, with slight deviations in their structures from that of the original wild-type virus. Dr Bloom's team then test the RBDs from each yeast cell to see how tightly they bind to ACE2, a receptor protein found on the surfaces of some human cells, to which the coronavirus attaches itself before entering those cells. RBDs that bind tightly have their underlying genomes sequenced, to determine which mutations are present.

When Dr Bloom's team ran this scan in the summer of 2020, on spike from a version of the virus then circulating, they spotted a mutation called N501Y which appeared to confer a binding advantage. A few months later, that mutation appeared in the Alpha variant, which for several months was dominant across much of the world. Dr Bloom says it would be "charitable" to say that he and his colleagues had predicted the emergence of N501Y. It was by no means the only mutation of interest to turn up. But even so, having a limited set of such mutations to focus on is useful for narrowing the field of research.

One firm taking advantage of that narrowing is Flagship Labs 77, a company based in Boston that has until recently been working in secret. FL77, as it

is known for short, is a spin out from Flagship Pioneering, a biotechnology incubator run by Noubar Afeyan, a venture capitalist. Moderna, a trailblazer of the messenger-RNA-based technology that helped speed up the production of coronavirus vaccines, was also a Flagship Pioneering company, and Mr Afeyan is its chairman.

FL77's researchers are trying to combine experimental data of the sort Dr Bloom is collecting with computation, in order to predict how viruses may evolve. That information could be used to develop vaccines and therapeutic antibodies pre-emptively. Whereas Dr Bloom's laboratory predicts only single mutational hops, FL77 can currently manage five or six. The firm calls its system "Global Pathogen Shield". The details remain confidential, but in June it published a paper outlining the project's goals. This described the scale of the challenge involved in keeping pace with viral evolution—namely that biology is so diverse that even looking at a small slice of possible mutations leads to a problem which rapidly grows beyond the plausible limits of observation, to one on the scale of counting and categorising all of the atoms of which Earth is composed.

The conventional response to such overwhelming odds has been observation rather than experimentation. The World Health Organisation's Global Influenza Surveillance and Response System does this for flu. It monitors which viruses are circulating in the southern hemisphere when it is winter there, in order to focus attention on which strains will be relevant during the next northern-hemisphere winter, and vice versa. During the coronavirus pandemic, organisations such as Nextstrain and GISAID have kept track of variants of SARS-CoV-2 in a similar way.

FL77 aims to take this much further—not only tracking which variants of a virus are where, but also predicting how they will evolve. It does this by feeding into a piece of software called Octavia data from a scaled-up version of Dr Bloom's deep mutational scanning that runs assays on between 1m and

10m variants.

Octavia's job is to recognise patterns in the Petri-dish data—for example, which of the millions of mutations tend to lead to tighter binding, and also which lead to poorer neutralisation by antibodies—and then to extrapolate those across all possible variants of spike. This leads to predictions about which mutations will defeat antibodies, and which will spread more easily. That, says the paper, “makes it possible to define a protective antibody repertoire”, whether through vaccination or manufacturing of antibody proteins themselves. FL77 calls this an “antibody net”.

Dr Bloom, who is advising FL77, and who holds patents on deep mutational scanning, says the value of these kinds of predictions has become clear with the development of messenger-RNA vaccines. These are not just quick to make, but quick to update. Their manufacturing process starts with the gene for the viral protein that the immune system is desired to attack, and ends with a strand of RNA which encodes that specific protein.

In covid-19 vaccines, the protein in question is spike. Updating vaccines to take account of predicted variants of spike is merely a matter of inserting the relevant genetic code at the start of the manufacturing process. At the least, such predictions would permit a library of candidate vaccines to be held ready, in anticipation of rapid manufacturing. At its most ambitious, FL77 imagines vaccinating people against variants of a pathogen that are not yet circulating, but are likely to.

Deep mutational scanning may have other uses, too. Gabriel Victora, an immunologist at Rockefeller University in New York, thinks predicting the evolution of a pathogen in this way will be useful not just for designing antibodies and vaccines, but also for detecting parts of the virus which change only rarely, and aiming antibodies at what would thus be reliable targets.

This, though, is difficult. The shape of any given segment of a protein depends on the rest of the molecule of which it is a part. Yet, for the immune system, the shape of its target is a crucial feature that it needs to learn in order to recognise its foe. So, though predictive approaches like FL77's might spot segments of viral proteins which are unlikely to change, getting the immune system to look at them specifically is difficult, because expressing an isolated protein segment in a way that makes it the same shape as it is when it is part of a bigger structure is tricky.

A more brute-force approach is simply to show the immune system all of the protein structures that are likely to emerge in future, so that it makes antibodies against the lot. Dr Victora says that immune systems have no known limit to their capacity to absorb information about pathogens. Instead, the problem with this approach may come if the system preferentially makes antibodies to some of the predicted variant proteins, but not others.

Seasonal flu vaccines already grapple with this problem when updating immune systems with information about the strain predicted to be circulating in the coming winter. Even after vaccination, immune systems may tend to make antibodies against the old virus instead. It is not clear whether the same thing will happen with updated messenger-RNA vaccines.

No programme will ever be able to predict the evolution of the entire array of pathogens which can plausibly infect human beings. But for those already known to pose a threat, systems like Octavia may be able to see far enough into the future to offer benefits. “We don’t have to be able to predict arbitrarily,” says Dr Bloom. “We don’t need to predict mutation in a decade. Just a radius of five to six mutations from where we are now. That’s good enough.”

FL77 is already doing this. The most radical version of the firm's vision—vaccinating against variants and strains of pathogens that are yet to emerge—is some way off, if it ever happens. Protecting people by programming their immune systems against future pathogens, not just those already circulating, would be a fundamental shift in the meaning, purpose and ethics of vaccination. But even in the absence of that, pathogen prediction should soon serve to speed existing sorts of vaccination programmes. And every increase in the speed of vaccine development means thousands of saved lives. ■



抗击未来病毒

预测病毒进化或许可以提前备好疫苗

新技术也许能诱导人体免疫系统准备好对付尚未出现的病原体

一般来说，免疫系统只会攻击已感染人体的病原体，发挥保护作用。不过，科学让人们找到了获得免疫力的捷径——接种疫苗。其原理是让免疫系统接触经过无害处理的危险病原体或与之相似的病原体，让人体有可能在实际感染前产生能对抗真正病原体的抗体和杀伤细胞，从而降低危险。

但是，与自然免疫反应一样，疫苗接种通常要等需要对付的病原体出现后才能实施。所以在病原体来袭时，疫苗的接种总是会慢一步。这种延误要付出生命的代价。虽说新冠疫情催生了全球史上进展最迅速的疫苗研发，但到去年底富裕世界开始接种疫苗时，估计已有数百万人死于新冠肺炎。

但是，正如疫苗接种让免疫系统可以接触到在空间上与之距离甚远的病原体，在这场全球疫情中暂露头角的新技术也让免疫系统有可能接触到在时间上与之距离甚远的病原体，也就是目前尚未出现但很可能在未来演变出来的病原体。在高通量DNA测序和现代机器学习技术的辅助下，现在我们不仅可以检测到某个病毒的哪些变种正在传播，还可以预测病毒可能发生的变异。通过这种方式了解病毒在未来数月和数年内可能出现的变异，疫苗和疗法的研发人员可以赢得先机，帮助更多人更早建立免疫，从而减少死亡人数。

这类预测的起点是病毒学家杰西·布卢姆（Jesse Bloom）的实验室正在推进的那类研究。在位于西雅图的弗雷德-哈钦森癌症研究中心（Fred Hutchinson Cancer Research Centre），布卢姆与同事们在培养皿中培养冠状病毒刺突蛋白（这种病毒用以附着于受体细胞的蛋白分子）的变体，然后逐个扫描它们，分辨什么突变会产生什么影响。

他们把这种技术命名为深度突变扫描。它利用了一大批酵母细胞，这些细胞经过基因改造而能表达刺突蛋白中名为受体结合域（receptor-binding

domain，以下简称RBD）的部分。当酵母细胞产生自己的RBD时，由于复制过程中不可避免会出现错误，许多新出现的RBD在结构上与原始野生病毒略有不同。布卢姆的团队测试每个酵母细胞的RBD，看它们与ACE2（人体某些细胞表面的受体蛋白，新冠病毒会附着其上，继而入侵细胞）结合的紧密度，再对那些能紧密结合的RBD做基因测序，以确定存在哪些突变。

去年夏天，布卢姆的团队对当时流行的一种新冠病毒毒株的刺突蛋白进行深度突变扫描，发现了一个名为N501Y的突变，似乎能提高病毒与受体结合的亲和力。几个月后，该突变出现在阿尔法毒株中，该毒株在世界大部分地区广泛流行了数月。布卢姆表示，他和同事们“算是”预测到了N501Y的出现，但实际上这绝非唯一值得关注的可能突变。即便如此，可以聚焦一组数量有限的突变的确有助缩小研究范围。

位于波士顿的“旗舰实验室77”（Flagship Labs 77，以下简称FL77）便受惠于此。这家之前一直行事低调的公司出自风险资本家努巴·阿费扬（Noubar Afeyan）经营的生物技术孵化器“旗舰先锋”（Flagship Pioneering）。旗舰先锋培育的另一家公司莫德纳（Moderna）开创了mRNA技术，加速了新冠病毒疫苗开发。阿费扬是莫德纳的董事长。

FL77的研究人员正尝试把布卢姆正在收集的那类实验数据结合以运算，以预测病毒可能如何演变。这些信息可用于提前研发疫苗和治疗性抗体。布卢姆的实验室只能预测单个突变，而FL77目前可预测五六个。FL77把该预测系统称为“全球病原体盾牌”（Global Pathogen Shield）。研究细节仍然保密，但FL77在6月发表的一篇文章概述了该项目的目标。文章指出，研发要赶上病毒变异的速度挑战极大，因为生物变化异常多样，即使只研究一小部分可能出现的突变也会导致研究范围越来越大，最终无法观察，就像要统计和分类地球上所有原子那么难。

面对这不可胜数的变异可能，一般的方法是观察而非做实验。世卫组织的全球流感监测与应对系统就用这种方法追踪流感。当南半球进入冬季，该系统就会监测哪些病毒在南半球流行，以集中分析哪些毒株将在之后的北

半球冬季流行，如此循环往复。在新冠疫情期间，Nextstrain和全球共享流感数据倡议组织（GISAID）等组织以类似的方式追踪新冠病毒变异。

FL77的目标远不止于此，它不仅要追踪病毒变体的传播情况，还要预测它们将如何演变。它的做法是运用布卢姆的深度突变扫描技术的加强版，对一百万到一千万个变体做检测分析，把所得数据输入名为Octavia的软件中。

Octavia的任务是识别培养皿数据中的模式（例如，在数以百万计的突变中，哪些会导致病毒与受体更紧密结合，哪些会导致抗体中和作用减弱），然后在所有可能的刺突变体中推导这些模式，从而预测哪些突变将打败抗体，哪些突变会更易传播。文章写道，这“使我们有可能列出一份保护性抗体清单”，通过疫苗接种或制造抗体蛋白本身来建立保护。FL77称之为“抗体安全网”。

拥有深度突变扫描技术专利的布卢姆是FL77的顾问，他表示，随着mRNA疫苗的发展，这类预测的价值已经明确。mRNA疫苗不仅可以快速制造出来，也可以快速更新。其制造流程从获取想让免疫系统攻击的病毒蛋白的基因入手，最终生产出能编码这种蛋白的一段RNA。

新冠疫苗要对付的病毒蛋白就是刺突蛋白。要根据刺突蛋白变异的预测来升级疫苗，只需在生产的开始阶段加入相应的遗传密码。这些预测至少可以让人们建好一个候选疫苗库，以备快速投产。而FL77最大胆的设想是根据预测提前接种，对抗尚未流行但很可能传播开来的病原体变体。

深度突变扫描或许还有其他用途。纽约洛克菲勒大学的免疫学家加布雷尔·维克托劳（Gabriel Victora）认为，以这种方式预测病原体的演变不仅可以用于设计抗体和疫苗，也可以用于检测病毒中极少发生变异的部分，让抗体瞄准这些可靠的攻击目标。

但这并不容易。蛋白分子任一片段的形状都取决于该分子的其他构成部分。而对免疫系统来说，要识别出攻击目标，一个必须掌握的关键特征就

是目标的形状。因此，尽管FL77的这类预测方法可能会发现病毒蛋白中不太会变异的片段，但要让免疫系统学会专门分辨出它们是件难事，因为很难找到方法来孤立表达蛋白分子的某个片段而使其形状与它作为整体的一部分时的形状一致。

一种更“蛮力”的方法是干脆让免疫系统认识所有未来可能出现的蛋白质结构，这样系统就会针对这些蛋白分子制造不同的抗体。维克托劳表示，据目前所知，免疫系统吸收病原体信息的能力并无上限。但如果免疫系统选择性地只对某些被预测出的变异蛋白产生抗体，对其他蛋白没反应，那这种方法可能就有问题了。

季节性流感疫苗就已经遭遇这个问题。基于会在即将到来的冬季流行的新毒株的预测，这些疫苗向人体免疫系统更新有关这些新毒株的信息。但即使在接种完成后，免疫系统可能仍倾向于制造针对旧毒株的抗体。目前还不清楚更新mRNA疫苗时是否也会如此。

没有任何程序能预测所有可能感染人类的病原体的演变。但是对于那些已知会构成威胁的病原体，Octavia这类系统力所能及的预测结果也许仍足以造福人类。“我们没必要做出任意的预测，”布卢姆说，“我们不需要预测十年内出现的突变，在目前的基础上预测大概五到六个突变就够了。”

FL77已经在这样做了。该公司最具革新性的愿景是针对尚未出现的病原体变体和毒株接种疫苗，但即使最终能实现，也有待时日。针对未来可能出现而非已在传播的病原体诱导免疫系统来保护人们免受侵害，这将从根本上改变疫苗接种的意义、目的和伦理。就算做不到这一点，病原体预测应该很快将能帮助加速现有的疫苗接种计划。而疫苗研发的每次提速都意味着成千上万生命获救。 ■



Proteinotopia

Remarkable progress has been made in understanding the folding of proteins

It will help open up almost limitless vistas

WHEN ST JOHN THE EVANGELIST wrote of the Word becoming Flesh, he was drawing on ideas of reason and order derived from classical Greek philosophy. But he was also providing a succinct description of the most basic truth in molecular biology. In a wonderful and ancient mechanism called the ribosome, words—in the form of messages stored in DNA—are translated into flesh, in the form of proteins.

Proteins are flesh both literally, in that they give meat the texture and bloodiness that carnivores savour, and figuratively, in that their actions lie behind all the strengths and frailties of body and mind. Both their manipulation and their mass production are fundamental to modern pharmacology. The huge market for statins rests on the way they interact with the workings of a protein called HMG-CoA reductase; Keytruda, the world's biggest-selling cancer drug, is a protein itself, a subtly tweaked antibody which turns off a mechanism that lets cancers evade the immune system. Understanding the form and function of proteins is crucial to medicine, to agriculture and to replacing the petrochemicals currently produced from oil. And that understanding is fast deepening.

Proteins are created as chains of smaller molecules called amino acids. The ribosome can fill each link in the chain with one of 20 different varieties of them. The words stored in DNA set out which of those 20 types of amino acid goes where.

In order to take on the shape required of it, a protein must fold itself up into a specific form, a process which produces all manner of kinks, twists, swirls,

sheets and cavities. The shape depends on the amino-acid sequence, but the interactions between the hundreds of amino acids are just too complex for the sequence alone to reveal much. To understand the structure of a protein in detail, scientists have had to make comparatively large amounts of it, coax those molecules into forming a crystal (or, more recently, flash-freeze them) and bombard the sample with X-rays (or, if it is a frozen one, electrons). These procedures take time, money and effort. Only a tiny fraction of the proteins whose sequences are known have been studied this way.

Now things look likely to get considerably easier. AlphaFold, a very elegant piece of software developed by DeepMind, a British AI company, has learned from the detailed study of sequence and structure to make predictions of protein shapes using just the amino-acid sequences of their very bendy backbones. On July 22nd DeepMind, which, like Google, is owned by Alphabet, made 350,000 of its predictions freely available to all, having released the code the week before. Millions more such predictions are expected soon.

As those suspicious of hype rightly point out, not all of these will be equally good and better prediction does not do away with the need for other ways of exploring protein structure. AlphaFold will not be the last word in the application of AI to the problem. All that said, the software looks likely to be massively useful, helping researchers spot possibilities and dead ends more quickly and letting them take on projects they would otherwise have steered clear of. If AlphaFold is not soon providing useful pharmacological results, as well as lots of basic biology, it will not be for want of application.

AlphaFold will also help usher in an era of altogether stranger things. Proteins are typically made from 20 different amino acids, each of which can, in principle, sit at any point in the chain. With 20 choices as to what should follow the first amino acid, you have $20 \times 20 = 400$ possible amino-

acid doublets, $20 \times 20 \times 20 = 8,000$ triplets and so on. By the time you get to an eight-amino-acid chain, there are more possibilities than there are people on Earth. Human proteins are typically 400 amino acids long; many have lengths in the thousands. There is no type of physical thing in the observable universe remotely as numerous as the possibilities inherent in a 400-amino-acid protein.

The “potential protein space” such calculations reveal is thus a cosmos unto itself, ordered yet near infinite. The bit that evolution has explored so far—which contains wonders as diverse as proteins that flex like springs, spin like wheels, extend like pistons and crank like ratchets, that turn sunlight into chemical energy, that build, demolish and recycle all the components of life and do more besides—is but the tiniest corner of it. Already some scientists are working on “de novo” proteins well outside nature’s comfort zone as ways of making tiny mechanisms and machines. As tools like AlphaFold increase the ease of molecular design, they will be joined by many more.

Compared with the designs evolution has honed over billions of years such things as this will be the crudest of toys, at least to begin with. But who can say what new flesh the designers’ words will eventually bring into being? ■



【首文】蛋白质宇宙

破解蛋白质折叠谜题取得显著进展

这将有助于开辟近乎无限的前景

当福音传道者圣约翰写下“道成肉身”（The Word became flesh）时，他借鉴了源自古典希腊哲学的理性和秩序的观念。但他也言简意赅地描述了分子生物学中最基本的真理。在一种叫作核糖体的奇妙而古老的机制中，“道”——也就是储存在DNA中的信息——以蛋白质的形式转化成为肉身。

蛋白质是肉身的说法可以从字面去理解，因为蛋白质让肉有了食肉动物嗜好的口感和血腥味。它也是一种比喻，因为肉体及精神的力量和软弱全都离不开蛋白质的作用。对蛋白质的操控和大规模生产构成了现代药理学的基础。他汀类药物市场广阔，全靠它们与一种名叫HMG-CoA还原酶的蛋白质的相互作用；世界上最畅销的抗癌药物可瑞达（Keytruda）本身就是一种蛋白质，是一种经过精妙调整的抗体，能够关闭致使癌症逃避免疫系统的机制。了解蛋白质的形式和功能对医学和农业至关重要，对于替代目前仍从石油中提取的石化产品也很关键。这种理解正在迅速加深。

蛋白质是由被称为氨基酸的更小的分子组成的链条。核糖体可以用20种氨基酸中的一种来填充链条中的每一环。存储在DNA中的信息指示这20种氨基酸中的哪一种去哪个位置。

为了呈现出所需的形状，蛋白质必须将自身折叠成特定的样式，这个过程中会产生各种各样的扭结、曲折、螺旋、片状和空腔。形状取决于氨基酸的序列，但成百上千个氨基酸之间的相互作用太复杂，单看序列无法揭示太多。为了详细了解一种蛋白质的结构，科学家不得不以较多的数量制造它，引导这些分子形成晶体（或者像近期的尝试那样将它们速冻），并用X光（如果用的是冷冻法，就用电子）“轰击”样本。这些工序需要付出时间、金钱和努力。只有一小部分序列已知的蛋白质是用这种方式被研究的。

现在，事情看起来会变得容易许多。英国的AI公司DeepMind开发了一款非常精巧的软件AlphaFold，它从对序列和结构的详细研究中学习，只根据蛋白质弯弯曲曲的“骨架”上的氨基酸序列就可以预测蛋白质的形状。7月22日，这家和谷歌一样隶属于Alphabet的公司将自己的35万个预测免费向所有人开放，此前一周还发布了编码。预计很快还会出现数百万个这样的预测。

一些怀疑存在炒作的人不无道理地指出，这些预测并不会全都一样好，而且就算有了更好的预测，也还是需要寻找其他探索蛋白质结构的方法。在运用AI研究这一问题时，AlphaFold不会是空前绝后的一个。尽管如此，这款软件看起来可能会大展拳脚，帮助研究人员更快地发现可能的出路和死胡同，让他们着手研究原本可能会回避的项目。如果AlphaFold不能在提供大量的基础生物学知识之外很快提供有用的药理研究成果，原因也绝不会是使用不足。

AlphaFold还将有助于迎来一个充满怪奇事物的时代。蛋白质通常由20种不同的氨基酸组成，原则上每种氨基酸都有可能位于链条上的任何一点。在第一个氨基酸后面有20种氨基酸供选择，所以一个双氨基酸链有20乘20也就是400种可能的组合，三氨基酸链有20乘20乘20也就是8000种组合，以此类推。等数到由八个氨基酸组成的链，可能的组合形式就比地球上的人口还要多了。人类蛋白质通常有400个氨基酸那么长，许多甚至有几千个。在可观测的宇宙中，没有任何一种有形事物在数量上能勉强与含有400个氨基酸的蛋白质包含的可能性一比。

因此，这些计算揭示出的“潜在的蛋白质空间”本身就是一个宇宙，有序但近乎无限。迄今为止，进化已经探索了其中一部分，里面包含各种各样的奇观——有的蛋白质能像弹簧一样伸缩，像轮子一样旋转，像活塞一样伸展，像棘轮一样转动，有的能将阳光转化为化学能，还有的能构建、破坏和回收生命的所有组成部分，等等。但这只不过是蛋白质宇宙中最微小的一个角落。一些科学家已经远远走出了自然的舒适区，开始研究“从头”(de novo)蛋白质，开拓制造微小的机械装置和机器的方法。随着像AlphaFold这样的工具提升了分子设计的便利度，还会有更多科学家加入

进来。

跟进化历经数十亿年的打磨而设计出来的产物相比，这些东西只会是最粗糙的玩具，至少在起步时是这样。但是，蛋白质设计师们的“道”最终会转化成什么样的新肉身，谁又能说得准呢？ ■



A little more moral hazard

Could sympathy for debtors help boost consumption in China?

Shenzhen becomes the first Chinese city to offer personal bankruptcy protection

SEVEN OR EIGHT times a day, aggrieved creditors would call Liang Wenjin demanding payment. A resident of Shenzhen, an entrepreneurial Chinese city bordering Hong Kong, Mr Liang had started a business in 2018 making Bluetooth headsets. But his company failed to connect with the market, and covid-19 dealt a final blow. Mr Liang returned to work as an engineer. But his debt of 750,000 yuan (\$115,000) remained, a lingering weight on his finances and his mind.

Debts like Mr Liang's have risen quickly. From less than 40% of GDP in 2015, household loans exceeded 62% at the end of last year. The biggest chunk was mortgage debt, a by-product of China's runaway property market. "Operating loans" of the kind weighing on Mr Liang accounted for about a fifth of the total.

These debts are now complicating the government's efforts to sustain China's growth. Having fought a tough battle against financial risk, policymakers are vowing to remain "vigilant in times of peace". To this end, they want to stabilise debt and cool the housing market. But they also have a third goal of spurring consumption to support a recovery that cannot rely on continued strength in exports.

The first two goals may be at odds with the third. On July 23rd the ministry of housing and seven other departments released tighter financial rules for the property sector. These come on top of the "three red lines" drawn last year, which limit the size of developers' debts relative to their assets, equity and cash. Mortgage costs have risen. And the ratio of household debt has

stabilised for now. But sales of cars and household appliances have lagged behind.

High debt does not prevent China's state-owned enterprises (SOEs) from splashing out when the economy requires it. They can count on banks to roll over their loans in a pinch. But households are not so lucky. The country has no bankruptcy law for overstretched individuals, who can face harassment, intimidation and blacklisting. Under the Qing dynasty, those who were late repaying their debts could be whipped with bamboo. (An extra stroke was added for each additional month of delinquency.) Nothing like that happens today. But the stigma remains.

Hence the interest in Mr Liang's fate. This month he became the first debtor to benefit from a law introduced in Shenzhen in March, which allows long-time residents to seek bankruptcy protection from creditors. He has promised to repay the principal he owes over three years. During that period, his household will live on no more than 7,700 yuan a month. He cannot travel in first-class on high-speed rail, patronise golf clubs or stay in hotels with more than three stars. But he will be spared interest, fees and incessant phone calls. The law, which should inspire similar innovations elsewhere in the country, represents a welcome step forward. China is not as "fabulously forgiving" as America, but it is starting to look more like Europe, says Jason Kilborn of the University of Illinois Chicago. China's policymakers have traditionally worried too little about the moral hazard posed by corporate borrowers. But they have worried too much about the hazard posed by people like Mr Liang. ■



多一点点道德风险

对债务人的同情能否提振中国的消费？

深圳成为中国首个提供个人破产保护的城市

愤愤不平的债权人每天要给梁文锦打七八次电话催债。梁文锦住在深圳，一座毗邻香港、富有创业精神的城市。2018年，他开始创业，生产蓝牙耳机。但他的公司没能与市场接轨，疫情又给了他最后一击。梁文锦重拾了工程师的工作。但他仍背负着75万元的债务，财务和精神上的双重压力挥之不去。

像梁文锦背负的这类债务已经迅速攀升。家庭贷款占GDP比例在2015年不到40%，在去年年底超过了62%。其中最大的部分是抵押贷款，这是中国脱缰的房地产市场的副产品。让梁文锦不堪重负的这类“经营贷款”约占总债务的五分之一。

这类债务现在正在拖累政府维持中国经济增长的努力。刚和金融风险打了一场硬仗的政策制定者誓言要“居安思危”。为此，他们希望稳定债务，给楼市降温。但他们还有第三个目标：刺激消费来为经济复苏提供支撑，因为这场复苏无法依赖出口的持续强劲。

前两个目标可能与第三个不一致。7月23日，住建部等八部门联合印发了对房地产行业更严格的财务细则。这些规则建立在去年划定的“三条红线”的基础上，后者限制了开发商的债务相对于其资产、股份和现金的规模。抵押贷款成本增加。家庭债务的比例目前也已稳定下来。但汽车和家用电器的销量已经滞后。

高额债务并不妨碍中国的国有企业在经济有需要时烧钱。它们可以指望银行在紧要关头准许延期偿还贷款。但家庭就没那么幸运了。中国还没有针对资不抵债的个人的破产法，他们可能面临骚扰、恐吓和黑名单。在清朝，逾期偿还债务者可能会受笞刑或杖刑。（每多拖欠一个月就多挨一下打。）今天这种事已不再发生，但耻辱还在。

因此，梁文锦的遭遇引人注目。7月，他成为首位受益于深圳在3月施行的个人破产条例的债务人，该法规允许深圳常住居民寻求破产保护。他已承诺三年内偿还所欠本金。在此期间，他的家庭每月生活费将不超过7700元。他不能乘坐高铁一等座，不能光顾高尔夫俱乐部，也不能入住三星级以上的酒店。但他会被免除利息和费用，也不用再接没完没了的催债电话。这部法律应该会激发中国其他地方做出类似的创新，代表着一个可喜的进步。伊利诺伊大学芝加哥分校的杰森·基尔伯恩（Jason Kilborn）说，中国虽不像美国那样“极其宽宏大量”，但开始越发像欧洲了。中国的政策制定者历来对企业借款人构成的道德风险担心得太少。但他们对像梁文锦这样的人带来的风险又担心得太多。 ■



Moving story

Pacific countries face more complex problems than sinking

Other effects of climate change are more urgent, more varied and more unpredictable

“HOW DOES a nation survive being swallowed by the sea?” So went the tagline for “Anote’s Ark”, a documentary film following Anote Tong, then president of Kiribati, as he toured the world warning that his islands were drowning. In 2014, he bought 20 square kilometres of land in Fiji, for Kiribati’s 120,000-odd people to move to as a “last resort”.

“Anote’s Ark” came out in 2018, two years after Mr Tong retired. The government that succeeded him was unimpressed. “It’s a drama, like a Star Wars film,” says Teburoro Tito, Kiribati’s ambassador to the UN. “The story is very convincing, but I must say, it’s not true.” The land in Fiji is being turned into a commercial farm.

Mr Tito has a point. In research published in 2010, Paul Kench, now at the Simon Fraser University in Canada, measured the size of 27 atolls over a period of decades and found that while 14% had shrunk and a couple had disappeared, 43% stayed the same size and another 43% became bigger. Many of the ring-shaped coral reefs have been able to adapt to sea-level rise, changing shape as sediment is eroded and pushed around. Tuvalu’s land surface, for instance, increased by 3% between 1971 and 2014 despite a rise in the local sea level of 4mm a year, twice the global average for that period. Mr Kench describes Mr Tong’s tale of sinking islands as “largely an emotional narrative”.

Such narratives have their uses. Kiribati, Tuvalu and the Marshall Islands, low-lying archipelagoes deep in the South Pacific (see map), are among the first countries to face the full onslaught of climate change. Stories like

Mr Tong's help capture international attention and much-needed funding—seven of the world's 15 most aid-dependent countries are islands in the Pacific. But there are other, more immediate effects of climate change that threaten the lives and livelihoods of the citizens of these countries. They are less arresting, harder to explain and, as in the changing shape and size of islands, sometimes counterintuitive. But the upshot is the same: the countries may soon become uninhabitable.

Start with the phenomenon of shape-shifting islands. The Intergovernmental Panel on Climate Change, a consensus-building body on climate science, warns that the natural adaptation of coastal ecosystems may be only temporary: faster rates of sea-level rise, stronger waves and a growing human population may reduce their capacity to adapt.

That is one risk. Another, more urgent one stems from even small rises in the sea level. These can cause exceptionally high tides to briefly but entirely inundate the narrow strips of low-lying land that comprise most atolls. Such “king tides”, as they are known, are becoming more frequent. The saltwater can kill crops such as banana and papaya and seeps into groundwater, making it unfit to drink. Desalination plants are pricey and, like all machines, can fail. “The islands are not drowning,” says Michael Walsh, a former economic adviser to Kiribati. “But, humans and plants alike, they may well die of thirst.”

Changing weather patterns are another factor that could make low-lying islands uninhabitable long before most of them disappear. Last year, Cyclone Harold damaged 21,000 houses in Vanuatu. Cyclone Pam in 2015 was one of the strongest ever to hit the South Pacific. Cyclones and tsunamis in the region are predicted to become ever more intense.

Many islanders have picked up and moved. Some 30,000 Marshallese, or

more than a third of the country's people, have migrated to America, many in the past two decades. Yet few cite climate change as the reason for their move. The Marshall Islands Climate and Migration Project, a research outfit, notes that the main reasons given are "education, health care, work, and family connections".

Already poor and dependant on aid, Pacific island countries have been particularly hard hit by covid-19. Travel restrictions have decimated the tourism industry and curbed seasonal migration to Australia and New Zealand.

Pacific leaders have ideas to revive their economies. Tuvalu makes lots of money from licensing its .tv internet domain (along with Vanuatu, it also sells passports to rich people). It now wants to set up an internet banking system and offer more services online. There are also ways to keep islands habitable: Kiribati plans to dredge its lagoons and use the sand to raise the surrounding islands higher above the sea. Tuvalu has embarked on a land-reclamation project. But the spectre of climate change makes it harder to drum up investment for such schemes. "I am trying to change the minds of the many people who say, 'We cannot invest in your country, you're finished,'" says Kiribati's Mr Tito.

The depressing long-term solution, as in Mr Tong's last resort, may be to move. The Marshall Islands hopes to renegotiate its post-colonial "Compact of Free Association" with America, which expires in 2023, to ensure a permanent right of residence in the United States for all Marshallese. Tuvalu has no such option. Maina Talia, a climate activist, thinks that the government should take Fiji up on its offer of a home where Tuvaluans could practise the same culture rather than "be dumped somewhere in Sydney".

Earlier this year, the government of Tuvalu, which until recently insisted

that there would be no Plan B, established a new UN initiative. Its aim is to work with “like-minded countries” to figure out how and where such countries could be relocated, how they could continue to function ex-situ, and whether they could still lay claim to vast exclusive economic zones if their land disappeared under water.

Relocating a country would raise other big questions, too, for both the international system and the way in which people think about statehood. “How to prepare to move a nation in dignity, that has never been done before,” says Kamal Amakrane, a migration expert whose ideas helped spark the UN initiative. He is confident that countries would be able to retain all the elements of statehood, but says that the world needs to start planning now. “This is happening,” Mr Amakrane warns. “We have 10-15 years to prepare for it.” ■



“动人”故事

太平洋岛国面临的问题比沉没更复杂

气候变化的其他影响更紧迫、多样化和不可预测

“一个国家如何逃脱被大海吞没的厄运？”纪录片《安诺方舟》（Anote's Ark）的宣传语写道。该片记录了基里巴斯前总统汤安诺（Anote Tong）走访全球、提醒世人他的岛国正在沉没的经历。2014年，他在斐济买了20平方公里的土地，好让基里巴斯的12万多人“在不得已时”能搬去那里。

《安诺方舟》一片于2018年上映，此时汤安诺已卸任两年。继任政府对此片反应冷淡。“这就是一出戏，就和《星球大战》一样，”基里巴斯驻联合国大使塞布罗罗·斯托（Teburoro Tito）说，“故事本身很有说服力。但我必须说，它讲的不是实情。”在斐济买的那块地正在被改造成一个商业农场。

斯托所言有一定道理。现供职于加拿大西蒙菲莎大学（Simon Fraser University）的保罗·肯奇（Paul Kench）在过去几十年里测量了27个环状珊瑚礁的面积变化，他在2010年发表的研究结果显示，尽管其中14%的环礁面积缩小了，并有个别环礁消失，但其中43%的环礁面积保持不变，而其余43%的面积还有所增加。许多环礁已经能够适应海平面的上升，随沉积物被侵蚀和转移而改变形状。例如，图瓦卢的陆地表面在1971年至2014年之间增加了3%，尽管周围海平面每年上升4毫米，是同期全球平均水平的两倍。肯奇认为汤安诺关于岛屿沉没的故事“在很大程度上是一种煽情叙事”。

这样的叙事有它的用处。基里巴斯、图瓦卢和马绍尔群岛是南太平洋深处的低洼群岛（见地图），属于最先面临气候变化全面冲击的那批国家。汤安诺这样的故事有助于吸引国际关注和急需的资金——世界上15个最依赖援助的国家中有七个是太平洋岛国。但气候变化还有其他一些更直接的影响威胁着这些国家人民的生命和生计。这些影响不那么引人注目，也更难

解释，而且就像岛屿的形状和大小不断变化那样，有时还有悖直觉。但结果都一样，那就是这些国家可能很快就会变得无法居住。

先说岛屿形状变化的现象。建立气候科学共识的机构政府间气候变化专门委员会（IPCC）警告说，沿海生态系统的自然适应可能只是暂时的，而海平面上升速度加快、海浪增强和人口增长可能会降低其适应能力。

这是一种风险。另一种更为紧迫的风险源自哪怕是小幅度的海平面上升。这会导致潮汐异常偏高，会短暂但完全淹没大多数环礁那狭窄的低洼陆地部分。这种被称作“国王大潮”的超级大潮正变得日益频繁。海水会杀死香蕉和木瓜等作物，并渗入地下水中导致其不宜饮用。海水淡化厂成本高，并且和所有机器一样可能会出现故障。“这些岛屿并没有在沉没，”基里巴斯前经济顾问迈克尔·沃尔什（Michael Walsh）说，“但人类和植物很可能因为缺水而死。”

天气模式的变化是又一个因素，可能导致低洼岛屿在大批消失之前很久就已不再适合居住。去年，飓风“哈罗德”损毁了瓦努阿图的2.1万所房屋。2015年的飓风“帕姆”是有史以来袭击南太平洋的最强飓风之一。预计该地区的飓风和海啸将变得日益猛烈。

许多岛屿上的居民已经搬离了家园。约三万名马绍尔人（占该国人口三分之一以上）迁去了美国，其中许多是在过去20年中移民的。不过很少有人说自己搬家是因为气候变化。研究机构马绍尔群岛气候与移民项目（Marshall Islands Climate and Migration Project）指出，这些移民给出的主要原因是“教育、医疗、工作和亲缘关系”。

太平洋岛国本就贫穷并依赖援助，新冠疫情对它们的打击尤为严重。旅行限制重创了旅游业，也阻碍了前往澳大利亚和新西兰的季节性劳动力迁移。

太平洋岛国的领导人想出了些重振经济的点子。图瓦卢通过授权.tv互联网域名赚了不少钱（和瓦努阿图一样，它还向外国富人出售护照）。现在它

想要建立网上银行系统并提供更多在线服务。同时，有一些方法可以让这个岛国继续适于居住。基里巴斯计划疏浚泻湖，然后用挖出的沙子将周围的岛屿垫高到海平面以上。图瓦卢已经启动了一个土地开垦项目。但气候变化的阴影增加了为此类计划吸引投资的难度。“许多人会说‘我们不能在你们国家投资，你们没希望了’，我正在试图改变他们的想法。”基里巴斯的斯托说。

和汤安诺不得已而为之的计划一样，令人沮丧的长期解决方案可能是搬迁。马绍尔群岛希望与美国重新谈判将于2023年到期的后殖民性质的《自由联合协定》（Compact of Free Association），以确保所有马绍尔人都能在美国拥有永久居留权。图瓦卢没有这样的选择。气候活动家麦娜·塔莉亚（Maina Talia）认为，图瓦卢政府应该考虑斐济的收留提议，去那里建立新家园，让图瓦卢人可以维续自己的文化，而不是“被丢到悉尼的什么地方”。

图瓦卢政府在不久前还坚持认为不需要后备方案，但在今年早些时候发起了一项新的联合国倡议。其目标是与“志同道合的国家”合作，研究大家可以往哪搬，怎么搬，搬迁之后如何继续运作，以及如果岛屿被海水淹没，它们是否仍然可以拥有广阔的专属经济区。

举国搬迁在国际体系和人们对独立国家的认知方面也会引发其他重大问题。“如何做好准备让一个国家有尊严地搬迁，在这件事上没有经验可循。”移民专家卡马尔·阿玛克兰（Kamal Amakrane）说。他的想法促成了上文提到的联合国倡议。他相信需要搬迁的各国将能够保留作为一个独立国家的所有要素，但认为全球需要现在就开始规划。“这是大势所趋，”阿玛克兰警告说，“我们有10到15年的时间来做准备。”■



Simply the best

By the numbers, Lionel Messi is European football's best scorer ever

Goals make up only half of his value, but his scoring was more impactful than that of other greats

FOOTBALL'S MOST fruitful partnership has ended in tears. On August 8th a weeping Lionel Messi said he was leaving Barcelona, the club he joined when he was just 13. The Argentine forward has scored a record 474 goals in La Liga, Spain's top league. His teams have won ten La Liga titles and four Europe-wide Champions League trophies.

Mr Messi offered to slash his salary in order to stay. But Barcelona is deep in debt, and pays 95% of its revenue in wages. La Liga has set a ceiling of 70%, forcing the club to let him go. On August 10th he joined Paris Saint-Germain (PSG), a rich French team.

Now 34, Mr Messi may not even be PSG's top scorer next season. But the only question about his peak in 2009-19 is whether it was the greatest ever. Although historical comparisons are tricky in football, the best available data suggest that it was.

Mr Messi's standing relative to his contemporaries can be analysed reliably. Today, the location and result of every shot, dribble, pass and tackle are tracked. KU Leuven, a university, and SciSports, an analytics firm, have built a system to measure how each action affects a team's odds of scoring, by comparing where the ball was before and after a player touched it.

In 2012-20, their model reckons that Mr Messi would have boosted an average team's scoring margin by 1.77 goals per match. Cristiano Ronaldo, his old rival at Real Madrid, came a distant second at 1.43.

Comparing Mr Messi with past greats is harder. The only data available for all European leagues before 2000 are goals scored and match results. And not all goals are created equal: scoring rates fell sharply from 1950 to 1970, and goals are easier to come by in weaker leagues.

To level the playing field, we devised an exchange rate called the Modern-Equivalent Soccer Scoring Index (MESSI). For each season in each league, it uses the average number of goals per match and team strength—as measured by the Elo system, which rates clubs based on their results and the quality of their opponents—to estimate how many goals players would have scored under different conditions. For example, in the 1960s Eusébio played in a weak, high-scoring Portuguese league. His goals are worth 37% less than those in La Liga in 2004-21. By contrast, Diego Maradona faced stout Italian defences, making his goals worth 5% more than the modern baseline. (We excluded penalties, which pad some strikers' stats more than others'.)

After these tweaks, the diminutive Mr Messi stands head and shoulders above the competition. At his best, he averaged one goal per 90 minutes. Mr Ronaldo reached 0.9; greats from earlier eras were below 0.8.

These rankings are far from perfect. They underrate players like Maradona and Johan Cruyff, who were as much creators as finishers. And they cannot capture the value of defenders like Franz Beckenbauer.

Even among strikers, important data are missing. Ferenc Puskas's latter years roughly match Mr Messi's recent seasons. Unfortunately, Elo ratings do not exist for the post-war Hungarian leagues that the young Puskas dominated. Nor are they available for Brazil or America, where Pelé, widely seen as the greatest player of the 20th century, played club football. ■



谁与争锋

从数据看，梅西是欧洲足球史上最佳射手

进球只体现了他一半的价值，但他的得分比其他伟大球员更有影响力

足球史上最富成果的一段合作关系在泪水中结束。8月8日，泣不成声的梅西宣布将离开他13岁就加入的巴塞罗那俱乐部。这位阿根廷前锋在西班牙顶级联赛西甲攻入了创纪录的474粒进球。他所在的球队十次夺得西甲冠军，四次问鼎欧冠联赛。

梅西曾提出愿意大幅减薪以求留下。但巴萨负债累累，薪资支出已达总收入的95%。西甲联赛设定了70%的薪资比例上限，俱乐部只能无奈让他离开。8月10日，梅西加盟法国豪门巴黎圣日耳曼。

梅西现年34岁，下个赛季甚至未必能够成为巴黎圣日耳曼的头号射手。但有关他在2009到2019年的巅峰期的唯一疑问是它是否是有史以来最伟大的巅峰期。虽然要在足球这项运动中做跨时代的比较并非易事，但现有的最好数据给出了肯定的答案。

梅西相对于同时代球员的成就可以被可靠地分析出来。今时今日，每一次射门、盘带、传球和抢断的位置和结果都被记录了下来。鲁汶大学（KU Leuven）和数据分析公司SciSports建立了一套系统，通过比较球员触球前后球的位置变化，来衡量他们的每个动作对球队得分机会的影响。

据他们的模型估算，从2012年到2020年，梅西每场比赛平均能给球队带来1.77个进球。他曾在皇家马德里效力的老对手C罗以1.43个的成绩被远远抛在第二位。

将梅西与过往的伟大球员相比较就更有难度了。所有2000年之前的欧洲联赛的可用数据就只有进球和比赛结果。而每个进球的含金量并不相同：从1950至1970年进球率急剧下降；在实力较弱的联赛里进球相对容易。

为公平起见，我们设计了一套换算率，名为现代等效足球得分指数（Modern-Equivalent Soccer Scoring Index，简称MESSI即“梅西指数”）。对于每个联赛的每个赛季，这套系统使用每场比赛的平均进球数和球队实力（由根据球队成绩和对手实力得出的Elo评分来衡量）来估算这些球员在不同条件下将能够进多少个球。例如，在1960年代，尤西比奥在实力较弱、进球数较多的葡萄牙联赛踢球，此时他进球的价值要比在2004至2021赛季的西甲联赛进球低37%。相比之下，马拉多纳要面对强硬的意大利防守，因此他的进球价值比现代基线要高5%。（我们将点球排除在外，因为一些前锋的数据会被相对放大。）

经过这些调整后，小个子梅西在竞争中鹤立鸡群。巅峰时期的梅西平均每90分钟进一个球。C罗进0.9球；而更早期的伟大球员不到0.8球。

这些排名远不算完美。它们低估了马拉多纳和克鲁伊夫这样的球员——他们既能把握机会，也能创造机会。它们也无法反映贝肯鲍尔这种后卫的价值。

即使只在前锋中比，也缺少一些重要数据。普斯卡斯后期的表现可与梅西最近几个赛季相媲美。但遗憾的是，年轻的普斯卡斯雄霸一方的战后匈牙利联赛并没有Elo评分。在巴西或美洲也没有，而在那里的俱乐部踢球的贝利是公认的20世纪球王。 ■



Veni, Nvidia, vici

Will Nvidia's huge bet on artificial-intelligence chips pay off?

The unassuming chipmaking giant was early to the AI revolution—and remains ahead of rivals

“WE’RE ALWAYS 30 days away from going out of business,” is a mantra of Jen-Hsun Huang, co-founder of Nvidia. That may be a little hyperbolic coming from the boss of a company whose market value has increased from \$31bn to \$505bn in five years and which has eclipsed Intel, once the world’s mightiest chipmaker, by selling high-performance semiconductors for gaming and artificial intelligence (AI). But only a little. As Mr Huang observes, Nvidia is surrounded by “giant companies pursuing the same giant opportunity”. To borrow a phrase from Intel’s co-founder, Andy Grove, in this fast-moving market “only the paranoid survive”.

Constant vigilance has served Nvidia well. Between 2016 and 2021 revenues grew by 233%. Operating profit more than doubled in the past five years, to \$4.5bn (see chart 1). In the three months to May sales shot up by 84%, year on year; gross margin reached 64%. Although Intel’s revenues are four times as large and it fabricates chips as well as designing them, investors value Nvidia’s design-only business more highly (twice as much in terms of market capitalisation). The data centres that make up the computing clouds of Amazon, Google, Microsoft and China’s Alibaba all use its products. So do all big information-technology (IT) firms, as well as countless scientific-research teams in fields from drug discovery to climate modelling. It has created a broad, deep “moat” that protects its competitive advantage.

Now Mr Huang wants to make the moat broader and deeper still. In September Nvidia said it would buy Arm, a Britain-based firm that designs zippy, energy-efficient chips used in most smartphones, for \$40bn. The

idea is to use Arm's design prowess to engineer central processing units (CPUs) for data centres and AI uses that would complement Nvidia's existing strength in specialised chips known as graphics-processing units (GPUs). Regulators in America, Britain, China and the EU must all approve the deal. If they do—a considerable “if”, given both firms' market power in their respective domains—Nvidia's position in one of computing's hottest fields would look near-unassailable.

Mr Huang, whose family immigrated to America from Taiwan when he was a child, founded Nvidia in 1993. For its first 20 years or so the firm made GPUs that helped video games look lifelike. In the past decade, though, it turned out that GPUs also excel in another futuristic, but less frivolous, area of computing: they dramatically speed up how fast machine-learning algorithms can be trained to perform tasks by feeding them oodles of data. Four years ago Mr Huang startled Wall Street with a blunt assessment of Nvidia's prospects in what has become known as accelerated computing. It could “work out great”, he said, “or terribly”. Regardless, the firm was “all in”.

Around half of Nvidia's revenues of \$17bn a year still come from gaming chips (see chart 2). These are also adept at solving the mathematical puzzles that underpin ethereum, a popular cryptocurrency. This has at times injected crypto-like volatility into GPU sales, which partly caused a near-50% fall in Nvidia's share price in 2018. Another slug of sales comes from selling chips that speed up features other than graphics or AI to hardware-makers.

But the AI business is growing fast. It includes specialised chips and software that lets programmers fine-tune them—itself made possible by Mr Huang's earlier bet, which some investors criticised at the time as a costly distraction. In 2004 he started investing in “Cuda”, a base software layer that enables such fine-tuning, and implanting it in all Nvidia chips.

A lot of these systems end up in servers, the powerful computers behind data centres' processing oomph. Sales to data centres contribute 36% of total revenues, up from 25% in early 2019 and nearly as much as gaming GPUs. As companies across industries adopt AI, the share of Nvidia's data-centre sales going to the big cloud providers has declined from 100% to half.

Today its AI hardware-software combo is designed to work seamlessly with the machine-learning algorithms collected in libraries such as TensorFlow, kept by Google, and Facebook's PyTorch. The firm has created programs to hook its hardware and software up to the IT systems of big business clients with AI projects of their own. This makes the job of AI developers immeasurably easier, says a former Nvidia executive. Nvidia is also getting into "inference": running AI models, hitherto the preserve of CPUs, not merely training them. Huge, real-time models like those used for speech recognition or content recommendation increasingly need specialised GPUs to perform well, says Ian Buck, head of Nvidia's accelerated-computing business.

This is where Arm comes in. Owning it would give Nvidia the CPU chops to complement those in GPUs, as well as its new abilities in network-interface cards needed in server farms (in 2019 it bought Mellanox, a specialist in the field). In April Nvidia unveiled plans for its first data-centre CPU, Grace, a high-end chip based on an Arm design. Arm's energy-efficient chips may go into AI wares for "edge computing"—in self-driving cars, factory robots and other uses far from data centres, where power-hungry GPUs may not be ideal.

Transistors in microprocessors are already the size of a few atoms, so have little room to shrink. Tricks such as outsourcing computing to the cloud or using software to split a physical computer into several virtual machines may run their course. So businesses are expected to turn to accelerated computing as a way to gain processing power without splurging on ever

more CPUs. Over the next 5-10 years, as AI becomes more common, up to half of the \$80bn-90bn that is spent annually on servers could shift to Nvidia's accelerated-computing model, reckons Stacy Rasgon of Bernstein, a broker. Of that, half could go on accelerated chips, a market which Nvidia's GPUs dominate, he says. Nvidia thinks the global market for accelerated computing, including data centres and the edge, will be more than \$100bn a year.

Nvidia is not the only one to spy an opportunity. Competitors are proliferating, from startups to other chipmakers and the tech giants. Firms such as Tenstorrent, Untether AI, Cerebras and Groq are all trying to make chips even better suited to AI than Nvidia's GPUs, which for all their virtues can use lots of power and be fiddly to program. Graphcore, a British firm, is promoting its "intelligence-processing unit".

In 2019 Intel bought an Israeli AI-chip startup called Habana Labs. Amazon Web Services (AWS), the e-emporium's cloud division, will soon start offering Habana's Gaudi accelerators to its customers. It claims that the Gaudi chips, though slower than Nvidia's GPUs, are nevertheless 40% cheaper relative to performance. Advanced Micro Devices (AMD), a veteran chipmaker that is Nvidia's main rival in the gaming market and Intel's in CPUs, is finalising a \$35bn purchase of Xilinx, which makes another kind of accelerator chip called field programmable gate arrays (FPGAs).

A bigger threat comes from Nvidia's biggest clients. The cloud giants are all designing their own custom silicon. Google was the first, with its "tensor-processing unit". Microsoft's Azure cloud division opted for FPGAs. Baidu, China's search giant, has "Kunlun" chips for AI and Alibaba, its e-commerce titan, has Hanguang 800. AWS already has a chip designed for inference, called Inferentia, and one coming for training. "The risk is that in ten years' time AWS will offer a cheap AI box with all AWS-made components," says the former Nvidia executive. Mark Lipacis at Jefferies, an investment bank,

notes that since mid-2020 AWS has put Inferentia into an ever-greater share of its offering to customers, potentially at Nvidia's expense.

As for the Arm acquisition, it is far from a done deal. Arm's customers include all the world's chipmakers as well as AWS and Apple, which uses Arm chips in iPhones. Some have complained that Nvidia could restrict access to the chip designer's blueprints. The Graviton2, AWS's tailor-made server chip, is based on an Arm design. Nvidia says it has no plans to change Arm's business model. Western regulators have yet to decide whether to approve the deal. Britain's competition authority, which had until July 30th to scrutinise it, is expected to be among the first to issue a ruling. China is unlikely to welcome an American takeover of an important supplier to its own tech firms, which is currently owned by SoftBank, a Japanese tech group.

Even if one of the antitrust watchdogs puts paid to the deal, however, Nvidia's prospects look bright. Intel has overpromised many things, including accelerated computing, for years, and has mostly not delivered. Venture capitalists have become markedly less enthusiastic about backing startups that are taking on Nvidia and its software, and the tech giants investing in accelerated computing, observes Paul Teich of Equinix, an American data-centre operator. As for AWS and the rest of big tech, they have other things on their plates and lack Nvidia's clear focus on accelerated computing. Nvidia says that, measured by actual use by businesses, it has not ceded market share to AWS's Inferentia.

Mr Huang says that it is the expense of training and running AI applications that matters, not the cost of hardware components. And on that measure, he insists, "we are unrivalled on price-for-performance." None of Nvidia's rivals possesses its software ecosystem. And it has a proven ability to switch gears and capitalise on good luck. "They're always looking around at what's out there," enthuses another former executive. And with an entrenched

position, Mr Lipacis says, it also benefits from inertia.

Investors have not forgotten the plunge in Nvidia's share price in 2018. It may still be partly tied to the fortunes of the crypto market. Holding Nvidia stock requires a strong stomach, says Mr Rasgon of Bernstein. Nvidia may present itself as a pillar of the computing industry, but it remains an aggressive, founder-led firm that behaves like a startup. Sprinkle in some paranoia, and it will be hard to disrupt. ■



我达，我见，我征服

英伟达在AI芯片上的豪赌会成功吗？

这家低调的芯片巨头很早便投身AI革命，现在依然领先于对手

“我们离倒闭永远只有30天。”这是英伟达联合创始人黄仁勋的口头禅。这话从英伟达老板嘴里说出来可能有点夸张，因为这家公司靠销售高性能的游戏和人工智能（AI）半导体，五年内市值从310亿美元增长到5050亿美元，令曾是全球最强大芯片制造商的英特尔黯然失色。不过这也仅仅是“有点”夸张。正如黄仁勋所说，英伟达正被“追逐同一个巨大机遇的巨头企业”包围。借用英特尔联合创始人安迪·格鲁夫（Andy Grove）的话来说，在这个飞速发展的市场，“只有偏执狂才能生存”。

保持时刻警醒让英伟达收获良多。2016年至2021年，它的收入增长了233%。营业利润在过去五年翻了一番多，达到45亿美元（见图表1）。今年3月至5月，销售额同比激增84%，毛利率达到64%。尽管英特尔的收入是英伟达的四倍，而且不但设计芯片还制造芯片，但投资者还是更看好只设计芯片的英伟达（它的市值是英特尔的两倍）。亚马逊、谷歌、微软以及中国的阿里巴巴的云计算数据中心都在使用英伟达的产品。它的客户还包括从药物研发到气候建模等各种领域里数不胜数的科研团队，以及所有的大型IT公司。它修建了一条又宽又深的“护城河”来保护自己的竞争优势。

如今，黄仁勋还想把这条护城河加宽、加深。去年9月，英伟达表示将斥资400亿美元收购安谋（Arm），大多数智能手机都使用这家英国公司设计的高性能且高能效的芯片。英伟达希望利用安谋的设计实力来设计供数据中心和AI使用的中央处理器（CPU），与英伟达在图形处理器（GPU）这一专用芯片上的既有优势形成互补。这笔交易必须得到美国、英国、中国和欧盟的监管机构一一批准。如果获批——鉴于两家公司在各自领域的市场支配力，这一点非常难说——英伟达在最热门的计算领域之一将取得

看上去近乎不可撼动的地位。

黃仁勋幼年时随家人从台湾移民到美国，在1993年创办了英伟达。这家公司在头20年左右的时间里生产让电子游戏画面栩栩如生的GPU。不过在过去十年里，人们发现GPU在另一个前沿但更严肃的计算领域也表现突出：它们能大大加速向机器学习算法输入海量数据来训练它们执行任务的过程。四年前，对于英伟达在所谓的“加速计算”领域里的前景，黃仁勋直言不讳的自我评估震惊了华尔街。它可能“发展得极好”，他说，“也可能很糟糕”。不管怎样，英伟达都“押上了全部身家”。

英伟达170亿美元的年收入仍有约一半来自游戏芯片（见图表2）。这些芯片还很擅长解决构成以太币这一流行的加密货币的基础的那些数学难题。这有时给GPU的销售注入了类似加密货币的波动性，在一定程度上造成了英伟达股价在2018年几乎腰斩。英伟达的另一块销售额来自向硬件制造商销售除图形和AI芯片以外的加速芯片。

但AI业务正在快速增长。其中包括程序员可以做出微调的专用芯片和软件——正是黃仁勋早先的押注让这一功能成为可能，当时一些投资者批评他是在烧钱和不务正业。2004年，他开始投资这种能够做微调的基础软件层“Cuda”，并将其植入所有的英伟达芯片中。

这些芯片系统很多最终都用到了服务器上，也就是让数据中心拥有超强处理能力的高性能计算机。英伟达对数据中心的销售额在总收入中的占比从2019年初的25%上升到目前的36%，几乎已与游戏GPU相当。随着各行各业的公司纷纷开始采用AI，在英伟达对数据中心的销售额中，对大型云服务供应商的销售占比从100%下降到50%。

如今，英伟达的AI软硬件一体化系统意图与机器学习算法无缝协作，比如谷歌维护的TensorFlow和Facebook的PyTorch等存储库中收集的算法。它开发了一些程序，将英伟达的软硬件与拥有自己AI项目的大企业客户的IT系统接通。一位前英伟达高管表示，这大大简化了AI开发人员的工作。英伟达还在向“推理”领域迈进：运行AI模型（迄今还是CPU的领地）而不仅

仅是训练它们。英伟达加速计算业务主管伊恩·巴克（Ian Buck）表示，用于语音识别或内容推荐等的大型实时AI模型越来越需要专用的GPU以取得良好效果。

这正是安谋的作用所在。它的加入将让英伟达获得CPU技术，与自己已有的GPU技术互为补充，此外英伟达也已经新增了在服务器集群所需的网络接口卡方面的能力（2019年它收购了该领域的专业公司Mellanox）。今年4月，英伟达公布了它的首款数据中心CPU，代号Grace，是一款基于安谋架构的高端芯片。安谋的高能效芯片可能会在AI设备中用于“边缘计算”，如无人驾驶汽车、工厂机器人和其他远离数据中心的场景，因为在这些场景中，高能耗的GPU可能并非最佳选择。

微处理器中的晶体管已经只有几个原子大小了，因此几乎再无压缩的空间。而将计算外包给云平台，或用软件将一台实体计算机拆分成多台虚拟机等解决办法可能迟早也会走到尽头。因此，企业预期会依靠加速计算来提高信息处理能力，而不必大笔砸钱购入越来越多的CPU。经纪公司盛博的斯泰西·罗根（Stacy Rasgon）估计，未来五到十年，随着AI越来越普遍，每年花在服务器上的800亿至900亿美元中，多达一半可能会转向英伟达的加速计算模型。这其中可能又有一半将流向加速芯片，这是一个由英伟达的GPU主导的市场，罗根说。英伟达认为，包括数据中心和边缘计算在内的全球加速计算市场规模每年将超过1000亿美元。

英伟达并不是唯一嗅到商机的公司。从创业公司到其他芯片制造商和科技巨头，它的竞争对手层出不穷。Tenstorrent、Untether AI、Cerebras和Groq等公司都在设法制造比英伟达的GPU更适合AI的芯片。尽管英伟达的GPU有很多优点，但在用于AI时它可能耗电量太大且编程过于繁琐复杂。英国公司Graphcore正在推广自己的“智能处理器”。

2019年，英特尔收购了以色列的AI芯片创业公司Habana Labs。电商巨头亚马逊旗下的云计算部门AWS很快就将开始让自己的客户用上Habana的Gaudi加速器。它声称，Gaudi芯片虽然速度不及英伟达的GPU，但性价比要高出40%。老牌芯片制造商AMD是英伟达在游戏市场的主要竞争对手，

也是英特尔在CPU市场的劲敌，如今它正在敲定一笔以350亿美元收购Xilinx的交易，Xilinx制造另一种名为现场可编程门阵列（FPGA）的加速芯片。

更大的威胁来自英伟达最大的那批客户。云计算巨头们都在设计自己的定制芯片。谷歌最先行动，开发出了它的“张量处理器”。微软的云计算部门Azure选择了FPGA。中国搜索巨头百度有“昆仑”AI芯片，电子商务巨头阿里巴巴有含光800芯片。AWS已经有了一款名为Inferentia的推理芯片，还将推出一款训练芯片。上文那位英伟达前高管表示，“危险的是，不出十年，AWS就能推出价格低廉的AI盒子，其中所有组件都是它自己制造的。”投资银行杰富瑞（Jefferies）的马克·里帕西斯（Mark Lipacis）指出，自2020年年中以来，AWS在自己的云计算服务中越来越多地使用了Inferentia，这可能损害了英伟达的利益。

至于对安谋的收购，还远未尘埃落定。安谋的客户不仅包括AWS、在iPhone中使用基于安谋架构的芯片的苹果，还有全世界所有的芯片制造商。一些企业已经开始诉苦说，英伟达可能会限制它们使用安谋的芯片设计方案。AWS定制的服务器芯片Graviton2采用的就是安谋的架构。英伟达表示不打算改变安谋的商业模式。西方监管机构尚未决定是否批准这笔交易。英国的竞争监管机构7月30日前审查了这笔交易，预期会是首批做出裁定的机构之一。鉴于目前归日本科技集团软银所有的安谋是中国本土科技公司的重要供应商，中国不大会乐于接受它被一家美国公司收购。

然而，即便其中哪家反垄断监管机构让这笔交易泡汤，英伟达的前景看上去还是一片光明。多年来，英特尔在包括加速计算在内的很多事情上夸下海口，但大多没能兑现。风险投资家对那些向英伟达及其软件发起挑战的创业公司的投资热情明显减退，科技巨头也不再热衷于投资加速计算，美国数据中心运营商Equinix的保罗·泰奇（Paul Teich）表示。至于AWS和其他大型科技公司，它们还有其他事情要做，不像英伟达那样明确专注于加速计算。英伟达表示，从企业实际使用情况来看，它并没有将市场份额拱手让给AWS的Inferentia。

黄仁勋表示，最重要的不是硬件组件的成本，而是训练和运行AI应用的费用。从这一点来衡量，他坚称，“我们在性价比方面没有对手”。英伟达的竞争对手无一拥有像它那样的软件生态系统。而且它已经展现了自己改变策略、抓住好运气的能力。“他们总是眼观六路，看外面的世界正在发生什么。”另一位前高管兴奋地说。而有了稳固的地位，即使什么都不做，它也能从中获益，里帕西斯表示。

投资者没有忘记2018年英伟达股价的暴跌。它的股价在一定程度上可能仍与加密货币市场的命运捆绑。盛博的罗根说，持有英伟达的股票要有颗强心脏。英伟达可能以计算行业的中流砥柱自居，但它行事仍然像一家激进的、唯创始人马首是瞻的创业公司。若再加上些偏执，它将很难被颠覆。





A new reality

The IPCC delivers its starker warning yet about climate change

The effects of a hotter planet are visible around the world

AT A KEY moment in the film “Jaws”, police chief Martin Brody, having known that a shark attack was possible, witnesses one actually happen. The director, Steven Spielberg, underlines the transformative nature of Brody’s shock with a shot which makes inspired use of a camera technique called a “dolly zoom”. Nothing on screen actually moves. But Brody’s guilty face seems to rush towards the audience, taking up more and more of the frame. At the same time his surroundings, rather than being displaced, are revealed more fully.

The report released on August 9th by the Intergovernmental Panel on Climate Change, the first part of the IPCC’s sixth assessment report (AR6), presents the spectacle of the possible becoming real in a similarly unnerving way, mixing close-up alarm with wide-angle context. It is a starker and blunter document than its predecessor in AR5, which was published in 2013. The statements in the summary expressing “high confidence” handily outnumber those that offer only “medium confidence”. Last time around the two categories were roughly level pegging.

Part of that higher confidence is down to better science, which is welcome. Another part is down to bitter experience, which is not. The report stresses that the world is living through climate change, not watching it draw near. Its 234 authors base their conclusions, in a phrase that acts as something of a refrain, on “multiple lines of evidence”. Some of that evidence comes from computer models, and some from improved physical understanding of various planetary processes. Crucially, an increasing proportion comes from direct observations of the way in which the world has changed so far.

Start with the predictions of what lies dead ahead. Over the past decade the Earth has been between 0.95°C and 1.2°C (1.7-2.2°F) hotter than it was in the second half of the 19th century; the best estimate is 1.1°C. That is more than 0.2°C higher than the change that AR5 found when it made the same comparison in the previous decade. Though some of the difference is now put down to AR5 having underestimated the then current temperatures, most is seen as being due to continued heating.

The total amount by which the planet will heat up depends pretty closely on cumulative greenhouse-gas emissions. That allows the “carbon budgets” associated with various levels of worldwide temperature rise to be calculated. For AR6 this exercise in climate accounting has been gone through all over again.

Worldwide greenhouse-gas emissions since 1850 are now put at 2,400bn tonnes of carbon dioxide, give or take 10%. Every subsequent 1,000bn tonnes is likely to cause between 0.27°C and 0.63°C more warming. If that seems quite imprecise, it is a much tighter estimate than was previously possible. Such calculations rely ultimately on how sensitive global temperatures are to rising carbon-dioxide levels. That crucial number is one of those things which is easier to estimate now that there is more experience to go on. The error range is notably smaller now than it was in AR5 (see chart 1).

The budget associated with a 50% chance of keeping warming below 1.5°C—the more ambitious of the two goals laid out in the Paris agreement of 2015—allows just 500bn more tonnes to be emitted. That is about 15 years of industrial emissions at current rates. To avoid busting that budget would require the whole world, not just rich countries, to get net emissions of carbon dioxide down to zero before 2050. That is a tall order, to put it mildly. Even the most ambitious of the various emissions scenarios modelled by

the IPCC's experts offers less than a 50% chance of staying below 1.5°C of heating.

The very-low-emission scenarios do offer a fighting chance of keeping warming below 2°C. But the emission cuts they require go far beyond what the nations of the world have currently promised. What is more, those scenarios mandate not just heroic emission cuts but also "negative emissions"—techniques that actively remove carbon dioxide from the atmosphere, thus paying back some of the carbon budget spent previously. It is just about conceivable that, if emissions fall very quickly and carbon-dioxide removal scales up really well, warming may exceed 1.5°C during the coming decades but fall back below that level by the end of the century.

Happily, the report confirms that removing carbon dioxide from the atmosphere might be a plausible way of reducing temperatures. Since such removals now offer the only way of reconciling the modest near-term cuts currently enshrined in national policies with the much more dramatic long-term ambitions those same countries proclaim, this is just as well. If the IPCC had found large-scale carbon-dioxide removal untenable that would have put the kibosh on the whole idea of reaching net-zero emissions.

But the report also notes that such removals could affect more than just temperatures. They could also have an impact on food production, biodiversity and water availability and quality, especially if they are carried out through the use of huge forestry plantations. And it has nothing to say about how those systems might operate or how much they would cost—that work is left to the reports on impacts and on mitigation, which are due out next year.

Meanwhile, in wide-angle, the predicted consequences of a warming world are becoming clearer and more fine-grained. Again, this is partly the product of better scientific understanding, and partly the product of direct

experience. In 2013 AR5 referred to just three studies linking extreme weather events to rising temperatures. The authors of the latest report were able to assess hundreds of such event-attribution papers. Those allow it to make the clear statement that climate change is already affecting every inhabited region of the planet, with human influence contributing to many observed changes in weather and climate extremes.

The current trend towards more frequent and intense heavy rainfall will continue, but not monotonically; rain and snowfall will become more variable within seasons and, probably, from year to year. The authors are thus fairly certain that flooding will be more frequent and intense in most of Asia and Africa if the world warms by 1.5°C, and pretty sure the same changes will be seen in North America and Europe. Earlier melting of mountain snow-packs will add to the flood risk in some areas; in others, higher sea levels will raise the risk, as will the greater frequency of the most intense tropical cyclones.

Heatwaves will climb in number and severity. Extreme “wet-bulb” temperatures—a measure which includes the degree to which humidity makes it harder for the human body to shed heat—will become more common more quickly than unadjusted high temperatures do. Temperatures on the hottest days in some mid-latitude regions, including parts of Europe, will rise 1.5 to 2 times as fast as global warming more generally.

The oceans will heat up more slowly than the land. But as they do so they will expand and rise, a trend exacerbated by the melting of glaciers and ice caps. The warming will not be even. The Arctic will heat up more than other seas; in every one of the IPCC’s scenarios there will be sea-ice-free days in the Arctic by the middle of the century. There will be local aberrations, too. Marine heatwaves—short-lived bursts of hot water which have only recently become a topic of concern—are expected to continue to become

more common, especially in the tropics and the Arctic.

Ocean warming will also suppress the tendency of waters from different depths to mix. Both the heatwaves and the increased stratification will have ecological effects that may be profound, both in the Arctic and beyond.

Generally speaking, what is wet becomes wetter, what is dry, drier, and what is uncommon more common. The rarer the event, the higher the likelihood that it will become more frequent. Even at 1.5°C of heating the report warns there will be some events—heatwaves, droughts and such—that are more severe than any that have been observed before. This is true at a global level as well as a regional one. “Low-likelihood, high-impact” events are, by their nature, hard to be specific about. It is a good bet they become more likely with higher temperatures. But even at comparatively modest levels of warming such calamities as widespread forest dieback or a collapsing Antarctic ice sheet are hard to completely rule out.

Recommendations about what to do are not part of this report’s remit. But nevertheless it pushes hard for more and stronger action on methane. In terms of its contribution to warming so far, methane is second only to carbon dioxide (see chart 2). Atmospheric levels of the stuff, like those of carbon dioxide, are higher than at any other point in human history. But unlike carbon dioxide, atmospheric methane is transient—it has an atmospheric half-life of less than a decade. This means that cuts in methane emissions pay off much faster than cuts in carbon dioxide. If the world is really serious about trying to keep below 2°C of warming, let alone 1.5°C, doubling down on attempts to cut methane emissions, both from industry and agriculture, should be a high priority.

As the report points out, this is particularly important because of the effects of another pollutant. Sulphates are given off mostly by coal plants and the

sorts of heavy fuel oils that power big ships. They have the opposite effect to methane and carbon dioxide: by reflecting sunlight back into space, they cool the planet. The IPCC reckons sulphate pollution keeps the world about 0.5°C cooler than it would otherwise be. Without it, the world would probably have already breached the Paris aspiration of limiting temperature rises to 1.5°C.

The problem is that sulphates are deadly. Over the past few decades they have contributed a great deal to the particulate air pollution that has killed tens of millions. Clean-air laws have seen them increasingly scrubbed out of fuels and smoke stacks. The IPCC report finds that continuing this good work on air pollution would contribute to global warming in all the emission scenarios it studied. That is another reason, it says, to promote quick and lasting cuts in methane emissions. Without increased ambition on methane, cleaner, clearer air will add to the challenge of rising temperatures.

Mr Spielberg's coup de cinema in "Jaws" marks the moment when the police chief realises that the opportunity to avert calamity is gone; his inaction has led to a covert threat becoming a blood-in-the-water reality. As a result the chief is seized by a new fervour for action—one which brings him into direct conflict with the mayor, who prefers to minimise the risks so as not to scare off the tourists.

When it comes to climate change the realisation has hardly been instantaneous; it has been dawning for at least a decade or so. But coming as it does in a summer of shattered temperature records and terrifying fires and floods, an IPCC report in which predictions of future global warming are, more than ever before, backed up with observations should offer a similar punctuation. Deciding how much action to take on climate change is politically hard, because it means imposing high costs today for largely hidden benefits tomorrow. But when, in November, the world's

governments get together in Glasgow to discuss how they can improve on the insufficient action they have taken to date, they need to think like people who have seen the blood in the water. ■



新现实

IPCC发出迄今最严峻的气候变化警告

地球变热的影响到处可见【深度】

在电影《大白鲨》中，警察局长马丁·布罗迪（Martin Brody）事先就知道可能发生鲨鱼袭击事件。在片中一个关键场景中，他亲眼目睹了一次袭击真实发生。导演史蒂文·斯皮尔伯格在这里巧妙运用了名为“推轨变焦”的拍摄手法来突显布罗迪的震惊，预示着这个角色的行为将发生巨大的转变。画面中其实什么都没动，但布罗迪愧疚的脸庞却似乎在向观众冲来，在画面中不断放大，同时背景不但没有被遮盖，反而更宽广地展现出来。

政府间气候变化专门委员会（以下简称IPCC）在8月9日发布了第六次评估报告（以下简称AR6）的第一部分，以同样令人不安的方式呈现了可能成真的前景：既用特写发出警示，也从广角展现背景。相比2013年发表的第五次评估报告（以下简称AR5），这份报告的语气更加冷峻直白。概述中表达出“高度可信”的陈述数量大大超过“比较可信”的次数。而在上一份报告中，两者大致持平。

可信度提升的一方面要归功于科学进步，这是好事。而另一方面是因为苦果已经显现，这很糟糕。该报告强调，地球已经在经历气候变化了，而不是看着它逐步逼近。234名科学家参与撰写该报告，他们的结论基于“多方面的证据”，这个说法反复出现在报告中。其中一些证据来自计算机模型，另一些源于对各种行星演化过程的物理研究的进展。重要的是，越来越多的证据来自对迄今世界变化的直接观察。

先看有关眼前变化的那些预测。过去十年，地球气温比19世纪后半叶高了 0.95°C 至 1.2°C ，最佳估计值为 1.1°C 。这比AR5对它发布前的十年所做的同一比较发现的变化高了 0.2°C 不止。这一差异虽然有一部分被归结为AR5低估了当时的温度，但主要还是地球不断变暖的缘故。

地球将来的总升温很大程度上取决于累积的温室气体排放。因此，与各种

全球升温程度对应的“碳预算”是可以计算出来的。AR6也再一次完成了这项气候核算工作。

目前估计，自1850年以来，全球温室气体排放量约为2.4万亿吨二氧化碳当量，上下误差在10%以内。之后每增加一万吨排放就可能导致气温上升0.27°C至0.63°C。这虽然看起来不算精确，但相比以往能得出的估计已经严谨得多。这类计算最终取决于全球气温对二氧化碳水平上升的敏感程度。如今有了更多经验可循，要估计包括这个关键数字在内的一些事情变得更容易了。现在的误差范围明显要比AR5时小（见图表1）。

要有50%的机会把全球升温幅度控制在1.5°C以下（2015年《巴黎协定》的两个目标中较宏伟的那个），温室气体的排放预算就只剩5000亿吨。按目前的排放速度，这大约是15年的工业排放量。要避免超出这一预算，不仅是富裕国家，整个世界都必须在2050年之前把二氧化碳净排放量降至零。说得客气点，这很难办。即使是IPCC专家模拟的各种排放情境中最具减排野心的那种，把升温幅度控制在1.5°C以下的几率也不到50%。

在那些排放水平很低的情境下，确实还有可能经过努力把升温控制在2°C以下，但所需减排量远远超出世界各国目前的承诺。更重要的是，这些情境不仅要求急剧减排，还需要实施“负排放”，即运用技术主动清除大气中的二氧化碳，以抵消之前消耗掉的一些碳预算。勉强可以想象一下，如果排放量迅速下降，二氧化碳得到大幅清除，在未来几十年升温幅度可能超过1.5°C，但到本世纪末会回落至该水平以下。

所幸，该报告证实从大气中清除二氧化碳也许是可行的降温方法。这是个好消息，毕竟，要调和各国目前已写入政策中的较保守的近期减排目标和这些国家宣称的更宏大的长期目标，当前唯一的办法就是清除二氧化碳。假如IPCC发现大规模清除二氧化碳行不通，净零排放这个想法也就会彻底泡汤。

但报告也指出，这种清除行动影响的也许不止是温度，还可能冲击粮食生产、生物多样性以及水资源的供应和质量，特别是通过大规模造林来清除

二氧化碳的话。报告第一部分没有提及这些系统的运作方式或成本，预计明年公布的关于影响和缓解效果的报告将对此做出解释。

同时，从更广阔的角度看，全球变暖的后果预测变得更清晰、细致。同样，这既是科学研究发展的结果，也是直接经验的产物。2013年发布的AR5只援引了三项有关极端天气事件与变暖关联的研究。AR6的作者则评估了数百份这样的天气事件归因文献。这使得报告能够明确指出气候变化已经在影响地球上每个有人居住的地区，而人类的影响是许多可观测到的天气变化和极端气候事件的原因之一。

如今强降雨更频繁猛烈的趋势将持续下去，但不是简单的重复：降雨和降雪的季节内变化会加大，而且可能每年的情况都不一样。因此，报告的作者们相当肯定地指出，如果全球变暖 1.5°C ，在亚洲和非洲的大部分地区，洪灾会更频繁、更凶猛，北美和欧洲也很可能出现同样的情况。山区积雪提前融化将加剧一些地区的洪灾风险，而在其他地区，威胁将来自海平面上升以及更频繁的超强热带气旋。

热浪出现的次数和严重程度都会攀升。极端“湿球”温度（这一指标计入了高湿度让人体难以散热的程度）相比未经调整的高温将更快成为更普遍的现象。在包括欧洲部分地区的中纬度地带，最热季节的升温速度将会是全球变暖速度的1.5至2倍。

海洋升温会比陆地慢。但当海洋升温时，海水会膨胀，海面上升，而冰川和冰盖融化更加剧了这一趋势。变暖将不会均匀地发生。北冰洋的变暖程度将高于其他海洋；在IPCC推演的每种情境中，到本世纪中叶，北冰洋每年都可能出现没有海冰的日子。还会出现局部反常现象。预计海洋热浪（暂时性的海水高温现象，近些年才引起关注）将不断变得更普遍，特别是在热带地区和北冰洋。

海洋变暖也将抑制不同深度的海水混合的倾向。热浪及海水分层加剧都可能对北冰洋和其他地区的生态环境产生深远影响。

总的来说就是，涝的愈涝，旱的愈旱，稀奇变寻常。越是罕见的气候现象

越有可能更频繁地出现。报告警告称，即使只升温 1.5°C ，热浪、旱灾等气候事件也可能比以往所见更严重，在全球和区域层面都是如此。“低可能性、高冲击性”的事件本身就是很难具体预测的。八九不离十的是，随着温度升高，这些事件将更可能出现。但即使变暖程度相对轻微，森林大范围枯萎或南极冰盖崩塌等灾难也难以完全排除。

提出对策不在这份报告的范围之内。尽管如此，报告还是大力敦促加强限制甲烷排放。论迄今对气候变暖的推动作用，甲烷仅次于二氧化碳（见图表2）。和二氧化碳一样，目前大气中的甲烷水平比人类史上任何时期都要高。但不同于二氧化碳，甲烷在大气中的存留时间短，半衰期不到十年。这意味着减少甲烷排放比减少二氧化碳排放收效快得多。如果世界真想把升温控制在 2°C 以下（更别说 1.5°C ），一大要务应是加倍努力减少工业和农业甲烷排放。

正如报告指出的，甲烷减排非常重要，因为还有另一种污染物的影响。硫化物排放主要由火电厂和大型船舶使用的那类重燃油造成，其影响与甲烷和二氧化碳相反：它把阳光反射回太空，令地球变冷。IPCC认为，硫化物污染使全球升温减少了 0.5°C 。如果没有硫化物污染，全球升温幅度可能已经超出了《巴黎协定》所期望的 1.5°C 。

问题是，硫化物污染会致人死亡。过去几十年，硫化物已成为导致数千万人死亡的颗粒物空气污染的一个重要因素。清洁空气法规的实施使燃料和烟囱的硫化物排放日益减少。IPCC报告发现，在其研究的所有排放情境中，继续推进这项有益于控制空气污染的工作都会加剧全球变暖。报告指出，这是提倡快速且持久地减排甲烷的另一个原因。不加大甲烷的减排力度，空气变得更干净清澈只会令全球变暖的挑战越发棘手。

斯皮尔伯格在《大白鲨》里那个神来之笔的镜头标志着那一刻警察局长意识到灾难已无可避免，他之前的无所作为令潜藏的威胁变成了血淋淋的现实。结果，局长转而决意采取行动，这让他和主张尽量淡化风险以免吓跑游客的市长产生了直接冲突。

谈到气候变化，人们并没有即刻认识到问题：危机在至少约十年前便已显现苗头。但是，随着这个夏天破纪录的焦灼高温、可怕的山火与洪灾涌现，IPCC报告对未来全球变暖的预测获得了前所未有的直观证据支持，应该能起到与电影中那一幕类似的警醒作用。决定究竟采取多少行动来应对气候变化要面对政治上的阻力，因为这需要在当下投入高成本，而收益却大部分潜藏于未来。但是，当各国代表在11月聚首格拉斯哥讨论改善至今力度不足的行动时，他们需要像那些亲眼看到水里泛起血色的人那样思考。 ■



Buttonwood

How the delisting of Chinese firms on American exchanges might play out

\$1.5trn of market capitalisation is at stake

THESE DAYS politicians in Beijing and Washington seem to agree on very little. Yet on the subject of ending the listing of Chinese firms on American exchanges they are in uncommon harmony. The collapse last year of Luckin Coffee, a Chinese beverage-delivery group listed on the Nasdaq that was caught inflating its sales, reignited political grievances in America. The result was the Holding Foreign Companies Accountable Act, which requires companies traded on American exchanges to submit to audits or face delisting within three years. The precise rules are still being drawn up, but will probably eventually involve a great shedding of shares.

China, for its part, seems happy for its companies to leave American markets. Its regulators seemed unbothered when their actions demolished the share price of Didi Global, a Chinese ride-hailing company, just days after it listed in New York. New rules from the country's cyberspace watchdog will make it harder for some firms to list outside of China. A sudden rule change in late July made online-tutoring firms serving school-aged children ineligible for overseas listings, wiping billions of dollars from several New York-traded Chinese stocks.

Rare as this moment of Sino-American agreement is, it hardly spells good news for investors. The American market has come to host \$1.5trn-worth of Chinese companies. That sort of market value has not been cast off by exchanges before. So what kind of damage might delisting do to shareholders?

That Chinese companies still trade in New York at all is remarkable. For a

decade now Beijing and Washington have sparred over the fate of China's American Depository Receipts (ADRs), as the shares of foreign companies trading in America are called. As a wave of accounting scandals at New York-listed Chinese firms began to wash over markets in 2011, American regulators started insisting on gaining access to certain accounting documents. Chinese officials have dug their heels in, refusing the requests and even making sharing the materials a crime.

There are some stocks for which delisting need not involve much pain. Many ADR contracts say that investors can convert those shares into corresponding securities listed on other exchanges, notes Wei Shang-Jin of Columbia Business School. Some of the biggest Chinese companies have been prepared, pursuing secondary listings in Hong Kong to which shares can be transferred. This started with BeiGene, a biotech group, when it launched a secondary listing in Hong Kong in 2018. Alibaba, which raised \$25bn in New York in 2014, held a second listing in Hong Kong in 2019 to raise another \$11bn. Of the 236 Chinese companies listed in New York, 16 have secondary listings in Hong Kong, with a combined market capitalisation of \$980bn.

The situation looks bleaker for shareholders in other firms. Stock prices will be dragged down by the potential for instability. (The Nasdaq Golden Dragon China Index, which tracks Chinese firms listed in New York, is down by 45% since February.) This will give managers and other company insiders a chance to buy out American shareholders' stock on the cheap, says Jesse Fried of Harvard Law School. The companies could eventually relist in China or Hong Kong at much higher valuations, but the original investors in the ADRs will not see a cent from the relisting. And shareholders are unlikely to have the right to review the valuation at which companies are taken private, notes Shaswat Das of King & Spalding, a law firm.

There is an even worse case. Some companies may simply "go dark",

meaning they stop reporting to American regulators and are delisted with no buyout at all. This might sound far-fetched—but it has happened before. In the aftermath of the accounting scandals of a decade ago, more than 100 Chinese companies vanished from New York's exchanges, destroying some \$40bn in market value. Many did not compensate investors. And shareholders in general stand little chance of recouping losses: because most Chinese groups have few assets in America, an angry shareholder seeking legal recourse would have to go to a Chinese court, says Joel Greenberg of Arnold & Porter, another law firm.

The smart move, then, is not to be caught holding these shares when delisting draws near. But here's the catch. Ten years ago experts also called time on cross-border listings for Chinese groups. The market capitalisation of Chinese firms listed on American exchanges has risen ten-fold since. ■



梧桐

中国公司从美国交易所退市会如何收场

1.5万亿美元的市值岌岌可危

如今，北京和华盛顿的政客似乎很少能就什么事达成一致。不过它们在终止中国公司在美国交易所上市的问题上倒是异常和谐。去年，在纳斯达克上市的中国饮料配送集团瑞幸咖啡被抓到夸大销售，它的坍塌再度触发了美国政界的不满。其结果就是《外国公司问责法案》（Holding Foreign Companies Accountable Act）的出台，该法案要求在美国交易所交易的公司三年内接受审计，否则将被摘牌。相关细则仍在起草中，但最终可能会引发大量股票被抛售。

中国倒似乎很高兴本国公司离开美国市场。中国网约车公司滴滴刚在纽约上市没几天，中国的监管机构展开的行动就重创其股价，但官员们似乎也不以为意。中国网信办的新规将使一些公司更难在境外上市。7月底，一项规则突然生变，使得为学龄儿童提供服务的在线辅导公司失去海外上市资格，几只在纽约交易的中国股票被抹去了数十亿美元。

中美像这样达成一致的时候虽然罕见，对投资者来说却不是什么好消息。美国市场已经接纳了总市值达1.5万亿美元的中国公司。之前从没有发生过交易所抛弃如此规模的市值。那么，这轮退市可能会对股东造成怎样的损害呢？

中国公司至今仍在纽约交易这一点本身就令人称奇。十年来，北京和华盛顿围绕中国的美国存托凭证（ADR，在美国交易的外国公司股票）的命运交锋不断。2011年，在纽约上市的中国公司的一波会计丑闻开始席卷市场，美国监管机构开始坚持要求查阅某些审计文件。中国官员拒不让步，甚至将分享这些材料列为违法。

有些股票不一定会因为退市经受太多痛苦。哥伦比亚大学商学院的魏尚进指出，许多ADR合约中都写明，投资者可以将这些股份转换成在其他交易

所上市的相应证券。一些最大的中国公司已经做好准备，寻求在香港二次上市，这样未来可以将股份转到那里。生物技术集团百济神州于2018年开了在香港二次上市的先河。阿里巴巴2014年在纽约融资250亿美元，2019年在香港二次上市，又融资110亿美元。在纽约上市的236家中国公司中，有16家在香港二次上市，总市值9800亿美元。

对其他公司的股东来说，情况似乎就比较糟糕了。潜在的不稳定因素将拖累股价。（自2月以来，追踪在纽约上市的中国公司的纳斯达克金龙中国指数下跌了45%。）哈佛法学院的杰西·弗里德（Jesse Fried）表示，这将为管理者和其他企业内部人士提供一个低价收购美国股东股票的机会。这些公司最终可能会以高得多的估值在中国大陆或香港重新上市，但ADR的原始投资者不会从重新上市中赚到一分钱。而且股东也不太可能有权审查公司被私有化时的估值，律师事务所King & Spalding的沙斯瓦特·达斯（Shaswat Das）指出。

还有一种更糟的情况。一些公司可能会干脆“进入休眠”，也就是停止向美国监管机构汇报，并被摘牌，而股票完全没人接手。这听起来可能难以置信，但以前也不是没发生过。十年前会计丑闻爆发后，100多家中国公司从纽约的交易所消失，约400亿美元市值灰飞烟灭。许多公司都没有补偿投资者。一般来说股东挽回损失的可能性也很小：由于大多数中国集团在美国几乎没有资产，愤怒的股东要想诉诸法律手段就不得不求助于中国的法院，另一家律师事务所Arnold & Porter的乔尔·格林伯格（Joel Greenberg）说。

因此，明智的做法是不要在退市临近时还持有这些股份。不过这里就有个问题。十年前专家们也说中国企业跨境上市该停了。但自那以后，在美国交易所上市的中国公司的市值增长了十倍。■



Chinese capitalism

What tech does China want?

The contours of the Communist Party's masterplan for its technology industry are emerging

THE VISION is becoming clear. In a decade or so China will, if the Communist Party has its way, become a techno-utopia with Chinese characteristics, replete with “deep tech” such as cloud-computing, artificial intelligence (AI), self-driving cars and home-made cutting-edge chips. Incumbent technology giants such as Alibaba in e-commerce or Tencent in payments and entertainment will be around but less overweening—and less lucrative. Policies to curb their market power will redistribute some of their profits to smaller merchants and app developers, and to their workers. Second-tier cities will boast their own tech industries with localised services, competing with the less-mighty titans. Data will pulse through the system, available to firms of all sizes, under the watchful eye of the government in Beijing. China’s internet will strengthen its authoritarian design.

Clearer, too, is the way in which President Xi Jinping wants to make this vision a reality. Besides talking up deep tech, this involves taking the shallower sort down a peg. In the past nine months China’s regulators have cracked down on the country’s effervescent tech scene, which, though it has generated world-beating innovations and astounding shareholder value, is no longer seen as fit for purpose. On August 11th the authorities indicated that regulations over all manner of tech businesses will be strengthened in the next five years. As a consequence of all this, the country’s hottest tech groups have lost at least \$1trn in combined market capitalisation since February (see chart 1).

Foreign investors who have backed Chinese online firms are retreating. Domestic Chinese investors are anxious. Indices tracking Chinese tech stocks in Hong Kong and Chinese groups more broadly in New York are down by 40-45% since mid-February. No matter. Indeed, it may be part of the plan. Consumer-internet companies make up at least 40% of big Chinese stocks in the MSCI China Index. Like their American peers—Apple, Alphabet, Amazon, Facebook, Netflix—these firms have made tonnes of money for their shareholders. But, the party seems to think, at the expense of abusing their market power, exploiting workers and polluting minds.

The list of casualties is a Who's Who of Chinese tech: Ant Group, an Alibaba affiliate whose \$37bn initial public offering (IPO) was suspended with days to go; Didi Global, whose ride-hailing app was expelled from Chinese app stores days after its own \$4.4bn IPO in New York; Tencent, fined by regulators for sexually explicit content and unfair practices, and told to end exclusive music-licensing deals; the online-tutoring industry, largely barred last month from making a profit.

And the list is getting longer. Trustbusters are reportedly getting ready to slap a \$1bn fine on Meituan, a super-app that delivers meals. On August 9th the Financial Times reported that NetEase, an online-entertainment group, decided to shelve the planned IPO in Hong Kong of its music-streaming business owing to investors' worries about the regulatory crackdown.

The ranks of potential winners are less well-defined. As a guiding principle, the vice-premier, Liu He, recently stated that China is moving into a new phase of development that prioritises social fairness and national security, not the growth-at-all-costs mentality of the past 30 years. The government will guide the “orderly development of capital”, he noted, the better to suit the “construction of a new development pattern”. Barry Naughton of the University of California, San Diego, calls this the “grand steerage”. Dexter

Roberts of the Atlantic Council, a think-tank in Washington, DC, discerns an echo of Mao Zedong's "politics-in-command" economy. Either way, it is a break with the old pro-growth model and the beginning of "real state capitalism", as one investment banker puts it.

Start with data. Europe and some American states, such as California, have devised laws that seek to protect consumers from the misuse of their personal information by large companies. China has put similar rules in place; in some cases they are more severe than in the West. But Chinese regulators are going further. In a largely ignored, jargon-filled policy paper from the State Council, China's cabinet, in April last year, data were named as a "factor of production" alongside capital, labour, land and technology. This hinted at the importance assigned to information by the Chinese state, notes Kendra Schaefer of Trivium, a consultancy.

China's new data policy remains a work in progress. The Data Security Law will come into force on September 1st and the Personal Information Protection Law is due to be adopted by China's rubber-stamp parliament soon. It is unclear how they will be enforced, though data specialists intuit that many types of data currently held by internet giants could eventually be traded on government-backed and private exchanges. Ant, for example, is already being prodded by authorities to open up its vast stores of personal financial data to state-owned companies and smaller tech rivals. No specific rules for financial-technology firms have been issued but everyone is waiting for them, says Deng Zhisong of Dentons, a law firm.

Another prong of the state's strategy is to redistribute the wealth and power large tech platforms have accrued over the past decade. E-commerce groups such as Alibaba, JD.com and Pinduoduo have been targeted by the State Administration for Market Regulation (SAMR), China's newish antitrust regulator, which accuses them of monopolistic behaviour. Merchants on these platforms often indeed pay high fees and must choose between selling

on one or the other. Payment systems run by Tencent and Alibaba have prevented exchange of information between them, which led to a bifurcation of the market.

The giants are now being forced to shift to more open models where payments and shopping activity are no longer exclusive to one platform, allowing merchants to regain some control over the prices of their wares. Analysts believe that the changes will lead to higher margins for sellers and lower prices for consumers but slower growth for the tech titans. Alibaba warned investors in early August that long-running tax benefits could soon come to an end, adding billions of dollars in costs.

Workers will benefit from the wealth transfer, too. Companies like Didi and Meituan, which use armies of low-paid drivers and warehouse staff, are on the hook. The authorities are already going after Meituan for not providing adequate care to such employees. It will be forced to raise wages and give drivers better insurance. Meituan's market value has fallen by a fifth, or \$42bn, since the measures were announced in late July.

The final facet of China's campaign is a transfer of resources from internet companies to firms that can create tangible advances in technologies that the party deems less frivolous. This would represent a striking shift in Chinese economic governance, which since the 1990s has put rapid development and attracting foreign direct investment over all else. Under-regulated internet firms have been the prime example. Local officials lowered taxes and gave away land in order to attract the online giants to their cities and provinces.

Now the government wants to use such carrots, as well as its anti-tech sticks, to create a less unruly and more hardware-focused technology sector to help it surpass America and the rest of the West in economic might, writes Rush Doshi, an adviser to President Joe Biden, in "The Long Game:

China's Grand Strategy to Displace American Order". Mr Xi has referred to "great changes unseen in a century" in areas such as AI and quantum computing (which would harness the weirdness of subatomic physics to drastically speed up certain types of calculations). These, he has suggested, will usher in a new global economic order that revolves around China. Senior officials believe that if China can get a first-mover advantage on the cutting edge of technology, it will become not just an economic superpower but a geopolitical and military one, too, writes Mr Roberts of the Atlantic Council.

Many politicians in America and Europe would love to fashion their tech industry into something like Mr Xi's vision: less social media and other "spiritual opium", as Chinese state news outlets recently dubbed video-gaming; more strategic development of the techno-infrastructure of the 21st century. This includes computer chips, clean energy and much besides, partly to counteract an effort by America and its allies to restrict exports to China of semiconductors and other critical technologies. When launching a new business, entrepreneurs and investors must therefore ask, "How does this solve China's problems?" sums up Liu Jing of Cheung Kong Graduate School of Business in Beijing.

Yet the way China's regime is going about the transition is far from guaranteed to work. One problem stems from who is doing the regulating. The Communist Party presents an image of a unified force with a single set of objectives. In fact, like any large bureaucracy, Chinese authorities are fragmented, and can act at cross-purposes.

The policies behind the techlash are born of sweeping goals for society from the highest reaches of central government, an echelon of engineers and economists who lack expertise in most of the sectors being targeted. But it is up to specialists in bodies such as SAMR and the Cyberspace Administration of China (CAC) to enact these objectives. And as regulators' remits expand,

the odds of a clash shorten.

Some run-ins have already happened. A recent policy from the central bank aimed at breaking up powerful fintech groups spilled into antitrust territory covered by SAMR, notes Angela Zhang of the University of Hong Kong. Following the bans of Didi's app and online tutors' profits, in both of which the CAC played a part, the China Securities Regulatory Commission (CSRC), which has spent years convincing global investors that Chinese markets are stable, had to contact bankers and investment funds to assure them that other industries would not be treated so harshly. The CSRC's move was interpreted by some as a sign that regulators were rethinking their scorched-earth tactics. Instead, the situation highlights how uncoordinated the campaign has been at times.

Another worry is that the crackdown has spooked entrepreneurs and venture capitalists. It is true that some smaller firms view the tech giants as bullies that have strong-armed rivals and snuffed out competition. China's most innovative startups have had the choice of selling out to big tech or facing a quick and brutal demise, says Mr Liu. The recent dismantling of online monopolies has been a godsend for many promising young executives who have long struggled under the thumb of big tech, he observes. And entrepreneurs have flocked to the approved deep-tech fields: last year alone Chinese founded 22,000 chip firms, 35,000 cloud-computing companies and 172,000 AI startups.

But the online giants' founders, such as Jack Ma of Alibaba, are still held in high regard by other tech bosses. Many industry executives fear that years of hard work and sacrifice have gone unnoticed by their regulatory overlords. The party has communicated its intentions and goals poorly to a generation of talented businesspeople, says an executive at a small startup. If the current turmoil persists, China may end up with an open field for free and fair competition "but no one to run the companies", says another

executive.

Investors face similar considerations. A prominent private-equity financier fully agrees with the goals of the regulation campaign. If carried out correctly, it could reduce inequality while becoming a global model for regulating big tech. But, he adds, the tactics have not been thought out. Pointing to China's world-beating fintech sector, he warns that "harming China tech is harming China as a nation." A more level playing field could let smaller tech companies flourish. But "who would invest in these right now?" asks Chen Long of Plenum, a Beijing-based research group.

A big test of investor sentiment will come with the rumoured IPO of ByteDance, a \$180bn unlisted giant which owns TikTok and its Chinese sister short-video app. But venture capitalists are already getting cold feet. Fundraising for privately held tech firms peaked at \$28bn in the last quarter of 2020, when the techlash began, according to CB Insights, a data provider. In the second quarter of this year Chinese startups raised just \$23bn, even as those in America raked in ever more capital (see chart 2). The bulk of last year's litter of new deep-tech companies probably predates the clampdown. Their prospects and easy access to capital remain uncertain.

Apparently without irony, Chinese media have likened the government's push to spur domestic chipmaking to the Great Leap Forward. In 1958 Mao decreed that farmers set up furnaces in their backyards in order to help China surpass British steelmakers. What the media have omitted to mention is that the resulting steel was mostly unusable pig-iron. Meanwhile, millions of Chinese starved as fields went unploughed. Mr Xi's technoleap towards cutting-edge chips and other deep tech will not be as calamitous—China is too prosperous for that. But it is not immune to the law of unintended consequences. ■



中国的资本主义

中国想要什么样的科技？

党对科技产业的总体规划轮廓显现【深度】

愿景日渐清晰。再过十年左右，如果能如共产党所愿，中国将成为具有中国特色的科技乌托邦，其中云计算、人工智能（AI）、无人驾驶汽车和国产高精尖芯片等“深科技”应有尽有。电子商务领域的阿里巴巴或支付和娱乐领域的腾讯等现有科技巨头将会继续存在，但不会再那么神气十足，也不会再有那么高的利润。遏制它们市场支配力的政策会将其部分利润重新分配给较小的商家和应用开发者，还有它们的员工。二线城市将拥有自己的科技产业来提供本地化服务，与实力被削弱的巨头竞争。在中央政府的监视下，数据将在系统中脉动，供大大小小的公司使用。中国的互联网将加强其威权控制。

国家主席习近平想要实现这一愿景的方式也变得更清晰了。除了大谈深科技之外，还要杀一杀那些技术没那么“深”的公司的锐气。过去九个月，中国的监管机构出手整治中国大热的科技圈——尽管这个行业产生了世界一流的创新技术和惊人的股东价值，但已不再被认为契合国家目标。8月11日，政府表示未来五年将加强对各类科技企业的监管。这一切使得自2月以来，中国最热门的那些科技集团的总市值蒸发了至少一万亿美元（见图表1）。

投资了中国互联网公司的外国投资者正在撤退。中国本国的投资者也很焦虑。自2月中旬以来，追踪在香港上市的中国科技股和在纽约上市的更多样的中国公司的指数下跌了40%至45%。那又有什么要紧的。事实上，这可能都是计划的一部分。在MSCI中国指数中，消费互联网公司至少占大盘股的40%。和苹果、Alphabet、亚马逊、Facebook、奈飞（Netflix）这些美国同类公司一样，中国的互联网企业为股东赚了很多钱。但共产党似乎认为，它们获取利润靠的是滥用市场支配力、剥削员工和腐蚀思想。

“伤亡”名单也是一份中国科技名企录，其中包括：脱胎于阿里巴巴的蚂蚁集团，其370亿美元的IPO在正式挂牌前几天被叫停；滴滴，在纽约上市融资44亿美元后没几天，它的应用就从中国的各个应用商店下架；腾讯，被监管机构以传播色情内容和不公平市场行为为由罚款，并被责令解除独家音乐版权；在线教育行业，上个月基本上被禁止盈利。

而且这份名单还在变长。据报道，中国的反垄断机构正准备对外卖超级应用美团处以10亿美元罚款。8月9日，英国《金融时报》报道称，由于投资者担忧监管机构的打压，在线娱乐集团网易决定搁置其音乐流媒体业务在香港的IPO计划。

哪些公司可能成为赢家就没那么明确了。副总理刘鹤近日的讲话传达了一条指导原则：中国正在进入的发展新阶段优先考虑社会公平和国家安全，而不是像过去30年那样不惜一切代价求增长。他指出，政府将促进“资本健康有序发展”，更好服务于“构建新发展格局”。加州大学圣地亚哥分校的巴里·诺顿（Barry Naughton）将此原则称为“宏大导向”。华盛顿智库大西洋理事会（Atlantic Council）的德克斯特·罗伯茨（Dexter Roberts）察觉其中有毛泽东“政治挂帅”式经济的意味。不论如何，这都是与从前增长优先模式的决裂，以及——用一位投资银行家的说法——“真正的国家资本主义”的开始。

先说数据。欧洲和美国的加州等州制定了法律，保护消费者的个人信息不被大公司滥用。中国已有类似的立法，在某些方面比西方的法律更严格。但中国的监管机构正走得更远。去年4月，中国国务院发布了一份没有引起太多关注的满篇术语的政策文件，将数据与资本、劳动力、土地和技术并称为“生产要素”。这表露出中国政府对信息的重视，咨询公司策纬（Trivium）的肯德拉·谢弗（Kendra Schaefer）指出。

中国新的数据政策仍在制定中。《数据安全法》将于9月1日生效，《个人信息保护法》将很快在中国的立法机构人大通过审议。目前尚不清楚这些法律将如何执行，但数据专家的直觉是，互联网巨头目前持有的多种类型

数据最终可能会在政府支持的和私有的交易平台上交易。例如，政府已经敦促蚂蚁集团向国企和规模较小的科技竞争对手开放其庞大的用户个人财务数据。大成律师事务所的邓志松表示，目前还没有出台针对金融科技公司的具体法规，但这是迟早的事。

政府战略的另一方面是要重新分配大型科技平台在过去十年中积累的财富和权力。近年设立的反垄断监管机构市场监管总局已经盯上了阿里巴巴、京东和拼多多等电子商务集团，指控它们存在垄断行为。这些平台上的商家确实往往需要支付高额费用，并且必须在平台之间做选择。腾讯和阿里巴巴的支付系统不能互通信息，导致市场被分割。

巨头们现在被迫转向更开放的模式，让支付和购物行为不再局限于某个平台，从而让商家重新获得对自身商品价格的部分控制权。分析人士认为，这些变化将为卖家带来更多的利润，让消费者享受更低的价格，但科技巨头的增长将放缓。阿里巴巴在8月初警告投资者称，互联网行业多年来享受的政府税收减免可能很快会结束，企业将增加数十亿美元的成本。

员工也将从财富转移中受益。滴滴和美团等雇用大量低薪司机和仓库人员的公司已经遇上麻烦。当局已经因美团对这些员工缺乏关怀而盯上该公司。它将被迫提高工资并为骑手提供更完善的保险。自7月底宣布这些措施以来，美团的市值已经下跌了五分之一，缩水420亿美元。

中国科技整治行动的最后一个方面是将资源从互联网公司转移出来，投向那些能够在党认为更紧要的技术领域创造切实进步的公司。这将意味着中国的经济治理会发生显著转变。自上世纪90年代以来，中国一直把快速发展和吸引外商直接投资放在首位。监管不足的互联网公司就是最好的例子。地方官员提供税收优惠并给予土地，以吸引互联网巨头落户自己的省市。

拜登的顾问杜如松（Rush Doshi）在《持久战：中国取代美国主导秩序的大战略》（The Long Game: China's Grand Strategy to Displace American Order）一书中写到，现在中国政府希望同时利用这些胡萝卜再加上打压

科技巨头的大棒，创建一个更守规矩、更注重硬件的科技行业，以帮助中国在经济实力上超越美国和其他西方国家。习近平提到了人工智能和量子计算（可利用亚原子物理的奇异特性来大幅加速某些类型的计算）等领域正经历“百年未有之大变局”。他认为，这样的变局将开创以中国为中心的全球经济新秩序。政府高级官员认为，如果中国能够在尖端技术上获得先发优势，它不仅将成为经济超级大国，还会成为地缘政治和军事的超级大国，大西洋理事会的罗伯茨写道。

美国和欧洲的许多政客都会愿意照着习近平的愿景打造自己的科技产业，也就是少些社交媒体和其他“精神鸦片”——中国官方媒体近期就如此定义电子游戏——多一些21世纪科技基础设施的战略性发展。这包括计算机芯片、清洁能源技术等等，一定程度上是为了应对美国及其盟友限制对中国出口半导体和其他关键技术的做法。因此，在创办新企业时，企业家和投资者必须要问这样一个问题：“这能否解决中国的问题？”主校区位于北京的长江商学院的刘劲总结说。

然而，中国的政治体制推动这一转型的方式远不能保证奏效。问题之一源于谁在监管。共产党对外呈现的面貌是拧成一股绳、向同一组目标努力。而事实上，与任何大型官僚机构一样，中国政府是碎片化的，可能会各自为政。

打压科技巨头背后的政策源于中央最高层确定的全面社会发展目标，这批工程师和经济学家出身的高层领导在大多数目前受打压的行业都缺乏专业知识。但制定和实施这些目标的是市场监管总局和网信办等机构的专家。而随着各监管机构职权范围不断扩大，它们之间发生冲突的可能性也越来越大。

一些磨擦已经出现。香港大学的张湖月指出，人行最近一项旨在拆分强大金融科技集团的政策已经涉及到反垄断，而这是市场监管总局的管辖范围。滴滴应用被下架和营利性在线教育被禁后（两项行动都有网信办的参与），中国证监会不得不联系各国银行家和投资基金，向他们保证其他行业不会受到如此严厉的打击。证监会此前已花费了多年时间努力说服全球

投资者相信中国市场是稳定的。证监会的这一举动被一些人解读为监管机构在重新考虑它们的焦土策略。而实际上，这种局面突显了这场整治行动有时非常缺乏协调。

另一个值得担忧之处是整顿行动吓坏了企业家和风投家。确实，一些较小的公司将科技巨头视为蛮横打压对手并扼杀竞争的恶霸。一直以来，中国最具创新力的创业公司只能选择是把公司卖给大型科技公司还是接受迅速而残酷的死亡，刘劲说。他认为，对于许多长期在科技巨头的颐指气使下苦苦挣扎的有前途的年轻高管来说，近来对网络垄断的打压是天赐良机。企业家们纷纷涌向获得国家首肯的深科技领域——仅去年一年中国就成立了2.2万家芯片公司、3.5万家云计算公司和17.2万家AI创业公司。

但阿里巴巴的马云等互联网巨头的创始人仍然备受其他科技老板的尊崇。许多行业高管担心他们多年的辛勤工作与牺牲都被监管老爷们忽视了。一家小型创业公司的高管表示，共产党没有清晰地向一代商业人才传达其意图和目标。另一位高管表示，如果当前的动荡持续下去，中国可能最终会拥有自由及公平竞争的开放市场，“但没人来管理公司了”。

投资者也面临类似的考虑。一位著名的私募股权投资人完全同意监管行动的目标。如果执行得当，它可以减少不平等，同时成为监管大型科技企业的全球典范。但是，他补充说，这些策略没有经过深思熟虑。他以中国领先世界的金融科技产业为例，警告说，“损害中国科技企业就是损害中国国家利益”。更公平的竞争环境可以让小型科技公司蓬勃发展。但“现在谁会投资这些公司呢？”总部位于北京的研究公司Plenum的陈龙问道。

传闻中的字节跳动IPO将是对投资者情绪的一次重大考验，这家估值1800亿美元的未上市巨头是TikTok及其中国版短视频应用抖音的母公司。然而，风投家已经开始退缩了。数据供应商CB Insights的数据显示，在2020年最后一个季度，也就是对科技业的打压刚刚开始时，私营科技公司的融资额达到了280亿美元的峰值。今年第二季度，中国的创业公司仅融资230亿美元，与此同时美国创业公司的融资规模越来越大（见图表2）。去年新

涌现的深科技公司很可能大部分都是在整顿行动开始之前成立的。它们的前景如何以及能否轻易获得资本仍不确定。

中国媒体将政府推动国内芯片制造的努力比作大跃进，显然没有讽刺的意思。1958年，毛泽东号令农民在自家院子里架起熔炉，帮助中国赶超英国的钢铁制造商。媒体没有提及的是，由此产生的钢材大多是无法使用的生铁疙瘩。与此同时，千百万中国人因田地无人耕种而挨饿。现在的中国非常繁荣，习近平向尖端芯片和其他深科技的科技大跃进不会造成那么大的灾难。但它也并非对“非预期后果定律”免疫。■



Automatic goods handling

Robots are poised to start unloading lorries

The last pieces of warehouse automation will soon be in place

UNLOADING LORRIES is wearisome for people, but hardly an intellectual challenge. For robots it is the reverse. Robots never tire. They do, however, have problems interpreting the data streaming in from the cameras and laser scanners that are their eyes. Seeing where one box in the back of a crowded lorry ends and another begins is second nature to a human being. But even the best artificial-vision systems struggle to cope.

And that is just the start. The next question is what the robot should do with what it sees. The less tidy the contents, the greater the problem. Shrink-wrapped pallets of packages are one thing, the miscellaneous jumbles of objects handled by parcel-delivery businesses quite another. Cases may get wedged, or be fumbled. Or the robot may need to work out how to lift an irregular consignment like a set of skis. People learn how to do such things gradually, as they grow up. And machines have to learn, too. That takes time and a lot of training.

Unloading lorries is therefore one of the few parts of operating a warehouse that has resisted automation. But not for much longer. A new generation of cargo-handling robots is poised to take on the task.

The robotics division of Honeywell, a large American technology company, has come up with a vehicle-sized unit (see picture) that fits onto the back of a lorry. It has a large arm fitted with suction cups which can pick up several boxes at a time and then feed them onto a conveyor belt, or knock down a wall of boxes and sweep them onto the conveyor. An individual human worker can unload between 600 and 1,200 boxes an hour. Honeywell hopes

that, once its robot is perfected, a single crew chief will be able to supervise the simultaneous unloading of three or four lorries, each at rates of up to 1,500 boxes an hour.

Thomas Evans, chief technology officer of Honeywell's robotics operation, says the robot does not need to be as precise as the pick-and-place robots that work on assembly lines. But it is still a challenge for it to distinguish between individual boxes and to recognise and identify anomalous objects such as loose pallets and the pallet jacks used to move stacked pallets around. At the moment, therefore, it works best with boxes of uniform size and shape.

Changing that will need a lot of training, which, in turn, means designing and assembling a variety of dummy loads inside a variety of vehicles. This is both time-consuming and labour-intensive. Dr Evans says his team can put together about four such test loads a day. Ideally, that number would be nearer 100—but running tests at this scale would be expensive. Digital simulations can help. They are, though, Dr Evans says, no substitute for the real thing. He is therefore negotiating with one of the potential customers for the robot, a company that already handles this volume of business, to do the training there.

In Massachusetts, a firm called Boston Dynamics takes a different approach from Honeywell's. Boston Dynamics is famous in the wider world for an acrobatic humanoid robot called Atlas, and for Spot, a robot that resembles a dog and is now on sale as a device for monitoring what is happening in factories and other large spaces. The firm's good-handling system, Stretch, is, however, the first it has custom-built for a particular task.

Stretch is smaller and more mobile than Honeywell's robot, and is able, according to Kevin Blankespoor, Boston Dynamics' general manager of warehouse robotics, to move easily from one lorry to another, or to a

different part of a site altogether. It sports a single arm festooned with sensors and a suction gripper able to handle boxes weighing up to about 25kg. Unlike Honeywell's system, Stretch can already manage the trick of examining a wall of boxes, working out their sizes and shapes, and choosing which to pick up first. It is, though, slower. The aim is that it will be able to handle 800 cases an hour.

A third contender, Dill, is made by the Pickle Robot Company, also based in Massachusetts. Andrew Meyer, Pickle's boss, believes Dill has an edge over the competition because Pickle's engineers have focused on the robot's ability to handle messy trailers with irregular loads. This is not just a matter of machine vision and an ability to work out where boxes are, but also of understanding the laws of physics, and therefore how particular objects will behave. That helps Dill decide which is the best box to pick up next, and how to deal with it as speedily as possible without dropping it.

In particular, Dill is designed for what Mr Meyer terms "centaur operation", in which human and robot collaborate, rather than the human's role being merely supervisory. Dill is skilled at spotting problems it cannot deal with and then calling in human assistance. It can handle 98% of cases on its own, Mr Meyer claims—though it has problems with things like damaged goods and unexpected objects. The upshot is an arrangement which, he says, has a maximum capacity of 1,600 packages an hour, with a realistic average of 1,000.

The next task, which all three companies are now engaged in, is to run the unloading process in reverse by using robots to load lorries in the first place. Besides simply lugging boxes around, this also involves working out how to stack them efficiently. Solving that problem, and doing so at the speed which commerce requires, would allow warehouses to be almost completely automated. The firm that perfects this trick may not be popular with unions. But managers will love it. ■



自动处理货物

机器人已准备好卸货

仓库自动化的最后几步将很快走完

从卡车上卸货累人又乏味，但对智力没什么挑战。对于机器人来说，情况正好相反。机器人永远不会疲倦。但它们在解读自己的“眼睛”——也就是摄像头和激光扫描仪——获取的数据时确实存在问题。对人类来说，在装满货物的车斗里分辨相邻两个箱子的分界处是习惯成自然的事情。但这即便对于最好的人工视觉系统也不容易。

而这还只是个开始。下一个问题是机器人应该怎么处理它看到的东西。物品越杂乱无章，困难就越大。用收缩膜包裹的一排排货品是一回事，快递公司要递送的形形色色的物件又完全是另一回事。箱子可能会卡住，或者要摸索着才能够着。机器人可能还得弄清楚该怎么抬起形状不规则的货物，比如一副滑雪板。人类在成长的过程中逐渐学会了怎么做这些事。机器也需要学习。这需要时间和大量的训练。

所以给卡车卸货是仓库运营中少数迟迟未能实现自动化的部分之一。但这样的情况不会持续太久。新一代货物装卸机器人已经准备好开工了。

美国大型科技公司霍尼韦尔（Honeywell）的机器人部门已经研制出一种可以安装在卡车后部、大小与一辆车相仿的装置（见图）。它有一个装着很多个吸盘的大机械臂，可以一次抓起几个箱子，把它们送到传送带上，或者推倒一整面墙的箱子，把它们“横扫”到传送带上。一名工人每小时可以卸600到1200箱货。霍尼韦尔希望等到它的机器人技术完善后，一个操作员就能监督机器人从三四辆卡车上同时卸货，每个机器人每小时最多能卸1500箱。

霍尼韦尔机器人业务的首席技术官托马斯·埃文斯（Thomas Evans）表示，这种机器人不需要像在装配线上工作的分拣机器人那样精确。但它还不能轻松区分开每个箱子、识别并确认不规则的物体，比如散装托盘和用

来移动叠放托盘的搬运车。因此，目前它最适合处理大小和形状一致的箱子。

要改变这种情况需要大量训练，这意味着要在不同的车辆中设计和装配各种负载仿制品。这既费时又费力。埃文斯说，他的团队每天能装配完四车仿造负载。理想情况下，这个数字应该接近100，但运行这么大规模的测试成本很高。数字模拟可以帮忙。不过，埃文斯说，真枪实弹的训练无可取代。因此，他正在与这款机器人的一个潜在客户协商，希望到对方的仓库实地训练，那里的装卸量已经有这样的规模。

在马萨诸塞州，波士顿动力（Boston Dynamics）研究的方法与霍尼韦尔有所不同。这家公司因为两款面向更广泛市场的产品而出名：会玩杂技的人形机器人Atlas和机器狗Spot。目前Spot已上市销售，用于在工厂等大型空间做巡检。而货物处理系统Stretch是该公司第一款为特定任务定制的产品。

Stretch比霍尼韦尔的机器人更小、更灵活。波士顿动力的仓储机器人部门经理凯文·布兰科斯普尔（Kevin Blankespoor）说，它能够轻松地从一辆卡车挪到另一辆上，或者移动到仓库里一个完全不同的地方。它有一条装着传感器和吸力抓手的机械臂，最多能抓起25公斤左右的箱子。与霍尼韦尔的系统不同，Stretch已经能够检视一整面墙的包裹，计算出它们的大小和形状，然后选择先拿哪一个。不过，它的处理速度要慢一些，目标是每小时处理800件。

第三个竞争者是同样位于马萨诸塞州的“泡菜机器人公司”（Pickle Robot Company）研发的Dill。公司老板安德鲁·迈耶（Andrew Meyer）认为，Dill有一个竞争优势，因为公司的工程师专注于研究如何让Dill处理装载着不规则货物的杂乱的拖车。这不仅仅涉及机器视觉和识别箱子的位置，还需要理解物理定律以了解特定物体如何反应。这能帮助Dill决定下一步拿哪个箱子最好，以及如何尽可能快地处理它而不会跌落。

一个特别之处在于，Dill是被设计用于迈耶口中的“半人马操作”——在其中

人类是与机器人协作，而不仅仅是监督它们。Dill善于发现它无法处理的问题，并寻求人类的帮助。迈耶称，尽管在处理受损货物、奇怪物件等方面存在问题，但它可以自行处理98%的情况。他说，这样做的结果是每小时最多能处理1600件包裹，常规情况下平均完成1000件。

这三家公司目前都在研究的下一个任务是反向执行卸货过程，也就是在一开始就用机器人给卡车装货。除了简单的搬运箱子，这还涉及到如何高效地堆放它们。攻克了这个难题，并以满足商贸活动所需的速度完成这项工作，将使仓库几乎完全实现自动化。完善这一技能的公司可能不会受工会欢迎，但经理们会热爱它。 ■



The Delta delta

Jabs mostly fend off the Delta strain but breakthroughs are infectious

A new British study also finds that immunity wanes over time

ON AUGUST 18TH America's surgeon general announced that people who got covid-19 vaccines at least eight months ago can receive an extra shot. Israel has already given a third jab to many citizens. France and Britain are also considering boosters.

Covid-19 vaccines offer better defences against hospitalisation and death than versus transmission. However, their protection against infection may have begun to wane. In Iceland and Israel, most adults got jabs months ago, but cases are soaring.

There are two leading explanations for this trend. One is that the Delta variant escapes protection from vaccines. Another is that the jabs' efficacy declines over time. A new paper finds evidence for both causes.

Led by Koen Pouwels of Oxford, the study, released on August 19th, uses a survey of 500,000 people in Britain who were tested regularly for covid-19. After adjusting for age and time since vaccination, it compared the jabs' efficacy during two time periods: one dominated by the Alpha variant, and another by Delta. For cases with a high viral load, the efficacy of Pfizer's jab fell from 94% against Alpha to 84% versus Delta. AstraZeneca's efficacy dipped from 86% to 70%, and protection resulting from previous infection declined from 87% to 77%.

The passage of time has reinforced this immune escape. One Israeli study showed that people who got Pfizer's jab in January or February were 50% more likely to have a "breakthrough" case in June or July than were those

vaccinated in March or April. The British data back up this result: in the three months following a second jab, Pfizer's efficacy declined by ten percentage points. AstraZeneca's vaccine had a milder drop, though it was less protective overall.

The study's most striking finding involved transmission. In the Alpha period, vaccinated people with breakthrough cases produced only small amounts of virus. This made them less likely to spread it. In contrast, viral loads in breakthrough Delta cases were just as high as those of people exposed to viral proteins for the first time.

The British paper does not study the severity of covid-19 cases. In theory, protection against infection can wane without harming defences against serious disease, because a vaccine-trained immune system can expel the virus quickly. However, hospitalisations in Israel have risen to levels last seen in March. The jury is still out on whether widespread boosters will be necessary to keep hospital beds open. ■



德尔塔变数

疫苗大多能抗德尔塔，但突破病例强传染

英国一项新研究还发现免疫力会逐渐减弱

八月十八日，美国医事总署署长宣布向完成第二针疫苗接种超过八个月的人提供加强针。以色列许多公民已注射第三针。法国和英国也在考虑提供加强针。

新冠疫苗预防重症及死亡的效果好于预防病毒传播。然而，它们在防感染上的保护力可能已开始减弱。在冰岛和以色列，大多数成年人几个月前就已接种疫苗，但当地感染病例正在飙升。

对于这一趋势，主要有两种解释。一是德尔塔变异毒株能突破疫苗保护。另一个是疫苗的保护力随时间推移而下降。一篇新论文为这两者都找到了佐证。

8月19日公布的这项研究由牛津大学的科恩·鲍威尔斯（Koen Pouwels）主持，使用了对英国定期接受新冠病毒检测的50万人的调查数据。按年龄和距完成接种的时间做调整后，研究人员比较了两个时期的疫苗接种效果：一个是阿尔法变异毒株流行的时期，另一个是德尔塔毒株流行的时期。在高病毒载量的情况下，辉瑞疫苗对抗阿尔法毒株的保护率为94%，对抗德尔塔毒株下降到84%。阿斯利康疫苗的保护率从86%降至70%。因之前曾感染病毒所获的免疫力保护从87%降至77%。

时间的流逝加强了这种免疫逃逸。以色列的一项研究表明，在1、2月间接种辉瑞疫苗的人比在3、4月间接种的更可能在6、7月间出现“突破性”感染，几率高出50%。英国的数据为这一结果提供了佐证：接种第二针三个月后，辉瑞疫苗的效力下降了十个百分点。阿斯利康疫苗的降幅较小，但整体保护率更低。

该研究最瞩目的发现是在病毒感染方面。在阿尔法毒株流行时期，已接种的突破性病例的病毒载量不高。他们传播病毒的可能性也就较低。相比之下，德尔塔毒株突破性病例的病毒载量与首次感染新冠病毒的未接种人群一样高。

这篇英国论文没有研究新冠病例的病情严重程度。理论上，感染保护力减弱不会影响对重症的保护力，因为经过疫苗训练的免疫系统可以迅速驱逐病毒。然而，在以色列，住院人数已回升至3月时的水平。是否需要广泛注射加强针以保障医院床位资源，目前还没有定论。■



Delta neutral

China's Delta dilemma

Efforts to battle the virus compound an economic slowdown

TRADE HAS flowed through the port of Ningbo on China's east coast since the Tang Dynasty in the 8th century. After the first opium war ended in 1842, it was one of five points of entry forcibly opened to foreign merchants. And in the first half of this year the port (which merged with neighbouring Zhoushan port in 2015) handled more tonnes of cargo than anywhere else in the world. A tour group of 80 students recently spent three days admiring the free-trade zone and the port's "hardcore" power, as Ningbo city government put it.

But on August 11th activity at one of the port's busiest terminals came to an abrupt halt. A 34-year-old dockworker, who had come into contact with visiting crews, was diagnosed with the Delta variant of covid-19 despite having received two shots of the Sinovac vaccine. That solitary infection was all it took for the government to shut down operations and consign 254 of his close contacts (and a further 396 of their contacts) to quarantine.

The case is revealing in three ways. It illustrates once more how hard it is to keep the Delta variant at bay. It demonstrates how hard China will, yet again, nonetheless try to do just that. And it shows how widely around the world this struggle will be felt. The terminal shutdown follows a similar closure at Yantian port on China's south coast in May (as well as disruptions wrought by last month's typhoon In-Fa). It now takes about 70 days for ocean freight to travel from its point of origin in China to its final destination in America, compared with 47 last August, according to Freightos, a digital freight marketplace. Some experts worry that the shipping delays and the prospect of future shutdowns may even disrupt the West's Christmas shopping.

The port infection is part of an outbreak that was first discovered on July 20th at Nanjing airport. By August 10th it had spread across a dozen provinces. Unlike other countries, which are learning to live with Delta, China has imposed a hardcore combination of widespread testing and uncompromising quarantines. Anyone who tests positive is whisked to hospital, even if they are free of symptoms. Anyone judged to have come into close contact with them (based on mobile-phone data and other indicators) is quarantined, as are close contacts of these contacts. By August 10th China had quarantined 50,808 people, more than 20 for every active confirmed case. The government has discouraged inessential travel between cities and provinces. And two of the worst-hit cities, Nanjing and Zhengzhou, have postponed the start of the school year. According to a gauge of lockdowns devised by Goldman Sachs, a bank, China's restrictions are now as tight as they were in April 2020.

The impact of the restrictions is already showing up in high-frequency data. Airports were operating at only 38% of their capacity on August 12th, according to Flight Master, an online-travel platform. And the median amount of traffic congestion in the 12 cities most affected by the outbreak has fallen 12% below its pre-pandemic norm, according to Ernan Cui of Gavekal Dragonomics, a research firm.

This immobilisation will add to an economic slowdown that was already under way. Industrial production, retail sales, investment and property sales were all weaker than expected in July (see chart), partly because the government is trying to curb steelmaking to preserve the environment, and housing speculation to preserve financial stability. Ting Lu of Nomura, another bank, expects GDP to be only 0.3% higher this quarter than last. He has cut his forecast for growth this year from 8.9% to 8.2%, which might warrant further easing from China's central bank, even as housing curbs remain.

China's slowdown is moving financial markets at home—the CSI300 index of large Chinese stocks has fallen by 4% since August 10th—and worldwide. The price of iron ore has slumped by 21% since the end of last month, and the price of copper has fallen by more than 5%. China's tough stance will also prevent any revival of travel to other countries. That is bad news for places like Thailand, which relied on Chinese visitors for almost 30% of its tourist receipts before the pandemic.

China's fight against Delta will be costly. But it is also proving successful. New local infections (excluding imported cases) dropped to just six on August 16th. The outbreak has started to narrow in scope as well as scale: 134 neighbourhoods still remain at risk, by the government's reckoning, down from 224 on August 10th.

China has both an unusual ability to contain Delta outbreaks and a strong incentive to do so. It lacks two of the characteristics that have allowed other countries to tolerate an otherwise disturbing rate of Delta infections. Relatively few of China's people have caught covid-19 in the past. As a consequence, few have any natural immunity to the disease. And although a respectable percentage of the population have received two jabs (over 55%, according to the government) China's vaccines appear less effective than Western versions. The share of China's population that enjoys some kind of immunity is lower than India's or even Indonesia's, according to Goldman Sachs, even though its vaccination rate is far higher. If China were to drop its defences and tolerate the infection rates common in Europe and America, the number of people suffering from severe illness could rise to alarming levels.

China is unusually good at fighting Delta. And it needs to be. Having failed to fail against previous waves of the disease, it is now obliged to succeed again. ■



德尔塔中性

中国面对德尔塔的两难之境

抗击德尔塔病毒加剧经济放缓

自八世纪的唐朝起，中国东部沿海的宁波港就一直有贸易流通。1842年第一次鸦片战争结束后，它成为被迫向外国商人开放的五个口岸之一。今年上半年，该港口（2015年与邻近的舟山港合并）的货物吞吐量居世界第一。前不久，一个80人的学生团体对宁波港自贸区以及宁波市政府所说的港口“硬核”力量开展了为期三天的参观学习。

然而在8月11日，宁波港最繁忙的码头之一突然停止了作业。一名曾与到访船员有过接触的34岁的码头工人被检测出感染了德尔塔变异毒株，尽管他已经注射了两剂科兴疫苗。就因为这仅有的一起病例，宁波市政府叫停了码头作业，并隔离管控此人的254名密切接触者和396名次密切接触者。

这起事件说明了三点。首先，它再次显示了抗击德尔塔变异病毒的难度之大。其二，尽管如此之难，中国还是会再次不遗余力地遏制它。其三，这轮艰难的抗疫行动将在全世界造成广泛影响。今年5月，中国南部沿海的盐田港也曾因疫情关闭过（上个月，台风“烟花”也一度造成各地港口停工）。数字货运市场Freightos的数据显示，目前货物从中国海运到美国大约需要70天，而去年8月为47天。一些专家担心，运输延误和未来可能再度发生港口关停甚至会影响到西方的圣诞节采购。

这轮疫情始于7月20日在南京机场首次发现德尔塔毒株感染，宁波港病例是这期间的一例。到8月10日，此轮疫情已经蔓延到十几个省份。与其他正在学习与德尔塔病毒共存的国家不同，中国采取了广泛核酸检测和强制隔离相结合的硬核措施。所有检测呈阳性的人，哪怕是无症状感染者，都会被迅速送往医院。根据手机数据和其他指标判定的所有密切接触者都会被隔离，次密切接触者也一样。截至8月10日，中国已经隔离了50,808人，平均每个现有确诊病例会导致20多人被隔离。政府已经号召民众非必

要不出省出市。疫情最严重的南京和郑州已经推迟了秋季学期开学。根据高盛制定的疫情封锁评估标准，中国目前的限制措施与去年4月时一样严格。

这些限制措施带来的影响已经开始在高频数据中显现出来。根据在线旅行平台Flight Master的数据，8月12日，机场运力利用率只有38%。研究公司龙洲经讯（Gavekal Dragonomics）的崔尔南表示，在受此次疫情影响最严重的12个城市，交通拥堵中值比疫情前的正常水平下降了12%。

这种“限流”将让本已在放缓的经济雪上加霜。7月的工业生产、零售额、投资和房地产销售额数据都不如预期（见图表），部分原因是政府试图限制钢铁生产以保护环境，以及抑制炒房以保持金融稳定。另一家投行野村证券的陆挺预计，本季度GDP环比仅增加0.3%。他已将今年的经济增长预期从8.9%下调至8.2%。这可能让人行据此在继续保持楼市调控的同时进一步采取宽松的货币政策。

中国经济放缓正在给本国金融市场带来影响——自8月10日以来，代表中国大盘股的沪深300指数已经下跌了4%——同时也影响着全球金融市场。自7月末以来，铁矿石价格骤降21%，铜价下跌超过5%。中国强硬的防疫立场也让出境游没有丝毫复苏的可能。这对泰国等依赖中国游客的地方来说是个坏消息。新冠疫情前，泰国近30%的旅游收入来自中国游客。

中国将为抗击德尔塔病毒付出高昂的代价。但这场抗疫也在取得成功。8月16日，本土新增病例（不包括境外输入病例）下降到仅六例。疫情爆发的规模和范围都在减小：根据政府统计，当时仍有134个中高风险地区，而8月10日有224个。

在控制德尔塔病毒爆发方面，中国既有特有的能力，也有强烈的动机。其他国家之所以经受得住原本应该令人不安的德尔塔病毒感染率，是因为它们具备了几个特征，而其中有两个是中国不具备的。其一，中国已经感染过新冠肺炎的人数相对较少。因此，很少有人获得对这种疾病的自然免疫力。其二，虽然有相当比例的人接种过两剂疫苗（根据政府的数据，这一

比例超过55%），但中国疫苗的有效性似乎不如西方的疫苗。高盛的数据
显示，中国具有一定免疫力的人口比例低于印度，甚至低于印尼，尽管中
国的疫苗接种率要高得多。如果中国放弃防控措施，经受欧洲和美国习以
为常的感染率，重症患者数量可能就会上升到令人担忧的水平。

中国在遏制德尔塔病毒上鹤立鸡群。它也必须如此。中国在与前几波新冠
疫情的斗争中从未失手，现在它必须再次胜出。■



SEA change

Chinese cloud giants eye South-East Asia

As the business climate worsens at home and in the West, Alibaba, Tencent and their peers seek friendlier markets

CHINA'S TECHNOLOGY giants are having a torrid time. At home, a regulatory crackdown is intensifying. In the latest move, on August 17th the authorities released draft antitrust rules that would hurt the business models of titans like Alibaba and Tencent. In the West, meanwhile, governments want to make it harder for Chinese companies to do business in their countries and, in America's case, to list shares. Some global asset managers are calling Chinese tech stocks "uninvestable".

The firms are thus casting around for friendlier climes. Foreign markets account for a relatively small share of the Chinese groups' sales. Tencent made around \$5bn in revenues outside mainland China last year, less than 8% of the total. So little of Alibaba's income is derived from abroad that the company doesn't bother publishing a geographical breakdown. If it were to start, however, no place would feature more prominently than South-East Asia.

The region is home to nearly 700m people, fast-digitising economies and, crucially, no hardened geopolitical persuasion. Having taken an interest in South-East Asian online darlings such as Lazada (an e-commerce venture majority-owned by Alibaba) or Sea Group (in which Tencent holds a 23% stake), China's giants are expanding more directly in the region. Last year Alibaba bought half of a 50-storey skyscraper in Singapore, the regional commercial hub. Tencent and ByteDance, the unlisted owner of TikTok, a hit short-video app, have also opened beachhead offices there and set out on local hiring sprees.

Cloud computing presents a particular opportunity. Although the cloud market's total size in South-East Asia is still relatively small, at less than \$2bn a year, it grew by more than 50% in 2020, and shows no signs of slowing. And the Chinese firms are winning an ever greater share of this ever larger pie, mostly from Amazon Web Services (AWS), the American e-commerce empire's cloud division.

According to Gartner, a research firm, in 2020 Tencent, Alibaba and Huawei, a privately held telecoms colossus, had 22% of the cloud market in South-East Asia and the smaller Asia-Pacific economies, up from 18% in 2019. This year Tencent opened its first data centre in Indonesia and its second in Thailand. In June Alibaba said it would build its first in the Philippines.

Unlike AWS and its American cloud rivals, Google Cloud and Microsoft's Azure, Chinese firms are comfortable with the principle of data localisation. Many South-East Asian governments mandate that data about their citizens be processed and stored in their territory. Whereas Microsoft and AWS publish reports on the data requests made to them by governments and law-enforcement agencies, Chinese firms do not. This makes the Chinese services attractive to authorities unwilling to compromise on localised data. It also complicates embryonic efforts by America to negotiate a digital trade pact with Asian countries, which would almost certainly try to limit data localisation.

Even before it contributes a big slug of revenues, business activity in South-East Asia is a way to learn what works outside China, notes Tan Bin Ru, the regional boss of OneConnect Financial Technology, a subsidiary of Ping An, a huge Chinese insurer. The environment is both familiar (with millions of Chinese-speakers, who often dominate commerce) and diverse (with different legal jurisdictions and a wide range of income levels). Asian companies have used the region as a staging post to global conquest in the past, notably Toyota, which began its international expansion in Thailand

in 1957. China's giants would love to follow in its tyre tracks. ■



风云变幻

中国云计算巨头盯上东南亚

面对在国内及西方的经营环境恶化，阿里巴巴、腾讯等大企业寻求更友好的市场

中国的科技巨头正备受煎熬。在国内，一轮监管打击行动不断加码。最新的举措是当局在8月17日公布了可能打击阿里巴巴和腾讯等巨头的商业模式的反垄断法规草案。与此同时，西方政府正着力加大中国公司在这些国家开展业务的难度，对美国而言就是要加大中国公司赴美上市的难度。一些全球资产经理如今认为中国科技股“不具备可投资性”。

于是这些企业正在四处寻找更友好的经营环境。海外市场占中国科技集团销售额的比例相对较小。去年，腾讯在中国大陆以外的收入约为50亿美元，不到总收入的8%。阿里巴巴的海外收入之少，甚至都懒得公布地区明细。但假如公布出来的话，没什么地方会比东南亚更引人注目。

该地区有近七亿人口，数字经济快速增长迅速，关键是没有强硬的地缘政治主张。中国的科技巨头在投资了Lazada（阿里巴巴控股的电商企业）和Sea Group（腾讯持有23%股份）等东南亚的网络宠儿后，正在该地区更直接地拓展业务。去年，阿里巴巴在东南亚商业中心新加坡购入一栋50层摩天大楼一半的股权。腾讯和热门短视频应用抖音的未上市母公司字节跳动也在新加坡设立了“滩头堡”办事处，刮起一股本地招聘旋风。

一个特别值得关注的机会是云计算。尽管东南亚的云计算市场总规模仍相对较小，每年不到20亿美元，但2020年该市场增长超过50%，而且没有放缓的迹象。而中国企业在这个越做越大的蛋糕中抢占到的份额也越来越大，主要是从美国电商帝国亚马逊的云计算部门AWS那里抢夺过来的。

研究公司高德纳的数据显示，2020年，腾讯、阿里巴巴和私营电信巨头华为在东南亚和小型亚太经济体拥有22%的云计算市场份额，高于2019年的18%。今年，腾讯在印尼开设了首个数据中心，在泰国设立了第二个数据中心。6月，阿里巴巴表示将在菲律宾建立首个数据中心。

有别于AWS及其美国国内对手谷歌云和微软Azure，中国公司能安然接受数据本地化的原则。许多东南亚国家政府规定，其公民的相关数据必须在本国境内处理和存储。微软和AWS发表报告公开各地政府和执法机构提出的数据要求，中国公司没有这一操作。这使得在数据本地化问题上不愿妥协的东南亚政府会觉得中国的服务更具吸引力。这也会让美国与亚洲国家酝酿中的数字贸易协定谈判节外生枝，这项协定几乎肯定会寻求限制数据本地化。

中国大型保险公司平安集团旗下金融科技公司金融壹账通的东南亚CEO陈敏如指出，在东南亚的商业活动即便还不能贡献大份额收入，也可以探索如何在中国以外的地区经营。这里的环境既熟悉（有几千万人说中文，而且往往是商业的主力军）又多样（覆盖不同司法管辖区和各种收入阶层）。以往，亚洲企业一直把该地区作为征战全球的中转站，一个著名的例子就是1957年在泰国开启全球扩张的丰田公司。现在，中国的企业巨头会很乐意追随它的轮印而行。 ■



A quiet giant

A glimpse into Japan's understated financial heft in South-East Asia

It is a bigger investor in the region's infrastructure projects than China

VIETNAM'S FIRST two rapid-transit rail lines are inching closer to completion, after years of delays. The projects, one in each of the country's two largest cities, have become symbols not just of Vietnam's modernisation, but of the duelling interests of Asia's two biggest sources of infrastructure investment. Hanoi's line has been funded by Chinese development assistance; Ho Chi Minh City's was launched with help from the Japanese government.

Although China's financial reach overseas attracts enormous attention, when it comes to infrastructure in South-East Asia, Japan is still very much the leader (see chart). In total, it has \$259bn invested in unfinished projects in Indonesia, Malaysia, the Philippines, Thailand and Vietnam, according to Fitch Solutions, a data provider, compared with China's \$157bn. Both figures have declined since 2019, as the covid-19 pandemic has deterred greenfield infrastructure investment, but Japan's lead has widened a bit.

The construction of Ho Chi Minh City's Urban Railway Line 1 is a microcosm of the Japanese infrastructure offering abroad. Government and quasi-governmental agencies laid the groundwork for the country's mammoth business groups. The project began almost nine years ago with early support from the Japan International Co-operation Agency, which facilitates most of the country's overseas development assistance. Sumitomo Corporation, a sprawling private-sector conglomerate, won the construction contract as part of a consortium, Tokyo Metro has provided technical assistance, and Hitachi's trains have been delivered to run on the line.

While America under President Joe Biden has been forthright about its ambition to challenge China's Belt and Road Initiative (BRI), Japan has been reluctant to frame its pursuit of large infrastructure projects as a contest with China. Still, it is not hard to spot the change in strategy, particularly during former prime minister Abe Shinzo's period in office. In 2015 the government launched the "Partnership for Quality Infrastructure" (PQI) with the Asian Development Bank and other investors, which promised to provide public and private capital worth \$110bn for infrastructure projects in the region over the next five years (though progress in reaching this goal has not been closely tracked). Despite not calling out the BRI in public, the message behind Japan's repeated emphasis on quality has not gone unheard in the region.

The PQI was explicitly made part of the country's "Free and Open Indo-Pacific" strategy, launched in 2016, linking its foreign-policy objectives with its financial priorities. That same year, the Japan Bank for International Co-operation, which began life in 1950 as an export-promotion bank, saw its role amended to allow for greater financial risk-taking. In recent years it has pivoted towards financing overseas investment: in the year to March 2020 only 11% of the bank's commitments were export loans, while 82% were overseas investment loans.

Japan has some distinct advantages compared with most Western economies, each of which goes some way to explaining the country's relatively discreet financial heft. Simple proximity is one of them: Japan's largest companies are deeply familiar with other Asian markets, which have made up a significant share of their international sales for decades. Japan exported more to the Association of South-East Asian Nations than American firms did in 2019, even though the American economy is more than four times the size of Japan's.

Although the country cannot deploy private investment through large state-

owned enterprises, as China does, relationships between the private sector and the government are much closer than in other capitalist economies, greasing the wheels of co-operation. Saori Katada of the University of Southern California notes that, in competing with China for regional infrastructure, Japan has reverted a little to its “Old Japan” strategy of the post-war boom, in which the private and public sectors worked seamlessly together. The partnership is far less heavy-handed than it was in the heyday of the “iron triangle”—the politically dominant Liberal Democratic Party, the apparatus of the state and the country’s business scions. But the legacy of a mercantilist attitude to foreign trade and investment is clear.

That blending and blurring of state and private investment objectives might once have produced consternation from Western governments, particularly when Japan was seen as Asia’s ascendant economic power. But the advent of the BRI and concerns about China’s economic influence in the region have changed priorities. As the only serious competitor to Beijing’s financial clout in the region, Japan’s overseas infrastructure heft is likely to be welcomed across much of the world—even if Tokyo doesn’t shout too loudly about it. ■



不声张的巨人

一瞥日本在东南亚低调的金融实力

它在该地区的基建投资超过中国

经过多年的一再延期，越南的头两条地铁逐渐接近完工。这两个项目分别位于越南最大的两座城市，不仅成为了越南现代化的象征，也成了亚洲最大的两个基建投资来源国之间利益冲突的象征。河内地铁得到了中国发展援助项目的资助；胡志明市地铁的开工则得到了日本政府的帮助。

尽管中国伸向海外的金融触角引发了极大关注，但在东南亚的基建投资方面，日本仍然显著领先（见图表）。数据供应商惠誉（Fitch Solutions）的数据显示，日本在印尼、马来西亚、菲律宾、泰国和越南的未完工项目的总投资额为2590亿美元，而中国为1570亿美元。由于新冠疫情导致新建基础设施投资停滞，两国的投资额自2019年以来都有所下降，但日本的领先优势略有扩大。

胡志明市地铁一号线的建设是日本海外基建投资的一个缩影。政府和准政府机构为日本庞大的企业集团开路。该项目差不多开始于九年前，早期得到了日本国际协力机构（Japan International Co-operation Agency）的资助，日本大部分海外发展援助都由此机构促成。业务繁多的私营企业集团住友商事作为项目合作方之一赢得了建设合同，东京地铁（Tokyo Metro）提供了技术援助，日立公司交付的列车将在这条线路上运行。

拜登治下的美国毫不掩饰自己挑战中国“一带一路”倡议的雄心，而日本却一直不愿意将自己追逐大型基建项目说成是与中国竞争。尽管如此，还是不难看出日本在战略上的变化，尤其是在前首相安倍晋三执政期间。2015年，安倍政府和亚洲开发银行以及其他投资者推出了“高质量基础设施合作伙伴关系”（PQI），承诺在之后的五年内提供1100亿美元的政府和民间资本用于东南亚的基础设施项目（虽然朝向这一目标的进展没有得到密切跟踪）。尽管日本没有公开叫板“一带一路”，但它反复强调“高质量”的弦

外之音在这一地区并非无人意会。

日本在2016年推出“自由开放的印太”战略，将外交政策目标与金融优先事项连接起来。PQI被明确列为该战略的一部分。1950年为促进出口而设立的日本国际协力银行（Japan Bank for International Co-operation）也在2016年修改了职能以容许更大的金融风险。近年来，它已经将重心转向为海外投资提供融资：截至去年3月的一年里，该行提供的资金中出口贷款仅占11%，而境外投资贷款占到了82%。

与大多数西方经济体相比，日本具有一些独特的优势，每一条优势都可以在某种程度上解释日本为什么具备这种相对不显山露水的金融实力。近水楼台是明摆着的优势之一：日本最大的那些公司对亚洲其他市场了如指掌，几十年来，这些市场在它们的国际销售额中占据了相当大的比重。2019年，日本对东盟的出口超过了美国公司，尽管美国的经济规模是日本的四倍多。

尽管日本不能像中国那样通过大型国有企业调动私人投资，但相比其他资本主义经济体，其私营部门与政府的关系要密切得多，因而能顺畅地合作。南加州大学的坚田沙织指出，在与中国争夺地区性基础设施项目的过程中，日本有点回到了为它带来二战后经济繁荣的公私部门无缝合作的战略老路上。相比全盛期的“铁三角”（政治上占主导地位的自民党、政府机构和日本财阀），这种合作关系要松泛得多。但对外贸易和投资中的重商主义传统还是显而易见的。

政府和私人投资目标如此相互交融、界限不清，可能一度让西方国家感到震惊，尤其是在日本被视为亚洲崛起的经济大国之时。但“一带一路”的出现以及对中国在东南亚经济影响力的担忧让关注重点转移。作为中国在东南亚金融影响力的第一有力的竞争者，日本在海外基建方面的实力很可能受到世界大多数地区的欢迎——即使日本并不大声宣扬它。■



Monkey business

Attitudes towards experimenting on monkeys are diverging

Many countries are growing warier, even as China races ahead

IN 2014 A GERMAN animal-rights group called SOKO Tierschutz planted a caretaker in the laboratory of Nikos Logothetis, a neuroscientist working at the Max Planck Institute in Tübingen. The infiltrator secretly filmed around 100 hours of lab work over six months, some of which was later broadcast on German television. The footage showed monkeys with metal plugs grafted into their skulls—ports which researchers used to probe and study their brains. One vomits on camera, apparently as a result of damage done to blood vessels in its brain while electrodes were inserted.

The impact was immediate and lasting. Around 800 people massed outside Dr Logothetis's lab, demanding an end to his work with monkeys. He was called a monster and a murderer. He and his family received death threats. He faced charges (which were dismissed) of breaking German animal-welfare laws. So in 2020 he announced that his laboratory would move to China. He is building a new research facility in Shanghai, working with Mu-ming Poo of the Institute of Neuroscience, one of China's leading brain researchers, who was on the team responsible for first cloning a genetically modified primate in 2018. Dr Logothetis is packing up his Tübingen lab.

Research on primates—mostly macaque monkeys—is increasingly unpopular in Europe and America. The EU has promised that it will reconsider rules about the use of monkeys in research every five years. It wants to end all animal research at an unspecified point in the future. American lawmakers are trying to pass the Humane and Existing Alternatives in Research and Testing Sciences Act. It would encourage scientists funded by the National Institutes of Health, the country's largest

funder of biomedical research, to move away from reliance on animals. In both Europe and America the number of monkeys in research has been flat or falling for the last five years.

And yet in East Asia, particularly China and Japan, the volume of research carried out on monkeys is growing. Most of this has been driven by creating and expanding domestic primate-research programmes. Leading institutions such as the Shanghai Institute of Neuroscience focus on breeding monkeys whose genomes have been modified in order to make their physiology more like humans' and so more useful for studying human diseases.

This kind of genetic modification of research animals is common around the world in biomedical research, but is almost exclusively carried out on mice. No American or European laboratory maintains a line of genetically modified monkeys, but several Chinese and Japanese laboratories do. And since monkeys' brains are far more like human ones than those of mice, transgenic monkeys will probably serve as a better model for studying neurological disease than transgenic mice. While such experiments remain beyond the pale in many countries, China and Japan are racing ahead.

Campaigners argue that no animal should be used for research because they cannot give informed consent. Julia Baines, who works on science policy at People for the Ethical Treatment of Animals (PETA), an animal-rights group, suggests that all animals, including primates, can be replaced in biomedical research by a combination of in vitro studies (carried out in Petri dishes and test tubes without relying on living creatures), computer simulations and consensual human trials.

Others, such as researchers at the Centre for Alternatives to Animal Testing at Johns Hopkins University, advocate replacing animal experimentation where that seems possible and refining how it is used where it does not.

Monkeys make up just one in every 2,000 lab animals, according to Stefan Treue, a neuroscientist who works on them at the University of Göttingen in Germany. But they generate by far the most controversy. The social nature of their lives and their intelligence—which is why they are so useful for research—also help explain why such experiments are so troubling. Research which relies on them is simultaneously more valuable and more ethically fraught than research on other creatures. Neuroscientists in particular consider monkeys irreplaceable.

The brain is so poorly understood that looking at its activity in living creatures is the only way to fathom how it works, says Dr Treue. Dissecting dead brains produces only limited information. Brains only really make sense when active. Few humans would volunteer to have electrodes implanted in their brains. The consent of any who did would be suspect.

Allyson Bennett, a psychologist at the University of Wisconsin-Madison, also argues for experiments on monkeys based on the value of pure science—research with no set goal. She cites Vittorio Erspamer, a physiologist working in Italy in the early 1930s. He was curious about the properties of chemicals found in the intestines of rabbits and frogs. In studying them he discovered serotonin.

Drugs that regulate the body's production of serotonin nowadays treat various depressive disorders, improve the lives of millions and help prevent thousands of deaths. Erspamer, however, had no interest in depression or anxiety. It was decades before his discovery became the foundation for such treatments.

The list of medical advances which rest on animal experimentation is long, but Dr Bennett points to one in particular that could not have happened without monkeys: prosthetic limbs which “talk” to the brain, known as neural prosthetics. The brains of non-human primates are sufficiently

similar to ours to allow for a prosthetic developed on monkeys to be used by humans. They are still rare, but prototypes have restored the power to interact with the physical world to people who have lost the use of their own limbs.

China is becoming the global centre for the kind of neuroscience that uses monkeys. And the stakes are getting higher. Neurological disorders are the world's second-leading cause of death after heart disease. Conditions such as Parkinson's disease, Alzheimer's and dementia are becoming more burdensome as the world gets greyer. Meanwhile technology companies hope that an understanding of the brain can help them build cleverer software. Generals think advances in neuroscience can help them build better weapons.

The pandemic has bolstered China's position. In February 2020 China's government banned the export of all wild animals in an effort to tamp down the wildlife trade that is thought to be a vector for the zoonotic spillover of pathogens such as SARS-CoV-2, the virus that causes covid-19. Exceptions for research are subject to the government's approval. Until recently the majority of monkeys used in America were imported from farms in China. But export controls have created shortages (see chart).

"China holding onto its primates fits into a long-term strategy it announced in 2015: the China 2025 policy," says Kirk Leech of the European Animal Research Association. Understanding the brain was one of the key areas of scientific research for that policy. To achieve it, China needs more monkeys. Dr Treue says China has decided that research primates are a strategic resource. Exports are unlikely to revert to their previous levels.

This leaves Europe and America in a bind. The farms in China are well respected by the research community. Alternative suppliers from Vietnam

and Cambodia operate in a way that is closer to grabbing wild monkeys out of their natural habitat. This is both more traumatic for the animal and less useful for research, as the health and age of such animals varies. Increasing the harms and reducing the usefulness of any research exacerbates the ethical dilemma of using monkeys.

Meanwhile, even as it keeps all of its farmed monkeys in its own country, Chinese neuroscience is expanding at such a pace that even domestic labs are experiencing shortages, according to Mr Leech. While researchers and campaigners in America and Europe battle over whether any sort of primate research is permissible, China and Japan are racing ahead.

The Institute of Neuroscience in Shanghai is the largest buyer of the Neuropixel, a new brain probe. These are easier to install in animals' brains than the kinds currently used. The institute bought 3,000 of the probes when they were released to install in macaque monkeys. This would have allowed it to gather neurological data on an unprecedented scale. The probe also offers a path to less invasive research than older, bigger electrodes, though the harm done by putting sensors into a brain will always be considerable.

Erika Sasaki at the Central Institute for Experimental Animals in Kawasaki near Tokyo has developed a line of genetically modified marmosets, a small monkey native to South America. She and her collaborators at the RIKEN Centre for Brain Science, also in Japan, are creating a 3D atlas of the marmoset brain to map both the higher cognitive functions unique to primates (humans included) and the neurodegenerative diseases that disrupt them.

Diverging attitudes towards scientific research on monkeys have three consequences. America and Europe may find themselves outsourcing the creation of knowledge that relies on research methods they consider

unethical. In future they may have to choose between relying on the fruits of that knowledge, such as treatments for neurological disorders, and rejecting them in principle. The UN's World Health Organisation estimates that neurological disorders affect at least a billion people worldwide. Treatments for such conditions almost certainly involving some neuroscientific research on monkeys will become increasingly valuable.

Competition for control of the supply chains may sharpen. The pandemic has exposed the significance of Chinese supply chains for producing a range of medical equipment and supplies. If cutting-edge neuroscience becomes concentrated in China, new companies and medical treatments will emerge there too. Many governments are already wary of plugging Chinese-made networking equipment into their phone networks; they will probably be queasy about bunging vital Chinese-made probes into their citizens' brains.

Probing the workings of the brain is a 21st-century equivalent to exploring the farthest reaches of the planet. The results will not only teach humans about their own minds but will also help them design artificial intelligence—a separate but connected field in which competition between countries has become fierce. If such scientific knowledge is largely produced in China and Japan, it will become ever harder for others to catch up, should they decide they wish to do so. ■



猴子生意

对猴子实验的态度分道扬镳

许多国家对这类实验日益谨慎，而中国冲到了前头【深度】

二〇一四年，德国动物权利组织SOKO动物福利（SOKO Tierschutz）在图宾根的马克斯·普朗克研究所（Max Planck Institute）神经科学家尼科斯·洛戈塞蒂斯（Nikos Logothetis）的实验室里悄悄安插了一名看护员。六个月里，这名潜入者偷偷拍下了约100个小时的实验室工作视频，其中一些后来在德国电视台播出。视频显示一些猴子的头骨上被植入了金属插头，研究人员通过这些端口来深入和研究它们的大脑。一只猴子一口呕吐在了镜头上，看来是因为被插入电极时损伤了脑血管。

一石激起千层浪。大约800人聚集在洛戈塞蒂斯博士的实验室外，要求他停止用猴子做研究。他们叫他恶魔和凶手。他和家人收到了死亡威胁。他被指控违反了德国的动物福利法（后来撤诉）。于是在去年，他宣布自己的实验室将搬到中国。他正在上海创建一个新的研究设施，与中国脑科学顶尖研究人员之一、中科院神经科学研究所的蒲慕明合作。蒲慕明是于2018年在全球首次实现转基因非人灵长类克隆的团队的成员。洛戈塞蒂斯正在关闭他在图宾根的实验室。

用灵长类动物（主要是猕猴）做研究在欧美地区越来越不受欢迎。欧盟已承诺每五年重新考虑有关在研究中使用猴子的规定。它希望在将来某个未定的时间点结束所有动物研究。美国立法者正试图通过《研究和测试科学中的人道和现有替代方案》法案（HEARTS）。它将鼓励那些获得美国国家卫生研究院（NIH，美国最大的生物医学研究资助机构）拨款的科学家摆脱对动物的依赖。欧洲和美国的科研用猴子数量在过去五年里都持平或下跌了。

然而在东亚，尤其是中国和日本，在猴子身上开展的研究量在增长。这大部分是受到了创建和扩大国内灵长类动物研究计划的推动。上海的神经科

学研究所等领先机构致力于培育被修改了基因组的猴子，以使它们的生理机能更接近人类，为研究人类疾病发挥更大用处。

这种对实验用动物的基因改造在世界各地的生物医学研究中都很常见，但几乎都只在小鼠身上进行。美国和欧洲没有一家实验室维持着整个谱系的转基因猴，但几家中国和日本的实验室有。而由于比起小鼠，猴子的大脑要接近人类得多，转基因猴很可能会比转基因小鼠更适合研究神经系统疾病。虽然这类实验在许多国家仍是禁忌，中国和日本已经冲在了前头。

活动人士提出，不应将任何动物用于研究，因为它们无法给出知情同意。动物权益组织“善待动物组织”（People for the Ethical Treatment of Animals）的科学政策专员朱莉娅·贝恩斯（Julia Baines）建议，在生物医学研究中，可以用体外研究（在培养皿和试管中展开研究，而不依赖活体动物）、计算机模拟和经各方同意的人体试验相结合的方式来代替使用包括灵长类在内的任何动物。

其他人，例如约翰霍普金斯大学的动物试验替代方案中心（Centre for Alternatives to Animal Testing）的研究人员，则主张在可能的情况下替换掉动物实验，在不可行的情况下改进对动物实验的运用。

在德国哥廷根大学用猴子做实验的神经科学家斯特凡·特罗伊厄（Stefan Treue）表示，每2000只实验动物中只有一只是猴子。但它们引发的争议要多得多。猴子的社交特性以及智力使得它们对科研用处很大，但也让这类实验非常令人不安。依赖于它们的研究比使用其他生物的研究更有价值，同时却也有更多伦理争议。神经科学家尤其认为猴子不可替代。

特罗伊厄说，对脑部的了解如此之少，以至于观察活体生物的脑活动是了解它如何工作的唯一方法。解剖死脑得到的信息有限。脑部只有在活动时才显现其复杂能耐。很少有人会自愿将电极植入自己的大脑。任何人对此给出的知情同意都很可疑。

威斯康星大学麦迪逊分校的心理学家阿利森·贝内特（Allyson Bennett）也支持基于纯科学的价值用猴子做实验。纯科学即没有明确设立目标的研

究。她以1930年代初在意大利工作的生理学家维托里奥·埃尔斯巴美尔（Vittorio Erspamer）为例。他对在兔子和青蛙肠道中发现的化学物质的特性感到好奇，在研究过程中发现了血清素。

如今，调节人体生成血清素的药物用于治疗各种抑郁症，改善了数百万人的生活，帮助防止了成千上万人死亡。但埃尔斯巴美尔不曾关注过抑郁或焦虑。他的发现在几十年后才成为此类治疗的基础。

依赖动物实验取得医学进展的清单很长，但贝内特特别指出了其中没有猴子不可能实现的一项：与大脑“对话”的假肢，被称为神经义肢。非人灵长类动物的大脑与我们的大脑足够相似，因此人可以使用在猴子身上研发出来的假肢。它们仍然很少见，但其原型已经让那些失去了肢体的人重新获得了与物理世界互动的能力。

中国正在成为使用猴子的那类神经科学的研究的全球中心。而且潜在回报越来越高。神经系统疾病是全球仅次于心脏病的第二大死因。随着世界日益老龄化，帕金森氏症、阿尔茨海默症和痴呆症等疾病带来的负担日益沉重。与此同时，科技公司希望对大脑的理解可以帮助它们创造出更聪明的软件。军事将领们则认为神经科学的进步可以帮助他们构建更好的武器。

新冠疫情巩固了中国这种中心地位。去年2月，中国政府禁止所有野生动物出口以遏制野生动物贸易，这种贸易被视为新冠病毒等病原体从野生动物向人类传播的载体。科研用途的例外情况须经政府批准。直到最近，美国使用的大多数猴子都还是从中国的农场进口的。但出口管制已经导致了短缺（见图表）。

“中国保住自己的灵长类动物库存符合它在2015年宣布的一项长期战略：中国制造2025。”欧洲动物研究协会（European Animal Research Association）的柯克·利奇（Kirk Leech）说。脑科学是该战略的关键科研领域之一。为实现它，中国需要更多猴子。特罗伊厄说，中国已经明确了实验用灵长类动物是一种战略资源。出口不太可能恢复到以前的水平。

这令欧洲和美国处境尴尬。中国的农场很受科研圈子推崇。来自越南和柬埔寨的替代供应商的运作方式更接近于把野生猴子从其自然栖息地抓来。抓来的动物的健康状况和年龄各异，这不仅对动物自身造成更多创伤，对研究也不那么有用。在任何研究中增加危害和减少有用性都加剧了使用猴子的伦理困境。

与此同时，据利奇说，尽管中国把所有养殖猴子都留在本国，但中国神经科学的发展速度之快，使得哪怕国内的实验室也面临短缺。就在美国和欧洲的科研人员和动物权益活动人士就是否应该准许任何形式的灵长类动物研究争论不休时，中国和日本已经领先一步。

上海的神经科学研究所是新型大脑探针Neuropixel的最大买家。它们比目前使用的探针更容易安装进动物的大脑中。探针一上市，该研究所就购入3000个，安装在猕猴身上。这将使它能以前所未有的规模收集神经学数据。该探针还提供了一种相比更大的老式电极侵入性更小的研究途径，尽管把传感器置入大脑造成的危害总归不可小觑。

位于东京附近川崎市的实验动物中央研究院（Central Institute for Experimental Animals）的埃丽卡·佐佐木（Erika Sasaki）培育了一个谱系的转基因狨猴。狨猴是一种原产于南美洲的小猴子。她和同样位于日本的理化学研究所脑科学中心（RIKEN Centre for Brain Science）的合作者正在创建狨猴大脑的三维图谱，以阐明灵长类动物（包括人类在内）独有的高级认知功能以及破坏这些功能的神经退行性疾病。

对猴子科研实验的不同态度会产生三个后果。美国和欧洲可能会需要把那类依赖它们视为不道德的研究方法的知识创造过程外包出去。未来他们可能不得不二选一：要么依赖这些知识的成果（例如神经性疾病疗法），要么从原则上完全拒绝它们。联合国世卫组织估计，神经系统疾病影响全球至少十亿人。几乎肯定会涉及到某些猴子神经实验的神经疾病疗法将变得越来越有价值。

对掌控供应链的竞争可能加剧。新冠疫情暴露出中国供应链在生产各种医

疗设备用品方面的重要性。如果尖端的神经科学集中在中国，新的公司和医疗手段也会在那里出现。许多政府已经对于把中国制造的网络设备插入自家电话网络很警觉；它们可能会对把性命攸关的中国造探测器塞入本国公民的大脑深感不安。

探索大脑的运作机制是21世纪的发现地球边界之旅。这场探索的结果不仅会让人类了解自己的大脑运作，还会帮助他们设计人工智能——在这个独立但相关的领域，国家间的竞争已变得异常激烈。如果这类科学知识主要在中国和日本产生，其他国家想要追赶上会越来越难——如果有朝一日它们决定这么做的话。 ■



Bartleby

Chief executives are the new monarchs

The habits and flaws tycoons share with dynastic rulers

IN THE EARLY 15th century many of the Portuguese voyages of discovery around Africa and into Asia were financed by Prince Henry of Portugal, whom historians dubbed “Henry the Navigator”. When Christopher Columbus sought finance for his planned westward voyage to the “Indies”, he first turned to the king of Portugal before achieving success with Ferdinand and Isabella of Spain. Monarchs financed explorations because they believed such trips would boost their power and their treasuries.

In the 21st century corporate executives have become deeply involved in adventure and exploration. Sir Richard Branson of Virgin and Jeff Bezos of Amazon have just travelled to the edge of space. Elon Musk of Tesla has developed the SpaceX programme and is talking of the eventual colonisation of Mars. Messrs Musk and Bezos competed for the contract to operate future Moon landings. Mr Bezos even offered to part-finance the project.

In itself, this is a remarkable development. Sixty years ago, when the space race was between America and the Soviet Union, few could have imagined that individual businessmen would ever have the resources to enter the fray. The shift says something about the extremes of wealth in the 21st century.

The resemblance to absolute monarchs does not stop with exploration. Like past rulers, modern tycoons build their own monuments in the form of corporate headquarters, not just skyscrapers in London and New York but the vast, low-rise campuses in Silicon Valley. Whereas the ancient dynasts travelled in horse-driven coaches, modern CEOs separate themselves from

the public in chauffeur-driven limos and private jets.

Like monarchs of old, executives have to deal with rival sources of power. They face the equivalent of feudal barons, in the form of boards of directors who may try to unseat them. And they need to contend with ambitious princelings, who in the modern era are younger executives who would like their job. The good news is that whereas an unseated monarch was likely to be executed, a dethroned boss can enjoy a generous pay-off.

Then there is their ability to control time. At the court of Louis XIV, France's "Sun King", the rhythm of the day was entirely devoted to the monarch's habits, with the luckiest courtiers watching him get dressed, have lunch and go to bed. Modern CEOs also have the ability to change the schedules of those around them. If he or she gets up at 5am to send messages, someone on the staff will feel obliged to rise early and answer them. Similarly, if the CEO likes to hold Zoom conferences on weekends, or have working dinners on a Friday night, the family life of subordinates will suffer.

Another parallel with monarchs is a tendency towards arrogance. In his book "Fall", John Preston recounts that when Robert Maxwell, the publishing tycoon, was dissatisfied with his food, he would sometimes sweep the plate on to the floor and leave others to clear it up. Maxwell also bugged the phones of his staff and listened to their conversations, which also recalls Louis XIV, who intercepted the mail of his courtiers.

Lavish entertainment is a further common denominator. Monarchs held elaborate balls and competed to show off their wealth. Modern tycoons pay rock stars to perform at their birthdays. Carlos Ghosn, the boss of Nissan, even held an extravagant party at the Sun King's former digs in Versailles.

Royal dynasties added to their empires through both military conquest and strategic marriages. Modern executives achieve the same effect through

mergers and acquisitions, using their financial clout to buy smaller rivals and reduce the threat of disruptive competition. In effect, ancient monarchs were monopoly providers of security services, who received payment in the form of taxation and conscription. Their abiding sin was too much ambition; Philip II of Spain's military overreach in battling England and the Netherlands was followed by the country's steady decline as a global power, for example.

The same trap awaits modern tycoons. Often they make the mistake of taking on too much debt by acquiring businesses that do not mesh with the rest of the enterprise. Or, like many an ancient ruler, they make the mistake of fighting on two fronts. Space-obsessed Mr Bezos is still executive chairman of Amazon. Mr Musk is trying to make both rockets and Tesla cars. The greatest danger to monarchs may come when they seem at the height of their powers. ■



巴托比

首席执行官是新君主

大亨们与王朝统治者有着同样的习惯和缺陷

十五世纪早期，葡萄牙环绕非洲和进入亚洲的许多航海探险都是由葡萄牙的亨利王子资助的，历史学家给他起了个“航海家亨利”的名号。当克里斯托弗·哥伦布为他向西前往“印度群岛”的航海计划寻求资金时，他先是向葡萄牙国王求助，然后在西班牙的费尔南多和伊莎贝拉那里如愿以偿。君主们资助探险活动是因为他们相信这样的远行会增加自己的权力和财富。

到21世纪，企业高管已深入参与到冒险和探索活动之中。维珍航空的理查德·布兰森和亚马逊的杰夫·贝索斯近期刚刚抵达了太空边缘。特斯拉的伊隆·马斯克开发了SpaceX项目，并大谈最终实现火星殖民。马斯克和贝索斯还争夺起未来的登月合同。贝索斯甚至提出为该项目提供部分资金。

这本身是个非同寻常的进展。60年前美苏两国上演太空竞赛时，没什么人会想象得到有一天商人个体会有足够的资源加入战局。这种转变透露出21世纪财富的极化。

高管们与专制君主的相似之处并不限于探索活动。像过去的统治者一样，现代大亨们以公司总部的形式为自己树碑，它们不仅有建在伦敦和纽约的摩天大楼，还有位于硅谷的巨大低层园区。古代的王朝统治者乘马车出行，现代的CEO则乘坐配备司机的豪华轿车和私人飞机，将自己与大众区隔开来。

像从前的君主一样，高管们也得应付跟自己作对的势力。他们面对的是董事会，相当于封建贵族，可能会企图把自己赶下台。他们还需要跟雄心勃勃的诸侯——也就是觊觎自己工作的更年轻的高管——争权夺利。好消息是，一个被推翻的君主很可能会被处决，而一个被撵下台的老板却可能享受丰厚的遣散费。

接着是控制时间的能力。在法国“太阳王”路易十四的宫廷里，一天的节奏完全按照这位君主的习惯来，最幸运的朝臣会看着他穿衣打扮、吃午饭和睡觉。现代的CEO也有本事改变周围人的时间表。如果他或她早上5点起床发信息，就会有员工觉得有必要早起回复。同样，如果CEO喜欢在周末开Zoom会议，或者在周五晚上吃工作餐，下属的家庭生活就会受影响。

CEO与君主的另一个相似之处是傲慢的脾性。约翰·普雷斯顿（John Preston）在《坠落》（Fall）一书中记述道，出版大亨罗伯特·麦克斯韦（Robert Maxwell）如果对食物不满意，有时就会把盘子扫到地板上，等别人来收拾。他还窃听员工的电话和偷听他们谈话，这也让人想起会拦截朝臣信件的路易十四。

他们还有一个共同点是喜爱奢华的娱乐。君主们举行盛大的舞会，竞相炫富。现代大亨花钱请摇滚明星在自己的生日宴会上表演。日产的老板卡洛斯·戈恩甚至在太阳王位于凡尔赛的旧居举办了一场铺张的派对。

皇朝通过军事征服和战略联姻来扩张帝国。现代高管通过并购达到同样的效果：利用雄厚的财力收购规模较小的竞争对手，降低颠覆性竞争的威胁。实际上，古代君主是安全服务的垄断供应商，他们以税收和征兵的形式获得报酬。他们恒久的罪恶是野心太大。例如，西班牙的腓力二世在对战英格兰和荷兰时军事过度扩张，之后这个全球强国就持续走下坡路。

同样的陷阱也在等着现代大亨们。他们常犯的错误就是收购不能与企业其他部门紧密配合的业务，结果背上过多的债务。或者像许多古代统治者那样，他们会犯下双线作战的错误。痴迷太空的贝索斯仍是亚马逊的执行董事长。马斯克正试图既造火箭又造车。君主们看似如日中天之时，他们最大的危险可能就来了。 ■



Automatic for the people

China's future economic potential hinges on its productivity

Can the government boost it?

NOBLELIFT, BASED in Changxing, a town on the banks of Tai Lake, provides robotic tools for warehouse management: self-driving pallet jacks and sorting systems that make picking and fetching quicker and less dependent on humans. The factories in which it builds its wares are themselves a blur of robot arms. “There’s no comparison with the way things used to be,” says Ding Yi, Noblelift’s founder. The company’s main factory has only 350 workers. He says that in the old days it would have needed nearly four times as many.

In 2010 China was home to fewer than 50,000 industrial robots. Today it has 800,000—nearly one in three of the robots in the world. This is in part because robots are cheaper than they used to be, and more capable. But it is also because, as China has grown wealthier and older, wages have increased a lot.

Factory workers who earned about 8,000 yuan a year in 2000 (\$1,000, at the time) may now make almost ten times that. For bosses like Mr Yi that has dramatically tipped the balance in favour of automation (see chart 1). Almost overnight, Chinese industry has gone from being labour-intensive to robot-intensive.

Companies are always in pursuit of such ways to increase productivity. Countries in search of economic growth like them, too. Xi Jinping, China’s president, has made productivity a priority.

In some respects, the ambitions of Mr Yi and Mr Xi seem well aligned. But

many observers believe that Mr Xi is relying too little on the market forces which have shaped Mr Yi's investments and too much on state power. As a result he risks steering the country away from the high-productivity future he wants to bring about. The shape of tomorrow's global economy hangs on whether those critics are right or whether, armed with numerous detailed plans and burdened with glorious purpose, China's leaders can achieve their goal.

Economic growth depends on just three basic factors: how many people are working; how much capital they have at their disposal; and how productive they are. China's turbocharged growth over the past four decades was the result of all three factors coming together at full pelt.

The urban workforce soared from 100m in 1980 to about 500m today. The increase in the capital stock was even more dramatic. In 1980 China had fewer than 15,000 kilometres of modern road; today it has more than 700,000km, not to mention high-speed trains, too many airports to shake a stick at, power grids and all the other accoutrements of industry. And at the same time China experienced a productivity boom thanks, in large part, to the steady dismantlement of central planning. Competition shook up the economy. Businesses became better run and workers went wherever wages were highest.

From 1980 to 2010 China's annual GDP growth averaged 10%. In the past decade, though, things slowed down. The central bank now thinks potential growth is about 5.5% a year. The working-age population is no longer expanding; the latest national census, published in May, revealed a total population on the brink of decline. The appetite for infrastructure is increasingly sated, if not glutted; spending on the built environment has reached the per-person levels of much wealthier countries.

That leaves productivity paramount. But the improvements which came

from loosened state control have not been maintained. The World Bank calculates that, since 2008, China's total-factor productivity (TFP)—the amount of GDP growth that cannot be explained by capital or labour—has grown by just 1.1% per year, less than a third the rate of the previous three decades. That is still double the level in America over the same decade. But the relevant comparator for Mr Xi and his colleagues is China's recent past.

Some of this slowdown simply reflects the move from catch-up to caught-up. Developed countries have lower potential productivity growth. But many analysts also think that China's economic model is particularly wasteful, a failing evidenced by its surging debts. Nowadays it adds about four yuan of new debt for every additional yuan of GDP; a decade ago it needed just two yuan of debt to get the same result.

It was in 2017 that Mr Xi, better known for quoting Mao and Marx, started to talk of TFP and the need to increase it. In March last year, just as China emerged from its covid-19 lockdown, the central committee of the Communist Party and the State Council released a 32-point vision for boosting productivity. In the five-year plan for the economy which was finalised this March, the government specified that it wants labour productivity to grow quicker than GDP.

If there is to be real progress, it will be driven by companies and individuals, not top-down diktats. But the state's moves are shaping the landscape in which those processes will play out. With all due respect to the government's 32 points, it is possible to batch them into three broad categories: industrial modernisation; further urbanisation along new lines; and what might be called catch-up reforms.

The first element, as Noblelift illustrates, is the upgrading of industry. For companies the calculations are simple: modernising their factories stops them from becoming uncompetitive. The government, though, has two

grander goals.

The one which has received most attention outside China is a perceived geopolitical imperative. Faced with rising American enmity, China wants to cultivate greater self-reliance in making essential products from semiconductors to agricultural machinery. That goal, encapsulated in the “Made in China 2025” policy, requires improving its factories, raising its ambitions and conquering new industries.

The other goal reflects economic philosophy. China believes that sustaining high productivity depends on retaining a large manufacturing base. Schooled in Marxist doctrine, China’s leaders have long regarded industry as more economically valuable and more strategically useful than services. Whether the services in question consist of waiting tables or creating financial derivatives hardly matters.

That is a debatable proposition: service-sector work can be highly productive. Nevertheless, the government has cemented it as policy. It will fight to prevent a decline in manufacturing’s share of GDP, which at about 25% is higher than that of Germany or Japan, the industrial heavyweights of the rich world.

Plans to achieve this go well beyond automating assembly lines. The government is giving companies advice and subsidies to get information technology deeply embedded into all their operations. Local developers are designing software tailored to helping them manage their processes more efficiently.

Until a few years ago factory bosses regularly kept track of inventories and orders on paper, says Zhou Yuxiang, founder of Black Lake, one such developer. The desktop-based systems of SAP and Oracle never translated well to China. Now, manufacturers are using applications on their mobile

phones, letting them collect, analyse and act on data in real time. “They are becoming the most flexible companies in the world,” he says. The country hopes that it can enjoy a late-starter advantage in digitising industry, in the same way that it leapfrogged from being a cash-dominated economy to being the world leader in mobile payments.

The second part of the productivity push is better urbanisation: bigger agglomerations to which workers have better access. China has capped the size of its biggest cities, fearful that they might become unmanageable. At the same time, it knows that bigger urban agglomerations, which allow for specialised labour and interwoven supply chains, tend to be more productive. So it is developing giant city clusters in which big hubs are linked to smaller satellites. The idea is to generate the benefits of agglomeration without horrifically congested traffic, overburdened schools and other very-big-city blues.

China has approved plans for 11 mega-clusters in all (see map). The average population of the five biggest is about 110m, nearly three times bigger than the 40m in Greater Tokyo, the world’s biggest existing cluster. Having discussed the idea for several years the government is beginning to invest in making it real. Over the next three years it has committed to double the length of intercity commuter rail lines.

Even deep in China’s interior, cityscapes are changing. In the west, Xi’an, the capital of Shaanxi province, has been fused to Xianyang, a separate city 30km away, creating a metropolitan area with 15m residents. An hour’s drive north of the cities fields of grain have been replaced by logistics zones and industrial parks. “This place used to be far out of the way. No one would come here,” says Ma Yu, a middle-aged migrant from the countryside. Now a bullet train carries her to Xi’an in 13 minutes.

As well as joining cities together, it is also blanketing them in 5G mobile networks, planting sensors galore in their highways and sewers to monitor performance, and studding their lampposts with surveillance cameras. The party believes all this will allow the distributed mega-cities to be managed with a precision and efficiency which makes them paragons of hyper-productive modernity. This may betray a lack of insight into what it is that really makes cities hives of innovative oomph.

Making the most of what cities offer also requires reform of the hukou, or residency permit, system which makes most migrants second-class citizens in the cities where they work. Without a local hukou they cannot collect unemployment insurance, and their children struggle to get into local schools.

Along with being profoundly unfair, discriminating against some zoom citizens this way is also costly. When workers hit their 40s and worry about access to health care and pensions, they tend to go back to their natal towns. In doing so they willingly opt for lower-paid, lower-productivity jobs, says Cai Fang, an adviser to the central bank. The government has talked about hukou reform for years and done little. Recently, though, it has actually eased the pathway to hukou in most cities (just not its very biggest). It has also made social benefits more portable within the urban mega-clusters.

The last of the three categories of productivity enhancement is what might be termed catch-up reform: a series of changes to bring the country closer to the standards of richer countries, albeit in a dramatically different political context. The higher-education system is testament to the potential gains. It is easy to point to problems that still bedevil China's schools, from too much emphasis on test preparation to too little investment in rural students. Yet the increasing number of university graduates—46m in 2000, 218m this year—is a good proxy for large, continuous improvements in workers' skills.

Another critical area of reform is allowing failure. One of the main ways to ensure that capital is allocated well is to let bad firms go bust; Mr Cai has cited evidence that firms going under drives as much as 50% of productivity growth in rich countries. In corporate China this form of creative destruction has often been suppressed. Over the past few years, though, bankruptcies have soared.

The courts accepted nearly 30,000 insolvency applications in 2020, a record (see chart 2). Investors are currently fixated on the saga of whether regulators will let Evergrande, the country's biggest property developer, go bust—something which would previously have been unthinkable. And state-owned firms accounted for roughly half of last year's bond defaults, giving the lie to expectations that the government would always save them.

Better education and more bankruptcies are just a couple of the paths forward. The 32-point productivity plan vows to make it easier for companies to issue bonds in the first place, to co-operate more with other countries on scientific research, to better protect intellectual property, and on and on. The plan received little attention at the time; many observers have grown tired of such promises by China. Yet the fact that there is still so much unfinished business, and that the government acknowledges this, may signal that such cynicism is being overdone, at least a bit.

Will China's productivity policies actually work? History offers little by way of precedent. Autocracies have become successful industrial nations before, if never on such a huge scale. But it is not obvious that they can move beyond that. China is currently at roughly the same income level that its two closest Asian forerunners, South Korea and Taiwan, were when they became democratic and strengthened their independent legal institutions—a transition which, in retrospect, seems to have been essential for governing their increasingly complex economies.

In China the party will remain the law. And the way that Mr Xi is using that power is making investors increasingly pessimistic. The government's crackdown on tech darlings, from Ant, a fintech dynamo, to Tencent, a social-media giant, has served up a reminder of just how capricious its regulations can be.

Chinese officials say they are limiting the power of big tech platforms in order to make the economy more competitive and thus more productive. Few investors buy that. Instead, the realisation has seeped in that Mr Xi's references to communist ideology are, at some level, sincere. He appears to be uncomfortable with business leaders getting too rich. And he has made it his mission to reinforce the party's grip on power. When he says "Government, the military, society and schools, north, south, east and west—the party leads them all," he means it. This is not a basis for improving productivity you will find in many economic textbooks.

Deepening distrust between China and much of the world is another problem. Plugging itself into the global trading system did not boost Chinese growth just by opening up new export markets. International competition pushed its companies to be more efficient; access to cutting-edge technology allowed them to become more sophisticated. Now countries from Israel to the Netherlands are subjecting Chinese investments to closer review and limiting exports of some key inputs. A lengthening list of companies have chosen to scrap acquisition plans in America because they would have been impossible to complete.

Officials have come to believe that industrial policy of the "Made in China 2025" sort is, to an increasing extent, the only option available for some types of technological improvement. Li Daokui, a former adviser to the central bank, is confident that it will eventually succeed: "We are not the Soviet Union. We have the world's largest contingent of young engineers.

If pushed, we will develop our own technology." Perhaps. But it will be expensive, both in terms of the direct cost and other spending priorities forgone.

Less funding for pension systems, for example, will hold back consumption, thus holding back investment and productivity in the services sector. According to S&P, a credit-rating agency, a full-bore pursuit of self-reliance could lop as much as one-third off China's growth this decade. But Mr Xi is unlikely to be swayed. He seems to believe that truly ambitious technology investment, though it may often fail, offers the possibility of world-beating breakthroughs that will bring his country both power and productivity.

The biggest reason to believe that things might turn out better for China's economy than these trends would suggest is that it has consistently shown an ability to correct mistakes. In the 1990s the government cut down bloated state-owned firms. Over the past five years it went from dismissing concerns about its debts to launching a deleveraging campaign, though those efforts are far from complete. "Leaders are willing to change when the pressure is there," says Liu Shengjun of the China Financial Reform Institute. That they have become obsessed with how to boost productivity is a good starting-point. Achieving their aim, though, will take much more than robots—and maybe more change than they can stomach. ■



自动化为人民

中国未来的经济潜力取决于其生产率

政府能提高它吗？【深度】

诺力集团的总部位于太湖之滨的长兴县，这家公司生产管理仓库的机器人工具，包括自动驾驶托盘搬运车和分拣系统等。这些工具让拣货和取货变得更快捷，也更少依赖人力。在诺力自己制造产品的工厂里就有各种机械臂在快速移动。“今非昔比。”公司创始人丁毅说。主厂房目前只有350名工人。他说，若是在过去，这里得需要将近四倍的人手。

2010年，全中国共有不到五万台工业机器人。如今则多达80万台，占全球工业机器人保有量的将近三分之一。这一快速增长有部分原因是机器人比以前更便宜了，功能也变得更强大。但另一个原因是随着中国变得更富裕和老龄化，工资水平已经大幅提升。

在2000年时年收入在8000元人民币左右（当时合1000美元）的工厂工人现在的年收入可能是这个数字的近十倍。这使得对像丁毅这样的老板来说，天平急速向自动化倾斜（见图表1）。几乎一夜之间，中国工业从劳动密集型转向了机器人密集型。

企业永远都会寻找这类方式来提高生产率。寻求经济增长的国家也一样。中国国家主席习近平已经将生产率列为优先事项。

从某些方面看，丁毅和习近平的抱负似乎相当协调一致。但许多观察人士认为，习近平对决定丁毅如何投资的市场力量依赖过少，而对国家权力依赖过多。其结果是，他有可能带领国家偏离他想要实现的高生产率的未来。未来全球经济的格局取决于这些批评者的看法是否正确，或者，拥有周密计划、背负荣耀使命的中国领导人能否实现他们的目标。

经济增长仅取决于三个基本要素：有多少人在工作；他们有多少资本可供

支配；他们的生产效率如何。中国在过去40年里的高速增长是这三个要素全速会合的结果。

中国的城镇就业人口从1980年的一亿人猛增到今天的约五亿。资本存量的增长更加惊人。1980年，中国的现代化道路不到15,000公里，今天已超过70万公里，更不用说高速铁路、不计其数的机场、电网和所有其他工业装备。而与此同时，中国经历了一轮生产率快速增长，这在很大程度上要归功于逐步抛弃计划经济模式。竞争激活了经济。企业经营得更好了；哪里工资最高，工人就往哪里走。

1980年到2010年间，中国的GDP年均增速达到了10%。但在过去十年里速度慢了下来。人行现在认为潜在增长率为5.5%左右。劳动年龄人口不再增长；5月发布的最新全国人口普查结果显示总人口已处于缩减的边缘。基础设施即便不是供过于求也已日趋饱和；在人造环境上的支出已经达到富裕得多的国家的人均水平。

这就使得生产率这一项变得至关重要。但是，放松国家控制带来的生产率提升并没有得以维续。据世界银行计算，自2008年以来，中国的全要素生产率（TFP，无法用资本或劳动力解释的GDP增长）每年仅增长1.1%，不到之前30年里增速的三分之一。这仍然是美国同期水平的两倍。但对于习近平和他的政府而言，中国最近的过去才是要紧的比较对象。

这一放缓在一定程度上只是源于从追赶到被追赶的地位转变。发达国家的潜在生产率增长更低。但许多分析人士同时也认为，中国的经济模式尤其浪费，其债务的激增就证明了这一缺陷。现在，它每增加1元GDP就增加约4元新债务，而十年前它只需要2元债务就能取得同样的增长。

更常引用毛泽东和马克思的习近平从2017年开始谈论全要素生产率以及提高它的必要性。去年3月，中国刚从新冠疫情解封之际，中共中央和国务院发布了提高生产率的32点“意见”。在今年3月敲定的五年规划中，政府明确提出劳动生产率增长高于GDP增长的目标。

如果要取得真正的进步，它将由企业和个人驱动，而非自上而下的指令。

但政府的政策正在塑造展开这些进程的大环境。没有对政府的“32点”有任何不敬之意，但我们认为它们可以被分为三大类：工业现代化；沿着新运输线进一步城镇化；以及姑且称之为“追赶式改革”的举措。

第一大类，正如诺力所展示的，是产业升级。对企业而言这笔帐很简单：把自己的工厂现代化可以防止它们丧失竞争力。但政府有两个更宏大的目标。

最受外界关注的那个目标出于一种对地缘政治上的紧迫性的认知。面对美国日益增长的敌对情绪，中国希望在制造半导体和农业机械等各种关键商品上更加自力更生。这个目标体现在“中国制造2025”政策中，要求改造工厂、提升抱负、征服新产业。

另一个目标是经济哲学观的体现。中国相信，要维持高生产率有赖于保持一个庞大的制造基地。中国的领导人接受马克思主义理论训练，长期以来都认为工业相比服务业在经济上更有价值，在战略上更有用。不论这里说的服务业是餐饮还是创造金融衍生品都无甚区别。

这种理念值得商榷，因为服务部门的劳动可以是非常高产的。尽管如此，政府已将它确定为政策。它将力求防止制造业在GDP中的份额下降——这个数字目前约为25%，已经高于德国和日本这两个发达世界的工业巨头。

实现这一目标的计划远不止自动化装配线。政府正向企业提供建议和补贴，让它们把信息技术深深嵌入运营的方方面面。本地开发人员正在设计为企业量身定制的软件，以帮助它们更高效地管理流程。

黑湖智造就是这样一家开发公司。其创始人周宇翔说，直到几年前，工厂老板们还经常在纸上跟踪库存和订单。SAP和甲骨文公司基于电脑桌面的系统从来没有很好地移植到中国。现在，制造商们正在自己的手机上使用应用，让他们可以实时收集和分析数据并据此采取行动。“它们正在成为世界上最灵活的公司。”他说。中国希望在工业数字化中享有后发优势，就像它从一个现金主导的经济体一跃成为移动支付的全球领军者那样。

推动生产率的第二部分是更好的城镇化：创建更大的聚集区，让工人们更有机会进入其中。中国已经限制了它最大城市的规模，担心它们大到无法管理。与此同时，它也知道，更大的城镇聚集区能发展专业劳动力和相互交织的供应链，往往生产率更高。因此它正在发展超级城市群，让大型枢纽与较小的卫星城市连接。其思路是得到集聚的益处，同时却不会有可怕的交通拥堵、不堪重负的学校和其他超大城市的通病。

中国迄今批准了11个超级城市群的规划（见地图）。其中五个最大的城市群平均人口约为1.1亿，是世界上现有最大的都会区东京都会区四千万人口的近三倍。在围绕这一构思探讨数年后，政府目前正在启动投资来切实推进它。它承诺接下来三年里将城际通勤铁路线的长度翻番。

即使在偏远的中国内陆地区，城市景观也在发生变化。在西部，陕西省省会西安已与距离它30公里的城市咸阳融合，形成一个拥有1500万居民的都会区。从这里驱车往北一小时，农田已被物流园区和工业园区取代。“这地方过去偏僻得很。没人会来这儿。”中年农民工马玉（音译）说。现在，一辆动车在13分钟内就把她运到了西安。

除了把城市连接起来，中国还让它们被5G移动网络覆盖，在高速公路和下水道中安装大量传感器来监测运行，在路灯柱上安上监控摄像头。共产党认为，所有这些将使得分布各地的超级城市群能被精确和高效地管理，使之成为超高产现代化的典范。而这可能会暴露出它对真正令城市充满创新魅力的原因缺乏洞察。

要充分利用城市的优势还需要改革户籍制度，现有的“户口”系统使得大多数外来务工人员在他们工作的城市沦为二等公民。没有本地户口，他们无法领取失业保险，子女难以在本地入学。

这不仅极为不公平，这样区别对待约两亿民众也面临高昂的代价。当工人们到了40多岁并开始担心医疗和养老金时，他们往往会回到自己的出生地。人行顾问蔡昉表示，他们这样做就是心甘情愿地选择了工资更低、生产率也更低的工作。多年来，政府一直在谈论户籍改革，但做得很少。不

过，近期它已经实际简化了大多数城市（虽然不包括最大的城市）的落户申请程序。在超级城市群的内部办理社保关系转移也更容易了。

提高生产率的最后一类或可称之为“追赶式改革”：这一系列改变要让中国更接近于富裕国家的标准，尽管政治环境截然不同。高等教育系统为这类改革的潜在收益提供了佐证。人们很容易指出中国的学校挥之不去的那些问题，比如应试教育、对农村学生投资太少。但大学毕业生不断增加——从2000年的4600万增至今年的2.18亿——是工人技能持续大幅提高的一个很好的指标。

另一块关键的改革是放手让企业倒闭。确保资本配置良好的主要方法之一是让经营不佳的企业破产。蔡昉引用的证据表明，企业倒闭推动了富裕国家生产率增幅的50%之多。在中国企业界，这种创造性破坏的形式常被压制。不过，过去几年里破产数量已经飙升。

2020年，法院受理了近三万宗破产申请，创历史新高（见图表2）。投资者目前都在密切关注监管机构到底会不会让中国最大的房地产开发商恒大破产——这在过去是不可想象的。而在去年的债券违约事件中，国企约占了一半，打破了人们以为政府总是会出手拯救的预期。

提升工人受教育水平和放任更多企业破产只是前路中的两条。32点生产率计划誓言要让企业首先更容易发债、更易与其他国家开展科研合作、能更好地保护知识产权等，不一而足。该计划在发布当时没有引来多少关注：许多观察家已经厌倦了中国的这类承诺。不过，既然还有这么多未完成事务，而政府又承认这一点，那么这种冷嘲热讽就有可能过了头——至少有那么一点吧。

中国的生产率政策真能奏效吗？历史上找不到什么可供参考的先例。过去也有威权国家晋级为成功的工业国家，虽然未曾发生在如此巨大的规模上。但它们能否超越这一阶段，答案并不显而易见。中国大陆目前的收入水平与韩国和台湾这两个它最接近的亚洲先行者在转变为民主政治并加强司法独立时的水平差不多。而回顾来看，后两者当时的这种转变似乎对它

们治理日益复杂的经济体至关重要。

中国的情况依然将是党即是法。而习近平使用这种权力的方式正让投资者日益悲观。政府对科技宠儿的打击——从金融科技巨头蚂蚁金服到社交媒体巨头腾讯——提醒人们其监管可以如何反复无常。

中国官员们表示，他们正在限制大型科技平台的影响力以增加经济中的竞争，从而提高生产率。投资者很少相信这种说法。相反，他们逐渐意识到，习近平援引共产主义意识形态在某种程度上是真诚的。他似乎对商业领袖变得太过富有感到不安。而他已经将加强党对权力的控制作为自己的使命。当他说“党政军民学，东西南北中，党是领导一切的”，他不是说说而已。而这不是你能在许多经济学教科书中找得到的提高生产率的依据。

中国与世界许多地区之间的不信任加剧是另一个问题。中国将自己接入全球贸易体系所带来的增长提振并不仅仅是依靠开辟新的出口市场。国际竞争促使中国企业提高效率；接触到尖端技术让它们变得更先进。现在，从以色列到荷兰的国家都在更严格地审查中国投资并限制对中国出口一些关键投入。越来越多的公司选择取消在美国的收购计划，因为它们已经不可能完成。

官员们开始相信，像“中国制造2025”这类产业政策正日益成为实现某些类型的技术进步的唯一选择。人行前顾问李稻葵有信心它最终会成功：“我们不是苏联。我们拥有世界上最大的年轻工程师队伍。不得已时，我们会开发自己的技术。”或许如此。但这将是代价高昂的，无论是考虑到直接成本还是牺牲掉的其他支出优先项。

例如，养老金系统资金减少将抑制消费，继而抑制服务部门的投资和生产率。据信用评级机构标准普尔称，全力追求自力更生可能会在这个十年内让中国经济增长减少多达三分之一。但习近平不太可能动摇。他似乎相信真正雄心勃勃的技术投资——即便实际上可能常常失败——可能实现领先全球的突破，而这些突破将为他的国家同时带来影响力和生产率。

中国经济的走向最终可能好过这些趋势的预示，这么想的最主要原因是它一贯展现出的纠正错误的能力。上世纪九十年代，政府削减了臃肿的国有企业。过去五年里，它从对有关债务的担忧不屑一顾转变为发起去杠杆化运动——尽管那些努力还远未完成。国是金融改革研究院的刘胜军说，“当压力在那儿的时候，领导人是愿意做出改变的。”他们已经开始执着于如何提高生产率，这就是一个很好的起点。但是，实现他们的目标所需的变化远不止更多机器人，而可能超出他们所能容忍的范围。 ■



Prosthetics

A new prosthetic hand

It is cheaper and better than anything now available

PROSTHETIC LIMBS have been around for a long time. The oldest known, a piece of wood carved and painted to replace the lost toe of an Egyptian noblewoman, dates back more than 3,000 years. But prosthetics which behave like the real thing as well as looking like it are still very much a work in progress. And a group at Shanghai Jiao Tong University, in China, have just come up with what looks to be a significant advance—an affordable prosthetic hand that not only responds like a real one to signals from the wearer's brain, but is also able to signal back to the brain what it is touching and doing.

Gu Guoying and his colleagues describe their invention in *Nature Biomedical Engineering*. Its fingers are made of rigid tubes connected by soft joints. These are similarly connected to a 3D-printed plastic palm. The whole is covered with a flexible elastomer layer to mimic skin and is attached to the user's residual limb via a customised plastic socket. In contrast to current models, which are electrically powered, Dr Gu's hand is powered pneumatically by a pump held in a waist bag, with the connecting air lines running under the user's clothes alongside communication cables. This reduces its weight below 300 grams—half that of some current models, and less, indeed, than the weight of a real hand—though the waist bag adds a further 444 grams.

The hand uses similar signal-processing algorithms to other prosthetics on the market. The big advance is that it does not require invasive surgery or electronic implants into the residual limb to communicate with the user's brain. Sensors on the skin record electrical activity from the remaining

arm muscles. In an intact arm, this activity would tell those muscles how to operate the hand. Instead, they are interpreted by pattern-recognition software that sends appropriate commands to the pump to move the artificial hand in the same way. Meanwhile, other signals travel in the opposite direction from sensors in the hand's fingertips to nerves in the arm, whence they are relayed to the brain and provide a sensation of touch. The upshot is something which responds like a hand and feels like one to the user.

Dr Gu and his colleagues compared the efficacy of their invention with that of existing models using tests borrowed from research into strokes and spinal-cord injuries. These included writing, grasping and lifting objects, lifting food to the mouth, and stacking draughtsmen. Normally, they found, it worked better—particularly for delicate tasks like handling fragile objects, petting a cat and shaking hands.

The other advantage of Dr Gu's invention is that it is cheap. The components it is made from cost about \$500. Existing models may sell for \$10,000 or more. If it, or something similar, goes into production, that will permit the transformation of many more of the lives of the 5m people who have lost a hand, or were born without one, than is possible at the moment. ■



义肢

一种新型假手

它比目前市场上的任何假手都更便宜，也更好

义肢的历史相当久远。已知最古老的义肢可以追溯到3000多年前，是一块雕刻过并涂了漆的木头，用以代替一名埃及贵妇人失去的脚趾。不过外形和功能都像真肢体的假肢基本上仍在研发中。中国上海交通大学的一个研究小组最近取得了一项看起来意义重大的进展——一只普通人买得起的假手，不仅能像真手那样响应使用者的大脑发出的信号，还能向大脑发回有关它的动作和物品触感的信号。

谷国迎和他的同事在《自然-生物医学工程》（Nature Biomedical Engineering）上介绍了他们的发明。这只假手的手指由用柔软“关节”连接的硬管组成。这些手指又通过相似的方式连到一个3D打印的塑料手掌上。整只假手上覆盖着一层柔性弹性体，模拟皮肤，并通过定制的塑料接口连接到用户的残肢上。与目前的电动假手不同，谷国迎的气动假手通过装在一个腰包里的气泵驱动，连接气泵与假手的充气线和通讯电线藏在使用者的衣服里面。这将假手的重量减少到300克以下，只有目前一些型号的一半重，实际上比真手还要轻。不过，装有气泵的腰袋还有444克的重量。

这种假手使用的信号处理算法与市场上其他义肢相似。它的重大进步是无需实施侵入性手术或在残肢上植入电子设备就能与使用者的大脑通信。皮肤上的传感器会记录残肢上肌肉的电活动。在健全的手臂上，这些电活动会告诉手臂肌肉要如何运作手部。而在假手上，模式识别软件会解读这些电活动，并向气泵发送适当的命令来以同样的方式移动假手。与此同时，其他信号会沿着相反的方向从手指上的传感器传递到手臂上的神经，然后再传递给大脑，从而产生触觉。结果就是它的反应像一只真手，给用户的感觉也像一只真手。

谷国迎及其同事借用中风和脊髓损伤研究中的一些测试，比较了他们的发

明与现有假手的功效。这些测试包括书写、抓取并举起物品、把食物送到嘴里和堆叠棋子。他们发现，通常情况下他们这款假手表现更好，尤其是在抓取易碎物品、抚摸猫和握手等精细动作方面。

谷国迎这项发明的另一个优点是成本低廉。它的部件成本约为500美元。现有假手的售价可能在一万美元以上。如今有500万人存在先天或后天的手部残疾，现有的假手无法让他们的生活获得极大改善。而如果这款假手或类似的型号投产，他们中很多人的生活将有机会发生重大变化。■



Production-line poets

How Chinese factory-workers express their views on life

Poems, videos and fashion all speak to migrants' alienation

AS TRENDSETTERS GO, Luo Fuxing was an implausible one. A school drop-out, Mr Luo spent his days catching fish and herding goats in a village in southern Guangdong province. Eating pork was a once-weekly treat. At the age of 14, he left home to earn a wage in the province's sweatshops. He hated the tedium of the work. He read that American criminals had tattoos of spiders' webs inked onto their elbows to show time spent behind bars. Mr Luo got one too, because "the factory was just a bigger prison."

He quit for a job in a hair salon. Inspired by Japanese manga and punk fashion, he dyed his hair and styled it into dramatic, gravity-defying spikes. Dark lipstick and eyeliner completed the look. He posted selfies to QQ, a messaging service—and soon hundreds of thousands of factory-town youth were copying his style. Mr Luo called its adopters the shamate, from a Chinese rendering of "smart". It was "a wild-growing art form among workers", he says. The trend, which peaked around a decade ago, helped newly arrived migrants from the countryside to bond. They met in parks, roller-skating rinks and online groups, where they shared not just sartorial cues but gripes about migrant life, from low pay and poor conditions to divorcing parents.

China has developed a distinct working-class culture in recent years, of which shamate fashion is only the most garish example. In mainstream media assembly-line workers are commonly shown in serried ranks and drab uniforms, with no hint as to how they spend their time outside factory walls. The stereotype is that workers who migrate to boomtowns and big cities—as 300m have done over the past four decades—are there only to

earn a living. They are still commonly referred to as “migrant workers”, on the assumption that they are outsiders who will return to their rural hometowns. Many once did. But today’s working-class youth have no interest in going back to the land; many have lived in the city from a young age. They want to put down roots. Although marginalised in mass culture, workers are expressing themselves, in forms as varied as poetry and short videos shared online.

The government tends to portray migrant workers as patriotic and self-sacrificing. A museum dedicated to them in Guangzhou, the capital of Guangdong, lauds their contribution to China’s economic ascent. Exhibits extol the Communist Party’s efforts to improve workers’ livelihoods and applaud their diligence. A sign at the entry reads: “Guangdong lets migrant workers create proud glories and legends again and again!” The hardship of factory work is glossed over, as are common injustices such as withheld wages.

Elsewhere, workers are often treated as country bumpkins. A “migrant-workers” version of the annual Spring Festival Gala, a big television show broadcast on the eve of the lunar new year, airs on a channel about agricultural news. Workers who began to stage their own unofficial gala some years ago were condescendingly described by state news outlets as offering “a little song, a little dance and a lot of passion”.

Small wonder that a coruscating memoir by Fan Yusu, a domestic worker living in Beijing, was a national sensation when it was published online in 2017. Ms Fan is now the editor-in-chief of New Workers’ Literature, an unofficial bimonthly journal of working-class writing, launched in 2019. One genre winning admiration from the literati is called dagong shige or “labour poetry”. Its most famous practitioner was Xu Lizhi, who worked on an assembly line for Foxconn, a Taiwanese firm that makes most of Apple’s iPhones. Before he committed suicide in 2014, at the age of 24, he had

written almost 200 poems about the drudgery of factory work. Among the best known is “I Swallowed An Iron Moon”:

I swallowed an iron moon / they called it a screw / I swallowed industrial wastewater and unemployment forms / bent over machines, our youth died young / I swallowed labour, I swallowed poverty / swallowed pedestrian bridges, swallowed this rusted-out life / I can't swallow any more / everything I've swallowed roils up in my throat / I spread across my country / a poem of shame

Many workers' poems refer to homesickness, alienation, injuries and powerlessness. A few deliberately evoke beauty, in jarring contrast to their bleak surroundings. In “Sundress”, Wu Xia—a rare female worker-poet, hired by a textile factory at the age of 14—writes of her love for the “unknown girl” with the means to buy the garment she sews. She also thus lays bare the elusive promise of social mobility that drives so many to the assembly line: Ms Wu, now 40 and a published poet, still works at a clothing factory.

The packing area is flooded with light / the iron I'm holding / collects all the warmth of my hands / I want to press the straps flat / so they won't dig into your shoulders when you wear it / and then press up from the waist / a lovely waist / where someone can lay a fine hand / and on the tree-shaded lane / caress a quiet kind of love...

Some literature is defiant, including towards government policies that make it extremely hard for factory-workers born in rural areas to make use of schools and hospitals in the cities. In “Who Can Forbid My Love”, Ms Wu writes of her adoptive city of Shenzhen: “This kind of love seeps into the pores, skin, cells, blood, bone / Even though there's no residence permit with my name on it.” Chen Nianxi, a worker in a private mine, speaks of fellow miners who, employed by state-run firms, toil less yet earn more

while he must blast “the rocks layer by layer / to put my life back together”. (English translations of these and other poems were published in 2016 in “Iron Moon”, an anthology of labour poetry.)

Such writing is tolerated by the government partly because journals like New Workers’ Literature are written for limited circulation and may not be sold in bookshops. Many poets publish online where, to avoid censorship, they steer clear of “unfiltered representations of the horrors” inside unregistered workshops known as “black factories”, notes Maghie van Crevel of Leiden University. Some poems are proud or patriotic; many of those who write are motivated by a desire to earn respect. In the visitors’ book at the museum in Guangzhou, a visiting labourer has written: “Migrant workers, working souls, we’re the finest of them all.”

Yet workers’ writing is not fundamentally about political resistance, says Mr van Crevel, who studies labour poetry. Few blue-collar youths today feel they belong to a cohesive working class. That is partly because officials and state media avoid using the word “class”, or jieji, owing to its antagonistic overtones. (“Social stratum”, or jieceng, is preferred.) Many young workers call themselves dagong ren, a word for labourer that connotes temporary and low-status work. Its most extreme display is a subculture in Shenzhen whose members style themselves “Sanhe gods”. These young migrant workers hang around the city’s Sanhe job market to find day work, often as builders or delivery drivers. They reject the grind of the factory; their slogan is: “Work for a day, party for three.” Some even sell their national-identity cards.

Becoming a shamate was also a form of rebellion against the monotony of factory life. In a Chinese documentary released in 2019, “We Were Smart”, 70 former and current shamate shared their views on what it meant to be one. Their exuberant hairstyles turned heads. “People paid attention. It wasn’t positive attention. But they saw you. And the point was to be seen,” says

one interviewee. Many felt they were part of a select group, and that cutting their hair would have meant going back to being “just another unknown line worker”. For some, the punk identity became more important than earning a better wage at a big factory, where they would have been forced to cut their hair. For men and women alike, it was a way of seeming tougher in a disorienting new city where many were cheated: “We felt we weren’t safe out there. That we were too honest, and were afraid of being messed with.” The hair, tattoos and clan mentality all helped.

As the fashion spread, its adherents began to be ridiculed by prim, middle-class netizens. A sustained online attack against shamate around 2010 led thousands to lop off their hair and drop out of the group. Police began to round up anyone with the telltale style, to check their papers; anyone without a temporary residence permit would be detained.

Shamate fans still congregate in parts of Guangdong. But the fashion has lost its edge as factory youth have found a new way to express themselves: video-sharing apps. Lorry drivers, construction workers and farmers have built followings and sometimes found stardom—not despite being blue-collar workers, but because of it. In manufacturing hubs, where phones are often banned inside factories, assembly-line workers document their lives outside them. Widely used hashtags include #FactoryLife and #LiftTheBucket. The last refers, often ironically, to quitting a job in search of a better one, with nothing but a bucket of belongings.

Through the videos, workers cheer each other on. They trade information: which factory has higher wages or fairer bosses, say. That is especially useful in a “hostile environment where there is no trade union to tell them about working benefits”, says Aidan Chau of China Labour Bulletin, an NGO in Hong Kong. Some speak of injuries or sexual harassment. Others parody the trendy life of urban middle-class youth. “Their aspiration to live in

a city and become an urban citizen grows, even as they realise it is implausible—even impossible,” says Mr Chau.

Whether expressed in poems or through video-sharing apps, a sense of disillusionment seems to be growing. There was once pride in being a worker, says Mr Luo. “Now it’s embarrassing to say you’re one.” Young people working in factories see short videos as an escape: a way to kill time, but also to be part of a wider world beyond their gritty boomtowns. Yet even online, they struggle to gain acceptance. Zhang Yurong is among a handful who have built a wide following by recording life as a worker at Foxconn. Some comments on her videos say factory workers are “people abandoned by society”. That angered her, she says, not because it was wrong but because it was right.

A fellow worker-poet and friend of Xu wrote in tribute after his death: “Another screw comes loose / Another migrant-worker brother jumps / You die in place of me / And I keep writing in place of you.” ■



产线诗人

中国工厂工人如何表达对生活的看法

诗歌、视频和时尚都在诉说外来务工者的难以融入

罗福兴会成为潮流引领者这件事让人难以置信。辍学后，他在广东南部的一个村庄里打鱼放羊。吃猪肉是每周才有一次的享受。14岁时，他离家到省内的血汗工厂打工。他讨厌这种工作的乏味。他读到美国罪犯的手肘上有蜘蛛网纹身，代表他们在狱中度过的时间。罗福兴也去纹了一个，因为“工厂只是一个更大的监狱。”

他辞了职，改去一家发廊工作。受到日本漫画和朋克时尚的启发，他染了发，做成夸张的、反重力的尖刺造型，再涂上深色唇膏和眼线。他把自拍照发到即时通讯服务QQ上——很快，他的风格被成千上万的工厂镇青年效仿。罗福兴把这些追随者称为“杀马特”，源自于“smart”的音译。他说，这是“一种在工人中蓬勃发展的艺术形式”。这一风潮在大约十年前达到顶峰，帮助来自农村的务工一族建立连结。他们在公园、溜冰场和线上群组中见面，不仅分享服饰造型方面的心得，也相互吐槽倾诉背井离乡的生活——从低工资和恶劣的工作条件到闹离婚的父母。

近年来，中国已经形成了一种独特的工人阶级文化，杀马特时尚只是其中最扎眼的一个例子。在主流媒体的呈现中，流水线工人一般都是密集地排列，穿清一色单调的制服，却丝毫没有展示他们如何度过在工厂外的时光。对于这些迁移到新兴城镇和大城市的工人（过去40年中达三亿人），刻板印象是他们只是为了谋生。他们仍然常被称为“农民工”，认为他们是最终将返回农村老家的外来者。过去确实有许多人这么做。但是今天的工人阶级青年对回到农村没有兴趣；许多人从小就住在城市里。他们想扎根。尽管在大众文化中处于边缘地位，但工人们正在以诗歌和在线分享的短视频等多种形式表达自己。

政府倾向于将农民工描绘成爱国和自我牺牲的人。位于广东省省会广州的

一座专门为他们设立的博物馆赞扬了他们对中国经济崛起做出的贡献。展品颂扬共产党为改善工人生活所做的努力，也赞美工人的勤奋。入口处的牌子上写道：“广东，让农民工造就了一个又一个骄人的辉煌和传奇！”工厂工作的艰辛被淡化，工资被拖欠等常见的不公现象也未曾提及。

在其他地方，工人常被视为乡巴佬。“全国农民工春节联欢晚会”除夕在农业新闻频道播出。几年前开始自行举办非官方晚会的工人被国家新闻媒体傲慢地描述为“唱点小歌、跳点小舞，激情满满”。

难怪在 2017 年一篇才气逼人的自传文章在网上的发表引起了全国轰动。它出自生活在北京的家政工人范雨素之手，她现在是2019年创刊的非官方工人阶级写作双月刊《新工人文学》的主编。其中一种颇受文化界赞赏的体裁被称为“打工诗歌”。这方面最著名的创作者是许立志，他曾在富士康（生产苹果大部分 iPhone 手机的台湾公司）的装配线上工作。在他2014年自杀之前，24岁的他写了近 200 首关于辛苦单调的工厂工作的诗。其中最著名的一首是《我咽下一枚铁做的月亮》：

我咽下一枚铁做的月亮 / 他们把它叫做螺丝 / 我咽下这工业的废水，失业的订单 / 那些低于机台的青春早早夭亡 / 我咽下奔波，咽下流离失所 / 咽下人行天桥，咽下长满水锈的生活 / 我再咽不下了 / 所有我曾经咽下的现在都从喉咙汹涌而出 / 在祖国的领土上铺成一首 / 耻辱的诗

许多工人的诗歌都提到思乡、疏离、受伤和无力。一些诗刻意唤起美感，与他们凄凉的环境形成鲜明对比。在《吊带裙》中，14岁就受雇于一家纺织厂、少见的女工诗人邬霞写下了她对买得起她缝制的衣服的“陌生姑娘”的爱。由此，她也揭示了有关社会流动性的承诺难以达成，而这种承诺促使如此多的人走上流水线：邬霞现年40岁，已有诗作出版，却仍在一家服装厂工作。

包装车间灯火通明 / 我手握电熨斗 / 集聚我所有的手温 / 我要先把吊带熨平 / 挂在你肩上不会勒疼你 / 然后从腰身开始熨起 / 多么可爱的腰身 / 可以安放一只白净的手 / 林荫道上 / 轻抚一种安静的爱情.....

一些文学是反抗性的，比如揭示政府政策使得农村出生的工厂工人极难利用城里的学校和医院。在《谁能禁止我爱》中，邬霞写到收留她的城市深圳：“这爱渗入到毛孔里、皮肤里、细胞里、血液里、骨头里/虽然这座城市的户口簿上没有我的名字。”一家私营矿山的工人陈年喜谈到，在国营企业工作的矿工们干得更少挣得更多，而他必须“把岩层一次次炸裂/借此把一生重新组合”。（这些诗和其他诗的英文译本于 2016 年发表在工人诗集《铁做的月亮》 [Iron Moon] 中。）

政府容忍这种写作，部分原因是像《新工人文学》这样的期刊发行受限，不能在书店销售。莱顿大学的马吉尔·范克雷维尔 (Maghiel van Crevel) 指出，许多诗人在网上发表作品，而为避免审查，他们会注意不对被称作“黑工厂”的地下作坊内的“恐怖景象做未经过滤的呈现”。有些诗是自豪或爱国的；许多写作者的动机是为了赢得尊重。在广州博物馆的游客手册中，一位来访的农民工写道：“农民工，劳动者，我们是最优秀的人。”

不过，研究工人诗歌的范克雷维尔说，工人的写作从根本上无关政治抵抗。今天很少有蓝领青年认为他们属于一个有凝聚力的工人阶级。部分原因是官员和官方媒体避免使用“阶级”这个词，因为它带有对立的意味。

（他们更愿意使用“社会阶层”。）许多年轻工人自称“打工人”，这个词有工作临时和地位低的意味。其最极端的表现是深圳的一种亚文化，其成员自称“三和大神”。这些年轻的农民工在城市的三和就业市场上转悠，寻找日结工作，通常是建筑工人或送货司机。他们拒绝工厂的繁重劳动；他们的口号是：“干一天，玩三天”。有些人甚至出售自己的身份证件。

成为“杀马特”也是对单调的工厂生活的一种反抗。在 2019 年上映的中国纪录片《杀马特我爱你》中，70 位曾经和现在的“杀马特”分享了他们对身为“杀马特”意味着什么的看法。他们奔放的发型引起了人们的注意。“虽然说别人不是那种从心里面这种关注，是异类的那种关注，就看得到你，你只要能看得到。”一位受访者说。许多人认为他们是特殊团体的一员，剪头发意味着回到“只会默默无闻地在一条流水线里面工作”。对于一些人来说，朋克身份变得比在大厂挣高工资更重要，因为在那他们会被迫剪掉头发。无论男女，在一个许多人被欺骗、让人迷失的新城市中，这是一种

让自己看起来更加坚强的方式：“感觉外面这么乱，我们几个人太朴素了，怕被人欺负。”头发、纹身和小团体心态都有帮助。

随着这种潮流的传播，它的追随者开始受到古板的中产阶级网民的嘲笑。2010年左右，网上针对“杀马特”的持续攻击导致数千人剪掉头发并退出这个群体。警察开始围堵任何有这种明显风格的人，查他们的证件；没有暂住证的人会被拘留。

在广东的部分地区仍然有很多“杀马特”的粉丝。但这种潮流已经不那么时髦了，因为工厂青年找到了一种新的表达方式：视频共享应用。货车司机、建筑工人和农民都有了粉丝，有的甚至成了红人——不是“尽管是”蓝领，而恰恰是“因为是”蓝领。在制造业重镇，工厂内部经常禁止使用手机，装配线工人就在厂外记录他们的生活。广泛使用的主题标签包括“#工厂生活”和“#提桶”。后一个指的是（常具有讽刺意味）辞掉一份工作去寻找更好的工作，而除了一桶身家之外一无所有。

通过视频，工人们互相加油打气。他们交换信息，比如哪个工厂工资更高，老板为人更公平些。香港非政府组织中国劳工通讯的艾丹·周（Aidan Chau）说，这在“没有工会告诉他们工作福利的不利环境中”尤其有用。有些人谈到工伤或性骚扰。其他人则模仿城市中产阶级青年的时尚生活。“他们希望住在城市并成为城市公民的愿望越来越强烈，尽管他们意识到这很难——甚至不可能成真。”周先生说。

无论是通过诗歌还是视频共享应用来表达，幻灭感似乎都在增长。罗福兴说，曾经人们以做工人荣。“现在都不好意思说自己是工人。”在工厂工作的年轻人将短视频视为一种挣脱：既是为了消磨时间，也是为了超越身处的新兴城镇融入更广阔的世界。然而，即使在网上，他们也很难获得认可。张玉蓉（音译）是少数通过记录在富士康的工人生活而收获大批粉丝的人之一。她的视频中有一些评论说工厂工人是“被社会抛弃的人”。她说这激怒了她，不是因为这句话错了，而是因为它是对的。

许立志的一位朋友，另一位打工诗人在他去世后写道：“又一枚螺丝松动/

又一位打工兄弟坠楼/你替我死去/我替你继续写诗。”■



Sport

Roger Federer, Lionel Messi and the pursuit of greatness

Two new books examine the athletes' extraordinary careers and find they have much in common

The Barcelona Complex. By Simon Kuper. Penguin; 416 pages; \$27. Published in Britain as “Barça”; Short Books; £20

The Master. By Christopher Clarey. Twelve; 432 pages; \$30. John Murray; £20

AS TWO OF the most stylish and successful athletes of all time, Roger Federer and Lionel Messi naturally invite comparison. Mr Federer has won 20 men's singles titles, a record he shares with Rafael Nadal and Novak Djokovic, and reached more Grand Slam finals than any other male player. Mr Messi has won 34 trophies with Barcelona and been awarded the Ballon d'Or, a prize for the world's best football player, six times. Mr Federer praises the Argentine forward's abilities in the same language that many pundits use to describe his tennis: “There's always three options for him. He's one of the few who's got that.”

In recent years the similarities between the two sporting stars have deepened. Mr Federer won three of his major titles after turning 35; aged 34, Mr Messi has just won an international tournament—hitherto the one prize to elude him. Sport was once considered the sole career in which, after 30, you were fated to know only professional decline. Mr Federer and Mr Messi are both showing that no longer needs to be the case.

It is fitting, then, that two books about the athletes have been released at the same time. In “The Barcelona Complex” Simon Kuper, a journalist at the Financial Times, analyses how the Spanish football club became a behemoth, with Mr Messi its “engine and standard-bearer”. “The Master”

by Christopher Clarey, a journalist at the New York Times, is a more conventional biography, based on interviews with the tennis player and his inner circle. Both books offer valuable insight into how sporting greatness is achieved.

Modern athletes are more disciplined than their forebears, who often lived like rock stars and expected their bodies to give out before they reached middle age. In the early 1970s Johan Cruyff, another Barcelona footballing legend, was a chain-smoker. He was so unfit that, during his time at Ajax, Cruyff would hide in the woods while his teammates did running training, only rejoining them for the last lap. Mr Messi, by contrast, credits a mostly vegetarian diet with prolonging his career and has benefited from his club's focus on the science of nutrition, sleep and psychology.

By far the longest-serving member of Mr Federer's team is Pierre Paganini, a former decathlete who has been his fitness coach since 2000. "A big part of the reason that I'm here where I am today is definitely because of Pierre," Mr Federer has said. Modern tennis players need "explosive endurance": ie, the acceleration of a sprinter and the stamina of a marathon runner. A favourite drill of Mr Paganini's is to make Mr Federer sprint between four numbered posts while holding a heavy medicine ball above his head.

The story of Barcelona in recent years is, in many ways, the tale of Mr Messi. In everything from player signings to the team's tactics, Barcelona "handed Messi the keys to the club", Mr Kuper writes. Sandro Rosell, the club's former president, says: "If you have the possibility to be the best player in every match, you have to be a bit of a dictator, as Messi is."

For many years, it worked. Between 2006 and 2015, Barcelona played dazzling football and won four Champions League titles (they had won only one before in their history). Yet the years since have been of slight on-field decline and huge gross debt, which reached more than €1bn (\$1.2bn) this

year. While he has remained an extraordinary player, Mr Messi may partly be to blame. His astronomical fee—\$674m over four seasons from 2017 to 2021, according to reports—exhausts club funds and leads teammates to demand higher salaries, leaving less cash to sign new players. Rivals have also mimicked Barcelona’s tactics, refining the sophisticated passing style developed by Cruyff.

Both “The Barcelona Complex” and “The Master” emphasise the decision-making that helps set superlative athletes apart. Mr Messi is renowned, rightly, for his balletic dribbling, pinpoint passing and clinical finishing in front of goal. But underpinning all these qualities, Mr Kuper shows, is what sports scientists call “scanning”: looking around to take visual snapshots of play. An illuminating passage deconstructing Mr Messi’s art documents how he spends much of each match walking about—during the World Cup in 2014, only one outfield player covered less ground. Yet though his movement is economical, Mr Messi “is moving his head, right, left, right, left,” as his former coach, Pep Guardiola, observed. The best footballers in the world scan the pitch about 50 times per minute.

The finest tennis players also use visual cues, such as the positions of their opponents’ torso and hips, and the way they go to strike the ball, to deduce where the ball is likely to land even before it is touched. “It happens so fast that you have to hit the shot almost without thinking,” Mr Federer explains. With the best contenders, says Marc Rosset, a former Swiss tennis player who mentored Mr Federer, it is “as if they have more time for their brains to process it all”. The impression of effortlessness that this creates is a brilliant illusion.

Both authors reject the notion that Mr Messi or Mr Federer was fated to prevail. Mr Clarey highlights the fortune—particularly the decision of Peter Carter, an Australian tennis coach, to accept a job in Basel—and hard work that made Mr Federer’s story possible. Mr Messi could also conceivably have

been lost to football: the sport long had a dogma about height, and he needed a growth hormone, funded by Barcelona when he moved from Argentina, even to reach a modest 1.7 metres. If Mr Federer's success "has been a long-running act of will, not destiny", as Mr Clarey argues, the same is true of Mr Messi's. ■



体育

费德勒、梅西，以及对伟大的追求

两本新书审视两位运动员非凡的运动生涯，找到了诸多共性【《巴塞罗那帝国》、《大师》书评】

《巴塞罗那帝国》，西蒙·库珀著。企鹅出版社，416页；27美元；英国版名为《巴萨》，Short Books出版社，20英镑。

《大师》，克里斯托弗·克莱雷著。Twelve出版社，432页，30美元；约翰默里出版社，20英镑。

身居有史以来最具风范、最成功的运动员之列，费德勒和梅西自然会被放在一起比较。费德勒已经赢得了20个男子单打冠军头衔，与纳达尔和德约科维奇的记录持平；他还是闯进大满贯决赛次数最多的男子选手。梅西在巴塞罗那赢得了34座奖杯，六次获得金球奖这一对世界最佳足球运动员的表彰。费德勒称赞这位阿根廷前锋的能力时说：“他的面前总有三种选择。他是少数有这种本领的人之一。”许多权威人士在评价他的网球技艺时的表述也差不多。

近年来，这两位体育巨星变得愈发相似。费德勒在35岁后赢得了三项大赛冠军；现年34岁的梅西也刚刚赢得一项世界大赛冠军，此前他一直未能获得这项荣誉。以前人们一度认为体育是唯一一个在30岁之后注定要走下坡路的职业。费德勒和梅西都证明了这不再是铁律。

因此，关于这两位运动员的两本书籍在同一时间出版真是再合适不过了。在《巴塞罗那帝国》（The Barcelona Complex）一书中，《金融时报》记者西蒙·库珀（Simon Kuper）分析了这家以梅西为“引擎和旗手”的西班牙足球俱乐部何以称雄。《纽约时报》记者克里斯托弗·克莱雷（Christopher Clarey）所著的《大师》（The Master）则是一部更传统的传记，素材来自对费德勒和他生活圈子的采访。两本书都就如何取得伟大的体育成就提供了宝贵的见解。

现代运动员比他们的前辈更自律。以前的运动员经常过着摇滚巨星一般的生活，认定自己在中年以前身体就消耗得差不多了。上世纪70年代初，另一位巴塞罗那足球传奇人物约翰·克鲁伊夫就是个老烟枪。他在阿贾克斯效力时身体状况已经很差，队友们做跑步训练时他会躲在树林里，等他们跑到最后一圈再混进队伍。相比之下，梅西将自己职业生涯的延长归功于以素食为主的饮食。他也受益于俱乐部对营养学、睡眠和心理学的重视。

迄今为止，在费德勒团队中任职最久的是皮埃尔·帕格尼尼（Pierre Paganini），他曾是一名十项全能运动员，自2000年起担任费德勒的体能教练。“毫无疑问，我能有今天的成就，很大程度上是靠皮埃尔。”费德勒说过。现代网球运动员需要“爆发性耐力”——既有短跑运动员的加速爆发力，又有马拉松运动员的耐力。帕格尼尼最喜欢的训练是让费德勒将一个沉重的健身实心球举过头顶，在四个有编号的柱子之间来回冲刺。

在很多方面，巴塞罗那近年的故事就是梅西的个人传奇。在从球员签约到球队战术的各种事情上，巴塞罗那“把俱乐部的钥匙交给了梅西”，库珀写道。俱乐部前主席桑德罗·罗塞尔（Sandro Rosell）说：“如果你有可能在每场比赛都是全场最佳，那你多少得有点独裁，梅西就是这样。”

很多年里，这种做法十分奏效。从2006年到2015年，巴塞罗那在球场上的表现光彩夺目，四次捧回欧冠冠军（在此之前他们只赢过一次）。然而此后几年的场上表现略显逊色，而总体债务迅速膨胀，今年已超过10亿欧元（12亿美元）。尽管梅西仍然表现杰出，但他可能要为此承担部分责任。据报道，他在2017年到2021年四个赛季的合同薪资总额高达6.74亿美元，这一天价薪资耗尽了俱乐部的资金，也导致队友要求涨薪，结果导致俱乐部缺少资金签入新球员。同时对手也在模仿巴塞罗那的战术，改进了克鲁伊夫建立起来的细腻传球风格。

《巴塞罗那帝国》和《大师》都强调了顶级运动员之所以出类拔萃，其决策能力功不可没。梅西当然以其芭蕾舞般的运球、精准的传球，以及门前的冷静处理而闻名于世。但库珀指出，所有这些素质背后依靠的是体育科学家所说的“扫视”：环顾四周，就场上情况建立视觉快照。书中一个段落

解构了梅西的技艺，让人深受启发，其中写道他每场比赛的大部分时间都在走：在2014年世界杯期间，除守门员外，场上只有一名球员的移动距离比他少。然而，他的前教练瓜迪奥拉注意到，尽管梅西的移动很经济，“他却在不停转头，左、右、左、右。”世界上最好的足球运动员每分钟大概要扫视球场50次。

最杰出的网球运动员也利用视觉线索，比如对手的躯干和臀部的位置，以及他们击球的方式，从而在对手击球之前就推断出可能的回球落点。“速度实在太快了，你必须近乎不假思索地击球。”费德勒解释说。曾指导过费德勒的前瑞士网球运动员马克·罗塞特（Marc Rosset）表示，最优秀的球员“就好像有比别人更多的时间让大脑处理一切信息”。这给人一种毫不费力的印象，实在是绝妙的错觉。

两位作者都不认同梅西或费德勒的胜利是命中注定的说法。克莱雷强调了运气——特别是澳大利亚网球教练彼得·卡特（Peter Carter）决定接受一份在巴塞尔的工作——加上勤奋才使得费德勒的成功故事成为可能。可想而知，梅西的足球才华也完全有可能被埋没：长期以来，这项运动对身高有着教条般的要求，他从阿根廷来到巴塞罗那时俱乐部出资给他提供生长激素，即便如此他也只长到了1.7米的普通身高。假如正如克莱雷所说，费德勒的成功是“一种长期意志力的结果，而非命运使然”，那么梅西的成功同样如此。■



The Economist Film

Could digital currencies put banks out of business? Part 1

Cryptocurrencies like Bitcoin have been billed as a major disruptor to finance. But digital currencies issued by governments might be even more radical.



经济学人视频

数字货币会让银行倒闭吗？（一）

比特币等加密货币被认为是金融的主要搅局者。但政府发行的数字货币可能走得更远。



Pharmaceuticals

American biotechnology is booming

The pandemic has highlighted the promise of clever new drugs—and the firms developing them

IN 1908 ASHTON VALVE COMPANY built a factory on the corner of Binney Street and First Street in Cambridge, Massachusetts. In what was a high-tech industry of the day, it made gauges, valves, whistles, clocks and other gadgets that helped make steam boilers less susceptible to blowing up and killing people. Just over 100 years later, in 2010, another purveyor of a life-saving technology moved into Ashton's long-abandoned premises: Moderna.

In the past year the biotech darling has become synonymous with the fight against covid-19. Its ingenious mRNA vaccine has, like a similar one developed by Pfizer, an American drug giant, and BioNTech, a German startup, saved millions of lives. Moderna's success has also brought attention to America's biotechnology industry, a lot of it centred on Cambridge. Home to Harvard University and the Massachusetts Institute of Technology, it is the closest that the biotech business currently has to a Silicon Valley.

And the industry is booming. Since 2010 an index of biotech firms listed on the Nasdaq exchange has quintupled in value (see chart), and the number of companies in it has more than doubled, to 269. Between 2011 and 2020 the money that biotech startups raised in American initial public offerings (IPOs) ballooned from \$4bn to \$65bn. So far this year venture capitalists have poured more than \$20bn into pharmaceutical and biotech firms, not far from last year's record tally of \$27bn.

Cambridge is filled with cranes and new buildings, dull on the outside but bursting with exciting science within. In next-door Boston new laboratories are going up around the revamped Seaport. Prices for lab space reportedly reach \$160 a square foot, perhaps the costliest commercial real estate in America not at street level.

The pace of the industry's expansion would have been inconceivable 10-15 years ago, marvels Jean-François Formela of Atlas Venture, a venture-capital (VC) firm. Businesses are popping up everywhere, including down the hall from Mr Formela's office. Flagship Pioneering, a VC firm which guides entrepreneurs from a promising idea to a business that can attract outside investors, has spun out 26 companies since 2013. Its founder, Noubar Afeyan (who is also Moderna's chairman), hopes to spin out up to ten a year from now on.

The boom has several causes. Tim Haines, chairman of Abingworth, a London-based asset manager focused on life sciences, notes that many investors have been swept up in the notion of "philanthropic capitalism": making money from products that could benefit society. Other reasons are more hard-headed. According to Mr Haines's estimates, 64% of drugs in late-stage development are being concocted by youngish biotech companies built around a novel technology rather than by big pharma firms such as Pfizer (which often team up with smaller biotechs like BioNTech, or acquire them, to juice up development pipelines).

Many of these technologies are themselves the result of recent advances in cell and gene therapies, in ways of delivering them, and in identifying which patients they are likely to benefit most. New money is flowing into firms developing treatments for cancer, illnesses of the immune system or the brain, and even infectious diseases. Everyone is vying to be the next Moderna, whose market capitalisation has jumped from \$5bn when it went public in late 2018 to \$156bn. Many are hoping to emulate it by expanding

from developing therapies to manufacturing them.

Walking past Moderna's headquarters just off bustling Binney Street it is easy to overlook the risks. People with both a PhD in life sciences and managerial nous are a rare breed. Unlike brainstorming the next app, life science cannot be done on Zoom. Many clever ideas never come to fruition. Those that do become therapies often cost a lot, which increasingly angers both Democrats and Republicans in Congress and has led to calls for price controls.

The greatest danger is a common one for startups: can they make money? Only one in six firms in the Nasdaq biotech index did so in 2020. The remaining five-sixths lost a combined \$33bn. Vertex, a star graduate of Binney Street that has relocated to Seaport, lost money from its founding in 1989 until 2017. Moderna turned a profit last quarter for the first time in a decade and its share price has slid. Still, its wannabe imitators can take comfort that biotech investors are a patient lot. ■



制药

美国的生物技术蓬勃发展

疫情凸显出先进新药及其研发公司的光明前景

一九〇八年，阿什顿阀门公司（Ashton Valve Company）在马萨诸塞州剑桥市的宾尼街（Binney Street）和第一街（First Street）的交汇处盖了一间工厂。它是那个年代的高科技产业，生产压力计、阀门、哨笛和钟表等小设备来帮助降低蒸汽锅炉爆炸和致死的风险。在刚刚过去100年后的2010年，阿什顿废弃已久的厂房进驻了另一家拯救生命的科技公司——莫德纳（Moderna）。

过去一年里，这家炙手可热的生物技术公司已经成为抗击新冠肺炎的代名词。与美国制药巨头辉瑞（Pfizer）和德国创业公司拜恩泰科（BioNTech）联合开发的类似疫苗一样，该公司自行开发的mRNA疫苗拯救了成千上万人的生命。莫德纳的成功也引发了人们对美国生物技术产业的关注。这个产业主要集中在剑桥市，这里是哈佛大学和麻省理工学院的所在地，是生物技术圈目前最接近硅谷的地方。

这个产业势头正猛。自2010年以来，追踪纳斯达克上市生物技术公司的指数的市值已经增长了四倍（见图表），指数中的公司数量也翻了一倍多，达到269家。从2011年到2020年，生物技术创业公司在美国IPO的融资额从40亿美元激增至650亿美元。今年到目前为止，风险投资家已向制药和生物技术公司投入逾200亿美元，接近去年全年创纪录的270亿美元。

剑桥市到处可见起重机和新建筑，从外面看索然无味，但里头进行着的可是激动人心的科学研究。在毗邻的波士顿市，新实验室在改造后的海港区（Seaport）不断涌现。实验室场地的租金据称达到每平方英尺160美元，可能是美国除一楼店面外最昂贵的商业地产。

这个行业的扩张速度放在10到15年前是不可想象的，风险投资公司Atlas

Venture的让-弗朗赛·弗梅拉（Jean-François Formela）惊叹。到处都是新开的公司，弗梅拉的公司所在的楼层里就有。Flagship Pioneering是一家风险投资公司，它指导创业者将有前景的想法转变为能吸引外部投资者的企业，自2013年以来已经孵化了26家公司。它的创始人努巴·阿费扬

（Noubar Afeyan，也是莫德纳的董事长）希望从现在开始每年最多能孵化10家公司。

这轮繁荣有几个成因。伦敦的资产管理公司Abingworth聚焦生命科学领域，它的董事长蒂姆·海恩斯（Tim Haines）指出，许多投资者沉浸于“慈善资本主义”的概念：从可能造福社会的产品中赚钱。其他的原因更加理性。据海恩斯估计，处于研发后期的药物中，有64%是由年轻的生物技术公司围绕某项新技术研发出来的，而不是来自像辉瑞这样的大型制药公司（它们经常与拜恩泰科这样的小型生物技术公司合作，或者收购它们，以充实自己的研发计划）。

这些技术中有许多本身是近年两类进展的结果：一是细胞和基因疗法的发展，新技术将这方面的研究成果付诸实践；一是确定哪些患者可能从中受益最大。新的资金正涌入开发各种疗法的公司，包括针对癌症、免疫系统或脑部疾病，甚至还有传染病。大家都争相要成为下一个莫德纳，这家公司的市值已从2018年底上市时的50亿美元跃升至1560亿美元。许多公司从开发疗法扩展到了制造相关药物和设备，以期赶上莫德纳。

走过位于熙熙攘攘的宾尼街尽头的莫德纳总部，你很容易忽视这股热潮中的风险。同时拥有生命科学博士学位和管理才能的人实属凤毛麟角。不同于头脑风暴出一款新应用，生命科学研究无法在Zoom上完成。许多绝妙的想法从来没有实现过。那些最终研发成功的疗法往往价格不菲，这让国会的民主党和共和党人都越来越愤怒，并引发了控制价格的呼声。

最大的危险是创业公司的一个常见问题：它们能赚钱吗？纳斯达克生物技术指数中只有六分之一的公司在2020年赚到了钱，其余六分之五的公司总共亏损了330亿美元。宾尼街的“杰出毕业生”、现已搬到海港区的福泰制药（Vertex）从1989年成立后一路亏损到了2017年。莫德纳在上一季度实

现了十年以来的首次盈利，而它的股价已经下滑。不过，那些想要模仿它的公司可以稍稍放宽心的是，生物技术领域的投资者是一群很有耐心的人。 ■



Nation-gilding

The Afghan government was undone by its own corruption

As with Vietnam, an American client state was crippled by graft

IT LOOKED LIKE the fall of Saigon in 1975 on fast-forward: an American-backed army melting away, enemy fighters strolling into the presidential palace, desperate crowds mobbing the airport. But the similarities between Afghanistan and South Vietnam were not only superficial. Both states, built to please their American sponsors, had been hollowed out by one of the oldest diseases of governance: corruption.

In Afghanistan, “from your birth certificate to your death certificate and whatever comes in between, somehow you have to bribe,” says Ahmad Shah Katawazai, a former Afghan diplomat. Officials and police routinely demand baksheesh (a “tip”). As the Taliban advanced, the pay-off required for a passport rose to thousands of dollars.

Worse, a government job is itself a valuable commodity. As Sarah Chayes, an expert on corruption, discovered while running an NGO in Afghanistan, officials often buy their posts and must extort kickbacks to recoup their investment. Mr Katawazai says it can cost \$100,000 to become a district police chief. Officials’ main goal becomes extorting revenue to distribute to their families and patronage networks.

Afghanistan was partly run by such networks, even before 2001. But America strengthened them by paying off warlords, according to the Special Inspector General for Afghanistan Reconstruction (SIGAR). In 2009 ISAF, the coalition of NATO-led forces in the country, set up an anti-corruption unit called Shafafiyat (“transparency” in Pashto), with modest results. The government’s anti-corruption prosecutor mainly pursued political

enemies. By the end the country was so corrupt that governors cut deals with jihadists. The army's numbers were inflated by "ghost soldiers", absentees listed on the payroll so that commanders could pocket their salaries.

Americans may remember the term "ghost soldiers" from the war in Vietnam, where corrupt senior officers used the same system. One South Vietnamese colonel used to order aimless artillery barrages in order to hawk the spent shell casings as scrap metal. As in Afghanistan, police and soldiers profited from the heroin trade. A report in 1978 on the fall of South Vietnam by RAND, a security think-tank, said South Vietnamese themselves believed that corruption was "largely responsible for the ultimate collapse".

Why then, when it invaded Afghanistan decades later, did America fail to take corruption seriously? One answer is that political thinkers are only now doing so. Scholars such as Francis Fukuyama, a political scientist, see corruption as a throwback to pre-modern governments where power is based on personal ties rather than institutions. In this way South Vietnam and Afghanistan resemble mafias or the feudal states of medieval Europe. States like these lack the cohesion needed to beat a disciplined insurgency such as the Vietnamese communists or the Taliban.

Another problem, says Mark Pyman of CurbingCorruption, a watchdog, is that corruption is too knotty a problem for military officers focused on their nine-month rotations. For their part, aid agencies too often judge success by how much money they disburse. In both South Vietnam and Afghanistan a vast influx of American dollars caused a surge in inflation, wiping out public-sector salaries. (Afghanistan, with a GDP of about \$20bn per year in 2020, received \$145bn in American aid in 2001-21. Inflation averaged 17.5% in 2003-8.) Public servants had to demand kickbacks to support themselves.

Hence anti-corruption experts recommend that aid should be frugal and

focused on achievements. That is easier said than done. If America does not learn that dollars cannot build a real government, it will end up creating more fake ones. ■



国家贴金

阿富汗政府因自身腐败而垮台

和越南一样，美国扶持的这个政府被腐败蛀空

看起来这就像1975年西贡陷落的重演：美国支持的军队节节败退，敌军士兵大步进驻总统府，绝望的人们将机场团团围住。不过阿富汗和南越不仅仅是表面看起来相似。这两个为取悦美国赞助者而建立的政权都被国家治理中的痼疾之一——腐败——给掏空了。

在阿富汗，“从领出生证到领死亡证，一辈子里总有各种事情要你行贿”，前外交官阿哈默德·沙阿·卡塔瓦扎依（Ahmad Shah Katawazai）说道。官员和警察例行公事地索要“baksheesh”（即小费）。随着塔利班的推进，拿到一本护照要给的贿金涨到了数千美元。

更糟糕的是，政府的职位本身就是一种很值钱的商品。腐败问题专家莎拉·查耶斯（Sarah Chayes）在阿富汗运营一家非政府组织时发现，官员们的职位常常是花钱买来的，所以得捞回扣把投资收回来。卡塔瓦扎依说，想当某个地区警察局的局长可能要花10万美元。官员们的主要目标变成了敲诈勒索，再把所得收入分给家人，还有回馈资助过他们的关系网。

早在2001年之前，阿富汗在一定程度上就是由这样的关系网管理。但据阿富汗重建特别督察长（Special Inspector General for Afghanistan Reconstruction, SIGAR）所说，美国向军阀行贿更助长了这些网络的势力。2009年，由北约领导的驻阿富汗国际安全援助部队（ISAF）建立了一个名为Shafafiyat（普什图语里指“透明”）的反腐败机构，但收效甚微。政府的反腐败检察官主要是在追查政敌。到最后，这个国家已经腐败到省长和圣战分子做交易的地步。士兵数量虚增，因为指挥官们为了吃空饷在名单上列出了并不存在的“幽灵兵”。

美国人可能还记得越南战争中的“幽灵兵”一词，当时腐败的高级军官也用了同样的套路。一名南越上校曾下令进行无目的炮击，这样就能把用过的

弹壳当作废金属兜售。在阿富汗也一样，警察和士兵从海洛因买卖中获利。1978年，安全智库兰德（RAND）发布了一份关于南越沦陷的报告，称南越人自己认为腐败是“最终陷落的主要原因”。

那么，在几十年后进驻阿富汗时，美国为什么没有严肃对待腐败问题呢？一个答案是，政治思想家只是现在才开始重视这个问题。政治学家弗朗西斯·福山（Francis Fukuyama）等学者认为，腐败是往前现代政府的倒退，其中权力基于个人关系而非制度。因此南越和阿富汗就像黑手党或中世纪欧洲的封建国家。这样的国家缺乏必要的凝聚力来打击有组织有纪律的叛乱分子，如越南共产党或塔利班。

监督机构“遏制腐败”（CurbingCorruption）的马克·皮曼（Mark Pyman）认为，另一个问题是，对于那些只关注九个月轮岗期内作为的军官来说，腐败问题太过棘手。至于援助机构，它们判断成功与否的标准通常是看花了多少钱。在南越和阿富汗，大量美元的流入都导致通胀飙升，令公共部门的工资大幅贬值。（阿富汗在2020年的GDP约为200亿美元，在2001年至2021年间接受了美国1450亿美元的援助。它2003年至2008年的平均通胀率为17.5%）。公务员不得不索要回扣来养活自己。

因此，反腐败专家建议，援助应该俭省，重点关注成果。这说起来容易做起来难。如果美国意识到只靠美元无法建立一个真正的政府，它最终就会造出更多虚有其表的政府。 ■



The Powell punt

Despite his shortcomings, Jerome Powell should be reappointed Fed chairman

It would be a bad time to cast any doubt on the Fed's independence

WHEN NOMINATING the chairman of the Federal Reserve, America's president picks the person who wields the greatest immediate power over the global economy. Fed leadership brings with it control over American interest rates, responsibility for an \$8.3trn balance-sheet and the obligation to regulate the world's most important banks. A mistake in the Eccles building can throw millions out of work, roil global markets or unleash inflation. The Fed even props up offshore financial markets by offering foreign central banks a ready supply of dollars.

The fate of Jerome Powell, the incumbent chairman whose term expires in February, lies in President Joe Biden's hands. It is unclear how history will view Mr Powell's first term. Before the pandemic, his loose monetary policy helped unemployment reach historic lows without provoking inflation. When the economy locked down in the spring of 2020, the Fed prevented a collapse of financial markets with enormous and swift interventions, some of which, such as the implicit underwriting of the corporate-bond market, were unprecedented. In August 2020 the central bank fine-tuned its 2% inflation target, which it had hitherto mostly undershot, by making it apply on average over the economic cycle, meaning that the Fed would have to compensate for its past misses.

Recently, though, Mr Powell's hand has looked less steady. By the measure the Fed targets, inflation has surged to 4% on a year earlier, or 6.4% if you annualise quarter-to-quarter price increases. The central bank's failure to foresee rising prices has made its promises that inflation will subside less

reassuring. The Fed could yet be forced into an abrupt reversal of stimulus.

In addition, the new inflation target, though desirable in theory, remains vague and poorly understood in practice. And the central bank is persisting with \$120bn per month of quantitative easing (QE), the buying of bonds with newly created money. Today's QE is unlikely to benefit the economy directly, but it creates hidden financial risks for taxpayers, because it involves the Fed, which they underwrite, issuing short-term reserves to buy long-term bonds. If short-term rates rise, the interest bill the Fed must pay on those reserves will soar.

Despite this mixed record, Mr Biden should reappoint Mr Powell. That is partly because any replacement the White House is likely to consider would probably be even keener on prolonging QE, and may also be sceptical of the welcome tidy-up of bank regulations that Mr Powell has also presided over. (The leading such candidate is Lael Brainard, a Fed governor.) But the most important reason to keep Mr Powell in his job is that this would be a terrible moment to give the impression that the White House wants to influence the Fed.

In the short term, the danger is that high inflation proves stubbornly persistent. With Mr Powell in charge, that would look like an honest mistake, one that his record suggests he would try to correct quickly. In 2018 the Fed raised rates as the economy heated up; in June it signalled that it would respond to higher inflation with tighter monetary policy, a plan markets took to be credible. However, with a Biden appointee at the helm, chosen primarily for his or her fondness for stimulus, the Fed might look insufficiently independent and thus have to raise rates more—and thus slow the economy more—to convince investors that it was determined to contain inflation.

In the long term, the economic environment threatens central banks'

independence. As interest rates have fallen close to zero, they have been left short of ammunition. QE, central banks' main alternative to cutting rates, is easily mistaken for the monetary financing of government deficits. Their armoury needs restocking and the division of responsibilities between central banks and government fiscal policy needs rethinking. Politicians and wonks must also co-operate to study central-bank digital currencies (CBDCs), which have the potential to transform how money and banking work. Decisions about CBDCs should be taken by elected leaders, but independent advice from technocrats will be crucial. A new appointment risks fuelling suspicions that all these reforms will politicise central banking.

Mr Powell got his job four years ago because Donald Trump threw out a precedent, intact since the 1970s, that presidents should reappoint Fed bosses chosen by their predecessors, even those from opposing parties. Mr Biden would do well to reassert that principle, and thereby send the message that the executive branch respects the Fed's independence. ■



【首文】押注鲍威尔

尽管表现有不足，鲍威尔应留任

现在尤其不宜引发对美联储独立性的怀疑

美国总统提名美联储主席时，就是在挑选一个能对全球经济施加最大直接影响力的人。领导美联储就意味着掌控美国利率，担负起8.3万亿美元的资产负债表，负责监管世界上最重要的银行。埃克尔斯大楼稍有失误，就可能导致数以百万计的人失业，搅动全球市场，或者引发通胀。通过随时向外国央行供应美元，美联储甚至还支撑着离岸金融市场。

现任主席杰罗姆·鲍威尔（Jerome Powell）的任期将于明年2月到期，他的命运掌握在美国总统拜登的手中。鲍威尔首个任期的功过还难以评说。在疫情之前，他的宽松货币政策在没有引发通胀的情况下让失业率降至历史低点。2020年春季因疫情实施封锁措施时，美联储大规模的果断干预使金融市场免于崩溃，其中一些举措堪称前所未见，例如对企业债券市场的隐性兜底。2020年8月，美联储微调了2%的通胀目标——此前大部分时间的通胀都低于这个水平——把它变成一段经济周期内的平均目标，这意味着美联储将必须对过去低于目标的部分做出补偿。

不过鲍威尔近期的表现似乎没有那么让人放心。根据美联储确定的指标，通胀相比去年同期已经飙升至4%，如果按季度环比价格涨幅年化计算，通胀已达6.4%。美联储没能预见这轮价格上涨，这让它做出的有关通胀将会回落的保证难以让人安心。美联储仍有可能被迫突然逆转刺激政策。

此外，尽管新的通胀目标在理论上是可取的，但在实践中仍然含混不清，不易理解。同时，美联储仍在坚持实施每月1200亿美元的量化宽松（QE，即用新发行的货币购买债券）。如今QE已经难以直接惠及经济，还为纳税人带来了潜在的财务风险，因为美联储实际上是发行短期储备金来购买长期债券，而纳税人最终要为美联储兜底。如果短期利率上升，美联储为这些储备金支付的利息将大幅增加。

尽管鲍威尔的表现好坏参半，拜登应该让他留任。原因之一是，白宫有可能考虑的任何替换人选都可能更加热衷延长量化宽松，也可能会质疑受到欢迎的银行监管调整——鲍威尔已在主持实施这方面的工作。目前呼声较高的人选是美联储理事莱尔·布雷纳德（Lael Brainard）。但让鲍威尔留任的最重要原因是，在现在这个时刻尤其不宜给人留下白宫意图干预美联储的印象。

短期危险是通胀到头来居高不下。在鲍威尔执掌之下，这看起来更像是一个无心之失，而他的履历也表明他会努力迅速纠正它。2018年经济升温之际，美联储实施了加息；今年6月，美联储发出信号将收紧货币政策来应对通胀上升，该计划也得到了市场的认同。不过，如果只是因为某个人选偏爱刺激政策，拜登就委任其掌舵，可能就会让美联储看起来不够独立，那么为了让投资者相信美联储遏制通胀的决心，就不得不进一步加息，进而导致经济进一步放缓。

长远而言，各国央行的独立性在当前经济环境中均受到挑战。利率已接近于零，央行已经弹药不足。既然无法减息，QE就成为央行选择的主要工具，但它很容易被误解为向政府赤字提供货币融资。央行需要重新补充弹药，而央行和政府财政政策之间的责任划分也需要重新考量。政客和专家还必须合作研究央行数字货币（CBDC），它很有可能改变货币和银行的运作方式。对CBDC的决策自然要由民选领导人做出，但技术官僚的独立建议至关重要。现在重新任命一位美联储主席可能会加剧人们猜疑所有这些改革都将使央行的运作政治化。

鲍威尔之所以在四年前得以上任，是因为特朗普摒弃了自70年代以来从未被打破的一个惯例，即总统应该继续任命前总统（即使来自反对党）所委任的美联储主席。拜登最好恢复这一原则，从而释放出行政部门尊重美联储独立性的讯息。 ■



Climate tech's Netscape moment

Billions are pouring into the business of decarbonisation

Wall Street giants and corporate titans are betting on climate innovation

“NERDS WILL invent the future,” declared Vinod Khosla in 2010. The venture capitalist was not talking about the sorts responsible for e-commerce sites, games apps or social-media platforms. Rather, his speech at the California Institute of Technology was intended to inspire brilliant engineers and scientists to pursue climate-related innovation. The “clean tech” investment bubble had just popped, so it seemed an unsexy career option. But if top talent took on the hard engineering challenges involved, he argued, commercial successes and rising public awareness would produce a “Netscape-like” moment, referring to the web browser that ushered in the consumer internet in the mid-1990s. “Ten years from now,” he predicted, “the level of invention will explode.”

The billionaire investor, who has since backed Impossible Foods (which makes low-carbon alternative protein and is valued at \$10bn) and QuantumScape (which develops batteries and last year raised \$680m via a special-purpose acquisition company or SPAC), got the timing about right. The International Energy Agency, an intergovernmental group, calculates that new patents related to core technologies like batteries, hydrogen, smart grids and carbon capture are far outpacing those in other technologies, including fossil fuels.

Money has followed innovation. BloombergNEF, a research firm, reckons that last year investors poured more than \$500bn into the “energy transition” (shorthand for decarbonising everything from energy and transport to industry and farming), twice as much as in 2010 (see chart 1). A slug of that has come in the form of risk-tolerant venture capital (VC)

flooding into many fields (see chart 2). PwC, a consultancy, estimates that between 2013 and 2020 VC investments in climate tech grew at five times the rate of global startup funding overall. In 2021 these investments may near \$60bn in America alone (see chart 3), up from \$36bn last year. Can this boom avoid the fate of the previous one and give rise to a blockbuster industry?

The short answer is: quite possibly. The modern climate-tech business looks fitter and more financially sustainable than a decade ago, when VC firms lost over half the \$25bn invested in clean-tech startups between 2006 and 2011. Abe Yokell of Congruent Ventures, an investment firm, recalls that in those dark years, “If you walked into a VC boardroom and said you are working on clean tech, the senior partners left the room.”

Now they are all ears, encouraged by success stories such as Beyond Meat, a rival to Impossible Foods that made its early backers a tidy sum when it went public in 2019 at a valuation of \$1.5bn and is now worth nearly \$8bn, and especially Tesla, the electric-car pioneer whose market capitalisation has ballooned from \$1.7bn when it went public in 2010 to around \$700bn. The S&P Global Clean Tech Index has generated annualised total returns of more than 40% over the past three years, more than double those of the benchmark S&P 500 index of big American firms.

Climate tech now makes up about a tenth of new investments made by Sequoia Capital, a legendary Silicon Valley VC firm. Last month Chris Sacca of Lowercase Capital, a high-flying internet investor known for early bets on Uber, Instagram and Twitter, said he would launch climate-tech VC funds worth \$800m. Nancy Pfund of DBL Partners, another VC veteran, reports that whereas in 2004 she barely scraped together \$75m for a clean-tech fund, her new climate-tech vehicle raised \$600m—and was oversubscribed.

Just as significant, Mr Yokell's listeners have grown more diverse. Besides VCs they include states, philanthropists, Wall Street and big business. And the newcomers are investing in new ways.

Take governments first. On August 12th America's Department of Energy (DoE) announced a \$1.5bn partnership with Breakthrough Energy Catalyst, part of a network founded by Bill Gates (which includes Breakthrough Energy Ventures, a \$2bn-plus blue-sky investment fund the billionaire has set up with a few chums, including Mr Khosla). It aims to accelerate development of novel technologies in sustainable aviation fuel, green hydrogen, direct air capture and long-term energy storage. This augments the \$20bn-plus loan programme that the DoE has available to boost clean energy and transport. If Joe Biden's infrastructure and climate proposals win final congressional approval, more funding for deployment and scale-up of projects may be on the way.

Europe's governments are splashing out, too. The European Commission, the EU's executive arm, has teamed up with Breakthrough Energy Catalyst on a \$1bn initiative to build large-scale demonstration projects for clean technologies. Britain has unveiled plans to invest \$235m in climate-related technologies. Climate is a sensitive issue in China. Nonetheless, says Peggy Liu of JUCCCE, a clean-energy NGO, it is the world leader in climate tech. Much of its official spending on "smart" technologies for more efficient factories, better batteries and motors is green-tinted.

States are not the only converts to climate investing. Charities and family investment firms are channelling capital into early-stage firms and offering patient capital willing to stick with "tough tech" for longer than a typical VC. By one estimate, family offices of the super-rich account for roughly 10% of total climate-tech VC deals, up from perhaps 5% a decade ago.

Elemental Excelerator, a Hawaii-based outfit part-funded by the Emerson Collective, a philanthropically minded firm set up by Laurene Powell Jobs, the widow of Apple's co-founder, Steve Jobs, looks to fund "first of a kind, transformational projects". Elemental's early-stage investments of \$43m have garnered \$3.8bn in follow-on funding, says Dawn Lippert, its CEO; 20 of its 117 portfolio firms have gone public or found private buyers. Ampaire, which develops hybrid-electric aircraft, was acquired in February for \$100m. Stem, an energy-storage firm, went public via a \$1.3bn SPAC deal in April.

Wall Street wants a look-in. Early this year JPMorgan Chase, America's biggest bank, said it would commit \$2.5trn to sustainable investing over ten years. Of that, \$1trn, which includes the bank's own capital and money raised from bond issues and flotations, is aimed explicitly at clean technologies. "Five years ago, we didn't have the capability to invest in such firms or their VC sponsors," says Brian Lehman of JPMorgan. Now the bank has dedicated employees like him who focus solely on climate and green issues. It is making smallish loans to pre-revenue firms in the sector and will expand into bridge financing between VC rounds and project finance for capital-intensive initiatives like indoor farms and solar-power plants.

Recent weeks have also seen the emergence of a few huge private-equity (PE) funds with a similar remit. In April BlackRock, one of the world's biggest asset managers, teamed up with Temasek, a Singaporean sovereign-wealth fund, to create a \$1bn decarbonisation vehicle. And in July alone PE firms committed over \$16bn to climate tech. TPG, a Texan PE titan, said it had raised \$5.4bn for its Rise Climate fund. Canada's Brookfield Asset Management announced its own \$7.5bn climate-focused fund, led by Mark Carney, former governor of the Bank of England. General Atlantic, another American PE giant, plans to raise \$4bn for BeyondNetZero (BNZ), a fund focused on climate that will be led by John Browne, a former boss of BP, a

British oil supermajor.

The final group of new climate investors comprises big companies. Many corporate giants are going beyond hollow commitments of greenery and “net zero” carbon pledges by investing directly in climate tech (see chart 4). According to Energy Monitor, a clean-tech web portal, between 2017 and 2020 such corporate venture investment surpassed \$58bn in all.

It looks set to grow. Microsoft, the software giant founded by Mr Gates which last year vowed to remove all the greenhouse gases it has ever emitted—and more—by 2050, has set up a \$1bn climate-tech fund. Its fellow Seattle tech titan, Amazon, has launched one worth \$2bn, financed entirely from its balance-sheet. As such, says Matt Peterson of Amazon, investments need not meet any internal rates of return. “The focus is on decarbonisation, which is a strategic need for Amazon,” he explains. Success will be measured by how much investments reduce Amazon’s carbon footprint. The fund has backed startups such as CarbonCure, which injects captured carbon into cement, Redwood Materials, a battery-recycling firm started by J.B. Straubel, formerly Tesla’s chief technology officer, and Zero Avia, a hydrogen-fuel-cell aviation firm. Amazon has also given money to Elemental Excelerator.

Even carbon-cuddlers are getting in on the action. Koch Industries, America’s biggest private firm and a fossil-fuel powerhouse reviled by environmentalists, is putting around \$350m of what it calls “long-term, patient capital” into the energy transformation. Early investments include EVBox Group, which develops the charging infrastructure for electric cars, and Freyr, a Norwegian firm that wants to build car-battery giga-factories in the Arctic.

On August 10th Reliance, an Indian power-to-phones conglomerate, led a \$144m fundraising round for Ambri, an energy-storage startup founded by Donald Sadoway, a professor at the Massachusetts Institute of Technology

with a few other clean-tech firms to his name. Reliance is in talks with Ambri (which also counts Mr Khosla among its backers) to build a big battery factory in India. And on August 17th Glencore, a Swiss mining giant with a big coal business, said it had bought a stake in Britishvolt, which is building a \$3.6bn giga-factory in Northumberland.

Big businesses, startups and their VC backers have also learned from past mistakes, as well as recent successes. Their approaches to climate investments have become more sophisticated as a result. One lesson is to go after a large industry that lets people break the carbon habit without sacrificing their lifestyles, says Ms Pfund of DBL Partners. Tesla, on whose board Ms Pfund sat when it was a private company, is a perfect example. Another is Apeel Sciences, which uses plant-based lipids to limit food waste, responsible for more greenhouse-gas emissions than notoriously carbon-intensive cement-making, by extending the shelf-life of produce. On August 18th the company, which DBL has backed, unveiled a new funding round that lifted its valuation to more than \$2bn.

Another novelty is the arrival of late-stage capital. BNZ will back companies from \$50m to \$500m or more in revenues. Lord Browne insists that, thanks both to supportive policy and growing public awareness of global warming, there is no longer a trade-off between tackling greenhouse gases and making a profit. On the contrary, he says, firms can reduce emissions while earning bigger returns. He is on the lookout for companies that could become “the Amazon of electricity”, and has no doubts that “some are going to grow to that size”.

The rise of late-stage VC and participation of PE firms is a healthy development for the climate-tech ecosystem, thinks Shaun Maguire of Sequoia. The industry needs innovative debt financing, so PE “can be quite useful”, he says. It could help the 95% of entrepreneurs who have

historically failed to secure follow-on funding, agrees Laura-Marie Töpfer of Extantia, a Berlin-based climate-VC fund.

Plenty of late-stage and growth capital may give earlier-stage VCs more confidence with startups working on hard tech. And the strong environmental, social and governance (ESG) commitments of PE funds will dramatically change founders' incentives. To be an attractive investment, Ms Töpfer says, founders and their backers must ensure that ESG "is baked into firms from day one".

The final lesson is the importance of collaboration. Where in the past VC firms backed startups chasing similar approaches to making thin-film solar panels, new climate-tech investors are open to working together to spread risk and speed up development. Glencore will provide Britishvolt with cobalt for its car batteries. Reliance would be a customer of the new giga-factory, not just its sponsor. Besides forking over \$1bn to Rivian, which makes electric vehicles, Amazon has also ordered 100,000 vans to help decarbonise its e-commerce delivery fleet. No VC has that sort of purchasing power.

Brookfield wants to use the low-carbon know-how from its many investments in big renewable-energy projects to help big companies meet ambitious decarbonisation targets. Connor Teskey of Brookfield says the sort of partner his firm has in mind is ArcelorMittal. In July the giant steelmaker unveiled a strategy to cut its global carbon emissions by 25% by 2030 at a cost of \$10bn. "A tech VC fund with just \$100m can't do this," says Mr Teskey. Large firms want "a partner who can write you a \$1bn cheque".

This new spirit of co-operation matters because, in the words of Carmichael Roberts of Breakthrough Energy Ventures, "in climate tech, everything is hard." Everything, that is, except raising capital. ■



气候科技的网景时刻

海量资金涌入脱碳领域

华尔街及企业巨头押注气候创新【深度】

“书呆子将创造未来。”维诺德·科斯拉（Vinod Khosla）在2010年宣称。这位风投家口中的书呆子不是搭建电商网站、编写游戏应用或建立社交媒体平台的那些人。他在加州理工学院的演讲意在激励杰出的工程和科学人才追求气候相关的创新。当时“清洁技术”投资泡沫刚刚破灭，这看起来是一个不那么吸引人的职业选择。但他认为，如果顶尖人才承担起这一领域所涉及的艰巨的工程挑战，商业成功和公众意识的提升将产生“网景式”的时刻——上世纪90年代中期“网景”网络浏览器开启了消费互联网时代。“十年后，”他预测，“发明将会有爆发性的增长。”

这位身家亿万的投资人此后注资了“不可思议食品”公司（Impossible Foods，生产低碳的替代蛋白质，目前估值100亿美元）和QuantumScape（研发电池，去年通过特殊目的收购公司[SPAC]融资6.8亿美元）。他对时机的把握还挺准。据政府间组织国际能源署（IEA）统计，目前电池、氢、智能电网和碳捕获等核心技术方面的新专利发展远远快于包括化石燃料在内的其他技术。

资金追逐创新而来。据研究公司彭博新能源财经（BloombergNEF）估计，去年投资者向“能源转型”（从能源、运输到工农业等各行业脱碳的简要说法）投入了超过5000亿美元，是2010年的两倍（见图表1）。大量资金通过能容忍风险的风险投资涌入诸多领域（见图表2）。咨询公司普华永道估计，2013年至2020年间，气候科技领域风险投资的增速是全球创业公司总体融资速度的五倍。2021年，这些投资仅在美国就可能接近600亿美元（见图表3），高于去年的360亿美元。这股热潮能否避免上一波投资的命运，催生一个重磅行业？

答案简单地说就是：很有可能。与10年前相比，如今的气候科技业务看起

来更健康，财务上更可持续。回顾2006年至2011年期间，风投公司向清洁技术创业公司投资了250亿美元，结果损失了超过一半。投资公司Congruent Ventures的亚伯·约克尔（Abe Yokell）回忆说，在那些灰暗的年头里，“如果你走进一家风投公司的董事会会议室，说自己是做清洁技术的，高级合伙人会转身离开。”

现在他们会洗耳恭听了，因为受到了成功案例的鼓舞，比如不可思议食品的竞争对手Beyond Meat，这家公司2019年以15亿美元的估值上市，为其早期投资者带来了不菲的回报，现在市值近80亿美元。电动汽车先锋特斯拉的故事更是鼓舞人心，其市值从2010年上市时的17亿美元飙升至约7000亿美元。标准普尔全球清洁技术指数（S&P Global Clean Tech Index）在过去三年中创下了超过40%的年化总回报，是美国大型公司基准指数标普500的两倍多。

现在，气候科技约占硅谷传奇风投公司红杉资本新投资的十分之一。明星互联网投资公司Lowercase Capital以早期押注优步、Instagram和推特而闻名，该公司的克里斯·萨卡（Chris Sacca）在8月表示他将推出8亿美元的气候科技风投基金。另一家老牌风投公司DBL Partners的南希·芬德（Nancy Pfund）说，2004年她好不容易募集了一只7500万美元的清洁技术基金，但她的新气候科技基金筹得了6亿美元，并且还被超额认购。

同样重要的是，愿意听约克尔推介清洁技术投资的听众更加多样化了。除了风投公司，还有政府、慈善家、华尔街和大企业。而后来者正在以新的方式展开投资。

先说政府。8月12日，美国能源部宣布了一项15亿美元的合作计划，合作方是“突破能源催化剂”（Breakthrough Energy Catalyst，隶属比尔·盖茨创立的一个网络，其中包括盖茨和科斯拉等一些好友设立的规模逾20亿美元的能源投资基金Breakthrough Energy Ventures [BEV]）。这一合作是为了加快可持续航空燃料、绿色氢能、直接空气碳捕集和长期储能等新技术的开发。这为美国能源部用于促进清洁能源和交通运输的200多亿美元贷款计划补充了资金。如果拜登的基础设施和气候提案获得国会的最终批准，

可能会有更多资金用于各种项目的部署和扩大。

欧洲各国政府也在大笔注资。欧盟的执行机构欧盟委员会与“突破能源催化剂”合作启动了一项计划，筹集10亿美元建设大型清洁技术示范项目。英国公布了2.35亿美元的气候相关技术投资计划。气候在中国是一个敏感问题。尽管如此，清洁能源非政府组织聚思（JUCCCE）的刘佩琦说中国在气候科技领域引领世界。它在提高工厂能效、改进电池和电机的“智能”技术上的大部分官方投入都是绿色导向的。

转向气候投资的不止政府。慈善机构和家族投资公司都在将资本投向处于早期阶段的公司，提供相比一般风投愿意坚守“硬科技”更久的“耐心资本”。据一项估计，超级富豪的家族办公室占到气候科技风投总额的10%左右，而十年前约为5%。

总部在夏威夷的公司Elemental Excelerator希望投资“首创的革新性项目”，这家公司的部分资金由苹果联合创始人乔布斯的遗孀劳伦·鲍威尔·乔布斯（Laurene Powell Jobs）创立的带慈善性质的风投机构Emerson Collective提供。其首席执行官道恩·利珀特（Dawn Lippert）表示，公司4300万美元的早期投资已经获得了38亿美元的后续投资；在它投资的117家公司中，有20家已上市或找到了私人收购者。研发混合动力电动飞机的Ampaire在2月以1亿美元的价格被收购。能源存储公司Stem在4月通过13亿美元的SPAC交易上市。

华尔街也想分一杯羹。今年年初，美国最大的银行摩根大通表示，将在未来十年内提供2.5万亿美元的可持续投资。其中，包括该银行自有资本和通过债券发行及上市所筹资金在内的1万亿美元将明确用于清洁技术。“五年前，我们没有能力投资此类公司或它们的风险投资方。”摩根大通的布赖恩·雷曼（Brian Lehman）说。现在，该行有像他这样专门关注气候和绿色议题的员工。摩根大通正在向该行业尚未有收益的公司提供小额贷款，并将扩展到风险投资轮之间的过桥融资，以及室内农场和太阳能发电厂等资本密集型项目的融资。

最近几周也出现了一些有类似投资范围的大型私募股权基金。4月，全球最大的资产管理公司之一贝莱德与新加坡主权财富基金淡马锡合作，创建了一只10亿美元的脱碳基金。仅在7月，私募公司对气候科技的投资就超过了160亿美元。得克萨斯州私募巨头TPG表示已为其Rise Climate基金筹集了54亿美元。加拿大博枫资产管理公司（Brookfield Asset Management）宣布成立自己的气候基金，规模75亿美元，由英国央行前行长马克·卡尼（Mark Carney）挂帅。另一家美国私募巨头General Atlantic计划为专注于气候问题的BeyondNetZero（BNZ）基金融资40亿美元，该基金将由英国石油巨头BP的前老板约翰·布朗（John Browne）领导。

最后一类新的气候投资者是大企业。许多企业巨头不再只是做出空洞的绿色和“净零”脱碳承诺，开始直接投资气候科技（见图表4）。根据清洁技术门户网站能源监测（Energy Monitor）的数据，2017年至2020年间，此类企业风投总额超过了580亿美元。

这类投资看起来还会增长。由盖茨创立的软件巨头微软已经设立了10亿美元的气候科技基金，它去年承诺要在2050年之前消除自己曾经排放的所有温室气体，甚至可能更多。西雅图科技巨头亚马逊推出了20亿美元的基金，完全由其资产负债表出资。亚马逊的马特·彼得森（Matt Peterson）说，这样的安排让投资无需满足任何内部回报率要求。“重点是脱碳，这是亚马逊的战略需要。”他解释说。衡量成功的标准是投资为亚马逊减少了多少碳足迹。该基金已经投资的创业公司包括将捕获的碳注入水泥中的CarbonCure、由前特斯拉首席技术官J.B.斯特劳贝尔（J.B. Straubel）创办的电池回收公司Redwood Materials，以及氢燃料电池航空公司Zero Avia。亚马逊也向Elemental Excelerator提供了资金。

就连碳排放大户也参与进来。科氏工业集团（Koch Industries）是美国最大的私营公司，也是备受环保主义者诟病的化石燃料巨头，它正在将大约3.5亿美元的所谓“长期耐心资本”投入到能源转型中。早期投资的对象包括开发电动汽车充电基础设施的EVBox Group和希望在北极地区投建汽车电池超级工厂的挪威公司Freyr。

8月10日，业务从手机到电力无所不包的印度集团信实工业（Reliance）领投了对Ambri公司一轮1.44亿美元的投资。Ambri是由麻省理工学院教授唐纳德·萨多韦（Donald Sadoway）创立的能源存储公司，他名下还有其他几家清洁技术公司。信实工业正在与Ambri（科斯拉也是该公司的投资者）商谈在印度建立一家大型电池工厂。8月17日，拥有庞大煤炭业务的瑞士矿业巨头嘉能可（Glencore）表示已入股Britishvolt，后者正在英国诺森伯兰郡（Northumberland）斥资36亿美元建造一座电池超级工厂。

除了从近期的成功案例中获得启发，大企业、创业公司及其风险投资者也从过去的错误中吸取了教训。它们对气候科技的投资手法因而变得更加成熟。其中一个经验是要找寻能让人们打破碳排放习惯却无需牺牲旧有生活方式的大产业，DBL Partners的芬德说。特斯拉（芬德在它还未上市时就进入了其董事会）就是一个完美的例子。另一个例子是Apeel Sciences，该公司使用植物基脂质来延长食物保质期以减少浪费。浪费食物造成的温室气体排放比以碳密集而闻名的水泥产业还要多。8月18日，该公司（DBL已投资）公布了新一轮融资，估值提升至超过20亿美元。

另一个新现象是后期资本的到来。BNZ将投资营收从5000万到5亿美元或更多的公司。布朗坚持认为，受益于支持性政策和公众日益关注全球变暖，在对付温室气体和盈利之间不再需要权衡取舍。相反，他说，企业可以在减排的同时获得更大的回报。他正在寻找可能成为“电气时代的亚马逊”的公司，并且毫不怀疑“有些公司能发展到那种规模”。

红杉资本的肖恩·马奎尔（Shaun Maguire）认为，后期风投的兴起和私募股权公司的参与是气候科技生态系统的一个健康发展。他说，该行业需要创新的债务融资，好让私募“能发挥很大作用”。柏林的气候风投基金Extantia的劳拉·玛丽·托普夫（Laura-Marie Töpfer）同意这一观点，认为这可以帮到95%过去未能获得后续资金的企业家。

大量的后期和成长资本可能会让早期风险投资者对从事硬技术的创业公司更有信心。而私募基金对环境、社会和治理（ESG）的重视将极大地改变

创始人的驱动力。托普夫表示，要成为有吸引力的投资，创始人及其投资者必须确保ESG观念“从一开始就深植于企业之中”。

最后一条经验是合作的重要性。过去，风投公司支持用雷同的方法制造薄膜太阳能电池板的创业公司，而新的气候科技投资者愿意相互合作来分散风险、加快发展。嘉能可将为Britishvolt提供其汽车电池所需的钴。信实工业将成为其投资的电池超级工厂的客户，而不仅仅是出资方。除了向电动汽车制造商Rivian投入超过10亿美元外，亚马逊还订购了10万辆货车，帮助自己的电商配送车队脱碳。风投公司可没有这种购买力。

博枫希望自己投资众多大型可再生能源项目所获的低碳专业知识，帮助大公司实现雄心勃勃的脱碳目标。博枫的康纳·特斯基（Connor Teskey）说，自家公司的意向合作伙伴是像安赛乐米塔尔

（ArcelorMittal）这样的企业。7月，这家钢铁巨头公布了一项战略，要耗资100亿美元在2030年前将自己的全球碳排放量减少25%。“只有一亿美元的科技风投基金做不到这一点。”特斯基说。大公司要的是“一个能开出10亿美元支票的合作伙伴”。

这种新的合作精神很重要，用BEV基金的卡迈克尔·罗伯茨（Carmichael Roberts）的话来说，原因是“在气候科技领域，什么都很难”。是的，什么都难，就是筹钱不难。 ■



Satoshis for cervezas

Using bitcoin as legal tender

Is El Salvador's move a costly gimmick or an attempt to lower transaction fees?

WHEN ASKED if anyone has tried to use bitcoin to pay her, a woman selling coffee and pastries in San Salvador, the capital city of El Salvador, replies “thank God, no”, and rebuffs an attempt to do so. A man selling soup for lunch brushes off the idea with laughter. By dinnertime, low on phone battery and morale, your correspondent is pointed to a bar called Leyendas where the logo for Strike, a digital bitcoin wallet, adorns the walls. But the attempt to pay with bitcoin is met with confusion. The bar’s owner, who controls the wallet, is missing. A few frantic texts later he sends his wallet address. At last, 26,618 Satoshis (one hundred millionth of a bitcoin), \$12.50-worth, are swapped for beers.

On September 7th bitcoin will become legal tender in El Salvador, alongside the dollar. The Central American country of 6.5m people is the first to attempt such a feat. A week before the big day those who had put plans in place to use bitcoin were the exception, rather than the norm. Three-quarters of Salvadoreans surveyed in July by Disruptiva, a polling firm, were sceptical of the plan to adopt bitcoin. Two-thirds were not willing to be paid in it and just under half knew nothing about it. Both the World Bank and the IMF have warned against adoption, citing the potential impact on macroeconomic stability and bitcoin’s environmental costs.

Legal tender is ordinarily defined as the money that courts of law must accept to settle debts. But El Salvador’s bitcoin law goes further, saying that businesses must accept the cryptocurrency as payment for goods or services. It has also come into effect very quickly. Nayib Bukele, the country’s president, who controls a large majority in the legislative

assembly, announced his plan to make bitcoin legal tender at a cryptocurrency conference on June 5th. The law was approved just three days later.

Sceptics have posited that the move is just a stunt: a sop to Ibrajim and Yusef Bukele, the president's brothers, who are crypto-enthusiasts. But the president claims the move will help El Salvador win foreign investment and reduce the cost of remittances. He may not be entirely wrong. The gambit might lure in deep-pocketed crypto-investors (though it may deter more conventional ones). And its experience may provide a case study in whether one of the long-touted benefits of bitcoin works for regular people. A diaspora of some 2m Salvadoreans sends remittances worth 20% of GDP home each year. But cross-border bank and wire transfers are slow and expensive. Wallet-to-wallet bitcoin transfers are quick and free.

The attempt will probably reveal bitcoin's limitations, too. Many locals understandably fear its volatility, which makes it ill-suited for payments and debt. Those accepting it, like Leyendas, do not quote prices in it, but convert from dollars at the point of sale. And there can be unexpected fees, which might stymie its use. There are 200 bitcoin cash machines being installed across the country to enable cash dollars to be converted into bitcoin in digital wallets. The one used by The Economist took a 5% fee. “I am not going to use it,” says Irma Gómez, who runs a diner near one such ATM in Santa Tecla, a town just outside San Salvador. But she is also intrigued. “Let the people try it.” ■



碎币几两换酒

把比特币用作法定货币

萨尔瓦多此举是不惜代价搞噱头还是要降低交易费用？

在萨尔瓦多首都圣萨尔瓦多，当被问到是否有顾客尝试用比特币付款时，一位卖咖啡和糕点的女士回答，“谢天谢地，没有”，并断然拒绝了笔者想用比特币付款的请求。另一位卖午餐配汤的男子对这个问题一笑置之，不予理睬。到了晚餐时间，手机电量和情绪都已很低落的笔者经人指点来到一家名为Leyendas的酒吧，里面的墙上贴着比特币钱包Strike的标识。但当笔者尝试用比特币付款时，店员显得不知所措。持有这种数字钱包的酒吧老板这会儿人不在店里。一通手忙脚乱的短讯来回后，他终于发来了自己的数字钱包地址。最后，相当于12.5美元的26,618聪（Satoshi，即百万分之一一个比特币）被收下，笔者买到了啤酒。

9月7日，比特币将在萨尔瓦多成为与美元并列的法定货币。这个拥有650万人口的中美洲国家成为了全球第一个吃螃蟹者。但在这个大日子来临的前一周，已经准备好接受使用比特币的仍只是少数人而远非常态。7月，在接受民调公司Disruptiva调查的萨尔瓦多人中，有四分之三对采用比特币的计划持怀疑态度。三分之二表示不愿接受比特币支付，而将近一半人对这种数字货币一无所知。世界银行和国际货币基金组织都已就采用比特币为法定货币发出警告，指出宏观经济稳定可能受到冲击以及比特币破坏环境。

法定货币通常被定义为法院必须认可用于结算债务的货币。但萨尔瓦多有关比特币的法律更进一步，指明商家必须接受顾客以这种加密货币购买商品或服务。这项法律的实施也异常迅速。控制萨尔瓦多国会大多数议席的总统纳伊布·布克尔（Nayib Bukele）在6月5日召开的一个加密货币会议上宣布计划采用比特币为法定货币。相关法律三天后便在国会通过。

质疑人士认为此举只是个噱头：用以讨好总统那两位热衷加密货币的兄弟

伊布拉希姆·布克尔（Ibrajim Bukele）和尤塞夫·布克尔（Yusef Bukele）。但总统声称此举将帮助萨尔瓦多吸引外国投资并降低汇款成本。这也许不完全是空想。这样抢占先机可能吸引到财力雄厚的加密货币投资者（尽管也可能让更多的传统投资者却步）。其中的经验可能成为案例，供人们研究比特币一直被吹捧的优点之一是否对普通人也成立。每年约有200万萨尔瓦多侨民向国内汇款，总值占该国GDP的20%，但跨境银行转账和电汇的速度慢、费用高。比特币钱包点对点转账不但快捷而且免费。

这种尝试大概也会暴露比特币的局限性。许多当地人担心比特币的波动性使其不适合用作支付和债务偿付手段，这是可以理解的。接受比特币的商家，比如Leyendas酒吧，并不以比特币报价，而是在收款时按美元价格换算成比特币。而且使用比特币也可能产生意想不到的费用，阻碍其普及。萨尔瓦多全国各地正在安装200台比特币自动提款机，以便把美元换成数字钱包中的比特币。笔者使用的那台机器收取了5%的手续费。在圣萨尔瓦多郊外的圣塔克拉镇（Santa Tecla），伊尔玛·戈麦斯（Irma Gómez）经营的餐馆旁边就有一台这样的机器。“我不打算用这玩意儿。”她说。但她也不无好奇，“让大家试试看吧。”■



Free exchange

Xi Jinping's talk of "common prosperity" spooks the prosperous

The idea might be motivating everything from China's crackdown on tech tycoons to a putative property tax

IN A SPEECH in 2016 Xi Jinping, China's president, explored the roots of an idea that is now troubling the country's tycoons and depressing the stockmarket—an idea that may be motivating China's crackdown on private tutoring, its antitrust fines on internet firms, its new guidelines on the treatment of gig workers and its steps towards a property tax, as well as inspiring large charitable donations from some of the country's most prominent enterprises. That idea is common prosperity.

Common prosperity, Mr Xi pointed out, has been an ideal of the Chinese people since ancient times. It was espoused by his predecessors as Communist Party leader. (Even Deng Xiaoping, who was famously happy to let some "get rich first", insisted that they then help others to catch up.) The ideal appears not just in Marx but also in Confucius, Mr Xi said. He quoted a well known line from "The Analects", which says something to the effect that a wise leader worries not about poverty but about inequality; not that his people are too few, but that they are too divided. (It is snappier in the original Chinese.)

The idea, then, is not new. But it is newly important. The term has appeared 65 times in Mr Xi's speeches or meetings this year, according to Bloomberg. A recent example is the powerful Central Financial and Economic Affairs Commission, which sets and enforces the party line on the economy. It focused on the idea at its meeting on August 17th.

But what precisely does it mean? The party has clarified what it does not entail: it does not imply that everyone will end up enjoying equal prosperity.

Entrepreneurs who create their own wealth, “work hard with integrity and have the guts to start their own businesses” should be encouraged. Nor will the egalitarian turn be abrupt. It should be pursued “step by step” in a “gradual” manner, the commission reiterated this month.

But the goal also rules out a continuation of the status quo. “We must not allow the gap between rich and poor to get wider,” Mr Xi insisted in January. People in the top fifth of Chinese households enjoy a disposable income more than ten times as high as people in the bottom fifth, according to official figures. Disposable incomes in cities are two and a half times as high as in the countryside. And the top 1% own 30.6% of household wealth, according to Credit Suisse, a bank (compared with 31.4% in America).

Unfortunately, defining what will count as common prosperity is complicated by the sheer volume and variety of aspirations and exhortations that often follow in the term’s trail, aspirations that could be laudable or lamentable depending on details that have yet to be formulated, let alone divulged.

Common prosperity will require a stronger safety-net for the unfortunate, better pensions, more equal access to public services, including education and health. It will result in an “olive-shaped” distribution of income that is fat in the middle but thin at the bottom and top. China has about 400m people living on incomes between 100,000 and 500,000 yuan (roughly \$15,000-77,000) for a family of three or the equivalent. It wants to double that number to 800m people in about a decade, according to the Development Research Centre, a think-tank attached to China’s State Council.

The party says it will increase the role of taxation in fighting inequality. It will adjust high incomes “reasonably”. But it has yet to quantify that reasonableness by specifying future tax rates or thresholds. Besides, the

government overhauled personal taxes as recently as 2018, making it unlikely to have another go soon, according to Gabriel Wildau of Teneo, a risk-advisory firm. A crackdown on tax evasion and illicit income is more likely. This week the party's corruption watchdog said it had instructed over 24,800 party cadres in the city of Hangzhou to undertake "self-examination" and confess to any illegal borrowing from local firms or other conflicts of interest.

Most egalitarian governments content themselves with tweaking taxes and transfers. But China's reach is broader. It is also championing two other kinds of redistribution: "voluntary" donations by the rich (Tencent, an internet giant, ploughed \$7.7bn into its social initiatives soon after the August 17th meeting) and what is sometimes called "pre-distribution". This can entail altering the split of national income between wages and profits. A common prosperity "demonstration zone" in Zhejiang province, for example, includes a target to raise labour's share of the province's income from 47.8% (in 2017) to over 50%.

The labour share is not easy to measure let alone manipulate. It has declined steadily in many developed economies, thanks to deep forces like globalisation and technological change. But China's wage-earners might benefit from policies like the government's new guidelines on gig workers, which seek to improve their wages and bargaining position. Certainly, investors in the gig economy fear these policies will leave a smaller slice of the cake for them. The share price of Meituan, a food-delivery giant, has fallen by 18% since the guidelines were released.

As with many of its signature initiatives, the party will not impose a common approach to common prosperity. "Local authorities will be encouraged to explore effective ways that suit local conditions," it said on August 17th. Cities in Zhejiang are scrambling to add the label to various initiatives, from narrowing the gap between urban and rural areas to

promoting the “spiritual” riches of the populace. Over time, the successful projects will be said to conform to Mr Xi’s vision; in reality, his vision will coalesce around them.

Just because common prosperity remains nebulous does not, however, mean it is vacuous. “Achieving common prosperity is not only an economic issue, but also a significant political issue,” Mr Xi said in January. The party hopes that reviving this ancient ideal will help strengthen the foundations of its rule. Confucius again got there first. “Where there is contentment,” the sage says, “there will be no upheavals.” ■



自由交流

习近平的“共同富裕”论让富人惊惧不安

可能正是这一理念引发了打击科技大亨和推进房产税等种种行动

在2016年的一次讲话中，中国国家主席习近平探究了一个理念的思想起源。眼下，这一理念正令这个国家的企业巨头们坐立不安，令股市下滑。也许正是在这一理念的驱动下，政府整顿民办教育培训，对互联网公司施以反垄断罚款，制定零工劳动者待遇新规，逐步推进房产税，并鼓励国内一些顶尖企业做出大笔慈善捐赠。这一理念就是共同富裕。

习近平指出，共同富裕自古以来就是中国人民的一个基本理想。历任中共领导人都倡导这一理念。（即使是乐于让一部分人“先富起来”的邓小平也坚持认为，这些人要带动其他人逐步达到共同富裕。）习近平表示这一理想不仅存在于马克思理论中，也存在于孔子的思想中。他引用了《论语》中孔子的一句名言：“不患寡而患不均，不患贫而患不安。”

所以说，这个理念并非什么新鲜事物，但在新近受到了重视。据彭博社统计，“共同富裕”一词在今年习近平的讲话或会议文件中出现了65次。最近一次是在8月17日召开的中央财经委员会（负责制定执行共产党的经济路线）的会议上，共同富裕成了讨论重点。

但共同富裕到底是什么意思？中共已经澄清了它不是什么：它不是整齐划一的平均主义。要鼓励“辛勤劳动、合法经营、敢于创业”的致富带头人。共同富裕不能一蹴而就。要“分阶段逐步”实现，中央财经委员会在8月重申。

但这一目标也排除了维持现状的可能性。“我们决不能允许贫富差距越来越大。”习近平在1月坚决主张。官方数据显示，在全国居民可支配收入的五等份分组中，最高五分之一的家庭是最低五分之一的十倍多。城镇居民的可支配收入是农村居民的2.5倍。中国最富有的1%家庭拥有全民家庭财富的30.6%（在美国，该比例为31.4%），瑞信（Credit Suisse）的数据显

示。

遗憾的是，要定义什么算是共同富裕非常复杂，因为往往有数量庞大、种类繁多的抱负和敦促追随这个大方向，而这些抱负到底是会受人称颂还是不尽人意还要看有待制定（更遑论对外透露）的细节。

共同富裕意味着要为弱势人群建立更强固的社会安全网，完善养老金制度，让人们能更公平地享受教育和医疗等公共服务。它将形成中间大、两头小的“橄榄形”的收入分配格局。按年收入在10万元至50万元之间的典型三口之家来算，中国的中等收入群体大约有四亿人。国务院发展研究中心透露，政府希望在大约十年内让这个数字翻一番，增至八亿。

中共表示将加大发挥税收对不平等的调节作用。它将“合理”调节高收入。但至于怎样才算合理，政府并没有通过明确未来的税率或征税门槛来加以量化。此外，风险咨询公司Teneo的吴佳柏（Gabriel Wildau）表示，中国政府在2018年刚对个人所得税制度进行了全面改革，短期内不太可能再次改革。更有可能的是开展行动打击逃税和非法收入。最近，党内纪检监察机关表示，已指示杭州市24,800多名党员干部“自查自纠”，坦白与当地企业存在的任何违规借贷或其他利益冲突。

大多数奉行平等主义的政府都止于微调税收和转移支付。但中国政府的举措范围更广。它还提倡另外两种再分配方式：富人“自愿”捐赠（8月17日的中央会议结束不久，互联网巨头腾讯即宣布向其社会价值项目再投入500亿元）和有时被称为“初次分配”的做法。后者可能涉及调整国民收入中工资和利润的比例。例如，浙江省这一共同富裕“示范区”订立目标，要把劳动报酬在该省总收入的占比从2017年的47.8%提高到50%以上。

劳动报酬的比例不易衡量，更别说调节。在许多发达经济体中，由于全球化和技术变革等深层力量，该比例已逐步缩小。但中国的工薪阶层可能会受惠于政府政策，例如旨在提升零工劳动者工资水平和谈判地位的指导意见。零工经济的投资者肯定担心这些政策会导致他们分到的蛋糕变小。自该指导意见颁布以来，外卖巨头美团的股价已经下跌了18%。

与中共许多标志性政策一样，它不会采取一刀切的措施来推进共同富裕。8月17日的会议表明将“鼓励各地因地制宜探索有效路径”。浙江各市如今争相在从缩小城乡差距到促进“精神生活”富裕的各项措施上贴上这一标签。日后，成功的项目会被说是遵照了习近平的愿景；实际上，他的愿景将围绕这些项目展开。

共同富裕的概念依旧模糊，但这不表示它空洞无物。习近平在1月指出，“实现共同富裕不仅是经济问题，而且是关系党的执政基础的重大政治问题”。中共希望通过重振这一古老理想来巩固统治根基。对此，孔子同样早有论述：“安无倾。”■



Free exchange

The case for mutual educational disarmament

And for a high-stakes, lower-effort test

ECONOMISTS TEND to be big fans of education, which is perhaps not surprising given how much of it they consume and how well their textbooks can do. Alfred Marshall, writing in 1873, hoped that education would help erase the “distinction between working men and gentlemen”. Gary Becker of the University of Chicago reimagined education as an investment in “human capital” that would earn a return in the market much like other assets. Harvard University’s Greg Mankiw, whose books have educated more than most, once calculated that differences in human capital between countries could account for much of their otherwise inexplicable differences in prosperity.

But economics can also be scathing about schooling. The theory of signalling likens many educational credentials to peacock’s tails: costly encumbrances, useful only as conspicuous proof that their owners are intellectually strong enough to bear them. And in “The Social Limits to Growth”, a book published in 1976, Fred Hirsch, once a writer for this newspaper, pointed out that education is often “positional” in nature. What matters is not only how much you have, but whether you have more than the next person. For many students it is not enough merely to acquire a good education. They must obtain a better education than the people jostling with them in the queue for sought-after jobs.

Positional goods are, by their nature, in strictly limited supply. Everyone can in principle live in a good neighbourhood, attend a good school, and work in a good job. But logic sadly dictates that not everyone can enjoy the nicest neighbourhoods, best schools or most prestigious jobs. As Hirsch pointed

out, “what each of us can achieve, all cannot.”

An unhappy corollary is that one family’s outlays on schooling raise the bar for everyone else. Families are drawn, often unwittingly, into educational arms races. They spend money and time on after-school tutoring or extra-curricular activities (so-called shadow education) in the expectation that it will improve their child’s position in the queue for advancement. But they quickly discover that everyone else is doing the same, leaving them in the same position as before. They are in fact worse off, because of the costs and frustration incurred. “If everyone stands on tiptoe, no one sees better,” Hirsch noted. And their feet also hurt.

These arms races are often particularly ferocious in East Asia. In China and South Korea, schoolchildren face nationwide “high-stakes” tests—the gaokao in China and the suneung in South Korea—that play a big role in determining whether and where they can go to university. In China’s cities, pupils spent 10.6 hours a week on after-school tutoring, according to a report by Frost & Sullivan, a market-research firm.

The governments in both countries have tried to orchestrate a kind of collective disarmament. South Korea imposed a 10pm curfew on cramming schools in 2009. Inspectors would go on patrol looking for schools with their lights on. (Some schools covered their windows with black tape.) China has been introducing restrictions on after-school tutoring at an increasing pace since 2018. In July it barred tutoring firms from listing on the stockmarket, raising foreign capital or making a profit. The strictures have wiped tens of billions of dollars off the market value of China’s once-booming edtech sector.

Will these measures work? It is almost impossible to stop families hiring private tutors to teach their children in their own homes. And if shadow education is successfully curtailed, the arms race can take different forms.

Parents who cannot buy a better education directly can instead buy homes near better schools. A study by Xuejuan Su of the University of Alberta and Huayi Yu of Renmin University found that when the management of a public elementary school in Beijing is taken over by another better-regarded school, property prices nearby rise by an average of 7%.

The arms race is notably less intense in parts of Europe. In Norway and Sweden parents show little demand for tutoring—the wealthy even less than others, according to Steve Entrich of the University of Potsdam. And overeducation is less common in Germany and other countries that sort children early into academic or vocational schools, with little mobility between the two, according to a study by Valentina Di Stasio of Utrecht University together with Thijs Bol and Herman Van de Werfhorst of the University of Amsterdam. Vocational schools are supposed to teach what employers want recruits to know. That may limit the scope for credential inflation. For better or worse, they also remove large numbers of students from the race for more academic laurels.

Both China and South Korea have begun promoting vocational education. China's latest five-year plan (which concludes in 2025) promises to explore an “apprenticeship system with Chinese characteristics” and to “vigorously cultivate talents with technical skills”, according to one translation. Some of the edtech firms squeezed out of after-school tutoring are exploring vocational education instead.

Germany's custom of placing children on different tracks at age ten or 11 also invites an interesting thought experiment. What if the gaokao (and similar tests) were held earlier in a pupil's career? If these exams truly test the knowledge required for university, they must be held just before university starts. But if such tests mostly serve as filters, sifting better students from worse, they need not be held so late. An aptitude test at 16 years of age, say, will probably generate a similar ranking as one held two years later. The

tests would remain stressful. But an earlier gaokao would save families a year or two of costly cramming, shortening “the obstacle course”, as Hirsch put it, without much changing the results. Such tests will always have high stakes. But they need not require such high effort. ■



自由交流

支持共同教育裁军的理由

以及支持高风险、较低投入的考试的理由

经济学家往往是教育的忠实支持者，这也许并不奇怪，毕竟他们自己消费了那么多教育，而他们的教科书有时极为成功。阿尔弗雷德·马歇尔（Alfred Marshall）在1873年写道，他希望教育能有助于消除“劳动者和绅士之间的差别”。芝加哥大学的加里·贝克尔（Gary Becker）将教育重新定义为对“人力资本”的投资，会在市场上收获回报，就跟其他类型的资产差不多。哈佛大学的格雷格·曼昆（Greg Mankiw）的著作指导的人数之多出类拔萃。他曾经计算过，人力资本的差异或许能在很大程度上解释各国在繁荣程度上令人费解的差异。

但是经济学也会严厉批评学校教育。信号理论把许多教育证书比作孔雀的尾巴：不过是昂贵的累赘，唯一的用处就是充当显眼的证据，证明持证人的智力水平足够拿下一纸证书。在1976年出版的《成长的社会限制》（The Social Limits to Growth）一书中，曾为本刊撰稿的弗雷德·赫希（Fred Hirsch）指出，教育在本质上往往是“位置性的”（positional）。重要的不仅仅是你拥有多少，还要看你是否比另一个人拥有更多。对许多学生来说，仅仅受过良好的教育是不够的。他们受的教育必须比那些跟自己一道争取热门工作的人更好才行。

位置商品的本质决定了其供应是严格受限的。原则上人人都可以住在一个好社区，上一所好学校，有一份好工作。但遗憾的是，单凭逻辑就能知道，不可能每个人都享受到最好的社区、最好的学校或最有声望的工作。正如赫希所指出的，“我们每个人都能做到的，不是所有人都能做到。”

一个不幸的必然结果就是，一个家庭的教育支出提高了其他所有人的门槛。家庭往往在不知不觉间被卷入教育军备竞赛。他们为课后辅导或课外活动（所谓的影子教育）花钱花时间，希望能提升子女在晋升队列中的位

次。但是他们很快发现其他人也全都在做同样的事情，结果就是自己孩子的位臵还和从前一样。他们的境况其实还变差了，因为付出钱、时间和心力只换来挫败感。“如果每个人都踮起脚，那谁也别想看得更清楚。”赫希指出。而且他们的脚也会很痛。

这样的军备竞赛在东亚往往尤为激烈。在中国和韩国，学生要面对全国性的“孤注一掷”的考试——中国的高考和韩国的“修能”（suneung）。他们能否上大学、能上哪里的大学，这场考试的成绩举足轻重。市场研究公司弗若斯特沙利文（Frost & Sullivan）的一份报告显示，在中国的城市里，学生每周花10.6小时接受课外辅导。

两国政府都已尝试组织某种形式的集体裁军。韩国在2009年要求补习班晚上10点前关门，检查员会巡视，看哪家还亮着灯。（有些补习班会用黑色胶带遮住窗户。）自2018年起，中国限制课后辅导的步伐越来越快。7月，课外辅导公司被禁止上市、筹集外资或盈利。这些限制致使中国一度繁荣的教育科技领域市值缩水数百亿美元。

这些措施会奏效吗？要阻止家庭请私人教师上门辅导孩子几乎不可能。而且，就算成功限制了影子教育，军备竞赛也可能会以另外的形式出现。父母若不能直接购买更好的教育，可能就会把房子买在更好的学校附近。阿尔伯塔大学（University of Alberta）的苏雪娟（音译）和中国人民大学的余华义的一项研究发现，当北京一所公立小学被另一所口碑更好的学校接管，附近的房价平均上涨了7%。

在欧洲部分地区，教育军备竞赛明显没那么激烈。根据波茨坦大学的史蒂夫·恩特里奇的（Steve Entrich）说法，在挪威和瑞典，父母对课外辅导没什么需求——富人的需求甚至比其他人更少。乌特勒支大学的瓦伦丁娜·迪斯塔西奥（Valentina Di Stasio）、阿姆斯特丹大学的蒂伊斯·博尔（Thijs Bol）和赫尔曼·范·德沃夫霍斯特（Herman Van de Werfhorst）合作进行的一项研究显示，在德国和其他一些国家过度教育没那么常见，这些国家在学生求学生涯的早期就完成了学术教育和职业教育的分流，而两者间几乎没什么流动性。一般认为职业学校应传授雇主希望新雇员掌握的内容。这

可能会限制文凭通胀的范围。不论好事坏事，职业学校还将大量学生排除在了争取更多学术桂冠的竞逐之外。

中国和韩国都已经开始促进职业教育。一份材料显示，中国最新的五年规划（2025年结束）承诺探索“中国特色的学徒制”，要“大力培养技术技能人才”。一些被挤出课后辅导的教育科技公司正转而探索职业教育。

像德国那样在孩子们十岁或十一岁就将他们送上不同轨道的惯常做法也促使我们开展一场有趣的思想实验。如果高考和类似的考试在学生求学期间提早一些举行会如何？如果这些考试真的是测试上大学需要掌握的知识，那就必须在临近读大学时举行。但是，如果它们主要是为了充当过滤器，以便把更好的学生和较差的学生区分开来，那就没必要举行得那么晚。假设学生们在16岁时参加一场才能测试，这和两年后才接受测试生成的排名很可能会差不多。这场考试仍然会让人倍感压力。但提前举行高考将可为家庭节省一两年昂贵的考前恶补费用——用赫希的说法就是缩短“障碍赛跑道”——同时不致影响结果多少。这样的考试始终都会事关重大，但不需要再为之投入那么多了。 ■



Sad little men

Britain's private schools are lambasted in Richard Beard's book

Assessing the impact of an elite education

Sad Little Men: Private Schools and the Ruin of England. By Richard Beard. Harvill Secker; 288 pages; £16.99

AS ITS SUBTITLE promises, this book is an uncompromising denunciation of Britain's private schools. They offer their charges a Faustian bargain, says Richard Beard: the tools of success (principally fluency and self-confidence) in return for emotional impoverishment. He knows whereof he speaks: in 1975 he was sent from home to a new life sleeping in dormitories and climbing hierarchies, much like David Cameron and Boris Johnson.

This argument is far from original; lambasting public schools for tormenting their inmates and ruining the country is one of Britain's oldest traditions. (In England and Wales private schools are confusingly known as "public schools"; they themselves prefer "independent schools".) Thomas Macaulay, a Victorian historian and politician, avoided them after a family friend told his mother that "throwing boys headlong into those great public schools always puts me in mind of the practice of the Scythian mothers, who threw their new-born infants into the river."

In the 20th century Evelyn Waugh quipped that "anyone who has been to an English public school will always feel comparatively at home in prison." Goronwy Rees, a journalist, wrote of the public-school boys he encountered at Oxford that they "were all well-taught at school and what they understood they understood very well; what they did not understand included almost everything which would change the world in their lifetime". Two of the best books about the classic public school (both by T. C. Worsley, a former

schoolmaster) are entitled “Barbarians and Philistines” and “Flannelled Fool”.

Updating these criticisms, Mr Beard makes some striking points about the way “total institutions” (a phrase he borrows from the sociologist Erving Goffman) can reconstruct the human personality. The aim of public schools is to make people fit in effortlessly with the changing rules and rituals of the tribe. They do this by removing children from their natural environments, then forcing them to play a succession of different roles. “We were post-modernism come to life,” he writes. “We had our different ‘I’s’, some more made-up than others, customised as required because we didn’t have the peace or privacy to become ourselves in our own time.” Thus Alexander Johnson became Boris, Eric Blair became George Orwell, and Philby, Burgess and Maclean became Soviet agents.

The author also makes good use of his own memories at Radley College. The school was trapped in the past, both the 1940s and 1950s—playground games were an endless fight against the Germans—and to some extent the late Victorian era, when the British Empire encompassed much of the globe. Mr Beard writes movingly about being sent away from home at eight. One boy in his year had to be dragged out of the family car, kicking and screaming, as his mother sat sobbing in the front.

All the same, he sometimes tries too hard to condemn the institutions that evidently caused him much misery. He presents Mr Johnson as the archetype of a public-school man—an entitled and unprincipled bloviator on the surface but, inside, a sad little boy crying for his mother. But there is a range of other public-school types, including dutiful swots like Rishi Sunak, Britain’s chancellor of the exchequer. And Mr Beard fails to notice the way public schools have reinvented themselves to serve a new plutocratic elite, a group both more sentimental about its children and less tied to the nation state.

Today's public schools are much softer places than Mr Beard remembers. They pamper their pupils with first-class facilities and are hyper-alert to signs of bullying and emotional distress. With the notable exception of Eton College, most now take girls. They are also highly globalised (a third of today's boarders are born abroad) and increasingly enlightened (Eton has a director of inclusion). The most pressing question about them today is not whether they produce emotional pygmies who will nevertheless go on to run—and ruin—Britain. It is whether they are producing well-adjusted members of the global meritocracy who don't give a fig for public service. ■



悲伤小男人

理查德·比尔德的新作痛斥英国私立学校

评估一种精英教育的影响【《悲伤小男人》书评】

《悲伤小男人：私立学校和英国的覆灭》。理查德·比尔德著。哈维尔·塞克出版社，288页，16.99英镑。

从副标题就看得出，这本书无情鞭笞了英国的私立学校。理查德·比尔德（Richard Beard）说，这些学校为自己的照管对象提供了一种浮士德式的交易：用情感上的贫乏换取成功的手段（主要是流利的表达和自信）。对此他深有体会：1975年他被从家里送到一个新的生活环境，睡宿舍，沿等级的阶梯向上爬，和大卫·卡梅伦和鲍里斯·约翰逊的经历很像。

这种说法绝非比尔德首创：痛斥公学折磨“囚犯”学生和葬送国家是英国最悠久的传统之一。（在英格兰和威尔士，私立学校被令人费解地称作“公学”，而它们自己更喜欢被叫做“独立学校”。）维多利亚时期的历史学家和政治家托马斯·麦考莱（Thomas Macaulay）家里的一位朋友跟他的母亲说，“把男孩子扔进那些名牌公学总让我想起做了母亲的斯基泰人，她们会把新生的婴儿扔到河里。”自此他对公学避之不及。

20世纪，伊夫林·沃（Evelyn Waugh）曾调侃道：“任何上过英国公学的人，去监狱总会感觉更像家一些。”记者哥伦威·里斯（Goronwy Rees）谈到他在牛津遇到的公学男孩时写道，他们“在学校都受过良好的教育，对于自己懂的事情那真是了如指掌；若说他们有什么不懂的，那么对那些会在他们有生之年改变世界的事他们几乎一无所知”。关于老牌公学最好的书有两本都出自担任过公学校长的T. C. 沃斯利（T. C. Worsley）之手，一本叫《野蛮人与非利士人》（Barbarians and Philistines），另一本是《穿法兰绒的傻瓜》（Flannelled Fool）。

比尔德更新了这些批评，对“全控机构”（total institution，借自社会学家厄文·高夫曼[Erving Goffman]之语）如何有可能重建人格提出了一些惊人

的观点。公学的目的是让人轻松自如地适应所在群体不断变化的规则和仪式。它们采用的方法是将孩子从自然的环境中带走，然后强迫他们扮演一连串不同的角色。“我们就是活生生的后现代主义的化身，”比尔德写道，“我们有着不同的‘我’，有些‘我’比其他的‘我’更虚假。我们会根据需要改换面目，因为我们不能在安宁私密的状态下按自己的步调成为自己。”就这样，亚历山大·约翰逊成了鲍里斯·约翰逊，埃里克·布莱尔成了乔治·奥威尔，费尔比、伯吉斯和麦克林成了苏联特工。

作者也充分调用了拉德利公学（Radley College）留给自己的记忆。这所学校被困在过去，也就是上世纪40和50年代的时候——当时操场上的游戏就是跟“德国人”没完没了地战斗；在某种程度上它也被困在了大英帝国几乎横跨全球的维多利亚时代晚期。比尔德以动人的笔调写下自己八岁时就被从家里送走的经历。一个和他同年级的男孩被从家里的汽车中拖出来，又踢又叫，而他的母亲坐在前排啜泣。

尽管如此，他在斥责公学这一显然带给他诸多痛苦的机构时，有时还是会用力过猛。他把约翰逊描述成“公学男”的典型——表面上是个自以为是、不讲道德的嘴炮王，内里就是一个哭着喊着要妈妈的悲伤小男孩。但公学出身的人多种多样，也有像英国财政大臣里希·苏纳克（Rishi Sunak）这样尽职尽责的书呆子。比尔德也没有注意到，公学已重塑自我以服务于一个新的富豪精英群体。这一群体对待子女更诉诸情感，与民族国家的捆绑也已减弱。

如今的公学跟比尔德记忆中的相比要柔软许多。它们让学生尽情享受一流的设施，对欺凌和情绪问题的迹象高度警惕。除了伊顿公学这个明显的例外，现在大多数公学都招收女生。它们还高度全球化（如今寄宿生中有三分之一出生在国外），也越来越开明（伊顿设有一位“包容总监”）。今天关于公学的最紧迫的问题不是它们是否会制造出情感上的矮子，让这些人去统治进而毁了英国。问题在于它们是否正在出产适应力良好的全球精英阶层成员，而这些人对公共服务漠不关心。 ■



Delta and the world economy

How the pandemic became stagflationary

As the virus has changed, so has its relationship to the economy

IT HAS BEEN a summer of unpleasant surprises for the world economy. America, Europe and China are growing more slowly than investors had hoped. Consumer prices are rising uncomfortably fast, especially in America. Even in the euro area, used to tepid inflation, prices in August were 3% higher than a year earlier, the most in a decade. Economies are troubled by shortages of parts and labour, slow and expensive shipping and the bewildering variation of lockdown measures.

The spread of the Delta variant is to blame, but the way the pandemic is affecting the economy is shifting. The world had become accustomed to the virus battering growth, as waves of infection caused a sudden stop in activity, and prices moderated or even fell. Delta, by contrast, looks like a stagflationary force that is sapping growth less dramatically but firing up inflation.

Delta is weighing on consumer spending in the rich world but not causing a collapse. In countries with lots of vaccine, cases are no longer doing as much to stop consumers from moving around. Europe's service sector has reopened amid its Delta wave.

Consumers seem less scared of the disease even if there are enough unvaccinated people to fill up hospitals. A year ago the number of diners in American restaurants was nearly half the level in 2019. Now service is about 10% down, even though hospitals are three times fuller. In Japan a state of emergency covering Tokyo does not seem to be keeping consumers away from the shops. Only in countries with draconian policies aimed at

eliminating the virus are people stuck at home. Australia and New Zealand face new recessions as a result of their lockdowns and China's service sector appears to be shrinking.

Meanwhile, the spread of Delta continues to interfere with the global supply of goods just as consumers, especially Americans, are intent on buying more cars, devices and sporting gear than ever. Outbreaks in South-East Asian countries with low rates of vaccination are causing production plants and logistics networks to shut down temporarily, prolonging the disruption to supply chains. In America retailers, including Gap and Nike, have lobbied the White House to donate more vaccines to Vietnam, so crucial have its factories become to their businesses. Shortages are driving up prices.

The changing relationship between the virus and the economy has implications for policymakers. They will not be able to repeat the trick from earlier in the pandemic of restricting people's movement as a way to contain the spread of the virus, while at the same time unleashing stimulus to create a compensating boom in demand for goods.

A service-sector revival is now the only quick route to fast growth because that is where the slack is. In the second quarter of the year spending on services by American households was about 3% below its level in 2019 in real terms. Should the spread of Delta interfere with service industries such as leisure and hospitality, more stimulus will only create more inflation.

It is also harder to argue that fear of the virus scares consumers off spending, and that government restrictions to slow the spread of disease therefore have little extra economic cost. A weaker link between cases and people's movement, and the necessity of service-sector growth, raise the cost of lockdowns. If pressure on hospitals causes even highly vaccinated countries like Britain to restrict services over the winter, the economic

damage will be large and the benefits smaller. The Delta wave may subside soon, easing the pressure on the world economy. If it does not or another variant takes its place, the trade-offs involved in fighting the virus will become harder to justify. ■



【首文】德尔塔与世界经济

疫情如何引发滞胀

随着新冠病毒不断变异，疫情对经济的影响也已发生变化

对世界经济来说，这是一个惊扰频传的夏天。美国、欧洲和中国的经济增长都慢于投资者的预期。消费价格急速上升，令人不安，尤其是在美国。即使在通胀一贯温和的欧元区，8月的价格也比一年前高出3%，升幅为十年来最高。零部件和劳动力供应短缺，航运缓慢且昂贵，加上各种令人晕头转向的封锁措施，各国经济备受干扰。

这要归咎于德尔塔变种的传播，但疫情影响经济的方式正在转变。之前一波又一波疫情导致经济活动戛然而止，世界各地对于疫情打击经济增长已经习以为常，价格走势平稳甚至下降。相比之下，当前的德尔塔变种更像是一股滞胀力量——不会那么剧烈地影响增长，却会刺激通胀。

德尔塔变种对富裕世界消费支出形成压力，但没有致其崩溃。在疫苗供应充足的国家，新增感染病例不会像之前那样阻碍消费者外出活动。欧洲就在德尔塔变种流行期间重启了服务业。

消费者似乎不再那么惧怕新冠肺炎，即便医院里满是未接种疫苗的感染者。一年前，美国餐馆的食客数量是2019年同期的将近一半。而现在，尽管感染入院人数是之前的三倍，服务业客流也只下降了约10%。在日本，东京等地进入紧急状态也似乎没阻碍消费者踏足商铺。只有在实施严厉政策力求“清零”的国家，人们才会困居家中。澳大利亚和新西兰因为封锁措施面临新一轮衰退，而中国的服务业也显出萎缩之势。

与此同时，消费者（尤其是美国人）对汽车、电子设备和运动用品的需求增长前所未见，但德尔塔变种肆虐，持续干扰全球商品供应。疫苗接种率低的东南亚国家疫情爆发，导致工厂和物流网络暂时关闭，延长了供应链中断的时间。盖璞（Gap）和耐克等美国零售商已游说白宫向越南捐赠更多疫苗，因为越南的工厂对这些零售商的业务已变得至关重要。商品短缺

正不断推高价格。

新冠病毒与经济的关系变化将影响到政策制定。政策制定者将无法再祭出疫情早期的招数：通过限制人员流动来遏制病毒传播，同时推出刺激措施来创造出补偿性的商品需求增长。

重振服务业是目前实现快速增长的唯一捷径，因为这里是闲置产能所在。按实值计算，今年第二季度美国家庭的服务支出比2019年约低3%。假如德尔塔变种的传播影响到休闲及酒店餐饮等服务行业，政府推出更多刺激措施只会进一步推高通胀。

而且也很难再说人们不愿消费是因为害怕感染病毒，以及说政府为遏制疫情采取的限制措施因而不会带来额外的经济成本。感染病例与人员流动的关联减弱，加上必须要重振服务业，令封锁措施的成本上升。如果医院承受的压力加大，导致英国这类高接种率国家也在冬季限制服务业，那么这些措施的收效会变小，而经济损失会很大。德尔塔变种引发的这波疫情可能很快将消退，让世界经济所受的压力得以缓解。如果德尔塔继续肆虐或是另一个变种传播开来，为遏制病毒所付出的代价就更难证明其必要性了。 ■



The great successor's second act

Apple has had a successful decade. The next one looks tougher

As Tim Cook celebrates his tenth anniversary at the helm, the world's most valuable company faces fresh challenges

THE APPLE will surely fall, even if ever so slowly. When Tim Cook took the helm from Steve Jobs, the firm's co-founder, a decade ago, even the most boosterish of Apple fanboys worried that the company was destined to decline. Without Apple's original Willie Wonka, the digital chocolate factory was about to be run by an automaton who made his career organising global supply chains and scrutinising spreadsheets. How could someone with so little dazzle inspire Apple employees to continue creating "insanely great" products, in Jobs's famous formulation?

It turned out Mr Cook could. As he celebrated his tenth anniversary as Apple's boss on August 24th, no one made a peep. And for good reason. He has staged what is arguably the greatest succession success in tech, an industry littered with managers who failed in the effort to follow in the founders' footsteps. In fact, in pure financial terms, he has been a far more successful chief executive than the late Jobs, who succumbed to pancreatic cancer six weeks after stepping down.

No chief executive in history has created as much overall shareholder value as Mr Cook (see chart 1). When he took over from Jobs the company had a market value of \$349bn. Today it is worth \$2.5trn (see chart 2), more than any other listed firm ever. Under his aegis annual sales surged from \$108bn in 2011 to \$274bn last year. Net profit more than doubled, to \$57bn, overtaking Saudi Aramco's oil-fuelled earnings and turning Apple into the world's most profitable company. Less widely noticed, during his tenure the "Apple economy"—its own annual revenue plus everything other

companies make on one of its platforms—has grown sevenfold, to more than \$1trn.

Given such achievements, Mr Cook could have retired amid gushing tributes around now (and with a spot in the billionaire club). Instead, he is likely to stick around at least until 2025, when his current stock grant will fully vest. This in turn raises the question of how long he can keep Apple on its stratospheric trajectory. The short answer is that it will be much harder than in his first decade. Many of the global tailwinds that have lifted Apple to such dizzying heights are now reversing.

For a longer answer it helps to understand what Mr Cook got so right. Besides being an exceptional manager, he proved adept at harnessing the forces that have powered the tech industry—and with it global economy—in the 2010s.

The first of these was the mobile-led digitisation of life. To satisfy the world's voracious appetite for mobile computing, he kept pushing for constant improvement of the iPhone. Whereas the iPhone 4s, announced shortly after he became chief executive, was still essentially a souped-up mobile phone, the iPhone 13, expected to be launched in September, will be a hand-sized supercomputer with a processor nearly 50 times faster. Even Apple's Watch and AirPods, the main new products since he took over, can be seen as extensions of the mighty iPhone. More than a billion of Apple's smartphones are now in use globally, one for every seven Earthlings.

Another force which Mr Cook has deftly harnessed is globalisation, in particular the rise of China. Even before he took over from Jobs, he was instrumental in outsourcing assembly of Apple's devices to the country. Its biggest contract manufacturer, Foxconn, now employs about 1m people there. Most of them assemble iGadgets. On top of that, untold numbers work

for suppliers of other components. And besides using China as a factory, Mr Cook was early to see its potential as a market—now Apple's biggest after America and Europe, generating 19% of revenue and, possibly, a bigger share of profits.

Mr Cook's third coup was understanding the importance of network effects—the economic mechanism in digital markets which makes big businesses even bigger. That is something that eluded even Jobs, who was ambivalent about the iPhone's App Store. By contrast, Mr Cook doubled down on the digital “flywheel”: the App Store attracted more app makers, which attracted more users, which attracted even more developers and so on—until it became the world's foremost digital marketplace by revenues. Today it hosts nearly 2m apps, which facilitated \$643bn in billings and sales in 2020 for app developers, according to a study sponsored by Apple.

Mr Cook was also the first big-tech boss to signal, loudly and often, that companies of Apple's size and reach must take some responsibility for their impact on the wider world. Under Jobs, a gadget's looks were more important than how they were made. Today Lisa Jackson, a former head of America's Environmental Protection Agency and now a vice-president directly reporting to Mr Cook, is involved in product development from the start. Apple has set itself the laudable goal of becoming carbon-neutral across all its products by 2030. And Mr Cook has called privacy “a fundamental human right” and, among other things, forced app makers to ask users whether they want to be tracked by advertisers.

Admittedly, being pro-privacy aligns with Apple's business model, which unlike those of Facebook and Google does not make money by collecting data to sell targeted ads, and climate-cuddling plays well with the sensibilities of Apple's mostly well-off users at little cost, given Apple's relatively shallow carbon footprint. This has helped keep regulators off

Apple's back—and made it into the world's most valuable brand, according to one estimate.

In other words, after ten years of Cookery Apple is a bigger and better version of itself, says Horace Dediu, a long-time Apple watcher. That, though, is not to say it is invulnerable. Three challenges stand out: growth, geopolitics and competition.

On the surface, growth looks healthy enough. To the surprise of those analysts who have for years predicted the iPhone's decline, the device keeps raking in money. Global unit sales are down from a peak of 231m in 2015, but only a bit: Apple still sold 200m of them last year. But the market for smartphones will eventually mature. And even if this takes time, Apple will increasingly run up against a problem familiar to all large firms: the bigger they get, the harder it becomes to grow rapidly.

Mr Cook has been able to tap into other sources of revenue, notes Neil Cybart, who runs Above Avalon, a website that analyses all things Apple. The firm's services business, including the App Store and Apple Music, has surged from \$8bn in sales in 2011 to \$65bn in the past four quarters (see chart 4). Though wearables like the Apple Watch and accessories such as the AirPods are a smaller business than the iPhone, they generate lots of revenue: nearly \$9bn in three months to June. Last year AirPods ended up in more than 200m ears and Apple Watches on 34m wrists, respectively outselling all other high-end ear buds and all Swiss timepieces combined.

At some point, however, Apple will need another keystone innovation like the iPhone. Hence talk of “iGlasses”, which would add a digital layer to the physical reality perceived by the wearer, and even an “iCar”. Although the firm does not confirm this, it is an open secret that it has been working on both for years. Leaks suggest that augmented-reality glasses may finally be

coming in the next year or two and Apple reportedly has plans to release a vehicle that is both electric and self-driving in 2024. But it is also widely known that things have not been going well and timelines have slipped in the past.

The car, which unlike the glasses is not a natural extension of Apple's current consumer-tech line-up, would be difficult to pull off. Even without a petrol engine and a gearbox, a vehicle is much harder to manufacture than a smartphone. Apple's automotive thinking appears to have gone back and forth between building its own self-driving cars from scratch or providing the necessary electronics and software to other carmakers.

Mr Cook's second big challenge is geopolitics. Apple has so far escaped the mounting tensions between the West and China, where most of the firm's products are assembled and many of them are sold. Mr Cook has made all sorts of concessions to the authorities in Beijing, from moving its Chinese users' information to data centres in the country, where they can be accessed by local law enforcement, to taking down some apps in the Chinese version of its App Store. "We follow the law wherever we do business" is Mr Cook's motto.

Now, though, the pugnacity with which the Chinese government has gone after its own technology giants must be making some in Apple's futuristic headquarters in Cupertino, Silicon Valley, nervous. Though it has been beefing up manufacturing in other countries, particularly in India and Vietnam, Apple does not have an alternative to China for the bulk of its assembly. It is hard to see where else it might find one. Only China has a ready army of workers needed to quickly ramp up production of the latest iPhone.

Judging by Apple's latest supplier list, the firm has even increased its reliance on Chinese companies. Of the top 200 suppliers, 51 were based in

China, up from 42 in 2018. At the height of the trade war then-president Donald Trump waged with China in 2019, Goldman Sachs, an investment bank, estimated that in the worst-case scenario Chinese retaliation could reduce Apple's profits by nearly 30%.

The fallout could be worse if Apple's products and services were banned in China. As the Communist Party turns increasingly authoritarian and the West increasingly suspicious of China, Apple may become a target of Beijing's wrath or the sort of nationalist-tinged boycotts that have hurt Western brands from the NBA to Zara.

And if Apple's importance to China's economy continues to offer a protective shield, this may anger governments and consumers in the West. According to human-rights groups, some of Apple's suppliers are linked to forced-labour camps for Uyghurs, an oppressed Muslim minority, in Xinjiang. Mark Zuckerberg, Facebook's boss, has called out Apple for hypocrisy for touting privacy protection at home while allowing the government in Beijing to access personal data in China. "At some point something will happen that becomes a loyalty test," thinks Willy Shih of Harvard Business School.

Apple says that it has found no evidence of any forced labour in its supply chain. And Mr Zuckerberg himself could also be accused of being hypocritical, since Facebook is making billions from Chinese advertisers on its social networks. But even if those controversies end up being resolved in Apple's favour, they are feeding into pushback against its behaviour at home: witness the recent brouhaha over its plans to scan private pictures on iPhones for child pornography.

Mr Zuckerberg's China-related broadside also hints at Mr Cook's third challenge: competition. Network effects are not the only thing benefiting firms like Apple. Another is the lack of real rivals. Some view Alphabet

(Google's parent company), Amazon, Apple, Facebook and Microsoft as a cartel whose members have tacitly agreed not to encroach on each other's core businesses. Apple has never made an effort to be a social-media powerhouse and Facebook has not attempted to create an alternative app store. Instead of building its own search engine, Apple cut a deal with Google, making it the default search engine on the iPhone (and charging an estimated \$8bn-12bn annually for the privilege, equivalent to 14-21% of Apple's net profit in 2020).

Such cosiness is fraying. To sustain trillion-dollar valuations all the tech giants are searching for new sources of growth—and finding them on one another's turf. Giving iPhone users more control over their data may be rooted in a genuine wish to protect their privacy, but it also keeps data out of Facebook's hands, which could help Apple build its own advertising business. Apple is also rumoured to be working on its own search engine.

The rivalry is heating up in its principal hardware business, too. In America the iPhone remains dominant. Globally, however, iPhones account for one in seven smartphones sold, according to Canalys, a data provider. Earlier this year Xiaomi, a Chinese firm, overtook Apple as the world's second-biggest smartphone-maker by volume.

Apple's forays into newer markets face stiff competition. Its HomePod smart speakers came late and did not make much headway against Amazon's and Google's products. Apple's mixed-reality glasses, should they indeed see the light of day, will have to duke it out against Facebook's Oculus, Microsoft's HoloLens and other fancy headgear. And an iCar would be taking on Teslas and a car park's worth of offerings from established carmakers.

Regulators may also try to make digital markets more competitive. Apple is expected to win its trial against Epic Games, the maker of "Fortnite", a popular online video game, which accuses Apple of illegally protecting its

App Store. A ruling should come later this year. Even if Apple prevails in American courts, however, trustbusters elsewhere may not let it off the hook as easily.

In July Margrethe Vestager, the European Commission's deputy head and the EU's trustbuster-in-chief, warned Apple that the bloc's proposed Digital Markets Act will not allow it to hold up privacy and security as reasons to limit competition in the App Store, as Apple has argued in the Epic lawsuit. Loosening of the App Store's rules and lower commissions (currently up to 30% on most app purchases) could make a serious dent in the company's lucrative services business.

An executive of Mr Cook's stature and experience may well be able to overcome these headwinds. Whether that will be Mr Cook himself is less clear. He is 60 and has said he will "probably" not stay on for another ten years. This raises the question of who might have the vision and the skills to succeed him.

One former executive has a radical proposal: Apple should stop being a pedlar of luxury goods. The firm's "obscene" gross margins of more than 40% in the past quarter make it lazy, he argues. To maintain them, the firm squeezes developers and suppliers. Instead, it should use its power and cutting-edge technology to develop devices and services for the 3bn people on Earth who have yet to enjoy the benefits of the digital era.

This could help solve Apple's growth conundrum. But it is unlikely to fly with its margin-loving shareholders. The possible successor to Mr Cook mentioned most frequently, Jeff Williams, is a less radical departure from the status quo. Mr Williams is considered by many insiders to be "Tim Cook's Tim Cook": a doppelganger not just in looks (tall, lean and grizzled) but also in thinking and experience. He has been doing Mr Cook's old job overseeing Apple's supply chain and operations since 2010. Those skills

have served the company remarkably well in the past decade. To keep thriving Apple's next chief executive may need a different set of abilities. ■



伟大继任者的第二幕

苹果过去十年很成功。未来十年显艰难

蒂姆·库克掌舵十周年之际，这家全球市值最高的公司面临全新挑战【深度】

苹果肯定是会掉下来的，即使掉得非常之慢。十年前，当蒂姆·库克从联合创始人乔布斯手中接过公司时，即使“果粉”中最乐观的那群人也担心它注定要跌落。没有了它的威利·旺卡（Willie Wonka），这家数字巧克力工厂即将由一个机器人般的领导来管理，而他的职业成就是组织全球供应链和检查数据表。一个如此缺乏光环的人怎么能够激励苹果员工继续创造——用乔布斯著名的表述来说——“酷毙了”的产品呢？

事实证明库克可以。8月24日，在他担任苹果一把手十周年之际，谁也没有发出一声不满。这是有充分理由的。他可以说是上演了科技界最成功的继任故事，而在这个行业里把创始人的成果搞砸的经理人比比皆是。事实上，纯粹从财务角度来看，作为首席执行官，他要比卸任六周后因胰腺癌离世的乔布斯成功得多。

历史上没有一位首席执行官像库克那样创造了如此高的整体股东价值（见图表1）。他接替乔布斯时，苹果的市值为3490亿美元，如今是2.5万亿美元（见图表 2），为上市公司史上之最。在他的领导下，苹果的年销售额从2011年的1080亿美元飙升至去年的2740亿美元。净利润翻了一番多，达到570亿美元，超过沙特阿美石油公司（Saudi Aramco），成为世界上最赚钱的公司。不那么广为人知的是，在库克任职期间，“苹果经济”（这家公司自己的年营收加上其他公司在其平台上赚取的所有收入）增长了六倍，超过了1万亿美元。

有了这些成就，库克本可以在人们热情洋溢的赞美声中退休（并在亿万富翁俱乐部中占据一席）。但他却很可能至少会干到2025年，到那时他会拿到苹果授予他的全部股票。这继而引出了一个问题：他能让苹果保持在高空轨道上多久。简短的回答就是这要比他第一个十年困难得多。许多把苹

果送上了如此令人眩晕的高度的全球东风如今正在转向。

至于更详细的答案，不妨先了解一下库克之前的成功经验。他不仅是一名杰出的经理人，还非常善于利用过去十年里那些推动了科技行业、进而推动了全球经济发展的力量。

第一股力量是由移动通信引领的生活数字化。为了满足全球对移动计算的巨大需求，库克持续推动iPhone手机不断改进。在他成为首席执行官后不久推出的iPhone 4s本质上仍只是一款性能增强的手机，但预计于9月发布的iPhone 13将是一台手持超级计算机，其处理器速度提高了近50倍。就连他接手后推出的主要新产品Apple Watch和AirPods也可以看作是性能强大的iPhone的延伸。目前全球正在使用的苹果手机超过10亿部，每七个地球人就有一部。

库克巧妙利用的另一股力量是全球化，尤其是中国的崛起。在接替乔布斯之前，他就力主将苹果设备的组装外包给中国。苹果最大的代工厂富士康现在在中国雇用了大约100万名员工，其中大多数人负责组装苹果产品，此外还有不计其数的工人受雇于其他组件的供应商。除了将中国用作工厂之外，库克还很早就看到了它的市场潜力，现在中国是苹果在美国和欧洲之外的第三大市场，贡献了19%的收入，利润份额可能还更大。

库克的第三个秘诀是深谙网络效应的重要性——数字市场的这一经济效益机制会让大企业规模愈大。乔布斯都没能想明白这一点，他对iPhone的App Store态度摇摆。相比之下，库克在这个数字“飞轮”上坚定压注——App Store吸引了更多的应用开发者，而更多的应用吸引了更多的用户，进而又吸引了更多开发者，如此循环，直到它成为全球收入最高的数字市场。苹果赞助的一项研究显示，如今App Store里有近200万个应用，2020年为应用开发者带来了6430亿美元的销售额。

库克认为像苹果这样规模和影响力的公司必须为自己给广阔世界带来的影响承担一些责任，他也是第一个经常公开做此表态的科技巨头老板。乔布斯掌舵时，一款产品的外观重要过它是如何制造出来的。如今，美国环保

署（EPA）前任署长、现任苹果副总裁、直接向库克汇报的丽莎·杰克逊（Lisa Jackson）从产品开发初期就参与其中。苹果为自己设定了一个值得称许的目标，到2030年其所有产品都要实现碳中和。此外，库克称隐私为“一项基本人权”，采取了多项措施予以保护，包括强制要求应用开发者询问用户是否允许广告主跟踪。

诚然，支持保护隐私与苹果的商业模式相吻合。与Facebook和谷歌不同，苹果不通过收集数据以销售定向广告来赚钱。另外，苹果的用户一般较富裕，积极应对气候变化正好契合他们的关注点，而由于苹果的碳足迹相对较浅，这样做成本也不高。这帮助它避开监管机构的盯梢，并使其成为（据一项估计称）世界上最有价值的品牌。

换句话说，由库克料理十年后的苹果已经长得更大更好，长期关注苹果的分析师贺拉斯·德迪乌（Horace Dediu）表示。不过，这并不是说它无懈可击。苹果面临着三个突出的挑战：增长、地缘政治和竞争。

从表面上看，苹果的增长足够健康。让多年来一直预测iPhone将衰落的分析师们意外的是，这部机器一直在赚大钱。全球销量虽较2015年的峰值2.31亿部有所下降，但跌幅很小——苹果去年仍售出了2亿部手机。但智能手机市场最终会饱和。而即使这需要时间，苹果也会越来越多地遭遇一个所有大公司都熟悉的问题——公司越大，要快速增长就越难。

库克已经挖掘出了其他收入源头，尼尔·赛巴特（Neil Cybart）指出，他的网站Above Avalon专门分析苹果的方方面面。包括App Store和Apple Music在内的服务业务销售额从2011年的80亿美元飙升至过去一年里的650亿美元（见图4）。尽管Apple Watch等可穿戴设备和AirPods等配件的业务规模比iPhone小，但它们产生了大量收入，截至6月的三个月内收入接近90亿美元。去年，超过2亿只耳朵戴上新购的AirPods，3400万只手腕戴上新购的Apple Watch，分别超过了所有其他高端耳机和所有瑞士手表的销量总和。

然而到了一定时候，苹果将需要另一项堪比iPhone的关键创新。因此据传苹果正在研发“iGlasses”，它将为佩戴者感知到的现实世界添加一个数字层，甚至还要研发“iCar”。尽管苹果未予以证实，但多年来它一直致力于这两方面的研发已是公开的秘密。泄露出来的消息表明增强现实眼镜可能终于要在一两年内问世了，而据报道苹果计划在2024年发布电动无人驾驶汽车。但同样众所周知的是项目进展并不顺利，进度已多次延后。

与眼镜不同，汽车并不是苹果当前的消费科技产品线的自然延伸，实现起来会更困难。即使没有汽油发动机和变速箱，制造汽车也远难于制造智能手机。苹果似乎一直没有确定造车的思路，在从零开始自己打造无人驾驶汽车和向其他汽车制造商提供必要的电子产品和软件之间游移不定。

库克的第二大挑战是地缘政治。到目前为止，苹果避过了西方世界和中国之间日益紧张的局势影响，它的大部分产品都在中国组装，其中很多也在中国销售。库克向北京当局做出了各种让步，包括将中国用户的信息转移到中国的数据中心，让当地执法部门可以访问，以及在中国区App Store里下架某些应用。“无论在哪里开展业务，我们都会遵守当地法律”是库克的座右铭。

不过，现在中国政府正重拳打压本国的科技巨头，这一定让苹果位于硅谷库比蒂诺（Cupertino）那未来范儿的总部里的一些人感到紧张。尽管苹果一直在扩大在其他国家的生产能力，特别是印度和越南，但就其大部分产品组装而言，除了中国别无他选。很难看出它能找到哪个国家来替代中国。只有中国拥有大批随时可上岗的工人来迅速提高最新款iPhone的产量。

从苹果最新的供应商名单来看，它甚至还加大了对中国企业的依赖。前200家供应商有51家在中国，而2018年是42家。在2019年时任总统特朗普掀起的对华贸易战最激烈之际，投资银行高盛估计，在最坏的情况下，中国的报复措施可能会让苹果的利润减少近30%。

如果苹果的产品和服务在中国被禁，后果可能会更糟。随着共产党日益威

权，加上西方对中国的猜疑越来越重，苹果可能会成为北京迁怒的对象，或者成为那类带民族主义色彩的抵制活动的目标——从NBA到Zara的西方品牌都曾因此受创。

而如果苹果对中国经济的重要性让它继续获得保护盾，可能就会激怒西方的政府和消费者。据人权组织称，苹果的一些供应商与新疆据称受压迫的穆斯林少数民族维吾尔人的强迫劳动营有关联。Facebook的老板扎克伯格指责苹果虚伪，因为它在美国国内大谈隐私保护，同时却允许北京政府访问在中国的个人数据。“总有一天会发生点什么事情，考验苹果的忠诚度。”哈佛商学院的史兆威（Willy Shih）认为。

苹果公司表示在其供应链中没有发现任何证据证明存在强迫劳动。而扎克伯格本人也可能被指虚伪之徒，因为Facebook正从它社交网络上的中国广告主那里赚取数十亿美元。但即使这些争议的解决最终有利于苹果，它们也在加剧苹果在美国国内的做法所引发的抵制：看看它计划在iPhone上扫描私人照片以查找儿童色情内容的消息在近期掀起了怎样的轩然大波吧。

从扎克伯格发出的与中国有关的抨击还可以看出库克面临的第三个挑战——竞争。让苹果等公司受益的并不只有网络效应。另一个因素是缺乏真正的竞争对手。一些人将Alphabet（谷歌的母公司）、亚马逊、苹果、Facebook和微软视为一个卡特尔联盟，其成员间心照不宣地互不侵犯核心业务。苹果从未尝试成为社交媒体巨头，Facebook也无意打造另一个应用商店。苹果没有建立自己的搜索引擎，而是与谷歌达成协议，让谷歌成为iPhone上的默认搜索引擎（并且每年就这一特权收取大约80亿至120亿美元的费用，相当于苹果2020年净利润的14%至21%）。

这种友好安逸的局面正逐渐瓦解。为了维持住万亿美元的市值，所有科技巨头都在寻找新的增长来源——结果瞄上了彼此的地盘。让iPhone用户能更多控制自己的数据可能真的是出于保护其隐私的愿望，但同时也让数据脱离了Facebook的掌控，这可能有助于苹果建立自己的广告业务。也有传言称苹果正在开发自己的搜索引擎。

在苹果最重要的硬件业务上，竞争也在升温。在美国，iPhone仍主导市场。然而，据数据供应商Canalys称，在全球范围内，iPhone仅占智能手机销量的七分之一。今年早些时候，中国公司小米出货量超过苹果，成为全球第二大智能手机制造商。

苹果在进军新市场时面临激烈竞争。它的HomePod智能音箱上市较晚，相比亚马逊和谷歌的产品进步不大。苹果的混合现实眼镜如果真能推向市场，将必须和Facebook的Oculus、微软的HoloLens和其他新奇的智能眼镜一较高下。而iCar将面对特斯拉和老牌汽车制造商打造的一大堆车型。

监管机构也可能试图让数字市场加大竞争。苹果预计将赢得与热门网络游戏《堡垒之夜》的开发商Epic Games的官司，后者指控App Store垄断。法院应该会在今年晚些时候做出裁决。然而，即使苹果在美国法庭上胜诉，其他地方的反垄断机构可能也不会轻易放过它。

7月，欧盟委员会副主席兼欧盟反垄断专员玛格丽特·维斯塔格（Margrethe Vestager）警告苹果，欧盟提出的《数字市场法案》（Digital Markets Act）将不允许其以隐私和安全为由在App Store内限制竞争——苹果在Epic诉讼案中正是以此为由来辩护的。放松App Store的规则和降低分成（目前大多数应用的分成最高达30%）可能会严重削弱苹果利润丰厚的服务业务。

对一个结合了库克这般地位和经验的高管来说，要迎着这些逆风而上或许不在话下。此人是否库克本人就不那么清楚了。他今年60岁，已表示过“很可能”不会再干10年。这就引出了一个问题：谁有足够的远见和能力来接替他。

一位前高管提出了一个激进的建议：苹果不应该变成一个奢侈品贩子。他认为，苹果上个季度超过40%的毛利率“高到离谱”，让它变得不思进取。为了维持毛利水平，苹果压榨开发者和供应商。相反，它应该利用自己的影响力和先进技术，为地球上尚未享受到数字时代好处的30亿人开发设备和服务。

这可能有助于解决苹果的增长难题，但不太可能获得追求利润的股东们的支持。最常被提及的热门继任人选杰夫·威廉姆斯（Jeff Williams）没那么激进，不会大幅脱离现行轨道。威廉姆斯被许多业内人士认为是“库克手下的库克”，两人不仅长相酷似（瘦高个、头发斑白），想法和经历也都如出一辙。自2010年以来，他一直负责库克原来的工作——管理苹果的供应链和运营。这些类型的技能在过去十年里为这家公司贡献良多。但若要继续繁荣下去，苹果的下一任首席执行官可能需要一套不同的能力。■



Red lines, grey rhinos and big mountains

China's bid to stabilise its property market is causing jitters

Can it be done without harming the wider economy?

OCTOBER 6TH 1979 was a beautiful Saturday in Washington. It was not the kind of day that augured wrenching change in economic policy. But on that date Paul Volcker, then chairman of America's central bank, announced a radical plan to quash persistent inflation. Before the battle was won, America's interest rates reached 20% and unemployment surpassed 10%. Car dealers sent him the keys to vehicles they could not sell, in coffins.

China is now facing its own "Volcker moment", according to Ting Lu of Nomura, a bank. The government's aim is not to curb an inflationary spiral (China's consumer prices are rising only modestly) but to break a vicious circle of property speculation and credit expansion. Regulators are making it harder for developers to raise money and for households to buy homes. The new rules have already pushed several property firms, including the country's biggest homebuilder, Evergrande, to the brink and contributed to a decline in home sales. But are China's rulers willing to endure anything like the economic discomfort that Volcker inflicted to achieve their goals? The world may be about to find out.

An Englishman's home is his castle. In China, a home is much more besides. As well as providing shelter and security, housing often serves as collateral, nest-egg, speculative investment, bride-price and ticket to a good school. Housing makes up three-quarters of household wealth, according to the China Household Financial Survey, a data set compiled by academics in China. It accounts for the biggest chunk of household debt, which by one estimate exceeded 70% of GDP at the end of last year. Local governments raise 30% of their revenue by selling land to developers. And policymakers

often rely on homebuilding to revive the economy in downturns.

Property dons other guises, too. The high price of housing is often likened to a “big mountain” (alongside costly health care and education) and a “grey rhino” (an obvious but neglected risk). In March Guo Shuqing, the head of China’s banking and insurance regulator, warned that if house prices were to drop, people holding multiple properties would not only suffer “huge losses”, they might also fall delinquent on their mortgages, endangering the banks and leading to “economic chaos”.

The government wants property to play a more modest role. In December 2016 President Xi Jinping said homes were for “living in, not for speculating”, a phrase that officials now often repeat. In 2019 the Communist Party declared that property was not a tool for short-term economic stimulus, a commitment reiterated at a meeting of the ruling Politburo in July.

The authorities are facing the grey rhino more squarely by trying to tackle the industry’s financial fragilities. Last year regulators capped the share of mortgages and property-related loans that banks may hold. They also imposed “three red lines” on prominent property developers, limiting the size of their debts relative to their assets, equity and cash. Now when the president of Country Garden, a high-end developer, talks of his aim to “turn green” he is not referring to the environment, but to keeping clear of those lines.

The impact of the curbs on the property market is becoming more stark. Sales of new homes in 30 cities tracked by Wind, a financial-data firm, fell by 23% in August compared with a year earlier, having fallen less sharply in July and June. Sales were also lower than in the same period of 2019, before the pandemic (see chart). Nomura’s Mr Lu says investors should prepare

for a “much worse-than-expected growth slowdown, more loan and bond defaults, and potential stockmarket turmoil.”

Will the regulators blink? In the past, policymakers have been quick to ease property curbs in downturns. A big drop in house sales or prices over several months would probably “jolt the government into a more dovish stance”, argues Rosealea Yao of Gavekal Dragonomics, a consultancy. But Mr Lu believes it will be hard for leaders to reverse course. They have publicly committed themselves to a tighter policy and created bureaucratic momentum behind it. Earlier this year the central government sacked officials in the southern city of Shenzhen for failing to tame prices.

The curbs can be seen as part of the government’s new preoccupation with creating “common prosperity”. Unaffordable housing conflicts with this aim. Research by three Chinese academics—Guanghua Wan, Chen Wang and Yu Wu—has found that the cost of housing causes about 75% of China’s wealth inequality. It may also be one reason why China’s families now have so few children, a trend that increasingly worries the government.

To shore up growth, China may try building more subsidised homes. It has ordered 40 cities to construct almost 1m low-rent housing units this year. But it will take time to ramp up such work on a sufficient scale. Meanwhile, China’s growth will face other threats. Service industries may suffer from pandemic-related lockdowns. Exports may grow more slowly as manufacturing recovers abroad. And infrastructure spending will weaken if local governments cannot sell as much land to developers.

It is hard to imagine China pushing things nearly as far as Volcker did. But then Volcker himself did not foresee the full economic pain that would follow that beautiful Saturday. China’s hard-pressed developers may find themselves with many unsold properties in the months ahead. Where will they send the keys? ■



红线、灰犀牛和大山

中国稳定房地产市场的举措引发不安

能稳定房市而又不伤及整体经济吗？

一九七九年十月六日是华盛顿一个美好的星期六。一点也看不出这天会是经济政策发生巨变的日子。但就在这一天，时任美联储主席的保罗·沃尔克（Paul Volcker）宣布了一项遏制持续通胀的激进计划。在这场战役取得成功之前，美国的利率一度飙升至20%，失业率突破10%。汽车经销商把滞销汽车的钥匙装在棺材里送给他。

投资银行野村证券的陆挺认为，中国现在也面临着自己的“沃尔克时刻”。中国政府的目的不是要抑制恶性通胀（中国的物价只在温和上涨），而是要打破房地产投机和信贷扩张的恶性循环。监管机构正在对开发商融资和家庭购房加以限制。新出台的法规已将包括中国最大的住宅开发商恒大集团在内的几家房地产公司推至破产边缘，并导致房屋销量减少。但是，中国领导人是否愿意为了实现目标而忍受像沃尔克造成那种经济困境？可能很快就会见分晓了。

英国的老话说，英国人的家就是他的城堡。而对中国人来说，家的含义要丰富得多。除了是安身立命之所，住房常常也是抵押品、储蓄、投机性投资、彩礼和进入好学校的门票。中国学者编制的数据集《中国家庭金融调查》显示，住房已占家庭财富的四分之三。住房也是家庭债务的最大组成部分，据一项估计，住房债务在去年年底已经超过GDP的70%。地方政府收入的30%来自向开发商卖地。在经济低迷时期，政策制定者往往依赖房地产建设来提振经济。

房地产还有其他形象。高房价常常被比作一座“大山”（另外两座是昂贵的医疗和教育）和“灰犀牛”（显而易见但被忽视的风险）。今年3月，中国银保监会主席郭树清警告称，如果房价下跌，持有多套房产的人不仅会蒙受“很大的损失”，还可能拖欠房贷，危及银行，那么“经济生活就发生很

大的混乱”。

政府希望房地产扮演更加适度的角色。2016年12月，国家主席习近平说，房子是“用来住的，不是用来炒的”，这句话现在成了官员们的口头禅。2019年，中国共产党宣称房地产不是短期经济刺激的工具，今年7月的政治局会议也重申了这一承诺。

政府现在试图从房地产行业的金融脆弱性着手，直面这头灰犀牛。去年，监管机构对银行的个人住房贷款和房地产贷款占比设置上限。它们还对知名房地产开发商实施“三条红线”，根据其资产、股东权益和现金来限制其债务规模。现在，当高端开发商碧桂园的总裁谈到“转绿”的目标时，他指的不是环境，而是要避开那三条红线。

限制措施对房地产市场的影响日益凸显。金融数据公司万得资讯跟踪了30个城市的的新房销售情况，显示8月同比骤降23%，高于7月和6月跌幅。销量也低于2019年同期疫情爆发前的水平（见图表）。野村证券的陆挺表示，投资者应该为“远差于预期的增长放缓、更多的贷款和债券违约，以及可能的股市动荡”做好准备。

监管机构会手软吗？过去，政策制定者在经济低迷期会迅速放松对房地产的限制。咨询公司龙洲经讯（Gavekal Dragonomics）的咬丽蔷认为，房屋销量或房价大幅下跌数月可能会“促使政府立场软化”。但陆挺认为，要领导层转向会很难。他们已经公开承诺收紧政策，并且在官场中形成压力。今年早些时候，深圳的一批官员因未能遏制高房价被中央免去了职务。

可以认为，这些限制措施是政府实现“共同富裕”的新工作重点的一部分。高昂的房价与该目标格格不入。万广华、汪晨、吴雨三位中国学者的研究发现，住房成本造成了中国约75%的财富不平等。这可能也是中国家庭少子化趋势的原因之一，政府对这一趋势日益担忧。

为了支撑经济增长，中国可能会尝试建造更多的保障性住房。政府已下令

40个城市在今年建造近100万套廉租房。但是这项工作要扩大到足够规模还需时日。与此同时，中国的增长将面临其他威胁。服务业可能因疫情相关封锁受到打击。随着国外制造业复苏，中国的出口增速可能放缓。而如果地方政府不能再向开发商大量卖地，基础设施的支出就会减少。

很难想象中国会把事情推到像沃尔克当时那种境地。但是，沃尔克本人也并没有预见到在那个美好星期六之后出现的全面经济阵痛。在未来几个月里，处境艰难的中国开发商可能会持有大量卖不掉的房子。他们会把钥匙送去哪里呢？ ■



The Oracle of AI

Flush with billions, Databricks has momentum and big plans

Silicon Valley's latest darling is on the move

"HI, JUST CHECKING in. Can I put in some more?" The bosses of promising startups are bombarded by such texts these days. Big funds in particular are falling over themselves to grab a piece of the tech pie (see chart). Yet one founder seems to have received more than his fair share of pitches: Ali Ghodsi, the chief executive of Databricks. And he has said yes to many. On August 31st the company confirmed that, only six months after a \$1bn financing deal, it had raised another \$1.6bn, valuing it at \$38bn—\$10bn more than after the previous round. Among the Silicon Valley cognoscenti, these numbers cement Databricks' status as the most hyped company of the hour.

The software-maker is soon likely to be known farther afield. Later this year it is expected to stage the largest-ever initial public offering (IPO) of a software firm—larger than that in late 2020 of Snowflake, its most serious rival. Alternatively, some predict, it could be snapped up by Microsoft in the largest ever software takeover. Whatever the outcome, there is substance to the hype. Databricks could become, in the age of artificial intelligence (AI), what Oracle and its databases once were in the world of conventional corporate software: the dominant platform on top of which applications are built and run.

Databricks was founded in 2013 to commercialise Spark, a piece of open-source software that processes reams of data from different sources to train algorithms which then become the engines of AI applications. The firm added features, including code that makes it easier for developers to program the system as well as manage their workflow, and offered the

package as a cloud-based subscription service.

Yet Databricks only really took off when it added another component called “lakehouse”. It is a combination of two sorts of databases, a “data warehouse” and a “data lake” (hence the portmanteau). Both have historically been separate because of technical constraints and because they serve different purposes. Data warehouses are filled with well-defined corporate data that allow a firm to look into its past, for instance at how its sales have evolved, something called “business intelligence” (BI). Data lakes are essentially a dumping ground for all sorts of data that can reveal a firm’s future, including whether sales are likely to go up or down. Yet this separation is increasingly inefficient and unnecessary, explains Max Schireson of Battery Ventures, an investor in Databricks. “Doing BI and AI in different systems today is kind of stupid,” he notes.

Firms have jumped on what Databricks offers, in particular incumbents worried about being disrupted by an AI-driven startup. Comcast, an American broadband provider, uses it to allow its customers to use their voice to select movies; ABN Amro, a Dutch bank, to recommend services; and H&M, a fashion retailer, to optimise its supply chain. Databricks now claims more than 5,000 customers and annualised subscription revenue of \$600m—75% growth year-on-year.

Mr Ghodsi has set his sights even higher. “Ultimately, everything data should be on Databricks,” he says. He is planning on investing the newly raised capital to keep growing and become the leader in lakehouse systems. Nobody should fault Mr Ghodsi, who once taught computer science at the University of California, Berkeley, for his ambitions. Yet realising them will not be easy. Other firms are already pushing into the territory. He will probably be able to fend off the three big cloud-computing providers: Amazon Web Services, Google Cloud Platform and Microsoft Azure. Although they have more than enough resources to compete and provide

integrated AI packages, they share one big problem. Firms increasingly prefer not to store all their data in a single cloud, fearing they will get stuck with one vendor. Instead, they opt for products, such as Databricks', that run across several clouds.

Snowflake is a different story. It, too, is building lakehouses. It is also taking a different approach. Whereas Databricks is adding BI to its AI platform, Snowflake, which has grown up in the data-warehouse world, is adding AI to its cloud-based BI package, meaning that their respective products will increasingly overlap. Whereas most of Databricks' code is open-source, Snowflake's is proprietary. And whereas Databricks has mostly stuck to a "land-and-expand" strategy, whereby small software deals grow into bigger ones, Snowflake practises a more conventional top-down sales model that focuses on big deals from the start.

All this will make for a battle over the next few years. But it could be rudely interrupted if Microsoft snaps up Databricks. The software firm is already one of Databricks' investors and co-operates closely with it. Among other things, Azure offers a version of Databricks' platform and Microsoft uses its name in presentations about its strategy, something it rarely does with other firms. It would be a good fit. At its core, Microsoft is still a company selling tools for developers to write applications and platforms to run them on. And Databricks represents both a complement and a strategic threat: it lets data, rather than people, write the code.

Databricks' IPO is not meant to take the firm public, according to some analysts, but to put a price on it, so that negotiations can start somewhere. But the hype surrounding the company could thwart such plans. Snowflake is now worth about \$90bn. If Databricks' IPO outdoes Snowflake's, its asking price may well be north of \$100bn. And like Pinterest, a social-media firm which Microsoft considered buying earlier this year, it may become too pricey even for a company as loaded as world's biggest software firm. ■



AI界的甲骨文

被砸数十亿， Databricks来势汹汹， 蓝图宏伟

硅谷最新的宠儿在行动

“你好，我就是想问问，还能再加点吗？”这些日子，那些前景可观的创业公司的老板们都在被这样的短信轰炸。尤其是大型基金，它们竭力要从科技蛋糕中分上一块（见图表）。不过有位创始人似乎特别受青睐：

Databricks的首席执行官阿里·戈德西（Ali Ghodsi）。而且他对很多人都说了“行”。8月31日，这家公司证实，在上一次融资10亿美元仅六个月后，它又融资16亿，估值已达380亿美元，比上一轮融资提高了100亿。在硅谷行家们看来，这些数字进一步确立了Databricks成为眼下最受追捧的公司。

这家软件公司应该很快就会变得更广为人知。预计今年晚些时候，它将上演软件行业有史以来规模最大的IPO，规模超过它最强劲的竞争对手雪花（Snowflake）在2020年底的IPO。一些人预测，如果不上市，它可能会被微软收购，成为有史以来最大的软件收购案。不管结果如何，围绕它的喧嚣事出有因。在人工智能（AI）时代，Databricks或许能达到甲骨文及其数据库过去在传统企业软件世界里的地位：成为支持构建和运行应用程序的主导平台。

Databricks在2013年创立以将开源软件Spark商业化。Spark处理不同来源的大量数据来训练算法，这些算法而后成为AI应用的引擎。该公司增加了一些功能，包括代码，让开发人员更易于编程和管理自己的工作流，并且通过云端订阅服务提供这些功能包。

不过Databricks真正开始腾飞是在添加了另一个名为“湖仓一体”（lakehouse）的组件之后。这是“数据仓库”和“数据湖”这两种数据库相结合的产物（所以才有了这个合成词）。过去由于技术上的限制，也因为各自服务于不同的目的，这二者一直是分开的。数据仓库里存储着定义

明确的公司数据，让公司能了解自己的过去，比如公司销售的变化，这被称为“商业智能”（BI）。数据湖本质上是堆积各种数据的垃圾场，这些数据可以透露公司的未来，包括销售可能上升还是下降。但把这两者分隔开来日益低效，也没必要，Databricks的投资者之一Battery Ventures的马克斯·希雷森（Max Schireson）解释说。“现在还在不同的系统中使用BI和AI有点蠢。”他说。

企业已经开始转用Databricks的服务，尤其是那些担心被AI驱动的创业公司颠覆的传统企业。美国宽带提供商康卡斯特（Comcast）用它来提供语音选播电影功能；荷兰银行（ABN Amro）用它推荐服务；时尚零售商H&M用它优化供应链。Databricks称它目前有5000多家客户，年订阅收入6亿美元，同比增长75%。

戈德西的目标更远大。“最终，所有东西的数据都要放到Databricks上。”他说。他正计划把新融到的资金用于让公司保持增长并成为湖仓一体系统的领导者。戈德西曾在加州大学伯克利分校教授计算机科学，对于他的这种雄心壮志不应横加指摘。但要实现这些目标并不容易。其他公司已经在向这一领域进发。他或许能击退三大云计算提供商：亚马逊AWS、谷歌云平台和微软Azure。尽管它们有足够的资源竞争并提供集成的AI服务，但它们都有同一个大问题。企业越来越不愿意将所有数据都存储在同一个云里，担心会被单个供应商困住。相反，它们倾向于选择像Databricks这样的产品，可以在多个云上运行。

雪花则是另一回事。它也在建造湖仓一体。它采取了一种不同的方式。Databricks是将BI添加到它的AI平台上，而做数据仓库出身的雪花则将AI添加到其基于云的BI包中。这意味着它们各自的产品将越来越多地重叠。Databricks的大部分代码都是开源的，而雪花的代码是专有的。Databricks基本上坚持“步步为营”的策略，把小型软件交易发展为大交易，而雪花则采用更传统的自上而下的销售模式，从一开始就专注大交易。

所有这些都将在未来几年引发一场战争。但如果微软收购了Databricks，这一进程可能会被粗暴地打断。微软已经是Databricks的投资者之一，并

与之密切合作。比如，Azure提供了一个Databricks平台的版本，微软在介绍其战略时提到了Databricks的名字，而这在它和其他公司的合作中极少见。二者可以说相得益彰。从本质上讲，微软仍然是这样一家公司：销售供开发人员编写应用的工具和运行这些应用的平台。Databricks既是一种补充，也是一种战略威胁：它让数据而不是人来写代码。

一些分析师认为，Databricks的IPO不是为了让公司上市，而是为了给公司标价，方便确定谈判起价。但对这家公司的追捧可能会阻碍这样的计划。雪花现在市值约900亿美元。如果Databricks的IPO超过雪花，它的要价很可能大大超过1000亿美元。就和微软今年早些时候曾考虑收购的社交媒体公司Pinterest一样，即便是对于世界上最大的软件公司这样富有的买家来说，它的价格也可能会变得过于昂贵。 ■



Free exchange

At the Jackson Hole meeting, the Fed ponders an uneven recovery

Research presented at the monetary policymakers' virtual pow-wow offers guidance

BUSINESS CYCLES are never perfectly symmetric across time and space. Yet they have rarely been as uneven as the rebound from covid-19. Some parts of the global economy are straining to meet roaring demand even as others limp along, battered by the spread of the virus. It is enough to take the fun out of monetary policy. Indeed, the Delta variant kept attendees of an annual symposium for central bankers from meeting in Jackson Hole, Wyoming, in the shadow of the majestic Teton mountains, on August 27th. Instead, they peered at their computer screens as they discussed how to shepherd an unbalanced economy through uncertain times.

A pressing question loomed over the proceedings: just how and when to tighten policy given high inflation and lingering unemployment. Tweaks to the Federal Reserve's framework in recent years are meant to give it room to manage such difficult circumstances. It now aims to hit its 2% inflation target on average and will court high inflation to make up for past shortfalls. But surging prices are testing this approach. Data released as the conference began showed that the Fed's preferred measure of inflation had risen to 4.2% in July, the highest in 30 years. Jerome Powell, the Fed's chairman, made no suggestion to his fellow participants that he would drastically change course, and confirmed that the Fed might begin to taper asset purchases later in the year. But policy, he cautioned, would have to change as new data come in.

Research presented at the symposium offered guidance on how to cope with a lopsided recovery. Veronica Guerrieri of the University of Chicago and her co-authors, for instance, considered how policymakers should respond

when demand surges in some sectors and lags in others. If there is little scope for workers to shift from unfavoured industries to the up-and-comers, they write, then the shift in demand acts like a “cost-push shock” (similar to a spike in oil prices). In such cases, central banks typically accept some pain in the form of above-normal inflation and some in above-normal unemployment. But if workers can move, then there are benefits to central banks’ facilitating this shift.

Easy money is not obviously the right answer. If loose monetary policy raises demand for both booming and busting sectors, then it might slow reallocation by propping up firms that ought really to close. But the authors argue that, in a world in which it is easy to adjust wages upward but tricky to cut them, inflation may in fact hasten reallocation. Because nominal wages in lagging industries cannot easily fall, workers face little incentive to move to promising sectors. Inflation, though, enables the real wage in lagging sectors to fall relative to that in booming ones, encouraging workers to move. Thus it makes sense, in theory, for monetary policy to have an inflationary bias during an uneven recovery.

Mr Powell would probably welcome that argument. But if American firms continue to hire at the recent pace, the unemployment rate may fall back to its pre-pandemic level of 3.5% by the end of 2022. That presents the Fed with a new dilemma. While the unemployment rate has recovered quickly, labour-force participation has not: of the drop experienced in early 2020, just under half has been clawed back; the unemployment rate, by contrast, is more than 80% of the way back. Part of Mr Powell’s justification for the change in framework was the beneficial effects of tight labour markets, which he reckoned would eventually draw workers from disadvantaged groups back into the labour force. But the patience needed to allow such effects to unfold could vanish amid high inflation and low unemployment.

Work presented by Bart Hobijn of Arizona State University and Aysegul

Sahin of the University of Texas at Austin on the “participation cycle” affirms the benefits of patience. It is not the case that workers from disadvantaged groups are more likely to drop out of the labour force during downturns and are only enticed back after sufficiently long recoveries. Rather, the probability that a worker drops out is much higher for unemployed workers than employed ones, whatever their background. It is thus the higher unemployment rates that disadvantaged groups tend to face that are responsible for their leaving the labour force. And this effect begins reversing as soon as labour markets begin to recover. Greater job stability—that is, a higher chance of finding work and a lower chance of losing a job—reduces the flow of workers into unemployment and out of the labour force, raising the participation rate.

The effect is powerful; the authors estimate that a one-percentage-point decline in the unemployment rate tends to raise the participation rate by 0.65 percentage points, other things equal. The beneficial effect continues even after unemployment reaches a trough, with the participation rate typically reaching a peak nine months later. The upshot for policy is therefore broadly similar to where Mr Powell has ended up: a low unemployment rate need not imply that labour-market slack has run out, or that patience on the part of the central bank will not eventually be rewarded.

Other research reinforced the doveish mood, pointing out the adverse effects on emerging markets of premature monetary tightening in the rich world. But outside the conference, Mr Powell has been bombarded by criticism of loose money. Inflation has now more than made up its shortfall since 2015, let alone the start of the pandemic. Some heads of regional Fed banks, such as Raphael Bostic of Atlanta, are eager to reverse quantitative easing soon. Prominent economists, such as Raghuram Rajan of the University of Chicago and Larry Summers of Harvard, have highlighted the dangers of prolonging asset purchases.

Academia lags reality, and there is little doubt that during the recovery from the global financial crisis the Fed overestimated the danger of inflation and undercounted the long-term benefits of driving unemployment lower. The critics' worry is that the central bank may now be overcompensating for that error. ■



自由交流

在杰克逊霍尔，美联储思索复苏不均衡难题

这次线上货币政策会议上发布的研究给出了指引

经济周期在时间和空间上的分布从来都不是完全对称的。然而，它们很少像这次疫情后的经济复苏那样不均衡。在全球经济中，有些部分正在努力满足迅速飙升的需求，其他部分却因病毒的传播而步履蹒跚。这足以让制定货币政策成为一件苦差事。实际上，由于德尔塔毒株的扩散，在全球央行年度研讨会在杰克逊霍尔（Jackson Hole）召开之际，与会者无法于8月27日齐聚这个位于怀俄明州雄伟的提顿山脉（Teton）山脚下的小城。他们只能透过电脑屏幕来讨论如何在不确定时期引导不平衡的经济。

一个紧迫的问题贯穿了整个会议，那就是在目前通胀飙高且失业率居高难下的情况下，如何以及何时收紧货币政策。近年来美联储对政策框架做出了微调，为应对这种困难处境提供空间。现在它的目标是将平均通胀率控制在2%，并将允许出现高通胀以弥补过去的低通胀。但飙升的价格正在考验这种做法。会议开始时公布的数据显示，美联储最关注的通胀指标在7月上升至4.2%，为30年来最高。美联储主席鲍威尔没有向其他与会者流露出他会彻底改变政策路线的意思，并确认了美联储可能会在今年晚些时候开始缩减资产购买规模。但他警告说，随着新数据的出现，政策将必须随之调整。

会上发布的研究为如何应对经济复苏不均衡提供了指引。例如，芝加哥大学的维罗妮卡·格列里（Veronica Guerrieri）等人研究了如果某些行业需求激增而其他部门需求滞后，政策制定者应该如何应对。他们在论文中写道，如果工人从萧条行业转移到繁荣行业的空间很小，那么需求的转移就会产生“成本推进型冲击”（类似于油价飙升）。在这种情况下，央行通常要接受一些超常通胀和超常失业率的痛苦。但如果工人可以转移，那么央行促进这种转移就会有益处。

宽松的货币政策看起来不像正确答案。如果宽松的货币政策同时提高了对繁荣部门和萧条部门的需求，就有可能支撑起那些本应倒闭的公司，从而拖慢资源的重新分配。但几位作者认为，在一个涨工资容易降工资难的世界里，通胀实际上可能会加速重新分配。由于衰落行业里的名义工资不容易下降，工人没什么动力转向有前途的行业。然而通胀会让衰落行业的实际工资相对于繁荣行业出现下降，从而鼓励工人流动。因此，从理论上讲，在经济复苏不均衡时，货币政策倾向于容忍通胀是有其道理的。

鲍威尔可能会欢迎这种论点。但如果美国企业近期的招聘速度不变，到2022年底失业率可能会回落到疫情前3.5%的水平。这给美联储带来了新的两难困境。虽然失业率迅速回落，但劳动参与率却没有以同样的速度恢复，它在2020年初的降幅仅回升了将将一半。相比之下，失业率的涨幅已经回落了80%以上。对于政策框架的变化，鲍威尔给出的解释之一是劳动力市场吃紧具有有利影响，他认为这最终会吸引弱势群体的工人重返劳动力市场。但在高通胀和低失业率的情况下，等待这种影响显现所需的耐心可能会耗尽。

亚利桑那州立大学的巴特·霍布因（Bart Hobijn）和得克萨斯大学奥斯汀分校的艾伊赛格·萨哈因（Aysegul Sahin）介绍的关于“参与周期”的研究肯定了耐心的好处。他们发现，并非是弱势群体的工人更有可能在经济低迷时期退出劳动力市场，且只有在复苏足够长之后才被吸引回来。实情是，无论来自什么群体，失业工人退出劳动力市场的可能性比就业工人高得多。因此，弱势群体往往面临更高的失业率才是让他们退出劳动力市场的原因。而一旦劳动力市场开始复苏，这种影响就会开始逆转。提高就业稳定性——也就是更容易就业以及更不容易失业——会减少工人陷入失业并最终退出劳动力市场的可能性，从而提高劳动参与率。

这种效应很强大。几位作者估计，在其他条件相同的情况下，失业率下降1个百分点往往会使劳动参与率提高0.65个百分点。即使当失业率降到低谷，这种有利影响仍会继续发挥作用，劳动参与率通常会在失业率触底的九个月后达到峰值。因此，他们的政策建议与鲍威尔目前的立场大致相似。失业率低并不意味着劳动力市场不再疲软，或者美联储的耐心最终得

不到回报。

其他一些研究指出了富裕国家过早收紧货币政策对新兴市场的不利影响，这强化了鸽派情绪。但在会议之外，鲍威尔已因宽松政策饱受批评。现在的通胀已经补偿了自2015年以来的低迷部分，还有富余，更别说自疫情开始以来的低通胀。一些地区联储的负责人，如亚特兰大的拉斐尔·博斯蒂克（Raphael Bostic），急于尽快扭转量化宽松政策。芝加哥大学的拉古拉姆·拉詹（Raghuram Rajan）和哈佛大学的拉里·萨默斯等著名经济学家都强调了继续购买资产的危险。

学术研究通常滞后于现实，而且毫无疑问的是，在从全球金融危机复苏的过程中，美联储高估了通胀的危险，也低估了降低失业率的长期好处。批评者担心的是，美联储现在可能是在过度补偿那次失误。 ■



Schumpeter

In the metaverse, will big gaming eventually become big tech?

Epic's fight against Apple and Google is about more than just app stores

IN “READY PLAYER ONE”, a science-fiction novel set in 2045, people can escape a ghastly world of global warming and economic mayhem by teleporting themselves into the OASIS, a parallel universe where they can change identity, hang out and forget the miseries of everyday life. In the book, published in 2011, the OASIS is the brainchild of a gaming tycoon who has everyone’s best interests at heart. Lurking in the background, though, is Innovative Online Industries, an evil internet conglomerate that intends to take it all over and reap the rewards for itself.

There are echoes of this “good v greedy” narrative in the way Tim Sweeney, founder of Epic Games, creator of “Fortnite”, an online-gaming phenomenon, talks about the metaverse. The idea is in vogue in Silicon Valley and is considered the next big thing in the internet. No one quite knows what the term means; at its most futuristic, the OASIS is a pretty good analogy for what tech utopians have in mind. For now, suffice to say that if you think you have spent more than enough time online during the covid-19 pandemic, think again. Using virtual and augmented reality, avatars and lifelike computer imagery, the metaverse will further erase the boundaries between people’s online and physical lives. Unsurprisingly, big tech is salivating at the prospect of yet more realms of human existence open to data extraction.

So is Mr Sweeney, who is creating a mini-metaverse for the 350m monthly users of “Fortnite”, immersing them not just in fantasy games, but virtual pop concerts and the like. However, he is determined to stop today’s Silicon Valley elite from creaming off all the rewards from this visionary future.

His ambition is for vibrant competition, fair pay for creators and economic efficiency unlike anything on the web today. How realistic—or sincere—is it?

Epic, a privately held company partly owned by Tencent, a Chinese tech goliath, already depicts the creation of the metaverse as a giant-slaying contest. It is part of the backdrop for its recent courtroom battles against Apple (a verdict is expected soon) and against Google (a trial has not yet started). Primarily, the antitrust cases are about the iPhone's App Store and Google's Android Play Store, which Epic portrays as price-gouging fiefs, in particular taking a cut of up to 30% on in-app purchases and refusing to let developers use alternative payment-processing platforms. But in court Mr Sweeney told the judge in the Apple case that the issue was also “existential” for the creation of the metaverse. Epic’s aim, he said, was to turn “Fortnite” into a platform on which independent developers could distribute their games and other forms of entertainment online and earn more of the profits themselves. “With Apple taking 30% off the top, they make it hard, very hard for Epic and creators to exist in this future world,” he said.

Both Apple and Google deny the allegations. In court, Apple countered that its commissions were an industry standard, and that it invested in creating a user-friendly environment. But it is being forced to give ground elsewhere. In a recent partial settlement of a class-action case in America Apple agreed to make it easier for app developers to contact customers about other payment methods. Then, on August 31st, South Korea passed a law allowing smartphone users to pay developers directly. Google calls Epic’s allegations baseless. Where does this leave Mr Sweeney’s vision of the new web? And how likely is it to materialise?

The vision certainly looks appealing. No “mega corporation” would be dominant. Instead, the metaverse will be built by millions of creators, programmers and designers, earning a bigger share of the rewards than the

tech giants currently allow. Instead of the siloed state of today's internet, he says there should be free movement of play between gaming networks, such as Microsoft's Xbox and Sony's PlayStation. The cutting-edge "engines" that the gaming industry uses to make real-world simulations should be based on common standards so that they, too, are interoperable. Adding to the economic efficiency could be decentralised tools such as the blockchain and cryptocurrencies.

Mr Sweeney makes no bones about contrasting such open competition with the current situation. That won't deter Silicon Valley giants from seeking a big future role. Gaming firms such as Epic, Roblox and Minecraft are furthest advanced in bringing metaverse-like aspects to their platforms; Minecraft has a virtual library of censored press articles to encourage freedom of thought in autocratic regimes. But the tech giants are hard on their heels. Mark Zuckerberg, Facebook's boss, believes its Oculus Quest headsets will be part of a virtual- and augmented-reality future that could supersede the smartphone. In August Facebook introduced Horizon Workrooms to its headsets, enabling workers to attend virtual meetings as avatars. Satya Nadella, Microsoft's CEO, talks of building an "enterprise metaverse". Doubtless they want to make the metaverse more of a walled garden than Mr Sweeney does.

As for Mr Sweeney's apparent altruism, it is probably wise not to take it at face value. Epic and other gaming firms could plausibly one day pursue dominance of a three-dimensional internet similar to that big tech has in the two-dimensional one. As Daniel Newman of Futurum Research, a consultancy, puts it, from Microsoft in the 1980s to Apple, Google, Facebook and Amazon in the 2010s, all tech giants have started out offering unique services that consumers loved, and fought for more open competition against incumbents. Over time, as their leadership positions strengthened, their missionary zeal waned. It is hard to imagine a world, no matter how futuristic, in which this pattern does not persist.

For now, the big gaming firms cannot conceive of themselves as cartoon villains. And the metaverse may indeed be too vast to be dominated by any one firm. But whatever parallel universes they build, the desire to create not just fantasy dystopias but also moats against competition is quintessentially the capitalist way. ■



熊彼特

在元宇宙中，游戏巨头终将变成科技巨头？

Epic与苹果、谷歌之争不止于应用商店

科幻小说《头号玩家》（Ready Player One）的背景设在2045年，故事中的人们可以穿越到一个叫“绿洲”的平行宇宙，从而逃离因全球变暖和经济混乱而变得糟糕透顶的世界。在“绿洲”里，人们可以变换身份，外出闲逛，忘记日常生活中的痛苦。在这本2011年出版的书中，“绿洲”是一位把所有人的最大利益挂在心上的游戏大亨的创造物。然而，一个潜伏在暗处的邪恶的互联网企业集团——创新线上企业（Innovative Online Industries）——想要全盘控制“绿洲”，把好处据为己有。

如今这种“高尚对贪婪”的叙事也出现在Epic Games公司（在线游戏现象级产品《堡垒之夜》的开发商）的创始人蒂姆·斯威尼（Tim Sweeney）关于元宇宙的谈论里。元宇宙的概念在硅谷很火，被认为是互联网行业的下一个大事件。没有人知道这个词的确切意思；“绿洲”中最具未来感的场景很符合技术乌托邦主义者的想象。目前而言，可以简单地说：如果你认为自己新冠疫情期间在网上花的时间已经够多的了，请再想想。利用虚拟现实和增强现实、数字化身和栩栩如生的计算机影像，元宇宙将进一步消除人们线上和线下生活之间的界限。也难怪，想到还可以从人类生活的更多方面提取数据，科技巨头们垂涎不已。

斯威尼也一样。他正在为《堡垒之夜》的3.5亿月活跃用户创建一个微型元宇宙，让他们不仅可以沉浸在玄幻游戏中，还可以参加虚拟流行音乐会等类似活动。然而，他决心要阻止当今的硅谷精英独吞这个创见性未来的所有好处。他追求活跃的竞争、创作者获得公平的报酬，以及经济效益，与互联网行业的现状截然不同。这样的志向有多切实可行，或者说，有多真诚？

Epic是私人公司，中国科技巨头腾讯持有部分股份。它已经将元宇宙的创

建描绘成一场绞杀巨头的竞赛。这和它最近与苹果（预计很快会作出裁决）及谷歌（还未开始审理）对簿公堂有一定关系。这些反垄断案件主要涉及iPhone的App Store和谷歌的安卓Play商店，Epic把它们说成是漫天要价的领地，尤其是对应用内购买抽取最高30%的分成，并且不准开发者使用其他支付平台。但在法庭上，斯威尼告诉苹果一案的审理法官，对元宇宙的创建来说，这也是“生死存亡”的问题。他表示，Epic的目标是把《堡垒之夜》变成一个平台，独立开发者可以在上面发布自己的游戏和其他形式的在线娱乐，并从中分得更多利润。“苹果从总收入中拿走了30%，这让Epic和创作者在这个未来世界的生存变得困难，不是一般地难。”他说。

苹果和谷歌都否认了这些指控。在法庭上，苹果反驳说，自己的提成符合行业标准，而且自己投资打造了用户友好的环境。但它正被迫在其他地方做出让步。近期在美国的一起达成部分和解的集体诉讼案中，苹果同意让应用开发者更容易向客户推介其他支付方式。之后，在8月31日，韩国通过了一项法律，允许智能手机用户直接向开发者付费。谷歌称Epic的指控毫无根据。这样的情形会给斯威尼的新网络愿景造成什么影响？它有多大可能实现？

斯威尼的愿景看起来确实很有吸引力。不会有一家“特大企业”独大的情形。取而代之的是，元宇宙将由数百万创作者、程序员和设计师创建，他们可获得的回报将高于目前科技巨头所允许的水平。他表示，应该让游戏能在微软的Xbox和索尼的PlayStation等不同游戏网络平台之间自由流动，而不是像今天互联网上相互隔离的状态。游戏行业用来制作模拟真实世界场景的尖端“引擎”应该基于共同的标准，这样它们也具有了互操作性。区块链和加密货币等去中心化工具可以提高经济效率。

斯威尼在拿这种公开竞争对比现状时毫不客气。这不会吓到硅谷巨头，令它们放弃谋求在未来的重要角色。在将元宇宙元素引入自己的平台方面，Epic、Roblox 和Minecraft等游戏公司一马当先；游戏《我的世界》（Minecraft）中有一个虚拟图书馆，保存着未过审的新闻报道，以鼓励专制政权下的思想自由。但科技巨头们也在紧追不舍。Facebook的老

扎克伯格认为，自己的Oculus Quest头显可能会取代智能手机，成为虚拟和增强现实未来的一部分。今年8月，Facebook把Horizon Workrooms引入了它的头显，让员工可以用数字化身参加虚拟会议。微软CEO萨蒂亚·纳德拉（Satya Nadella）也在谈论打造“企业元宇宙”。毫无疑问，比起斯威尼的做法，他们更想把元宇宙打造成一个围墙花园。

至于斯威尼表现出的利他主义，不要只看表面或许是明智之举。Epic和其他游戏公司很可能某天就会追求在三维互联网上的统治地位，就像大型科技公司今天在二维互联网上拥有的那样。正如咨询公司Futurum Research的丹尼尔·纽曼（Daniel Newman）所说，从上世纪80年代的微软到2010年代的苹果、谷歌、Facebook和亚马逊，所有的科技巨头一开始都提供备受消费者喜爱的独特服务，并针对传统公司争取更开放的竞争。但久而久之，随着它们主导地位的加强，它们传教士般的热情减弱了。无论一个世界多么具有未来主义色彩，都很难想象这套行为模式将不复存在。

目前，大型游戏公司还想象不出自己会是反派角色。而且元宇宙可能真的太大了，不可能被哪一家公司控制。但不管它们建立了什么样的平行宇宙，既喜欢描绘想象中的反乌托邦，又想筑造抵御竞争的护城河是资本主义的典型作派。 ■



AI for vehicles

Is it smarter than a seven-month-old?

How to improve the intelligence of self-driving cars

BY THE AGE of seven months, most children have learned that objects still exist even when they are out of sight. Put a toy under a blanket and a child that old will know it is still there, and that he can reach underneath the blanket to get it back. This understanding, of “object permanence”, is a normal developmental milestone, as well as a basic tenet of reality.

It is also something that self-driving cars do not have. And that is a problem. Autonomous vehicles are getting better, but they still don’t understand the world in the way that a human being does. For a self-driving car, a bicycle that is momentarily hidden by a passing van is a bicycle that has ceased to exist.

This failing is basic to the now-widespread computing discipline that has arrogated to itself the slightly misleading moniker of artificial intelligence (AI). Current AI works by building up complex statistical models of the world, but it lacks a deeper understanding of reality. How to give AI at least some semblance of that understanding—the reasoning ability of a seven-month-old child, perhaps—is now a matter of active research.

Modern AI is based on the idea of machine learning. If an engineer wants a computer to recognise a stop sign, he does not try to write thousands of lines of code that describe every pattern of pixels which could possibly indicate such a sign. Instead, he writes a program that can learn for itself, and then shows that program thousands of pictures of stop signs. Over many repetitions, the program gradually works out what features all of these pictures have in common.

Similar techniques are used to train self-driving cars to operate in traffic. Cars thus learn how to obey lane markings, avoid other vehicles, hit the brakes at a red light and so on. But they do not understand many things a human driver takes for granted—that other cars on the road have engines and four wheels, or that they obey traffic regulations (usually) and the laws of physics (always). And they do not understand object permanence.

In a recent paper in Artificial Intelligence, Mehul Bhatt of Orebro University, in Sweden, who is also the founder of a firm called CoDesign Lab which is developing his ideas commercially, describes a different approach. He and his colleagues took some existing AI programs which are used by self-driving cars and bolted onto them a piece of software called a symbolic-reasoning engine.

Instead of approaching the world probabilistically, as machine learning does, this software was programmed to apply basic physical concepts to the output of the programs that process signals from an autonomous vehicle's sensors. This modified output was then fed to the software which drives the vehicle. The concepts involved included the ideas that discrete objects continue to exist over time, that they have spatial relationships with one another—such as “in-front-of” and “behind”—and that they can be fully or partly visible, or completely hidden by another object.

And it worked. In tests, if one car momentarily blocked the sight of another, the reasoning-enhanced software could keep track of the blocked car, predict where and when it would reappear, and take steps to avoid it if necessary. The improvement was not huge. On standard tests Dr Bhatt's system scored about 5% better than existing software. But it proved the principle. And it also yielded something else. For, unlike a machine-learning algorithm, a reasoning engine can tell you the reason why it did what it did.

You could, for instance, ask a car fitted with a reasoning engine why it had hit the brakes, and it would be able to tell you that it thought a bicycle hidden by a van was about to enter the intersection ahead. A machine-learning program cannot do that. Besides helping improve program design, such information will, Dr Bhatt reckons, help regulators and insurance companies. It may thus speed up public acceptance of autonomous vehicles.

Dr Bhatt's work is part of a long-standing debate in the field of artificial intelligence. Early AI researchers, working in the 1950s, chalked up some successes using this sort of preprogrammed reasoning. But, beginning in the 1990s, machine learning improved dramatically, thanks to better programming techniques combined with more powerful computers and the availability of more data. Today almost all AI is based on it.

Dr Bhatt is not, though, alone in his scepticism. Gary Marcus, who studies psychology and neural science at New York University and is also the boss of an AI and robotics company called Robust.AI, agrees. To support his point of view, Dr Marcus cites a much-publicised result, albeit from eight years ago. This was when engineers at DeepMind (then an independent company, now part of Google) wrote a program that could learn, without being given any hints about the rules, how to play Breakout, a video game which involves hitting a moving virtual ball with a virtual paddle.

DeepMind's program was a great player. But when another group of researchers tinkered with Breakout's code—shifting the location of the paddles by just a few pixels—its abilities plummeted. It was not able to generalise what it had learned from a specific situation even to a situation that was only slightly different.

For Dr Marcus, this example highlights the fragility of machine-learning. But others think it is symbolic reasoning which is brittle, and that machine

learning still has a lot of mileage left in it. Among them is Jeff Hawke, vice-president of technology at Wayve, a self-driving-car firm in London. Wayve's approach is to train the software elements running a car's various components simultaneously, rather than separately. In demonstrations, Wayve's cars make good decisions while navigating narrow, heavily trafficked London streets—a task that challenges many humans.

As Dr Hawke puts it, “the complexity of most real-world tasks is greater than is possible to solve with handcrafted rules, and it’s well known that expert systems built with rules tend to struggle with complexity. This is true regardless of how well thought out or structured the formal logic is.” Such a system might, for instance, craft a rule that a car should stop at a red light. But lights are designed differently in different countries, and some are intended for pedestrians rather than cars. There are also situations in which you might need to jump a red light, such as to make way for a fire engine. “The beauty of machine learning”, Dr Hawke says, “is that all these factors and concepts can be automatically uncovered and learned from data. And with more data, it continues to learn and become more intelligent.”

Nicholas Rhinehart, who studies robotics and AI at the University of California, Berkeley, also backs machine learning. He says Dr Bhatt's approach does indeed show you can combine the two approaches. But he is not sure it is necessary. In his work, and also that of others, machine-learning systems alone can already predict probabilities a few seconds into the future—such as whether another car is likely to give way or not—and make contingency plans based on those predictions.

Dr Bhatt responds that you can train a car with data accumulated over millions of kilometres of driving, and still not be sure you have covered all the necessary situations. In many cases, it might be simpler and more effective to program some of the rules in from the start.

For champions of both strategies, the question goes beyond self-driving cars to the future of AI itself. “I don’t think we’re taking the right approach right now,” Dr Marcus says. “[Machine learning] has proven useful for some things like speech recognition, but it’s not actually the answer to AI. We haven’t really solved the intelligence problem.” One way or another, then, it seems seven-month-olds still have a lot to teach machines. ■



汽车人工智能

它比七个月大的孩子聪明吗？

如何提高无人驾驶汽车的智能

到七个月大时，大多数孩子都已经知道，物体即使在我们看不到它时仍然存在。把玩具放到毯子下面，这个年龄的孩子会知道它还在那儿，他可以伸手到毯子下面把它拿回来。这种对“客体永久性”的理解是孩子正常发育的一个里程碑，也是人感知现实世界的一个基本原则。

它也是无人驾驶汽车不具有的东西。而这是个问题。自主车辆日益先进，但它们仍然无法像一个人那样去理解世界。对一辆无人驾驶汽车来说，一辆被驶过的厢式车暂时遮住的自行车在那一刻就不复存在了。

这种缺陷是目前被广泛运用的一门计算学科的基本特征，这门学科不无误导地给自己取名人工智能（AI）。当前的AI通过对世界做复杂的统计建模来工作，但它缺乏对现实的更深入的理解。如何让AI多少拥有一些类似的深入理解——比如一个七个月大孩子的推理能力——是目前一个活跃的研究课题。

现代AI建基于机器学习的理念。如果一个工程师想让计算机识别出停车让行标志，他不会尝试编写成千上万行代码来描述可能意味着这类标志的每个像素模式。相反，他会编写一个能够自行学习的程序，然后向它展示成千上万张停车让行标志的图片。经过大量重复，程序逐渐找出了所有这些图片共有的特征。

类似的方法被用于训练无人驾驶汽车在道路交通中行驶。汽车由此学会了如何遵守车道标记、躲避其他车辆、在红灯前踩刹车等等。但它们并不理解人类驾驶员视为理所当然的许多事，比如路上的其他车辆有发动机和四个轮子，又比如它们要遵守交通法规（通常情况下），也要遵循物理定律（永远如此）。它们也不理解客体永久性这回事。

在最近一篇关于人工智能的论文中，瑞典厄勒布鲁大学（Orebro University）的梅胡尔特·巴特（Mehul Bhatt）描述了一种不同的方法。他也是CoDesign Lab的创始人，这家公司正在把他的创意商业化。他和同事把目前无人驾驶汽车使用的一些AI程序拿来，在其上加装了一种名为符号推理引擎的软件。

这种软件不像机器学习那样以概率的方式探究世界，而是通过编程，对那些处理无人机传感器信号的程序的输出应用基本的物理概念，再把修改后的输出传输给驱动车辆的软件。其中涉及的物理概念包括离散对象随时间推移继续存在、它们彼此之间具有空间关系——比如“在前面”和“在后面”，以及它们可以完全或部分可见，或被另一个物体完全遮蔽。

它奏效了。在测试中，如果一辆车暂时挡住了另一辆车，这种推理增强软件可以追踪被挡住的车，预测它何时何地再次出现，并在必要时采取措施躲避它。这种改进说不上巨大。在标准测试中，巴特的系统比现有软件得分高5%左右。但它证明了原理。它还带来了其他好处。这是因为与机器学习算法不同，推理引擎可以告诉你它之所以做出某种行为的原因。

比如，你可以问一辆安装了推理引擎的车它为什么刹车，它会告诉你它认为一辆被厢式车遮住的自行车即将进入前方的十字路口。机器学习程序无法做到这一点。巴特认为，除了有助于改进程序设计外，这类信息能帮到监管部门和保险公司。因此它可能会加快公众接受无人驾驶汽车的过程。

巴特的研究涉及到AI领域久已有之的争论。早期的AI研究人员在1950年代使用这种预编程推理，取得了一些成功。但是，自1990年代开始，改进的编程技术与更强大的计算机以及更多可获得的数据相结合，使得机器学习突飞猛进。今天几乎所有的AI都是基于这种方法。

但巴特不是唯一一个质疑这种方法的人。加里·马库斯（Gary Marcus）也认同巴特的观点。他在纽约大学研究心理学和神经科学，也是名为Robust.AI的人工智能和机器人公司的老板。马库斯博士用八年前一个被大量报道的研究结果来佐证自己的理念。那时，DeepMind（当时还是一

家独立公司，现在是谷歌的一部分）的工程师编写了一个程序，它可以在没有拿到任何规则提示的情况下学习怎么玩视频游戏Breakout：用一块虚拟的板击打移动中的虚拟的球。

DeepMind的程序是个杰出的玩家。但当另一组研究人员修改了Breakout的代码——将板的位置仅仅移动了几个像素——它的能力就直线下降。它无法将自己从特定情形中学到的东西推广到即便只是略有不同的情形中。

在马库斯看来，这个例子凸显了机器学习的脆弱性。但其他人认为符号推理才是脆弱的，而机器学习还有很大的进步空间。伦敦的无人驾驶汽车公司Wayve的技术副总裁杰夫·霍克（Jeff Hawke）就属于这一派。Wayve的方法是对控制汽车各种部件的软件元素同时开展训练，而不是分别训练。在演示中，Wayve的汽车在狭窄、拥堵的伦敦街道上行驶时一路都做出了明智的决策——这对于人类驾驶员而言往往也颇具挑战。

霍克是这样说的：“大多数现实世界任务的复杂性超出了手工规则能解决的范畴，而且众所周知，用规则构建的专家系统往往难以应付复杂性。形式逻辑不管有多么深思熟虑或结构完备也一样。”例如，这样的系统可能会制订汽车应在红灯前停下的规则。但不同国家的交通灯设计不同，而有些灯限制的是行人而非汽车。在某些情况下你可能需要闯红灯，比如给消防车让路。“机器学习的美妙之处，”霍克说，“是所有这些因素和概念都可以从数据中自动发现和学习。有了更多数据，它会继续学习并变得更加聪明。”

加州大学伯克利分校研究机器人技术和人工智能的尼古拉斯·莱因哈特（Nicholas Rhinehart）也支持机器学习。他说巴特的方法确实表明可以将两种方法结合起来，但他不确定是否真有必要。在他的以及其他人的研究中，仅靠机器学习系统就可以预测未来几秒后的事件概率——例如另一辆车是否会让路——并根据这些预测制定应急计划。

巴特回应说，你确实可以用数百万公里的行驶里程积累的数据来训练一辆车，但仍不能确定是否已经涵盖了所有必要情形。在许多情况下，从一开

始就把一些规则编写进去可能更简单，也更有效。

对于两种策略的拥护者来说，问题都不止于无人驾驶汽车，而关乎AI自身的未来。“我认为我们现在采用的方法不对，”马库斯说，“[机器学习]已被证明对语音识别等一些事情管用，但它实际上并不是人工智能的解决方案。我们还没有真正解决智能问题。”不论孰是孰非，看起来，七个月大的孩子还有很多东西值得机器学习的。■



Liberalism and the truth

Jonathan Rauch defends “the constitution of knowledge”

The architecture of knowledge-making has proved enduring. But now it looks fragile

The Constitution of Knowledge. By Jonathan Rauch. Brookings Institution Press; 280 pages; \$27.99 and £22.50

IF THIS REVIEW contains errors, they will probably be spotted by the first editor who reads it. If a mistake sneaks past him then other editors, who pride themselves on being able to find bloopers, will probably intervene. If they are all asleep at the keyboard, The Economist’s fact-checking team will embarrass them by flagging the mistake. And if all these safety features fail, then a reader will write to point out the error, which will then be corrected with a slightly sheepish apology.

This system, which has corollaries in science, law, academia, finance and everywhere that facts still matter, forms one node in an enormous decentralised, depersonalised network. Jonathan Rauch, a former journalist at The Economist and now at the Brookings Institution, a think-tank, calls the rules that govern it the “constitution of knowledge”.

Unlike America’s constitution, this one has no identifiable authors. Instead, the rules were discovered by trial and error over the course of centuries. In Mr Rauch’s telling, the constitution of knowledge draws on the same inspiration as the Founding Fathers: a mash-up of 17th-century ideas about liberty with the French and Scottish enlightenments. But it took more than a hundred years to perfect. In the mid-19th century American journalists still invented stories to boost their readership. In 1844, for example, the New York Sun published a fake story about a transatlantic hot-air balloon journey, written by Edgar Allan Poe.

The 20th century brought codes of ethics, professional bodies and unwritten rules that were passed on through institutions. In journalism, a field Mr Rauch knows well—and to which he pays particular attention because of its role in politics—these rules include seeking multiple sources, preferring information that is on the record, questioning received wisdom, affording subjects a right of reply and correcting mistakes. Karl Popper's philosophy of science gave the constitution of knowledge an epistemological basis. The truth might be unattainable, but by excluding enough falsehoods it was possible to get close to it.

Like science, what Mr Rauch describes is a social activity. He sets out the house rules. Nobody has the final say on anything. Authority on a subject is not personal: "if an experiment works for Yale's Sterling Professor of Social and Natural Science, it should also work for the lowly undergraduate who replicates it." Knowledge advances through disconfirmation, which means that when one person advances an idea, everybody else can try to knock it down. People must be accountable for mistakes, though if the punishment for being wrong is too severe it becomes counterproductive. Civility matters, as do earned credentials and reputation. Institutions are vital. Last, no bullshitting is allowed.

It will not come as news to Economist readers that the system Mr Rauch evokes so fondly is under threat, from three sources. News as entertainment, in the form of talk radio and cable-news outrage, was around decades before the birth of Twitter and Facebook. Yet social media have given the phenomenon extra oomph—and so far the big social platforms have proved better at undermining the authority of institutions that make knowledge than at strengthening them, or at creating new ones. Wikipedia is a lonely exception that illustrates what might be possible with a different set of incentives.

Then there is the threat from the populist right, which seemed to reach its

apogee in 2016. The knowledge-making that Mr Rauch describes is complex and questioning. One reason populism is popular is that it makes everything seem simple and certain. The sabotage from the right has also been deliberate. When Donald Trump was president-elect, Lesley Stahl of CBS asked why he spent so much time attacking the press. “You know why I do it?” Ms Stahl later recalled him saying. “I do it to discredit you all and demean you all, so when you write negative stories about me no one will believe you.”

Third comes the threat from the left, in the form of cancelling and self-censorship. Liberal knowledge-makers are more worried about this now, because to some the peril of Trumpism seems to be receding. The Yale students who were upset by a professor’s reluctance to police Halloween costumes, or those at Smith College who protested against Christine Lagarde giving a speech, are suspicious of the liberty on which knowledge-making depends. There is evidence that this preference for conformity is gaining ground. Two-thirds of college students who answered a poll run by the Knight Foundation in 2019 admitted that the climate on campus stopped them expressing their views because classmates might find them offensive.

“That so few now dare to be eccentric marks the chief danger of the time,” wrote J.S. Mill of Victorian England. Mr Rauch’s book is a manifesto for liberals and eccentrics, which explains how carefully the great, distributed knowledge-making network has been assembled, how enduring it has proved—yet how fragile it seems. ■



自由主义与真理

乔纳森·劳奇捍卫“知识的宪法”

用以创造知识的架构经受住了时间的考验。但现在它看起来很脆弱【《知识的宪法》书评】

《知识的宪法》。乔纳森·劳奇著。布鲁金斯学会出版社，280页，27.99美元/22.50英镑。

这篇书评如果出现了什么谬误，第一个过目的编辑可能会发现它们。如果错误溜过了他的眼睛，其他以自己的火眼金睛为荣的编辑可能就会介入。如果他们全都趴在键盘边睡着了，本刊的事实核查小组就会把错误标出来，让他们羞赧不已。如果这几道安全措施全都失效，就会有读者来信指出错误，然后本刊再略难为情地致歉并更正。

这个系统构成了一个去中心化和去个人化的巨大网络中的一个节点。在科学、法律、学术、金融等事实仍然很重要的领域也都存在着这样的系统。本刊前记者、现就职于智库布鲁金斯学会的乔纳森·劳奇（Jonathan Rauch）将管理这一网络的规则称为“知识的宪法”。

与美国宪法不同，这部宪法没有确切的作者。相反，人们是经过几个世纪的试错发现这些规则的。根据劳奇的讲述，知识的宪法和美国开国元勋们汲取了相同的灵感：17世纪关于自由的思想与法国和苏格兰启蒙思想的融合。不过它的完善花了一百多年。19世纪中叶，美国记者仍在编故事以吸引读者。例如在1844年，《纽约太阳报》（New York Sun）刊登了一篇关于乘热气球跨越大西洋的假新闻，作者是爱伦·坡。

20世纪迎来了道德准则、专业团体以及通过制度和机构传递下来的不成文规则。在劳奇非常熟悉的新闻领域——他也因为新闻在政治中的角色而特别关注它——这些规则包括寻求多方消息来源、偏向记录在案的信息、质疑流行观点、给予报道对象做出回应和纠正错误的权利。卡尔·波普尔（Karl Popper）的科学哲学为知识的宪法提供了认识论基础。真相也许无

法获得，但只要排除掉足够多的谎言和错误，就有可能接近真相。

和科学一样，劳奇描述的是一种社会性活动。他列出了一些“行规”。任何人对任何事都没有一锤定音的资格。在某个课题上的权威无关个人：“如果一项实验对耶鲁大学社会和自然科学斯特灵教席教授行得通，那对复制该实验的小小本科生也该行得通。”知识是通过否证（disconfirmation）取得进步的，也就是说当一个人提出一个想法时，其他所有人都可以尝试推翻它。人们必须对犯下的错误负责，不过如果对错误的惩罚过于严厉，就会适得其反。文明礼貌很重要，受之无愧的资格和声誉也很重要。制度至关重要。最后，胡扯是行不通的。

劳奇深情回忆的这个系统正受到来自三个方面的威胁，对本刊的读者来说这不算什么新闻。新闻娱乐化在推特和Facebook诞生的几十年前就已出现，表现形式就是电台听众热线节目和有线电视新闻的鼓噪。然而社交媒体给这一现象又加了把火。而到目前为止，大型社交平台更擅长的似乎还是削弱创造知识的现行体系的权威性，而不是加强其权威，也不是创造出新的体系。维基百科是一个孤例，显示了一套不同的激励措施可能会成就什么。

还有一种威胁来自民粹主义右派，在2016年似乎达到了顶点。劳奇描述的知识创造是个复杂和质疑的过程。民粹主义受追捧，原因之一就是它让一切看起来都简单而确定。右派的破坏活动也是蓄意的。特朗普当选总统时，哥伦比亚广播公司（CBS）的莱斯利·斯塔尔（Lesley Stahl）问他为什么要花那么多时间攻击媒体。“你知道我为什么这么做吗？”斯塔尔后来回忆他如此说道，“我是为了抹黑和贬低你们所有人，这样等你们再写关于我的负面报道时就没人会信你们了。”

第三种威胁来自左派的取消文化和自我审查。自由派知识创造者现在更担心的还是这一点，因为在有些人看来特朗普主义的危险似乎正在消退。耶鲁大学一名教授不赞同对万圣节服装加以约束，引起学生不满；史密斯学院（Smith College）的学生抗议克里斯蒂娜·拉加德（Christine Lagarde）去该校发表演讲——这些学生都对知识创造所依赖的自由持怀疑态度。有

证据表明，这种从众的倾向正越来越普遍。有三分之二的大学生在回答奈特基金会（Knight Foundation）2019年的一项调查时承认，校园气氛阻止了自己畅所欲言，因为自己的看法可能会让其他同学感到被冒犯。

“现在很少有人敢于离经叛道，这正是这个时代最大的危险。”英国维多利亚时期的约翰·密尔写道。劳奇的书是自由主义者和离经叛道者的宣言，它解释了这个伟大的分布式知识创造网络是如何被小心仔细地编织起来，以及它是多么地耐久——但如今看来却又多么地脆弱。 ■



The Economist film

Could digital currencies put banks out of business? Part 2

One-fifth of the world's population will have access to a central-bank digital currency (CBDC) by 2024. China is the clear frontrunner.



经济学人视频

数字货币会让银行倒闭吗？（二）

预计到2024年，全球五分之一的人口将能用上央行数字货币（CBDC）。中国显然是领跑者。



Gelsinger's opening gambit

Intel's turnaround and the future of chipmaking

America's historically hermetic semiconductor giant opens up—and tries to shake up its industry in the process

WHEN SATYA NADELLA took over as boss of Microsoft in 2014 he started by opening Windows. Unlike his predecessors, who had kept the software giant's crown jewel hermetically sealed from the outside world, he exposed the operating system (OS) to the breeze of competition. The firm's other programs, which used to run almost exclusively on Windows, could now operate on other OSs, including Linux, an “open-source” rival which Microsoft had previously called a “cancer”. The manoeuvre both broadened the market for Microsoft's software and improved Windows by forcing it to compete with rival OSs on more equal terms. In the process, it shook up Microsoft's culture, helped it shed its reputation as a nasty monopolist and paved the way for a stunning revival that saw its market value soar above \$2trn.

Now the other half of the once almighty “Wintel” arrangement, whereby PCs would run on Windows software and chips made by Intel, wants to throw the windows open. The American semiconductor giant has long guarded its core chipmaking business as jealously as Microsoft did its OS. After years of product delays, misplaced technology bets and changing management, it is ready for some fresh air. “Our processes, our manufacturing, our intellectual property through our foundry services [producing processors for other chipmakers]: all will now be available to the world,” professes Pat Gelsinger (pictured), Intel's newish boss.

If successful, Mr Gelsinger's strategy could reshape a \$600bn industry at the heart of the fast-digitising global economy for the better. Failure could, in

the short run, compound the chip shortages that are making life difficult for manufacturers of everything from cars to data centres. In the longer term, it could lead to further concentration of the already cosy chipmaking market, with Intel increasingly eclipsed by rivals. And it may cement Asia's dominance of the industry, creating all kinds of geopolitical complications.

Although Microsoft and Intel reside in different parts of the tech universe, they used to be structural twins. Just as Windows and Office, Microsoft's package of business applications, were designed to work best with each other, Intel has been designing its own microprocessors and making them in "fabs" optimised for the purpose. As the tech industry has grown bigger, more diverse and more networked this once-dominant "integrated device manufacturer" (IDM) model has fallen out of favour (just as vertical integration became a drag for Microsoft as other tech "ecosystems" popped up). As with the Microsoft of old, Intel's arrogance and insularity discouraged other chipmakers from working with it, for instance by combining chip designs. Instead they ploughed their own furrows, focusing increasingly either on designing chips (for example, AMD, Arm, Nvidia and Qualcomm) or fabricating them (notably Taiwan Semiconductor Manufacturing Company, TSMC).

Intel has managed to stay closed for longer than Microsoft thanks to the boom in cloud computing, which boosted demand for pricey high-end processors that power servers in data centres where its so-called X86 architecture is now dominant. These contributed one-third of Intel's total revenue of \$78bn in 2020, and much of its \$21bn in net profit. Now, though, the company is being overwhelmed by open systems like that of Arm, whose blueprints are used in most of the world's smartphones (a market which Intel missed) and are starting to appear in data centres—and which was last year acquired by Nvidia for \$40bn (though trustbusters may yet scupper the deal). At the same time, TSMC took advantage of Intel's technological and management missteps to pull ahead in both cutting-edge technology and

production volume. Both TSMC and Nvidia are now worth more than twice as much as Intel (see chart), despite lower revenues and profits.

Enter Mr Gelsinger, who in February became Intel's third CEO in as many years. He was the firm's chief technology officer until 2009, when he was pushed out. This background—plus what he calls a decade-long “vacation from the chip industry” as the boss of VMware, a software-maker—allowed him to shake things up within weeks. Rather than split Intel into a foundry and a chip-designer, as some activist investors wanted, his “IDM 2.0” strategy doubles down on integration. Mr Gelsinger sees this as Intel's competitive advantage. And an independent foundry arm would struggle to compete with TSMC, argues Pierre Ferragu of New Street Research, who estimates that Intel's manufacturing costs are 70% higher than the Taiwanese firm's.

Instead, Intel is opting for a sort of virtual decoupling. It will make more use of outside foundries, including TSMC, to save costs but also to benefit from TSMC's leading-edge manufacturing processes. In July Mr Gelsinger said his company intends to catch up with TSMC and Samsung of South Korea in its ability to forge top-end chips. His ambitious plan is to launch at least one new high-end processor a year, each with smaller transistors and faster circuitry. By 2025 Intel aims again to be ahead of the pack with designs that are no longer measured in nanometres but in angstroms, the next-smallest metric unit of measurement, equal to one ten-billionth of a metre.

At the same time the company will offer this manufacturing magic to others by relaunching its own foundry business. In contrast to its earlier iteration, which was created in 2012 but never really took off, Intel Foundry Services (IFS) will have its own profit-and-loss statement and, soon, at least two brand-new fabs, which Intel will build in Arizona at a total cost of \$20bn.

Mr Gelsinger is now off on a global tour to explain and promote his new strategy, for instance at a trade show in Munich on September 7th, where he announced that Intel would build two new fabs in Europe. He will need all his enviable communication skills (another thing he shares with Mr Nadella) to convince investors. After a jump earlier this year, Intel's share price has slumped back roughly to where it was before his appointment was announced. Mr Gelsinger seems undaunted. Investors are asking two questions, he says, both fair: can Intel execute this strategy successfully? And when will this show up in earnings? "I'm OK with that."

The answers will depend in part on whether Intel can change its attitude. That means rekindling what Mr Gelsinger calls its "Grovian culture", a reference to Andy Grove, the firm's legendary co-founder, who is best known for his mantra that "only the paranoid survive". It also entails shedding its insularity. "My team needs to exercise a different set of muscles," explains Ann Kelleher, Intel's chief technologist. Among other things, she says, it must learn how to work with external customers and use tools that are built elsewhere.

Above all, though, success will be contingent on flawless execution. Cutting-edge chipmaking involves around 700 processing steps and many nanoscopic layers printed and etched on top of each other. Adding to the complexity, Intel will at last fully embrace "extreme ultraviolet lithography" (which TSMC and others have already been using to great effect). The company's announcement in late June that it would postpone production of next-generation server processors for a few months hints at the trickiness of the task.

IFS, too, faces challenges. Most analysts agree with Mr Ferragu that the foundry business cannot really compete with TSMC. This is not only a matter of costs, size and a technological lag. Intel must also persuade customers that it can overcome a built-in conflict of interest in trying to

be both an IDM and a foundry, points out Willy Shih of Harvard Business School. In a future semiconductor shortage, the company may need to decide whether to allocate capacity to its own processors or honour the contracts it has with foundry customers.

Intel nevertheless hopes it can carve out a big and lucrative niche for its foundry. It is said to be interested in beefing it up by buying GlobalFoundries, spun off from AMD in 2009 and now owned by an Emirati sovereign-wealth fund, for around \$25bn. Although the talks had stalled and GlobalFoundries filed to go public in August, they may be restarted once the smaller firm gauges other investors' interest—and thus its possible price tag.

With or without GlobalFoundries, Intel pledges a new spirit of openness. It will no longer force customers to use its proprietary tools when designing their chips. More important, it will grant them access to its chip designs and the technology it has developed for “packaging” semiconductors into the chips that end up in electronic devices. Big cloud providers, such as Amazon Web Services (AWS), will be able to take the design of an Intel server processor, optimise it for their data centres and combine it with other designs on a single chip.

There seems to be growing interest in mixing and matching, says Linley Gwennap of the Linley Group, a consultancy. AWS and Qualcomm will be among IFS's first clients. There is also interest in doing this domestically. American politicians point to the present pandemic-induced chip shortage and the potential threats from China, particularly to Taiwan, as reasons to worry that most chips are made in Asia. Congress is expected soon to approve a \$52bn subsidy package. The European Union has even more ambitious plans.

Building new fabs in Asia would be 30-40% cheaper, Mr Gelsinger concedes,

“but the incentive dollars allow me to invest more and go faster” at home. That appeals to customers who are particularly sensitive about security. America’s Defence Department recently decided to use Intel’s American foundry. Indeed, attracting government money may be the foundry’s main raison d’être, notes Stacy Rasgon of Bernstein, a broker. But reliance on state support risks blunting the very competitive edge Mr Gelsinger hopes to sharpen. And as a mind-numbingly complex hardware business, Intel may find it more difficult to turn itself around than Microsoft, which benefited from the faster change that characterises the software industry.

The stakes are therefore high—and not just for Intel. If the company continues to lose its edge, the result will almost certainly be further consolidation. Today’s handful of big chipmakers could eventually be whittled down to a duopoly. Even if more survive, most fabs would probably all be based in Asia (though TSMC plans to build one in Arizona). Around 80% of the world’s semiconductor capacity is already there, Mr Gelsinger estimates; America accounts for 15% and Europe for the rest.

Western governments are not the only ones who ought to pay attention to the fate of Mr Gelsinger’s opening move. So, too, should today’s tech titans. Like Microsoft before it, Intel got into trouble largely because it was overprotective of its crown jewels. Others might decide that the best way to avoid such problems is to open up pre-emptively. Apple could be a less harsh steward of its App Store; Facebook could make its social network work better with those of rivals; and Google could give phonemakers more freedom to tinker with its Android mobile OS. This could ease trustbusters’ worries—and make shareholders happier, too. ■



盖尔辛格的开放式开局

英特尔的转机与芯片制造的未来

美国这家向来封闭的半导体巨头开窗换气，试图撼动整个行业

萨蒂亚·纳德拉（Satya Nadella）2014年接任微软CEO后做的第一件事就是“打开”Windows。对于这家软件公司这颗皇冠上的明珠，他的前任们向来严加保护，隔绝外界冲击。和他们不同，纳德拉让这个操作系统暴露于竞争的新风中。微软的其他程序原本几乎只能在Windows上运行，如今也可以运行于其他操作系统之上，包括Linux这个曾被微软斥为“毒瘤”的“开源”对手。这一步为微软的软件拓宽了市场，同时也迫使Windows在更平等的条件下与其他操作系统竞争而不断自我提升。这一过程撼动了微软的企业文化，帮它摆脱了垄断者的恶名，也为微软惊人的复兴铺平了道路。它的市值飙升，突破2万亿美元。

现在，曾经雄霸天下的“Wintel”联盟（个人电脑依赖Windows软件和英特尔制造的芯片运行）中的另一位主角也想打开窗户了。和微软对待自家操作系统一样，美国半导体巨头英特尔也一直小心翼翼地保护着自己核心的芯片制造业务。近年来，经历新品延误、技术押注失败、管理层变动等连串问题后，英特尔需要注入一些新鲜空气了。“通过我们的代工服务（为其他芯片制造商生产处理器），我们的工艺、我们的制造技术、我们的知识产权，现在都将向世界开放。”英特尔新任CEO帕特·盖尔辛格（Pat Gelsinger，见上图）宣称。

如果成功，盖尔辛格的战略将重塑芯片业，让这个总值6000亿美元、在快速数字化的全球经济中处于核心地位的产业进一步提升。如果失败，短期内可能加剧芯片短缺，使得从汽车到数据中心的各类产品的制造商日子更加难过。更长期而言，它可能导致本身已安逸无争的芯片制造市场进一步集中，而英特尔也将更加落后于对手。它还可能巩固亚洲在该行业中的主导地位，引发各种地缘政治争端。

虽然微软和英特尔身处科技业的不同领域，但它们在自身结构上曾经有如双胞胎。正如微软把Windows和Office（微软的商业应用软件包）打造成一对最佳拍档那样，英特尔一直在设计自己的微处理器，并在专门为此做了优化的“晶圆厂”里制造它们。随着科技业变得更庞大、更多元也更互联，这种曾经占主导的“集成器件制造商”（以下简称IDM）模式已经失宠（正如随着其他科技“生态系统”的涌现，垂直整合模式开始拖累微软）。就像昔日的微软那样，英特尔的傲慢和封闭令其他芯片制造商难以与之合作，比如把不同的芯片设计结合起来。相反，它们各自深耕自己的领地，日益专攻芯片设计（如AMD、安谋、英伟达和高通）或者芯片制造（台积电是最显著的例子）。

相比微软，英特尔保持封闭的时间更久，这得益于云计算的蓬勃发展——这种计算服务推动了对数据中心的服务器所采用的高价高端处理器的需求，而这些数据中心大多采用英特尔的X86架构。2020年，这些产品在英特尔780亿美元的总收入中占了三分之一，在210亿美元的净利润中占了大头。但现在，英特尔正受到安谋等公司推出的开源系统的猛然冲击。全球大多数智能手机（英特尔错过的市场）都采用安谋的架构，一些数据中心也开始采用它。安谋去年被英伟达宣布以400亿美元收购（不过这笔交易可能会被反垄断机构中止）。与此同时，趁英特尔在技术和管理上走歪路的当口，台积电在尖端技术和产量上都实现了赶超。目前，台积电和英伟达的市值均为英特尔的两倍多（见图表），虽然收入和利润比它低。

今年2月，盖尔辛格成为英特尔过去三年里的第三位CEO。他之前曾任公司的首席技术官，直至2009年被逼走。这一经历，再加上他后来担任软件公司VMware老板的经历（他自称是“从芯片行业休假”的十年），使他能在短短几周内实施大变革。他的“IDM 2.0”战略不像部分维权投资者希望的那样把英特尔分拆成一家芯片代工厂和一家芯片设计公司，反而是加倍整合。他视之为英特尔的竞争优势。而且，新街研究（New Street Research）的分析师皮埃尔·费拉古（Pierre Ferragu）指出，独立的代工部门很难与台积电竞争，他估计英特尔的制造成本要比台积电高出70%。

相反，英特尔选择了某种虚拟分离。它将更多使用外部代工厂，包括台积电，以节省成本和利用台积电领先的制造工艺。7月，盖尔辛格表示，公司要在高端芯片制造方面赶上台积电和韩国三星。他满怀雄心，计划每年至少推出一款新的高端处理器，其中晶体管的尺寸不断缩小，运算速度不断提高。英特尔的目标是在2025年再次领先其他公司，设计出的芯片不再以纳米计量，而是以埃米计。埃米是比纳米还小一级的公制长度单位量，一埃米等于百亿分之一米。

同时，英特尔将重启自己的芯片代工业务，以向其他公司提供这种制造魔法。与在2012年创立但从未真正起飞的前身部门不同，英特尔代工服务事业部（Intel Foundry Services，以下简称IFS）将拥有独立的损益表，而且很快会新建至少两家芯片代工厂，选址在美国亚利桑那州，总造价为200亿美元。

盖尔辛格正在全球各地巡讲，解释和宣传他的新战略。例如，9月7日在慕尼黑的一个贸易展上，他宣布英特尔将在欧洲建立两家芯片代工厂。他将需要不遗余力地施展他令人羡慕的沟通能力（他与纳德拉的另一点相似之处）来说服投资者。在今年早前一轮涨势过后，英特尔的股价已大致回落到宣布对他的任命前的水平。盖尔辛格似乎毫不气馁。他说，投资者在提出两个非常合理的问题：英特尔能否成功执行这一战略？其成效何时能体现在收益上？“我接受这样的质疑。”

一定程度上，答案将取决于英特尔能否转变自己的态度。这意味着要重燃盖尔辛格所说的“格鲁夫文化”——源自该公司极具传奇色彩的联合创始人安迪·格鲁夫（Andy Grove），他最为人熟知的是那句“只有偏执狂才能生存”的名言。还需要挣脱自身的狭隘。“我的团队要把另一组肌肉练起来。”英特尔的首席技术专家安·凯莱赫（Ann Kelleher）解释道。她表示，这包括必须学会如何与外部客户合作，运用其他公司设计的工具。

但最重要的是，成功将有赖于完美无缺的执行。尖端芯片制造涉及约700个加工步骤和在纳米尺度上做一层叠一层的光刻和刻蚀。让事情变得更加复杂的是，英特尔终于要全面采用“极紫外光刻技术”（台积电等公司已采

用该技术取得极佳效果）。6月底，英特尔宣布下一代服务器处理器的生产将延后数月，这项任务的棘手可见一斑。

IFS也面临挑战。大多数分析师的看法与费拉古一致，认为英特尔的代工业务无法真正与台积电较量。这不单是成本、规模以及技术落于人后的问题。哈佛商学院教授史兆威（Willy Shih）指出，英特尔还必须说服客户相信自己能克服同时作为IDM和代工厂的固有利益冲突。假如将来出现半导体短缺，英特尔可能面临一个抉择：是将产能分配给自家处理器，还是履行与代工业务的客户签订的合同？

但英特尔还是希望能为自家代工厂开辟一片宽广肥沃的根据地。据传它有意以约250亿美元收购格罗方德（GlobalFoundries）以壮大实力。这家公司2009年从AMD剥离出来，现由阿联酋一主权财富基金拥有。尽管收购谈判陷于停滞，而且格罗方德刚在8月申请上市，但等到这家较小的公司衡量过其他投资者的兴趣以及它可能获得的价码，收购谈判就有可能重启。

无论能否拿下格罗方德，英特尔都决意树立开放的新精神。它将不再强迫客户在设计芯片时使用英特尔的专有工具。更重要的是，它将授权客户使用英特尔的芯片设计，以及它为把半导体“封装”成电子设备中所用的芯片而开发的技术。亚马逊AWS等大型云计算供应商将能把英特尔服务器处理器的设计拿来，按自己数据中心的需要做优化调整，结合其他设计来制造一块芯片。

对于这样的混搭操作，市场的兴趣似乎日渐浓厚，咨询公司林利集团（Linley Group）的林利·格温纳普（Linley Gwennap）表示。IFS的第一批客户包括AWS和高通。人们也开始对在国内完成这样的操作感兴趣。美国政界人士指出，鉴于目前全球疫情引发芯片短缺，再加上来自中国的潜在威胁——特别是在台湾地区问题上，芯片制造集中在亚洲令人担心。预计美国国会很快将批准一项520亿美元的补贴计划。欧盟的补贴计划还要更宏大。

盖尔辛格承认，在亚洲建新厂的成本会低30%至40%，“但政府的扶持资金使我能（在美国国内）投资更多，推进更快”。这对特别关注安全性的客户很有吸引力。美国国防部最近决定使用英特尔的美国代工厂。事实上，吸引政府资金可能是英特尔自家代工厂存在的主要理由，券商盛博的史黛西·拉斯贡（Stacy Rasgon）指出。但依赖政府扶持有可能削弱盖尔辛格希望加强的那种竞争优势。而身为一家复杂到让人脑袋发胀的硬件企业，英特尔可能发现自己比微软更难扭转局面，后者受益于软件行业变化更快这一特征。

因此所下的赌注会很大，而且不仅是对英特尔而言。假如它的优势继续流失，结果几乎肯定是进一步整合。如今已为数不多的几家大型芯片制造商最终可能缩减到只剩双头垄断。即使有更多企业存活下来，大多数晶圆厂可能将完全设在亚洲（尽管台积电计划在亚利桑那州也建一座）。据盖尔辛格估计，全球半导体产能已有约80%位于亚洲，美国有15%，其余在欧洲。

盖尔辛格的开局招数将迎来什么结果，不但值得西方政府关注，当今的科技巨头们也应留神观察。跟之前的微软一样，英特尔陷入困境主要是因为过度保护自己皇冠上的明珠。其他公司可能做出判断：避免此类问题的最佳方案是先发制人地敞开大门。苹果对自家App Store的管理可能不再那么严苛；Facebook可能让自己的社交网络更好地与对手连通；谷歌可以给予手机制造商更大的自由度来调整安卓移动操作系统。这或许既能减轻反垄断机构的忧虑，也能让股东们更加满意。 ■



Bartleby

The pandemic has refashioned corporate dress codes

Suits v sweatpants

IN AN INTERNAL memo to staff in 2016 JPMorgan Chase relaxed its dress code. The American bank's 240,000 employees could hang up their suits and don business-casual attire—once reserved for casual Fridays—all working week. Some garments remained beyond the pale (T-shirts, flip-flops, tank tops, yoga pants). But many—polo shirts, skirts (of appropriate length), dress sandals—became fair game.

JPMorgan was, sartorially speaking, ahead of its time among stuffy corporate giants (turtlenecks and hoodies have long been the fashion choice of Silicon Valley titans). Others followed suit, as it were. Men's corporate uniform—and the female power suit designed to mirror it—increasingly came to be seen as a vestige of the male-dominated offices of yore and no longer fit for purpose in a world of greater (though still imperfect) workplace equality. As more and more people ran or cycled to work, they found that changing into a full suit was impractical, since jackets folded into rucksacks tend to lose their crispness.

These days ties are no longer de rigueur in client meetings even for pinstriped investment bankers at Goldman Sachs. Purveyors of formal wear have fallen on hard times. Last year Brooks Brothers, which had been sewing button-down shirts since 1818, filed for bankruptcy. Last month Marks & Spencer, a British retailer, announced it would no longer sell men's suits in more than half of its bigger stores.

As the pandemic completely decoupled work and presence in the office, employees at many companies switched into something even less starchy.

Unlike JPMorgan, however, most have not put any guidelines in place as to what is and isn't appropriate. Although the Delta variant is forcing companies to delay a return to the office, that day will come. When workers are back at their desks, at least some of the time, new sartorial rules may be required.

Much has been written about what people wore on Zoom calls during lockdowns (and what they did not wear: some retailers report that tops significantly outsold trousers in the past year and a half). Fashion designers like Giles Deacon in Britain have launched "work from anywhere" fashion collections, aiming for slightly looser-cut clothing that nevertheless looks smart. Two Japanese companies, Aoki and Whatever Inc, created pyjama suits—a hybrid of a suit and soft, comfy loungewear—perfect for the video conference attended from home. Aoki uses the same fabric as pyjamas but with a suit-like cut. Whatever Inc's WFH Jammies are "business on the top, loungewear on the bottom".

That is not to say that business-casual Fridays have given way to athleisure work weeks. Indeed, some workplaces are already experiencing a backlash against informality. In 2017 Britain's House of Commons decided that male MPs were no longer required to wear ties when attending debates; previously they could go tieless only on hot summer days. But at the beginning of September this year Sir Lindsay Hoyle, the Speaker, announced that he expected all parliamentarians to smarten up. Jeans, chinos and sleeveless tops are out.

Looked at in the aggregate, individuals' clothes speak to more than just personal preferences. People's sartorial choices add up to a zeitgeist. It is no accident that the cheerful glitz of the 1920s came right after the despondency of the first world war and the Spanish flu. Today's tailoring brands hope that when the pandemic recedes at last male and female professionals will feel a renewed desire to dress up.

So does Bartleby. Like Sir Lindsay, she would recommend that employees maintain a degree of formal presentation. Yes, some people can pull off a dishevelled look—but not everyone. Dressing with taste and elegance does not have to involve designer clothes or expensive watches. It signals commitment and seriousness. A freshly laundered, crisp shirt announces to the world that you have made an effort; a tracksuit does not.

And if going to the office is a ritual, styling an outfit can be a pleasure, not a chore. The way one dresses is part of his or her self-expression. It also separates the public and the private. Peeling off formal office clothes and slipping into something cosy marks a daily transition from work to non-work. That line was blurred during lockdowns and could do with some sharpening. A man in a suit and tie is a man loosening his tie at the end of the day. ■



巴托比

疫情改变了企业着装规范

正装对决休闲装

在2016年给员工的一份内部备忘录中，摩根大通放宽了着装要求。这家美国银行的24万名员工可以把正装挂起来了，每个工作日他们都可以穿曾经仅限周五的商务休闲装。有些衣服仍不被接受（T恤、人字拖、背心、瑜伽裤）。但polo衫、（长度合适的）半身裙、正装凉鞋等很多服饰都可以登堂入室了。

从着装来看，摩根大通此举在古板保守的企业巨头队伍中引领了风潮（高领衫和连帽卫衣早就在硅谷巨头中风行）。其他公司或多或少开始效仿。男性的商务正装——以及为了与之呼应的女式套装——越来越被视为是过去男性主导办公室的遗迹，在两性更为平等（虽然仍不完全平等）的职场中已不再合适。随着越来越多的人跑步或骑车上班，他们觉得到办公室再换上全套西装不切实际，因为折起来放进背包的外套往往不再平整。

如今，即使对高盛那些穿着细条纹西装的投资银行家来说，领带也不再是参加客户会议的标配了。正装供应商的日子日渐艰难。从1818年就开始生产正装衬衫的布克兄弟（Brooks Brothers）去年申请了破产保护。上个月，英国零售商玛莎百货（Marks & Spencer）宣布其一半以上的大型门店都将不再销售男士西装。

由于疫情已使得工作与办公室坐班完全脱钩，许多公司的员工都换上了愈发不正式的衣服。然而，与摩根大通不同的是，大多数公司都没有制定任何规范，说明哪些着装合适，哪些不合适。尽管德尔塔变种病毒迫使企业推迟回归办公室，但那一天终将到来。当员工回到他们的工位上——至少在有些时候——可能就需要新的着装规范。

已经有很多文章讨论封锁期间人们上Zoom开会时都穿了什么（以及没穿什么：一些零售商的数据显示，过去一年半上衣的销量明显超过了裤

子）。英国的吉尔斯·迪肯（Giles Deacon）等时装设计师推出了“灵活办公”时装系列，打造剪裁略微宽松但看来仍干练精神的服装。青木

（Aoki）和Whatever Inc两家日本公司创造了睡衣套装，这种套装把西装和柔软、舒适的家居服混合在一起，非常适合在家参加视频会议时穿着。青木所用面料与睡衣相同，但剪裁类似于西装。Whatever Inc的WFH Jammies系列是“上半身正式，下半身居家”。

这并不是说周五的商务休闲风已经让位给了整周的运动休闲风。事实上，一些职场已经开始扭转非正式着装的势头。2017年，英国下议院决定不再要求男性议员在参加辩论时系领带，以前只在炎热的夏天允许不系。但今年9月初，议长林赛·霍伊尔（Lindsay Hoyle）宣布他期望所有议员都好好穿戴。牛仔裤、卡其裤和无袖上衣都退场了。

集合起来看，个人穿什么不仅仅体现了个人喜好。每个人的着装选择合在一起就构成了一个时代的精神面貌。上世纪20年代的活泼华丽风紧跟在一战和西班牙流感时期的悲观消沉后出现，这绝非偶然。今天的时尚品牌希望，等到疫情最终退去，不论男女，专业人士们会重新燃起精心着装的欲望。

本专栏作者也是这么想。和林赛议长一样，她会建议员工着装保留一定程度的正式。是的，有些人可以驾驭不修边幅的风格，但不是每个人都能做到。有品位的、优雅的着装不一定需要设计师品牌服装或高档手表。这样的着装传达出敬业和认真。一件干净熨贴的衬衫向全世界宣告你用了心，一身运动服可没这效果。

而如果去办公室是一种仪式，那么搭配衣服可以是一种乐趣，而非一件苦差。一个人的着装方式是自我表达的一部分。它还能在公共和私人生活之间划出界限。脱掉在办公室的正装，换上舒适的衣服，标志着每天从工作到非工作时间的过渡。这道界限在封锁期间变得模糊，很需要明确一些。一个男人穿西装打领带，也意味着他将在傍晚松开领带。■



Home comforts

China turns to new stock exchanges to channel finance to innovative firms

As foreign listings become harder to pull off, Xi Jinping hopes to make domestic ones easier

CHINA'S ECONOMIC planners want more home-made semiconductors, but they are not satisfied with more chips simply being produced at home. They want to bring the entire supply chain—from raw materials and chip grinders to labour and capital—onshore. Tens of thousands of companies have established microchip businesses over the past year. Now the state is rushing to ensure such cash-hungry firms can raise capital at home, too.

On September 2nd Xi Jinping, China's president, announced that a new stock exchange will be launched in Beijing, joining existing markets in Shanghai and Shenzhen. It is hoped that the bourse, a revamp of an over-the-counter exchange called the New Third Board, will channel capital from professional investors to fast-growing small and mid-sized firms.

This is not the first time Mr Xi has backed a new stock exchange aimed at innovative companies: Shanghai's STAR market opened in 2019, advertising relaxed rules that help accelerate fundraising for smaller firms. Domestic listings appear to be thriving. Shanghai will bag two of the world's largest initial public offerings (IPOs) of the year, those of China Telecom, a state-owned communications company, and Syngenta, a state agrochemical giant. Funds raised through such offerings in the city are set to reach their highest level in a decade this year, according to Bloomberg.

The emphasis on domestic fundraising fits snugly into China's strategy of “dual circulation”, the cornerstone of the country's latest five-year plan, which aims to bolster domestic markets and reduce reliance on foreign

ones, often on national-security grounds. It also offsets the worsening environment for overseas listings. New domestic regulations make it harder for Chinese firms to list abroad: internet companies with more than 1m users, for example, must now apply to the cyberspace regulator for permission. In America, the securities watchdog has halted Chinese IPOs following several disastrous listings. Congress plans to force many Chinese groups to delist if they do not share certain auditing documents—ones that the Chinese state forbids them to reveal.

On the face of it, the roles of offshore and onshore IPOs seem to have reversed. An IPO in Hong Kong or New York was once seen as further removed from Beijing's reach and less sensitive to policy surprises. The latest policy and geopolitical turmoil, however, has rocked overseas listings while making Chinese-traded securities “a route to counter geopolitical risks stemming from US sanctions”, say analysts at Natixis, a bank.

Neither Hong Kong nor New York can offer such a defence. The Hang Seng Tech Index and Nasdaq Golden Dragon Index, both of which track some of China's biggest listed tech groups, tumbled by 28% and 33%, respectively, between the end of June and late August, according to Natixis. By contrast, the STAR 50 index rose by 1.4% over the same period.

Channelling capital at the snap of a finger might be harder than regulators think, however. Many tech groups raise funds privately through offshore structures not recognised by China's regulators. Part of the reason why Chinese tech companies listed abroad in the first place was because the foreign investments they took on made cashing out through an onshore IPO a regulatory minefield.

Mr Xi might launch all the new exchanges he wants, but he has neglected deeper reforms to their governance. The STAR market uses a “registration system” for IPOs whereby, in theory, companies need only meet a number of

clear requirements to go public. In practice, however, the China Securities Regulatory Commission (CSRC) retains control over who goes public and when. A number of listings have been put on hold this year. The CSRC has a “civil-servant mentality” towards keeping markets orderly and avoiding unwanted social disturbances, says a manager at a global investment group. Regulators will be reluctant to shed that mindset, be they in Shenzhen, Shanghai or Beijing. ■



在家千般好

中国设立新交易所为创新企业融资

随着海外上市愈加困难，习近平希望为国内上市提供便利

中国的经济规划者希望提高半导体国产化水平，但他们并不满足于仅仅在国内生产更多芯片。他们想要把整个供应链——从原材料和芯片加工设备到劳动力和资本——都搬到国内。在过去的一年里，已有几万家企业建立起微芯片业务。现在政府正急于确保这些亟需资金的公司也能在国内融到钱。

国家主席习近平9月2日宣布，在上海和深圳的证券市场之外，将在北京设立新的证券交易所。该交易所将由场外交易市场“新三板”改造而来，希望能够引导专业投资者把资本投向快速成长的中小企业。

这并非习近平第一次支持设立新的证券交易所来服务创新型企业：上海的科创板设立于2019年，宣称以更宽松的规则帮助规模较小的企业更快融资。目前国内的上市活动看起来热情高涨。今年全球最大的IPO中有两宗落户上海，分别是国有通信公司中国电信和国有农化巨头先正达。据彭博社报道，今年上海此类上市的融资额看来会达到10年来的最高点。

强调国内融资也非常契合中国的“双循环”战略，这是中国最新五年规划的基石，目标是提振国内市场，减少对外国市场的依赖——往往是出于国家安全的考虑。此举也能抵消海外上市环境不断恶化的影响。国内新规加大了中国公司在海外上市的难度，例如，用户超过100万的互联网公司现在必须首先向网络监管部门申请许可。美国的证券监管机构在几次灾难性的IPO发生后叫停了中国公司在美上市。国会不会对许多中国企业实行强制退市，除非它们提供某些审计文件——但中国政府禁止企业披露这些文件。

从表面上看，海外和国内IPO的角色似乎发生了对调。在香港或纽约上市曾一度被认为可以远离北京的监管，减少政策突变的影响。然而，最新的

政策和地缘政治动荡动摇了海外上市的基础，同时也让在中国上市的证券成了“抵御源自美国制裁的地缘政治风险的一条途径”，法国外贸银行（Natixis）的分析师表示。

香港和纽约都无法提供这样的保障。根据法国外贸银行的数据，从6月底至8月底，追踪中国一些最大的上市科技集团的恒生科技指数和纳斯达克中国金龙指数分别暴跌了28%和33%。相比之下，科创50指数同期上涨了1.4%。

然而，想要一声令下就引导资本的流向可能比监管者以为的要难。许多科技集团通过未获中国监管机构认可的离岸架构开展非公开融资。中国科技公司之所以首先选择了在海外上市，原因之一就是它们已接受的外国投资如果想通过境内IPO变现退出，必然会面临一个监管雷区。

习近平想设立多少个新的交易所都可以，但他忽略了更深层次的对交易所治理的改革。科创板采用IPO“注册制”，理论上，公司只需满足若干明确的要求就可以上市。然而在实践中，中国证监会仍然掌控着谁能上市、何时上市的决定权。今年已有几家公司被暂缓上市。一家全球投资集团的管理者表示，中国证监会有一种“公务员心态”，一心维持市场秩序，避免不必要的社会动荡。无论是在深圳、上海，还是北京，监管者都会难以摆脱这种心态。 ■



Codified crackdown

China has become a laboratory for the regulation of digital technology

There are new protections, but not from the Communist Party

WITH FOREIGN competitors such as Facebook and Google blocked, domestic tech giants have for two decades dominated the Chinese market. The Communist Party has kept a firm grip on politics, but the tech firms have had considerable leeway in their business activities. “It was a Wild West within an authoritarian system,” says Martin Chorzempa of the Peterson Institute, an American think-tank.

Now the Communist Party is reminding internet billionaires who is boss. President Xi Jinping has authorised an extraordinary crackdown. Last year the planned IPO of Ant Group, a giant internet finance company, was halted at the last moment. In July, two days after Didi, a ride-hailing firm, went public in New York, China’s internet regulator ordered it to stop signing up new users, and forced its apps off mobile stores. The city of Beijing on September 6th denied reports that it is considering taking Didi under state control.

Video-game companies are being pushed into scanning their users’ faces to help enforce a ban on children playing online games for more than three hours a week. The crackdown has shifted the balance, says Mr Chorzempa. Now, “technocrats, who have been frustrated for years that companies ignore proper, sensible regulations, are empowered.”

The party is pushing for more than superficial change. It is using a suite of new laws and regulations to force tech firms to alter both their behaviour and their products. The aim is to control what Chinese people see and do online. The new rules will require tech firms to write code for their

platforms so that they promote content that the government likes, and inhibit what it does not. This is likely to be more efficient than the whack-a-mole approach of enforcing the party's will case by case, and plausible at a scale that the labour-intensive approach of trying to control technological systems directly would not be.

In the past month alone Chinese lawmakers have finalised at least four new laws and regulations which, as they go into effect over the next three months, will have the potential to reshape the Chinese internet. Technology regulations in other countries and regions, such as Europe's General Data Protection Regulation (GDPR), mostly require companies to obtain their customers' consent for the specific processing of their data. China's new rules are much stricter and more wide-ranging. Tech firms will be expected to protect national security and public order, says Nicolas Bahmanyar, a data-privacy consultant with Leaf, a law firm in Beijing. "A little banner is not going to cut it," he adds.

A Personal Information Protection Law (PIPL), China's first privacy law, comes into effect on November 1st. Years in the making, it is much shorter and less detailed than GDPR, which inspired it, laying out principles that are both broad and intentionally vague. Details and future reinterpretations are to be dealt with by regulations particular to certain industries or technologies. This, says Mr Bahmanyar, allows regulation to keep pace with fast-changing technology. It also gives the government leeway to enforce vague rules as it sees fit. Didi was hit by rules brought in to govern companies whose digital services are seen as critical infrastructure. These were rewritten to cover foreign listings just as the firm was attempting to go public.

Not all new laws will worry investors as much as the ones used to clobber Didi. Some deal with problems that affect the West, too. One forthcoming set of regulations published in draft on August 27th by the Cyberspace

Administration of China (CAC) looks to set the rules for the use of recommendation algorithms. This is the sort of software that companies like Amazon and Alibaba use to recommend products based on a customer's shopping history, or that short-video apps like TikTok use to work out what viewers like in order to give them more of it.

The draft regulations require, for instance, that companies expose the keywords with which they have labelled their users, and allow users to delete them. This, in principle, will mean that internet users in China will no longer be dogged by advertisements for the refrigerator that a recommendation algorithm has decided they might like to buy. Writing algorithms which lead users to "addiction or high-value consumption" would also be banned. Algorithms which dispatch workers, such as Didi's driver-management system, must "ensure workers' rights and interests". The regulations read like an attempt to fix the problems griped about by consumers everywhere.

They also require firms that deploy recommendation algorithms to "uphold mainstream values" and to "vigorously disseminate positive energy". Such algorithms must not be used to "engage in activities harming national security" or to upset the economic or social order. As such, their aim seems to be to withhold algorithmic juice from any content that does not make the government look good.

Kendra Schaefer of Trivium, a consultancy in Beijing, has written that the publication of these new algorithm regulations marks the moment when Chinese tech laws have gone beyond those in Europe (in America, only California has such rules).

Data-protection experts say many of these changes will be beneficial. Chinese internet users are constantly assailed by spam messages and phone calls. An app developed by the ministry of public security, which promises

to screen fraudulent calls and messages, has become one of the most downloaded in China since it was released in March. The Chinese press is full of stories about people's personal data being stolen. In 2016 Xu Yuyu, a prospective student, died of a heart attack after transferring her life savings to fraudsters who used personal data purchased on the black market to trick her into thinking they represented her university.

Protecting people from such predations will burnish the party's reputation for standing up for the little guy. The new rules give citizens more rights against companies than people in any other country. But they give Chinese internet users precisely no privacy rights enforceable against the state. Indeed, says Sajai Singh of J. Sagar Associates, a law firm in Bangalore, the creation of a single common standard for the treatment of data in China will make it easier for the state to spy on citizens. Mr Chorzempa says rewriting the law to make firms rewrite software is a sea change. Once they start feeling they can intervene "at this level and granularity, what else will they do?" he asks. ■



代码立法整治

中国已成为数字技术监管的实验室

有了新的保护措施，但不防党

由于Facebook和谷歌等外国竞争者被拒之门外，过去20年里中国市场一直是国内科技巨头的天下。虽然共产党牢牢掌控着政治，但科技公司自身的经济活动享有相当大的自由度。“那曾是个威权体制内的‘狂野西部’。”美国智库彼得森研究所（Peterson Institute）的马丁·乔泽姆帕（Martin Chorzempa）说。

现在，共产党正在提醒互联网亿万富豪们谁才是老大。国家主席习近平已授权发起一轮非同寻常的整治行动。去年，互联网金融巨头蚂蚁集团原定的IPO在最后一刻被叫停。今年7月，网约车公司滴滴在纽约上市两天后，被中国互联网监管机构下令停止新用户注册，并从移动应用商店强制下架其应用。9月6日，北京市否认了它正考虑将滴滴收归国家控制的报道。

网络游戏公司不得不开始启用用户人脸识别，来配合执行儿童每周玩网游不得超过三小时的禁令。整治改变了力量平衡，乔泽姆帕表示。如今，“技术官僚们的权力变大了，一改过去多年里企业不把正当合理的监管当回事带给他们的无力感”。

共产党正在推动的不仅仅是表面的变革。它正在通过一整套新的法律法规来迫使科技公司改变其行为和产品，目的是控制中国人在网上的所见和所为。新规定将要求科技公司给自己的平台编写代码来推广政府乐见的内容，禁止政府不喜欢的内容。这应该会比用“打地鼠”式的方法逐个贯彻党的意志更为高效，而且较之那种投入大量人力试图直接控制技术体系的做法，现在的做法更能大规模实施。

仅在过去一个月里，中国的立法机构就敲定了至少四部新的法律法规。随着它们在未来三个月陆续生效，中国的互联网将有可能被重塑。其他国家和地区的法规，如欧洲的《通用数据保护条例》（以下简称

GDPR），大多要求企业在对用户数据做具体处理时须征得用户同意。中国的新规严格得多，涵盖范围也更广。科技公司将需要维护国家安全和公共秩序，立辅（Leaf）律师事务所驻北京代表处的数据隐私顾问尼古拉斯·巴赫马尼阿尔（Nicolas Bahmanyar）表示。“一条小小的横条口号是不够的。”他补充道。

中国首部隐私法《个人信息保护法》将于11月1日生效。这部法规历经多年起草审议，却比它有所借鉴的GDPR篇幅短得多，也粗略得多，列出的基本准则既宽泛又故意含糊其辞。该法的细节和日后的重新解释将交由针对特定行业或技术的具体规定来处理。巴赫马尼阿尔表示，这让监管能够跟上快速变化发展的技术。同时它也给政府留出了空间，以便根据其需要来决定如何执行模糊的规定。一些公司的数字服务如今被视为关键性基础设施，政府为此出台了管治这类企业的法规，滴滴正是因此而受挫：就在它试图上市时，这些规则做出了修订，把海外上市纳入管辖。

并非所有的新法律都会像用以打击滴滴的法律那样引发投资者极大的不安。一些新法律针对的问题同样困扰着西方国家。8月27日，国家网信办发布了一套即将出台的法规的草案，旨在规范算法推荐。亚马逊和阿里巴巴等公司都利用这类软件来根据购物记录向用户推荐产品，TikTok等短视频应用用它们推算观众的喜好，以向他们提供更多相关内容。

例如，该法规草案要求公司告知用户对其添加的标签的关键词，并允许用户删除这些关键词。原则上，这将意味着中国的互联网用户不会再因为推荐算法断定他们可能想买什么冰箱，而受到冰箱广告的困扰。公司也不得编写诱导用户“沉迷或者高额消费”的算法。涉及员工调度的算法，如滴滴的司机管理系统，必须履行“劳动者权益保障”。看起来，这些规定是想解决全世界消费者都在抱怨的问题。

草案还要求利用推荐算法的公司“坚持主流价值导向”并“积极传播正能量”。而且此类算法不得用于“从事危害国家安全”的活动或者扰乱经济和社会秩序。从这些表述来看，这些规定似乎是要让任何有损政府形象的内容都无法得到算法推荐。

北京策纬咨询公司（Trivium）的肯德拉·谢弗（Kendra Schaefer）写道，这些新的算法法规的发布标志着中国的科技立法已经比欧洲走得更远（美国只有加州已有这类法规）。

数据保护专家表示，其中很多改变将是有益的。中国网民频繁受到垃圾短信和电话的骚扰。公安部开发了一款承诺能屏蔽欺诈电话和短信的应用，自3月发布以来已成为中国下载量最大的应用之一。中国媒体上有大量关于民众个人数据被盗的报道。2016年，即将上大学的徐玉玉在把自己的全部积蓄转给骗子后死于心脏病，对方利用从黑市购得的个人数据向她行骗，让她误以为他们是大学的工作人员。

保护人们免遭此类侵害将会提升共产党心系普通民众的声誉。新法规赋予中国公民相比其他任何国家的民众都更多的权利去对抗企业。但它们却恰恰没有赋予中国互联网用户可行使的隐私权去对抗政府。班加罗尔的律师事务所J. Sagar Associates的萨吉·辛格（Sajai Singh）表示，事实上，中国在数据处理方面建立起单一共同标准会更方便政府监视公民。乔泽姆帕表示，修改法律来让公司重写软件是一种翻天覆地的巨变。一旦它们开始觉得自己可以“在这个层面和细节上进行干预，那它们还会再做什么？”他问道。 ■



The other pandemic

A new AIDS vaccine heads to clinical trials

It uses the same mRNA technology as some covid jabs

ONE SILVER lining to the covid-19 pandemic has been the speed with which effective vaccines have been developed. Victims of other pandemics have not been so lucky. Three decades of attempts to create a vaccine against HIV, the virus that causes AIDS, have proved fruitless. The latest setback came on August 31st, when an experimental vaccine produced by Johnson & Johnson, an American pharmaceutical firm, flunked a clinical trial. One obstacle is HIV's genetic slipperiness. The virus has a high mutation rate, which helps it adapt to evade both natural immune systems and artificial vaccines.

Undaunted, Moderna, a firm based in Massachusetts that has recently found fame by quickly coming up with a viable covid-19 jab, is planning to start human trials of a novel vaccine against HIV. Its researchers hope that the mRNA technology used to produce its covid-19 jab will succeed against HIV too, by creating a vaccine which the virus cannot easily dodge.

Moderna's approach is based in part on work by the International AIDS Vaccine Initiative (IAVI), a charity, and Scripps Research, a not-for-profit institute in San Diego. A joint study published in February showed, for the first time in humans, that it is possible to stimulate activity in immune cells called germline B-cells, which can produce things called broadly neutralising antibodies (bnAbs) against HIV.

Antibodies are proteins produced by the immune system in response to infection. Through a process of quick-fire trial and error in response to particular pathogen molecules, known as antigens, the body creates

specialised molecules designed either to gum up the workings of pathogens, or to flag them for destruction by other parts of the immune system. But most antibodies turned out in response to HIV fail to stem the infection for the same reason vaccines do—the virus's rapid mutation rate allows it to evolve to avoid them.

As their name suggests, bnAbs are less susceptible to such countermeasures. In the case of HIV, the antigen they recognise is part of a viral protein called gp120. This is the means by which HIV particles “dock” with their target cells prior to infecting them. The part of the protein that does the docking is so well tailored that almost any mutation will make it less effective. Since gp120 is trapped in an evolutionary corner, it is a desirable target for a vaccine.

Germline B-cells are diverse but rare. Each carries the blueprint of an antibody, and stands ready to do two things when alerted to the presence of a pathogen. The first is a process called somatic hypermutation, which generates daughter cells capable of producing many slightly different versions of that antibody. The second is clonal expansion, in which cells carrying the most successful of these variants multiply to deal with the infection.

The study conducted by IAVI and Scripps used a small engineered protein called eOD-GT8 6omer as an antigen. This protein resembles the cell-docking part of gp120. Crucially, empirical work in both mice and humans has shown that it also stimulates somatic hypermutation in germline B-cells carrying a broadly neutralising antibody called VRCo1. That makes it a promising basis for a vaccine.

The problem with this approach is that eOD-GT8 6omer is slow and expensive to make. Which is where Moderna's technology comes in. mRNA is the messenger molecule that carries, from a cell's chromosomes,

instructions which tell that cell how to make particular proteins. Instead of carrying eOD-GT8 6omer itself, Moderna's vaccine contains the mRNA instructions on how to make it, and leaves the job of production to the body's own cells. Once the molecule enters the bloodstream, it should stimulate the VRC01-carrying germline B-cells to do their stuff. After that, booster shots employing mRNAs for other small antigenic proteins will be used to guide the process of hypermutation in the right direction.

The trial is an early one, designed to test safety and prove the principle. It is testing two approaches. One uses only the mRNA for eOD-GT8 6omer. The other adds mRNA for one of the small, guiding antigens to the shot. It will begin in America later this month, with 56 people. Trials in Rwanda and South Africa should follow shortly after. (UNAIDS, the body charged by the United Nations with combating HIV, estimates that two-thirds of the 38m people infected with the virus by the end of 2020 were in Africa.)

The results from the American trial are expected in 2023. Beyond that, the timeline is less clear. Mark Feinberg, IAVI's boss, citing how difficult HIV vaccine development still is, does not want people thinking that "just because the covid vaccines were developed using RNA technology in less than a year we're going to have an HIV vaccine in less than a year". After three decades of waiting, though, a little more patience is not too much to ask. ■



另一种大流行病

一种新型艾滋病疫苗进入临床试验

它所用的mRNA技术与某些新冠疫苗相同

新冠疫情乌云中的一道曙光是有效疫苗的快速研发。其他大流行病的患者就没这么幸运了。30年来，研究人员一直在研制疫苗以求对抗导致艾滋病的HIV病毒，但始终徒劳无功。最近一次挫败发生在8月31日，美国制药公司强生研制的一种试验性疫苗未能通过临床试验。一个难点是HIV的基因很不稳定。这种病毒具有很高的突变率，有助于它适应新情况以逃避自然免疫系统和人工疫苗的攻击。

总部位于马萨诸塞州的莫德纳（Moderna）公司不为所惧，正计划启动一种新型HIV疫苗的人体试验。这家公司近来因为迅速推出了有效的新冠疫苗而声名鹊起。它的研究人员希望它用于生产新冠疫苗的mRNA技术也能成功创造出一种让HIV病毒无法轻易逃逸的疫苗。

在一定程度上，莫德纳的方法是基于慈善机构国际艾滋病疫苗倡议组织（以下简称IAVI）和圣迭戈的非营利机构Scripps Research的研究。这两者在2月发表的一项联合研究首次发现，有可能在人体中激发被称为生殖系B细胞的免疫细胞的活性，这种细胞可以产生对抗HIV病毒的广泛中和抗体（bnAbs）。

抗体是免疫系统应对感染而产生的蛋白质。通过抵抗被称为抗原的特定病原体分子的快速试错过程，身体会产生专门的分子来破坏病原体的运作，或将病原体标记出来，由免疫系统的其他部分加以破坏。但人体内大多数对付HIV病毒的抗体无法阻止感染，因为这种病毒的高突变率让它能够不断进化以逃逸抗体，疫苗不起作用的原因也在于此。

从广泛中和抗体的名字上可以看出，它们不太容易受这种逃逸机制的影响。在遭遇HIV病毒时，它们所识别出的抗原是病毒蛋白gp120的一部分。HIV病毒颗粒在感染目标细胞之前通过这种蛋白与目标细胞“结合”。

gp120上负责结合的那一部分非常严丝合缝，几乎任何突变都会降低其功效。因此gp120陷入了进化的死角，是疫苗的理想靶标。

生殖系B细胞种类繁多但数量很少。它们每个都携带着一个特定抗体的图谱，并准备好在发现有病原体时做两件事。第一是体细胞超突变，在此过程中一个生殖系B细胞会生成子细胞，这些子细胞能产生其携带抗体的众多略有不同的版本。二是克隆扩增，在这个过程中，携带最有效的那版抗体的细胞会自我复制以对抗感染。

IAVI和Scripps的研究把一种名为eOD-GT8 6omer的小型基因工程蛋白用作抗原。这种蛋白质类似于gp120上与细胞结合的那一部分。至关重要的是，对小鼠和人体的实证研究表明，它也刺激了携带名为VRC01的广泛中和抗体的B细胞的体细胞超突变过程。这让它有望成为一种有效疫苗的基础。

这种方法的问题是制备eOD-GT8 6omer的过程很慢且成本很高。莫德纳的技术在此有了用武之地。mRNA是一种信使分子，它携带来自细胞染色体的指令，告诉细胞如何制造特定的蛋白质。莫德纳的疫苗本身并不含有eOD-GT8 6omer，而是携带如何制造它的mRNA指令，把生产这种蛋白的工作留给人体自身的细胞。一旦mRNA进入血液，它应该就会刺激携带VRC01的生殖系B细胞发挥作用。之后，指示生成其他小抗原蛋白的mRNA疫苗加强针会指导超突变过程朝着正确的方向推进。

该项试验还处于早期阶段，目标是测试安全性并验证原理。它正在测试两种方法。一种仅使用mRNA来生成eOD-GT8 6omer。另一种在疫苗中添加mRNA以生成一种小引导抗原。试验将于本月晚些时候在美国开始，有56人参加。不久之后还将在卢旺达和南非展开试验。（联合国负责抗击艾滋病的机构联合国艾滋病规划署[UNAIDS]估计，到2020年底，全球3800万艾滋病病毒感染者中有三分之二在非洲。）

在美国的试验预计将于2023年得出结果。再往后的时间表就不太明确了。IAVI的总裁马克·范伯格（Mark Feinberg）提到HIV疫苗的研发仍然困难重

重，他不希望人们会以为“仅仅因为不到一年时间就用RNA技术开发出了新冠疫苗，我们就能在不到一年的时间内获得HIV疫苗”。不过反正都已经等了30年，再多给一点点耐心也不是什么太过分的要求。■



Buttonwood

Do physical assets offer investors refuge from inflation?

Property, infrastructure and farmland have their attractions. But they could prove victims of their own success

LIKE PENGUINS and the melting ice cap, investors' natural habitat is changing. Inflation is typically bad news for mainstream assets such as stocks and bonds, because it reduces the present value of future earnings and coupons. Yet this is where, after a decade of slow growth and sluggish inflation, investors have parked much of their trillions. As consumer prices rise uncomfortably fast in much of the world, they are scrambling to protect their portfolios from the changing economic climate.

A growing cohort is placing its faith in “real” assets—the physical sort, including property, infrastructure and farmland. Could these prove a haven in times of change? Investors certainly have good reasons to deem them safe places to perch. Inflation often coincides with rises in the prices of these assets. An economic expansion tends to fuel consumer-price growth as well as demand for floor space and transport or energy infrastructure.

Moreover, these assets produce cash flows that usually track inflation. Many property leases are adjusted annually and linked to price indices. Some—those of hotels or storage space, say—are revised even more often. The revenue streams of infrastructure assets are typically tied to inflation, too, through regulation, concession agreements or long-term contracts. Meanwhile, the rising maintenance or energy costs associated with these assets are often either passed through to tenants (for property) or fixed for long periods (for infrastructure). And debt raised against them—often fixed-rate, and in copious amounts—becomes cheaper to repay.

As a result, real assets have done well during inflationary periods. A recent

report by BlackRock, an asset manager, suggests that the total returns of privately held property and infrastructure assets globally have beaten those of main stock and bond indices when inflation has exceeded 2.5%. David Lebovitz of JPMorgan Asset Management reckons that a typical pension fund should start off by allocating 5-10% of its assets to them, with the share rising to 15-20% over time. Some big funds are in fact bolder: Ontario Teachers' Pension Plan, which manages C\$228bn (\$182bn), wants to lift its allocation from 21% to 30%.

That might all sound very alluring, but it should come with health warnings. For one, performance has become harder to predict: think of retail space and office blocks (under threat from e-commerce and remote work), airports and power plants (exposed to decarbonisation) and even farmland (vulnerable to climate change). The asset class may require a greater appetite for risk and more homework than its backers are used to.

Another difficulty is that real assets are hard to access. They are typically private, meaning that only the most sophisticated investors have the resources and patience to find gems on their own. The rest might gain exposure in public markets, through real-estate investment trusts, infrastructure stocks or exchange-traded funds. But these tend to be closely correlated with equities, defeating the point of investing in them. Institutional investors also have access to private funds, but these tend to deploy capital only slowly and come at a cost, as their managers typically charge high fees.

In any case, real assets cannot insulate an investor's entire portfolio against inflation. Their merit is that they preserve their own value when inflation is high. But to protect all of their capital investors must seek assets that do not just tread water, but gain value more quickly during inflationary bursts than their other holdings depreciate. And there is not a lot of consensus over which ones fit the bill. Gold, commodities, inflation-linked bonds,

derivatives: each has champions and detractors.

Perhaps the biggest danger, though, is that real assets fall victim to their success. Many investors already turned to them over the past decade as they hunted for stable yields and sought diversification. Between 2010 and 2020 private real assets under management more than doubled, to \$1.8trn. Finding things to buy is getting harder. Some \$583bn raised by funds since 2013 remains unspent. A bubble is possible, says David Jones of Bank of America Merrill Lynch. The definition of a real asset may become stretched. Already some argue for it to include exotic fare such as non-fungible tokens—digital media recorded on a blockchain. Rather like penguins that huddle ever closer on a shrinking bit of ice, some investors might find themselves falling into treacherous waters. ■



梧桐

实体资产是投资者抵御通胀的避难所吗？

房地产、基础设施和农田自有其吸引力。但它们的成功也可能最终害了自己

就像企鹅和融化的冰盖一样，投资者的自然栖息地也在发生变化。通货膨胀对于股票和债券等主流资产来说通常是个坏消息，因为它降低了未来收益和息票的现值。然而在经历了十年的增长缓慢和通胀低迷后，投资者已经把数万亿美元资金中的大头都投向了这些资产。随着世界大部分地区的消费价格以令人不安的速度上涨，他们正手忙脚乱地保护自己的投资组合免受经济气候变化的冲击。

越来越多的人把信心寄托在“实物”资产上，也就是包括房地产、基础设施和农田在内的看得见摸得着的那类资产。它们最终能够成为变化时期里的避风港吗？投资者当然有充分的理由认为它们是安全的栖息地。通胀经常与这些实体资产价格的上涨同时发生。经济扩张往往除了会刺激消费价格增长，还会刺激对建筑面积、运输或能源基础设施的需求。

此外，这些资产产生的现金流通常会跟踪通胀。许多房地产租约每年都会调整，并与价格指数挂钩。像酒店或仓储空间等一些房地产修正的频率甚至更高。基础设施资产的收入流通常也通过监管、特许协议或长期合同与通胀挂钩。与此同时，与这些资产相关的不断上涨的维护或能源成本一般要么转嫁给租户（对于房地产而言），要么是长期固定的（对基础设施而言）。而以这些资产做抵押的贷款（通常利率固定，且数额巨大）的偿还成本变得更低。

因此，实物资产在通胀时期一向表现不错。资产管理公司贝莱德（BlackRock）近期一份报告显示，当通胀率超过2.5%时，全球私人持有的房地产和基础设施资产的总回报率已经超过了主要股票和债券指数。摩根大通资产管理公司（JPMorgan Asset Management）的大卫·莱博维茨（David Lebovitz）认为，一个典型的养老基金应该一开始先在实物资产

上配置所管理资产的5%至10%，再逐步上调至15%至20%。一些大型基金实际上还要更大胆：管理2280亿加元（1820亿美元）的安大略省教师养老金计划（Ontario Teachers' Pension Plan）想将其配置比例从21%提高到30%。

这听起来可能非常诱人，但对此也应有所警惕。首先，要预测资产表现变得更难了：想想零售和办公场所（受到电子商务和远程工作的威胁）、机场和发电厂（受到脱碳的冲击）甚至农田（容易受气候变化的危害）。这个资产类别可能需要投资者提升风险偏好、多做功课，超过他们已经习惯的水平。

另一个困难是实物资产很难获得。它们通常是私有的，这意味着只有最老道的投资者才有资源和耐心靠自己寻到宝。其他人可能会通过房地产投资信托、基础设施股票或交易所交易基金在公开市场投资这类资产。但这些投资往往与股票密切相关，如此就又从实物资产回到了股票上，失去了意义。机构投资者也能接触到私募基金，但这些基金往往资本配置缓慢，而且成本不菲，因为它们的管理人通常会收取高额费用。

在任何情况下，实物资产都无法让投资者的整个投资组合免受通胀影响。它们的优点是能在通胀高企时保住自身的价值。但是，投资者若要保护自己的全部资本，就不能只寻觅不涨不跌的资产，还必须寻找能在通胀爆发期间快速升值的资产——速度要快过他们所持有的其他资产贬值的速度。至于哪些资产符合要求，人们并没有太多的共识。黄金、大宗商品、通胀关联债券、衍生品都各有支持者和反对者。

不过最大的危险可能是实体资产会栽在自己的成功上。过去十年，许多寻求稳定收益率和多元化的投资者都已经涉足这类资产。2010年至2020年间，受管理的私人实物资产增加了一倍多，达到1.8万亿美元。值得一买的东西越来越难找。各种基金自2013年以来募集的约5830亿美元现在都还没花出去。美银美林（Bank of America Merrill Lynch）的大卫·琼斯（David Jones）认为可能存在泡沫。实物资产的定义可能会变得过于宽泛。已经有一些人主张把非同质化代币（记录在区块链上的数字媒体）这样稀奇古

怪的品种也包括进来。就像在不断缩小的冰面上挤成一团的企鹅一样，一些投资者可能马上就要掉进危险的水域。 ■



A calculated risk

Why scientists are deliberately infecting volunteers with covid-19

“Human challenge trials” may help answer important questions quickly

IF YOU ARE going to catch covid-19, jokes Jacob Hopkins, a university student, the safest place to do it is in a hospital. So in March Mr Hopkins lay down on a bed in the Royal Free Hospital in London while doctors placed droplets of liquid carrying the SARS-CoV-2 virus into his nose. Mr Hopkins was one of 36 participants in the first “human challenge trial” (HCT) for covid-19.

Human trials are a valuable part of medical research. Studying sick people in the controlled environment of a lab allows scientists to collect valuable information about how diseases work much more quickly than relying on messy and uncertain data from the real world. Since the second world war, around 40,000 volunteers have allowed themselves to be infected with everything from malaria and typhoid to dengue fever and cholera.

But although the idea of doing HCTs for covid-19 has been discussed since the early days of the pandemic, it has proved controversial enough that only Britain has allowed them to go ahead. (A second HCT is under way at Oxford University.) The results from the Royal Free trial, conducted with help from Imperial College London and a firm called hVIVO, which specialises in HCTs, are expected in the coming weeks. They will include details on the natural course of infection of covid-19, how well different tests do in detecting infections, how much exposure to SARS-cov-2 is necessary to infect someone, and how useful masks are in preventing transmission.

Despite the safety worries, the trials have proceeded without incident, says Andrew Catchpole, hVIVO’s chief scientific officer. Volunteers in the trials

had only mild symptoms. And the data generated look like being very useful. Dr Catchpole says he and his team were “stunned” by how consistent the course of the disease was in different volunteers. The shedding of viral particles, for instance—which can then go on to infect others—usually starts within a few days of infection, typically up to day four, after which it increases very quickly.

Another strand of the trial aims to nail down just how long it takes, after an individual is infected, for covid-19 to be detected, both by cheap, widely used lateral-flow tests, and by more expensive, more accurate PCR ones. During the trial, researchers conducted frequent swabs of the rooms that volunteers were confined to. That allowed them to figure out exactly when infectious viral particles—as opposed to just passive blobs of genetic material—were present in the room. There will also be more to say on covid-19’s neurological symptoms, and on the immune response of infected individuals.

Despite this promised bounty of data, HCTs for covid-19 remain controversial. Opponents point out that covid-19 is a potentially dangerous disease that is not well-understood or always treatable. “Long covid”, a mysterious condition in which symptoms persist for months, is a possibility, as is death. Jan Helge Solbakk, head of research at the Centre for Medical Ethics in Oslo, says there is no longer any good argument in favour of HCTs now that vaccines have been developed and tested.

Proponents counter that the safety record of previous HCTs is “outstanding”, and that risks can be minimised by giving young and healthy volunteers the smallest possible dose of the virus. Arthur Caplan, a professor of medical ethics at the Grossman School of Medicine at New York University, points out that drug trials also involve the risk of injury or death, yet are uncontroversial. He says opponents of HCTs are not focusing on the research that is still needed, including into new vaccines, or the time it will

take to obtain such data without HCTs. He accuses them of “fuzzy moral thinking”.

The trial has infected participants with the original strain of SARS-CoV-2 that first emerged in China in 2019. That means not all the data will be generalisable to the Delta variant of the virus, which has become dominant in many countries. But Dr Catchpole says he expects at least some consistency in results concerning the minimum dose needed for infection.

And having conducted one set of HCTs safely, it should be easier to undertake more in future. Further trials could allow quicker tests of vaccines against new variants of SARS-CoV-2, for instance, or tightly controlled comparisons of different jabs to see which is the most effective. (Such questions could take years to answer with real-world data.) They could also help obtain swift answers on how well new or existing drugs work against covid-19.

Adrian Hill, the director of the Jenner Institute, a vaccine-research body based in Oxford, says the risks of conducting HCTs have been reduced by the availability of new treatments for covid-19, such as monoclonal antibodies. Yet even in gung-ho Britain, arguments about safety delayed the start of the trials by months. Covid-19 is unlikely to be the last novel disease the world faces, says Dr Hill. To help save lives in future, he would like to see the ethical questions around HCTs settled before the next pandemic arrives. ■



审慎冒险

为何科学家正故意让志愿者感染新冠

“人体挑战试验”或有助于迅速解答重要问题

如果你要感染新冠，最安全的地方就是在医院。大学生雅各布·霍普金斯（Jacob Hopkins）开玩笑地说。所以今年3月，霍普金斯躺在了伦敦皇家自由医院（Royal Free Hospital）的病床上，医生将携带新冠病毒的液滴滴入了他的鼻子。霍普金斯是首个针对新冠的“人体挑战试验”（human challenge trial，以下简称HCT）的36名参与者之一。

人体试验是医学研究非常有价值的部分。在实验室的受控环境内研究病人，让科学家得以收集有关疾病发展机制的宝贵信息，这比依赖现实世界中混乱又不确定的数据要快得多。自第二次世界大战以来，约四万名志愿者参与了试验，主动感染了疟疾、伤寒、登革热和霍乱等各类疾病。

但是，虽然针对新冠肺炎进行HCT的想法自疫情之初就已开始讨论，结果因为争议太大，只有英国让试验继续推进。（第二次HCT正在牛津大学进行。）皇家自由医院的那次试验的结果预计将在未来几周内公布。伦敦帝国理工学院和专门从事HCT的公司hVIVO协助开展了这次试验。其结果将包括关于新冠感染的自然过程的细节、不同测试在检测感染方面的效果、引发新冠感染的最低病毒载量，以及口罩在阻止病毒传播中的有效性。

hVIVO的首席科学官安德鲁·卡奇普尔（Andrew Catchpole）表示，尽管有安全方面的担忧，但试验过程顺利无虞。参与试验的志愿者只出现了轻微症状。而且产生的数据看起来非常有用。卡奇普尔说，他和他的团队对于不同志愿者的病程是如此一致感到“震惊”。例如，病毒颗粒的脱落——脱落后可以继续感染其他人——通常始于感染后的几天内，一般最晚是在第四天，之后迅速增加。

试验的另一个目的是确定个体感染新冠后需要多长时间才能被检测出来，无论是通过便宜且广泛使用的侧向流检测，还是通过更贵也更精准的PCR

检测。在试验期间，研究人员对隔离志愿者的房间频繁进行拭子检测。这帮助他们准确地弄清楚传染性病毒颗粒——而非被动的少量遗传物质——是何时出现在房间里的。关于新冠肺炎的神经系统症状以及受感染者的免疫反应，也将有更多要探讨的内容。

尽管试验会获得大量数据，但新冠HCT依然存在争议。反对者指出，新冠肺炎是一种有潜在危险性的疾病，尚未被充分了解，也不总是可治疗。它可能致命，还可能出现“长期新冠”这种尚无明确解释的病症：症状会持续数月。奥斯陆医学伦理学中心的研究部负责人贾恩·海里格·索尔巴克（Jan Helge Solbakk）说，既然疫苗已经被研发出来和测试，将不再有任何支持HCT的好理由。

支持者反驳说，先前HCT的安全记录是“出色的”，而且可以通过给年轻健康的志愿者提供最小的病毒剂量把风险降到最低。纽约大学格罗斯曼医学院（Grossman School of Medicine）的医学伦理学教授亚瑟·卡普兰（Arthur Caplan）指出，药物试验也存在受伤或死亡的风险，却并无争议。他说，HCT的反对者不关注仍有需要的研究，包括对新疫苗的研究，也不关心如果不使用HCT要等多久才能获得这些数据。他指责这些反对者有“模糊的道德思维”。

该试验用最早于2019年出现在中国的新冠病毒原始毒株感染了参与者。这意味着并非所有的数据都可以推广到病毒的德尔塔变种，而该变体在许多国家都已经成为主流病毒株。但卡奇普尔说，他预计有关感染所需的最小剂量的结果至少会有部分一致性。

有了安全完成一组HCT的经验，未来进行更多的试验应该会更容易。比如，进一步的试验可以更快地测试针对新冠病毒新变种的疫苗，还可以在严格控制下对比不同的疫苗，了解哪种疫苗最有效。（如果使用现实世界的数据，这些问题可能需要几年时间才能得到解答。）试验还可能帮助迅速查明新药或现有药物对抗新冠的疗效。

位于牛津的疫苗研究机构詹纳研究所（Jenner Institute）的负责人阿德里

安·希尔（Adrian Hill）表示，单克隆抗体等新冠新疗法的出现已经降低了实施HCT的风险。然而，即便在热情高涨的英国，有关安全的争论也将试验的开始时间推迟了数月之久。希尔说，新冠不太可能是全世界面对的最后一场新型疾病。为了帮助拯救未来的生命，他希望围绕HCT的伦理问题能在下一场大瘟疫来袭之前得到解决。■



The Thales of economics

Is China already the world's most dominant economy?

By one measure, yes

IN 2010, WHEN President Barack Obama welcomed his Chinese counterpart to a summit in Washington, DC, he greeted him with a handshake and a swift, shallow dip of the head. The image of America's president bowing before China made an arresting cover photo for the book "Eclipse", published the following year. The book, written by Arvind Subramanian of the Peterson Institute for International Economics, a Washington-based think-tank, predicted that China would soon come to dominate the world economy and that America could do precious little about it. Your correspondent once included the cover image in a presentation at the Central Party School in Beijing. It caused quite a frisson.

To gauge a country's economic "dominance" Mr Subramanian combined its share of world trade, net capital exports and global GDP (measured at both market exchange rates and purchasing-power parities, which try to correct for international differences in the price of similar goods). He gave each attribute a weight loosely based on the IMF's formula for allocating votes to its members. His index, he argued, successfully captured Britain's economic hegemony in 1870, its rivalry with Germany in 1913 and its eclipse by America in the subsequent decade.

According to this measure, Mr Subramanian predicted, China would become the world's most dominant economy by 2020. In the ten years since that forecast, China has faced a trade war with America, its growth has slowed and its currency has suffered bouts of volatility, obliging it to tighten controls on capital outflows. Yet Mr Subramanian's central prediction has come true. Based on the book's original formula, China became the world's

most dominant economy last year (see chart). Its growth slowdown has been no worse (so far) than Mr Subramanian expected and the covid-19 pandemic has helped increase its share of global trade.

Mr Subramanian successfully predicted how his own index would evolve. But does his index successfully capture economic dominance? Other authors have included wealth, GDP per person and other proxies for economic sophistication, as well as scale. (Our favourite index of a country's global influence, put together by Francesc Pujol of the University of Navarra, counts the number of times a country appears in the charts of *The Economist*.) These measures give America a bigger edge.

For the sake of tractability, Mr Subramanian's measure gives every dollar of exports equal weight. But some of America's high-tech exports appear to give it an economic "chokehold" over China that is worth more than their market value. Mr Subramanian thought that China's growing share of GDP and trade could soon elevate its currency into a rival to the dollar. But China's yuan has made little headway. That is partly because China has tightened capital controls, a possibility that Mr Subramanian acknowledged. But he thought that if China clung to such controls it would be to keep the yuan cheap (by preventing capital inflows) not to prop the yuan up (by deterring capital outflows). Still, given the sorry record of most economic predictions, the book's author deserves a handshake and a bow.





经济学先知

中国已雄霸全球经济？

从一种衡量方法来看，的确如此

二〇一〇年，在华盛顿特区的一次峰会中，美国总统奥巴马与来访的中国国家主席握手以示欢迎，还略点了一下头。美国总统向中国领导人鞠躬的这一幕被捕捉了下来，成了次年出版的《大预测》（Eclipse）一书的封面照片，颇为醒目。该书的作者是华盛顿智库彼得森国际经济研究所（Peterson Institute for International Economics）的阿文德·萨勃拉曼尼亚（Arvind Subramanian），他预言中国即将主导全球经济，而美国对此几乎无计可施。笔者在北京中央党校演讲时曾展示这张封面图片，令观众颇为兴奋。

为衡量一国的经济“主导地位”，萨勃拉曼尼亚综合考量该国在世界贸易、净资本流出和全球GDP（包括按市场汇率以及按购买力平价计算，后者根据同类商品在各国间的售价差异做调整）中的份额。他大致按国际货币基金组织为成员分配投票权的公式来给上述各项指标安排权重。他称自己的这个指数准确反映出英国在1870年的经济霸权、在1913年与德国的竞争，以及在随后十年被美国超越的情况。

按这个方法，萨勃拉曼尼亚当时预测中国将在2020年成为世界最具主导地位的经济体。在他提出该预测后的十年中，中美贸易战爆发，中国的经济增速放缓，人民币汇率不断波动，迫使政府加强管制，防止资本外流。但萨勃拉曼尼亚的核心预测已然成真。按他在书中提出的原始公式计算，中国去年已成为全球最主导的经济体（见图表）。中国增长放缓的程度没有超出萨勃拉曼尼亚的预期（到目前为止），而新冠疫情提升了中国在全球贸易中的比重。

萨勃拉曼尼亚成功预测了其指数的走向。但这个指数能准确反映经济主导力吗？除了经济规模，有些作者在衡量这一地位时还纳入财富总量、人均

GDP以及其他反映经济成熟度的指标。（本刊最喜欢的指数由纳瓦拉大学[University of Navarra]的教授弗朗西斯科·普霍尔[Francesc Pujol]编制，它用一国出现在本刊图表内的次数衡量其全球影响力。）按这些衡量方法，美国的优势更大。

为方便操作，萨勃拉曼尼亚的公式给每一美元的出口商品赋予了同样的权重。但美国的一些高科技出口似乎对中国经济有“卡脖子”的作用，因此其实际价值超过市场价值。萨勃拉曼尼亚以为随着中国在全球GDP和贸易中的比重不断增加，人民币地位会很快提升至可与美元抗衡。但人民币至今进展不大。原因之一是中国收紧了资本管制，萨勃拉曼尼亚当年也承认有这种可能。但他认为，如果中国坚持这种管制，目的会是为了保持人民币低汇率（通过阻碍资本流入），而非推高人民币（通过阻止资本外流）。不过，鉴于经济预测大多以失败收场，《大预测》的作者仍然值得我们握手鞠躬。 ■



Turbulent waters

A perfect storm for container shipping

Will prolonged disruptions shift the pattern of trade?

A GIANT SHIP wedged across the Suez canal, record-breaking shipping rates, armadas of vessels waiting outside ports, covid-induced shutdowns: container shipping has rarely been as dramatic as it has in 2021. The average cost of shipping a standard large container (a 40-foot-equivalent unit, or FEU) has surpassed \$10,000, some four times higher than a year ago (see chart). The spot price for sending such a box from Shanghai to New York, which in 2019 would have been around \$2,500, is now nearer \$15,000. Securing a late booking on the busiest route, from China to the west coast of America, could cost \$20,000.

In response, some companies are resorting to desperate measures. Peloton, a maker of pricey exercise bikes, is switching to air freight. But costs are also sky-high as capacity, half of it usually provided in the holds of passenger jets, is constrained by curbs on international flights. Home Depot and Walmart, two American retailers, have chartered ships directly. Pressing inappropriate vessels into service has proved near-calamitous. An attempt in July to carry containers on a bulk carrier, which generally carts coal or iron ore, was hastily abandoned when the load shifted, forcing a return to port. More containers are travelling across Asia by train. Some are even reportedly being trucked from China to Europe then shipped across the Atlantic to avoid clogged Chinese ports.

Trains, planes and lorries can only do so much, especially when it comes to shifting goods halfway around the planet. Container ships lug around a quarter of the world's traded goods by volume and three-fifths by value. The choice is often between paying up and suffering delays, or not importing at

all. Globally 8m TEUS (20-foot-equivalent units) are in port or waiting to be unloaded, up by 10% year-on-year. At the end of August over 40 container ships were anchored off Los Angeles and Long Beach. These serve as car parks for containers, says Eleanor Hadland of Drewry, a shipping consultancy, in order to avoid clogging ports that in turn lack trains or lorries to shift goods to warehouses that are already full. The “pinch point”, she adds, “is the entire chain”.

For years container shipping kept supply chains running and globalisation humming. Shipping was “so cheap that it was almost immaterial”, says David Kerstens of Jefferies, a bank. But disruption after disruption means that the metal boxes are losing their reputation for low prices and reliability. Few experts think things will get better before early next year. The dislocations could even hasten a reordering of global trade.

Shipping is so strained in part because the industry, which usually steams from short-lived boom to sustained bust, was enjoying a rare period of sanity in the run-up to the pandemic. Stephen Gordon of Clarksons, a shipbroker, notes that by 2019 it was showing self-discipline, with the level of capacity and the order book for new ships under control. Then came covid-19. Shipping firms, expecting a collapse in trade, idled 11% of the global fleet. In fact, trade held up and shipping rates started to climb. And, flush with stimulus cash, Americans started to spend.

In the first seven months of 2021, cargo volumes between Asia and North America were up by 27% compared with pre-pandemic levels, according to BIMCO, a shipowners’ association. Port throughput in America was 14% higher in the second quarter of 2021 than in 2019. There has been little growth elsewhere: throughput in northern Europe is 1% lower. Yet rates on all routes have rocketed (see map), because ships have set sail to serve lucrative transpacific trade, starving others of capacity.

A system stretched to its limits is subject to a “cascading effect”, says Eytan Buchman of Freightos, a digital-freight marketplace. Rerouting and rescheduling would once have mitigated the closure of part of Yantian, one of China’s biggest ports, in May and then Ningbo, another port, in August after covid-19 outbreaks. But without spare capacity, that is impossible. “All ships that can float are deployed,” remarks Soren Skou, boss of Maersk, the world’s biggest container-shipping firm. Empty containers are in all the wrong places. Port congestion puts ships out of service. The average door-to-door shipping time for ocean freight has gone from 41 days a year ago to 70 days, says Freightos.

Some observers think normality may return after Chinese new year next February. Peter Sand of BIMCO says disruptions could even take a year to unwind. Lars Jensen of Vespucci Maritime, an advisory firm, notes that a dockers’ strike on America’s west coast in 2015 caused similar disruption, albeit only in the region. It still took six months to unwind the backlog.

On the demand side much depends on whether the American consumer’s appetite for buying stuff continues. Although retail sales fell in July, they are still 18% above pre-pandemic levels, points out Oxford Economics, a consultancy. But even if American consumer demand slackens, firms are set to splurge as they restock inventories depleted by the buying spree and prepare for the holiday season at the end of the year. And there are signs that demand in Europe is picking up.

In a sea of uncertainty, one bedrock remains. The industry, flush with profits, is reacting customarily, setting an annual record for new orders for container-ship capacity in less than eight months of this year, says Mr Sand. But with a two-to-three-year wait, this release valve will not start to operate until 2023. And the race to flood the market may not match torrents of the past. There are far fewer shipyards today: 120 compared with around 300 in 2008, when the previous record was set. And shipping, responsible for 2.7%

of global carbon-dioxide emissions, is under pressure to clean up its act. Tougher regulations come into force in 2023.

The upshot is that the industry “will remain cyclical”, but with rates normalising at a higher level, says Maersk’s Mr Skou. Discipline in both ordering and managing capacity may prove more permanent, aided by consolidation within the industry.

The impact of higher shipping costs depends on the good being transported. Those hoping to import cheap and bulky things like garden furniture might be in for a long wait. Mr Buchman notes that current spot rates might add \$1,000 to the price of a sofa travelling from China to America. The effects on product prices so far may have been dampened: around 60% of goods are subject to contractual arrangements with shipping rates agreed in advance and only 40% to soaring spot prices.

Nonetheless, for most products, shipping costs tend to be a small percentage of the overall cost. The boss of a large global manufacturer based in Europe says the extreme costs now are “bearable”. Nor might shipping rates rise much more even if disruptions continue. CMA CGM, the third-largest container-shipping firm in the world, stunned industry watchers on September 9th when it said that it would cap spot rates for ocean freight. Hapag-Lloyd, the fifth-largest, rapidly followed suit.

Decarbonisation costs mean rates will eventually settle at higher levels than those before the pandemic. Yet research by Maersk suggests that this may not affect customers much. Even if sustainable fuel cost three times as much as the dirty stuff, increasing per-container fuel costs to \$1,200 across the Pacific, for a container loaded with 8,000 pairs of trainers, the impact on each item would be minimal.

Instead it is the problem of reliability that may change the way firms think.

“Just in time” may give way to “just in case”, says Mr Sand, as firms guard against supply shortages by building inventories far above pre-pandemic levels. Reliability and efficiency might also be hastened by the use of technology in an industry that has long resisted its implementation. As Fraser Robinson of Beacon, another digital freight forwarder, points out, supply chains can be made sturdier by using data to provide better “visibility” such as over which suppliers and shipping companies do a better or worse job of keeping to timetables and ordering goods earlier.

There is so far little evidence of “nearshoring”, except in the car industry, says Mr Skou. But the combination of trade war, geopolitics and covid-19 may together lead trade patterns to tilt away from China. Some Chinese firms and the companies they supply are relocating production to lower-cost countries to diversify supply chains and circumvent trade barriers. Mr Kerstens of Jefferies notes that after America under President Donald Trump imposed tariffs on China the volume of trade from China to America fell by 7% in 2019, but American imports remained stable overall as places like Vietnam and Malaysia took up the slack. Hedging against covid-19 shutdowns, particularly given China’s zero tolerance for infections, could provide another reason to move away.

For their part, shipping firms may be preparing for more regionalised trade. The order book is bulging for ships of 13,000-15,000 TEU, smaller than the mega-vessels that can only be handled at the biggest ports. Vietnam opened a new deepwater terminal in January, which can handle all but those largest ships.

Finding new manufacturers is hard, however, especially for complex products. And building buffers into supply chains is costly. But conversations about deglobalising are said to be starting among some makers of low-cost clothing and commodity goods. If high costs and delays persist, some will judge that the benefits of proximity to suppliers outweigh

the costs of bringing in goods made far away. With few alternatives to ships, the only choice will be to move the factories that make them. ■



波涛汹涌

集装箱航运业的完美风暴

旷日持久的混乱会改变贸易形态吗？

一艘巨轮搁浅卡死苏伊士运河。运费破纪录。船只在港口外大排长龙。新冠病毒引发停工。集装箱航运业很少像2021年这样跌宕起伏。运输一个标准大集装箱（40英尺，即一个FEU）的平均成本已超过一万美元，比一年前高出四倍左右（见图表）。将这样一个集装箱从上海运到纽约的即期运费在2019年约为2500美元，现在接近1.5万美元。在中国到美国西海岸这条最繁忙的航线上，临时订舱的运费可能高达两万美元。

因此，一些公司正诉诸于非常措施。高端健身自行车制造商Peloton正在转向空运。但空运成本也很高，因为空运的运力（通常有一半来自客机的货舱）因国际航班限飞而受限。美国零售商家得宝（Home Depot）和沃尔玛直接自己包船。调用不适用的船只的结果几乎是灾难性的。7月曾有公司试图用通常运煤或铁矿石的散装货船运集装箱，但集装箱在船上发生移位，结果不得不仓促放弃，返回港口。越来越多的集装箱通过铁路穿越亚洲。据报道，有些集装箱甚至是先用卡车从中国运到欧洲，然后再海运跨过大西洋，以绕过拥堵的中国港口。

火车、飞机和卡车的运力有限，尤其是要跨越半个地球运输货物时。集装箱船运输的贸易货物约占全球总量的四分之一和总价值的五分之三。现在的选择通常只能是要么支付高价并忍受延误，要么干脆别进口。全球有800万个TEU（20英尺标准集装箱）的集装箱停在港内或等待卸货，同比增加了10%。8月底，40多艘集装箱船在洛杉矶和长滩外等待泊位。这些船充当集装箱的停车场，以避免堵塞港口，港口没有足够的火车或卡车把货物转运到仓库，而且仓库也已经爆满，航运咨询公司德路里（Drewry）的埃莉诺·哈德兰（Eleanor Hadland）表示。“夹点是一整个链条”，她说。

多年来，集装箱航运保证了供应链的持续运转和全球化的繁荣。投行杰富

瑞（Jefferies）的大卫·克斯滕斯（David Kerstens）表示，海运“成本很低，几乎可以忽略不计”。但一次又一次的混乱局面意味着集装箱低价可靠的名声正在丧失。专家们基本认为情况在明年初之前不会好转。混乱甚至可能加速全球贸易的秩序重组。

航运如此吃紧，原因之一是这个行业在疫情前度过了一段罕见的克制期，而它通常的发展周期是在短暂繁荣后进入持续萧条。船运经纪公司克拉克森（Clarksons）的斯蒂芬·戈登（Stephen Gordon）指出，到2019年，航运业表现克制，运力水平和新船订单都受到控制。接着疫情来了。航运公司预计贸易将崩溃，闲置了全球11%的船只。事实上，贸易量持稳，运费开始攀升。而且，手里有了刺激资金的美国人开始消费。

根据波罗的海国际航运理事会（BIMCO）的数据，2021年前七个月，亚洲和北美之间的货运量与疫情前相比增长了27%。2021年第二季度，美国的港口吞吐量比2019年高14%。其他地方几乎没有增长，北欧的吞吐量还降低了1%。然而，所有航线的运费都已飙升（见地图），因为船只都跑去服务利润丰厚的跨太平洋贸易，导致其他航线运力不足。

数字货运市场Freightos的埃坦·布赫曼（Eytan Buchman）表示，一个拉到极限的系统容易出现“级联效应”。中国最大港口之一的盐田港以及另一个港口宁波港分别在5月和8月因出现新冠病例而局部封锁。在过去，这对货运造成的影响可以通过调整航线和变更行程缓解。但目前没有备用运力，没法做这样的调整。“所有能开的船都已经派出去了。”全球最大的集装箱航运公司马士基（Maersk）的老板施索仁（Soren Skou）说。空集装箱都没收回来。港口拥堵使船舶无法投入运输。Freightos表示，海运的平均门到门运输时间已从一年前的41天延长到70天。

一些观察人士认为，到明年2月中国农历新年后的状况可能会恢复正常。BIMCO的彼得·桑德（Peter Sand）表示，混乱局面甚至可能要持续一年才能缓解。咨询公司Vespucci Maritime的拉尔斯·詹森（Lars Jensen）指出，2015年美国西海岸的码头工人罢工造成了类似的混乱，不过影响仅限于该

地区。即便如此，当时仍用了六个月的时间才清理完积压的货物。

在需求这一侧，美国消费者的购买欲望是否会持续很关键。咨询公司牛津经济研究院（Oxford Economics）指出，尽管7月零售额下滑，但仍比疫情前的水平高出18%。但即使美国消费者需求减少，企业接下来应该会开始大笔支出，因为它们要补充因消费热潮而耗尽的库存，并为年底的节日季做准备。有迹象表明，欧洲的需求正在回升。

海上风云变幻，但有一样东西稳如磐石。桑德表示，利润丰厚的航运业正在做出习惯性反应：在今年不到八个月的时间里，集装箱船的年度新订单已创下纪录。但新船交付要等两三年，所以这些泄压阀要到2023年才能开始运作。而且目前的供应能力可能不像以前那样强劲。现在的造船厂要少得多，只有120家，而在2008年创下上一个订单纪录时大约有300家。此外，占到全球二氧化碳排放量2.7%的航运业面临着环保压力。更严格的规定将于2023年生效。

其结果就是航运业“将保持周期性”，但更高的运费会成为常态，马士基的施索仁表示。在行业整合的帮助下，订购和管理船只上的克制可能会更加持久。

运输成本增加造成多大影响取决于运的是什么货。那些希望进口花园家具等廉价大件商品的人可能要等上很久。布赫曼指出，目前从中国运往美国的一只沙发，售价里可能要包含1000美元的即期运费。到目前为止，对产品价格的影响可能被抑制，约60%的货物的运费已经提前在合同中商定，只有40%的货物受即期运费飙升的影响。

尽管如此，对于大多数产品，运输成本往往只占总成本的一小部分。一家总部位于欧洲的大型全球制造商的老板表示，现在的极端成本“尚可承受”。而即使混乱局面持续，运费也可能不会再上涨太多。全球第三大集装箱航运公司达飞（CMA CGM）在9月9日表示将对海运即期运费设定上限，此举震惊了行业观察人士。第五大航运公司赫伯罗特（Hapag-Lloyd）很快跟风。

脱碳成本意味着运费最终将稳定在比疫情前更高的水平上。然而马士基的研究表明，这可能不会对客户产生太大的影响。即便可持续燃料的成本达到污染性燃料的三倍，让跨太平洋运输一个集装箱的燃料成本增加到1200美元，就一个装有8000双运动鞋的集装箱而言，平均到每双鞋的影响也是微乎其微的。

实际上，可能会改变公司思考方式的是可靠性问题。桑德表示，“及时够用”的思路可能会让位给“以防万一”，很多公司建立起远高于疫情前水平的库存，以防供应短缺。在一个长期拒绝高科技的行业里，技术的运用也可能会加速改善可靠性和效率。正如另一家数字货运代理公司Beacon的弗雷泽·罗宾逊（Fraser Robinson）指出的那样，使用数据来提供更好的业务“能见度”，比如了解供应商和航运公司在遵守时间表和提前订货方面的优劣表现，可以使供应链更加稳固。

施索仁说，到目前为止，除了汽车行业外，几乎没有看到“近岸外包”的迹象。但贸易战、地缘政治和新冠疫情的综合作用可能会导致贸易模式绕开中国。一些中国公司及其客户正在将生产转移到成本较低的国家，以将供应链多元化，并规避贸易壁垒。杰富瑞的克斯滕斯指出，特朗普领导下的美国政府对中国加征关税后，2019年中国对美国的出口贸易下降了7%，但由于越南和马来西亚等国填补了空缺，美国的进口量总体保持稳定。对冲疫情封锁的影响可能会是供应商撤出中国的另一个理由，尤其是考虑到中国零容忍的防疫政策。

至于航运公司，它们可能正在为更加区域化的贸易做准备。1.3万至1.5万TEU的船舶订单量越来越大，这些船比只能在最大型港口作业的巨轮要小。越南一个新的深水码头今年1月开始运营，除了那些最大型的船舶，其他所有船只都可在此装卸。

然而，重新找制造商很难，尤其是复杂产品的制造商。而且在供应链中建立缓冲能力的成本高昂。但据说一些低成本服装和商品制造商已开始讨论去全球化。如果高运输成本和延误持续下去，一些企业会判定，靠近供应商的好处会超过把万水千山之外制造的货物运进来的成本。船舶运输无法

替代，唯一的选择将是迁移工厂。 ■



Free exchange

How America should spend on child care

More money is not a guarantee of success

UNLIKE MOST rich European countries, America lacks a coherent public child-care regime. But it has come surprisingly close to having one. During the second world war Congress set up federal child-care centres to encourage women to work in factories; these were later dismantled. In 1971 Congress passed a comprehensive child-care plan. But President Richard Nixon vetoed the bill, calling it “the most radical piece of legislation” to have crossed his desk, and arguing that “good public policy requires that we enhance rather than diminish both parental authority and parental involvement with children.” Now Democrats in Congress are trying again, fashioning a child-care system as part of an enormous social-spending package. It is expected to consist of a universal pre-kindergarten programme for three- and four-year-olds and free or heavily subsidised child care for most Americans. The potential gains from more systematic support are large. But there are trade-offs around its design, too.

The case for some sort of state intervention is straightforward. As any new parent will readily confirm, child care across the rich world is eye-wateringly expensive. Women are disproportionately likely to stay at home to look after their children, so encouraging them to work in the formal sector could increase gender equality. For some children, formal care doubles up as education, helping overcome the disadvantages associated with their family circumstances. Some public spending on child care has such vast benefits in later life that in broad terms it is an investment that pays for itself. Research led by James Heckman of the University of Chicago, for instance, has found that spending on some high-quality programmes for children from birth until their fifth year generated an internal rate of return

of 14%.

Once convinced that there is a case for intervention, governments must consider how to design their schemes: who should be eligible, and what sort of care to provide. The system must not only free up parents to work and be good for children; the benefits must also exceed the costs to the public purse. There is clear evidence that mothers gain from child-care policy. Many studies find that universal schemes (ie, those that apply to families of all incomes) boost labour-force participation. In 1997 the Canadian province of Quebec implemented a full-time universal scheme, costing parents just C\$5 (and later C\$7, \$4-5.50) a day. This raised mothers' participation rates by nearly eight percentage points.

When it comes to children's outcomes, however, the results are mixed. The available research on existing schemes is often patchy. The large returns on investment identified by Mr Heckman and his colleagues, for instance, relate to targeted programmes for poor families. The outcomes of universal schemes, though, are less glowing. One meta-analysis published in 2018 by Thomas van Huizen and Janneke Plantenga of Utrecht University examined 30 studies of such programmes. Only a third found a positive effect of the schemes on children's outcomes, and a fifth found negative effects. Though the scheme in Quebec raised mothers' participation substantially, a study by Michael Baker of the University of Toronto, Jonathan Gruber of the Massachusetts Institute of Technology and Kevin Milligan of the University of British Columbia found that children suffered worse cognitive and health outcomes.

The literature review also found that poor children gained the most from universal programmes. One oft-cited study by Tarjei Havnes, then at the University of Oslo, and Magne Mogstad of the University of Chicago examined what happened to Norwegian children born in the late 1960s and early 1970s, as a heavily subsidised child-care scheme began expanding.

They found strong positive effects on future earnings for poor children, but negative effects on rich ones, whose parents would otherwise have provided better child care than the state. The researchers conclude “that the benefits of providing subsidised child care to middle and upper-class children are unlikely to exceed the costs”.

Added to this, universal care could be regressive. Across rich European countries, low-income families are a third less likely to use early child-care schemes than richer ones. In America poorer families are more likely to tell surveys that they prefer informal, family-based child care to formal care. That suggests that a universal offering would direct public funds to those who do not need it, and that means-testing is a more efficient way to target support.

Having decided who should receive help, the next question is how to deliver it. Here the evidence suggests that quality matters a lot for children's outcomes. Full-time programmes do not necessarily deliver better results than part-time ones. The disappointing results from Quebec are often attributed to wildly disparate standards. By contrast, a study by Mr Havnes and Nina Drange of Statistics Norway of a lottery to enter toddlers into a care scheme in Oslo—where quality is closely regulated by the state—found big improvements in standardised tests taken at age seven.

Left-leaning American politicians like Elizabeth Warren tend to talk in terms of “underinvestment” and “child-care deserts”. But if existing child-care arrangements are low-quality, then spending alone will not improve outcomes for children. A framework that weighs up the benefits of spending on child care for families and setting that against the costs is essential, if the policy is to help the most in need. Without it, child care in America also risks becoming subject to an unseemly mess of regulations: the same tangle of subsidies, supply restrictions and poor quality that afflicts higher education and health care.

As America attempts to Europeanise its safety-nets, the question is not whether a more coherent child-care regime ought to exist, but how it should be designed. Fifty years after Nixon vetoed universal child care, the search is still on for a truly effective American nanny state. ■



自由交流

美国该如何安排儿童保育支出

多花钱不一定能办成事

与大多数欧洲富裕国家不同，美国缺乏一个连贯一致的公共儿童保育体系。但它其实离建成这样一个体系极为接近。第二次世界大战期间，为鼓励妇女去工厂工作，国会建立了很多联邦托育中心；这些中心后来被拆除。1971年，国会通过了一项全面儿童保育计划。但总统尼克松否决了该法案，称它是自己经手的“最极端的法案”，并声称“好的公共政策要求我们加强、而不是削弱父母的威信以及他们对抚养子女的参与”。现在，国会中的民主党人正再次尝试建立儿童保育体系，把它纳入庞大的社会支出计划中。预计该体系将包括一项面向所有三、四岁幼儿的托育计划，以及为大多数美国人提供免费或有高额补贴的儿童保育服务。更系统化的支持可能带来巨大的益处。但它的具体设计仍需要权衡取舍。

做出某种国家干预的理由很简单。在所有富裕国家，儿童保育费用高得令人瞠目，所有新手爸妈对此都深有感触。有太多女性可能要留在家里照顾孩子，鼓励她们进入正式部门工作可以促进性别平等。对一些孩子来说，正规的看护也可以起到教育的作用，有助消除家境造成的劣势。一些用于儿童保育的公共支出日后会带来巨大的好处，因而从大体上说堪称稳赚不赔的投资。例如，由芝加哥大学的詹姆斯·赫克曼（James Heckman）主持的研究发现，一些为从出生到五岁的儿童提供的高质量托育项目的支出产生了14%的内部收益率。

一旦确信有必要干预，政府就必须考虑如何设计自己的方案：覆盖哪些人，以及提供什么样的照护。这个系统不仅要让父母能有时间去工作并让孩子受益，而且对公共资金来说，收益也必须超过成本。有确凿的证据表明儿童保育政策让母亲受益。很多研究发现，全民托育计划（面向所有家庭，不论收入水平高低）提高了劳动力参与率。1997年，加拿大魁北克省实施了全日制的全民托育计划，父母每天只要交纳5加元（后来是7加元，

即4至5.5美元）。这让母亲的劳动力参与率提高了近八个百分点。

然而对于孩子的影响，结果却是有好有坏。对现行计划的已有研究往往不是很全面。例如，赫克曼和他的同事们所指出的高回报与专门针对贫困家庭的项目相关联。而全民保育计划的效果却没那么耀眼。2018年，荷兰乌得勒支大学（Utrecht University）的托马斯·范赫伊曾（Thomas van Huizen）和詹尼克·普兰滕加（Janneke Plantenga）发表了一项统合分析，查阅了针对此类项目的30项研究。只有三分之一的研究认为这种全民计划对孩子的成长有积极影响，有五分之一的研究认为有负面影响。虽然魁北克省的托育计划大大提高了母亲的劳动力参与度，但多伦多大学的迈克尔·贝克（Michael Baker）、麻省理工学院的乔纳森·格鲁伯（Jonathan Gruber）和英属哥伦比亚大学的凯文·米利根（Kevin Milligan）的一项联合研究发现，儿童的认知能力和健康状况反而下降了。

上述统合分析还发现，贫困儿童从全民托育项目中获益最多。上世纪60年代末和70年代初，挪威政府开始推行一项高额补贴的儿童保育计划。针对这一时期出生的挪威儿童所受的影响，曾在奥斯陆大学任教的塔杰亚·哈夫纳斯（Tarjei Havnes）和芝加哥大学的玛格尼·莫斯塔（Magne Mogstad）做了一项后来经常被引用的研究。他们发现，该计划对贫困儿童的未来收入有强烈的积极影响，但对富裕儿童却有负面影响，因为富裕儿童的父母原本会为孩子提供比政府更好的照护。他们的研究结论是，“为中上阶层的孩子提供有补贴的儿童保育所带来的收益不大可能超过成本”。

此外，全民托育的实际效应有可能是递减的。在富裕欧洲国家，低收入家庭参加托育计划的可能性比富裕家庭低三分之一。调查显示，在美国，贫困家庭更有可能选择非正规的居家儿童照护，而不是正规的看护。这表明，全民托育计划会把公共资金用到那些不需要支持的人身上，而经济状况调查可以更有效地确定哪些人需要支持。

确定了哪些人应该成为受助对象之后，下一个问题就是如何提供帮助。在这一点上，有证据表明，质量对于孩子能否受益很关键。全日制计划的效

果不一定好于全日制。魁北克的项目结果令人失望，原因常被归结于迥然不同的测评标准。相比之下，挪威统计局（Statistics Norway）的哈夫纳斯和尼娜·德兰格（Nina Drange）研究奥斯陆的一项保育计划发现，参与幼儿在七岁参加标准化考试时成绩大幅提高。该计划通过抽签的方式选择幼儿参与者，托育质量受到政府的严密监管。

伊丽莎白·沃伦（Elizabeth Warren）等美国左倾政客动辄大谈“投资不足”和“儿童保育的荒漠”。但是，如果现有的儿童保育计划质量不佳，那么单靠砸钱并不能让儿童受益更多。若要让政策能够帮助到最需要帮助的人，就必须建立一个框架来评估家庭儿童保育支出的益处，并与成本做比对。如果没有这样的框架，美国的儿童保育也有可能受制于一堆不合时宜的规章制度：补贴、供应限制和质量低下的“乱毛球”就同样困扰着高等教育和医疗保健。

在美国试图让自己的社会安全网向欧洲看齐之时，问题不在于该不该有一个更系统化的儿童保育体系，而在于该如何设计这个体系。在全民儿童保育被尼克松否决50年后，美国仍在探索成为一个真正有效的保姆式国家。





Robot masters

Edtech that helps teachers beats edtech that replaces them

As children go back to in-person lessons in America some innovations will stay

COVID-19 FORCED ten years of digital transformation in schools to take place in a month, says John Martin, the former leader of Sanoma Learning, an education technology (edtech) company. Teachers suddenly became more willing to use technology because the alternative was not to teach. Much of this technology will remain as pupils head back to the classroom this term. But the experience has refined what edtech is really for.

School closures also forced entrepreneurs to grapple with a stark truth: few are interested in completely disrupting the classroom. For decades innovators imagined a future without traditional learning. MOOCs (massive open online courses), like Udacity and Coursera, were supposed to replace in-person learning. Teachers and school administrators feared that technologists were aiming to replace them. Before the pandemic, most American schools were hesitant to adopt technology, says Jean Hammond, co-founder of LearnLaunch Accelerator, a startup programme. “Lots of cool, amazing little things would come along. But because...schools hadn't been trained in how to adopt new technology, change was very slow.”

Tech entrepreneurs “put the tech before the ed” before the pandemic, explains Mr Martin. Innovators have since grasped that their technology must support teachers in the classroom rather than attempt to remove them, he explains. Much of the \$2.2bn in venture and private-equity capital raised in 2020 is being invested with this in mind.

Teacher training is one example of what this means in practice. Traditional teacher training is limited. “When teachers learn, they listen to people talk

about teaching, and they talk with each other about teaching. They very rarely teach things,” explains Justin Reich of the Teaching Systems Lab at the Massachusetts Institute of Technology. “If you look at how nurses are trained, how therapists are trained, how clergy members are trained, they practise what they’re doing all the time.”

This is starting to change. Researchers at the University of Virginia (UVA) are training their education students using virtual reality simulators created by Mursion, a tech company. The teacher trainees experience several virtual practice scenarios such as a parent-teacher conference, small-group instruction, and large-group instruction. A digital puppet master plays the role of the parent and pupils behind the scenes, but the developers plan for the programme to eventually become automated. The technology is currently being used in over 50 American colleges.

Sarah Kiscaden, a teacher trainee at UVA, is pleased with the experience. “If we didn’t have this simulator, we would be learning everything in classes every day, and then be expected to just keep it all in our brain and apply it all at the same time, the next day in our schools. And I think that is a lot less realistic of an expectation than if you’re taught a skill, and you get to practice it and internalise it.” The simulators also relieve the pressure of teaching in front of children for the first time.

Artificial intelligence could also play a role in teacher training. Researchers at UVA and Worcester Polytechnic Institute are using machine learning, a process by which a computer learns to perform a task by analysing examples, to evaluate videos of teachers in action. Currently teachers get feedback from fellow humans, often administrators, who come to the classroom, observe a lesson and score the teacher. The researchers hope eventually to use machine learning to automatically score teachers, making the current feedback process more frequent, more accurate and less time intensive.

Barriers remain for edtech, despite the path cleared by the pandemic. Ms Hammond explains that outdated regulations can limit classroom innovation. Some state standards are rigid, even specifying the number of hours that must be spent in a classroom. Edtech is also unusual in that the end users are not often the buyers.

The buyer might be the school district, the user might be the teacher, and the real user is the learner. “It’s very hard to get the learner voice into the mix of things,” explains Ms Hammond. And the purchasing usually occurs only once per academic year. Tyler Borek, co-founder of Literably, an edtech startup, says that this provides fewer opportunities to iterate. Still, much of the technology used during the pandemic—classroom devices, apps for parents to follow their child’s progress and so on—is here to stay. ■



教师驾驭机器人

教育科技帮助教师免被教育科技取代

在美国，等孩子们重新回归面授教学，一些创新将会保留下来

新冠肺炎迫使学校在一个月内完成了原本需要十年的数字化转型，教育科技（edtech）公司Sanoma Learning的前老板约翰·马丁（John Martin）说。老师们突然间变得更愿意使用技术了，因为不这么做的话就只能挥别讲台。当学生们在本学期回到教室时，这些技术中的很大一部分都将保留下来。但这段经历明确了教育科技的真正目标。

学校关闭期也迫使企业家去适应一个明明白白的事实：没什么人对彻底颠覆课堂感兴趣。几十年来，创新者畅想一个传统学习方式消失的未来。人们本以为优达学城（Udacity）和Coursera之类的慕课（MOOC，大规模开放在线课堂）会取代面对面教学。教师和学校管理人员担心技术专家会把他们替代掉。创业项目LearnLaunch Accelerator的联合创始人简·哈蒙德（Jean Hammond）说，在疫情发生前，大多数美国学校都对采用技术犹豫不决。“本来会有很多很酷很棒的小事情发生。但是因为.....学校没有接受过如何采用新技术的训练，所以变化非常缓慢。”

马丁解释说，在疫情前，科技企业家“把科技置于教育之前”。创新者在那之后已经意识到，他们的技术必须给课堂上的教师以支持，而不是试图将他们赶走。2020年筹集的22亿美元风险资本和私募股权资本中，很大部分的投资都是基于这样的出发点。

这在实践中意味着什么？可以来看看教师培训这个环节。传统的教师培训是有局限的。“老师们在学着当老师时，他们听别人谈论教学，互相谈论教学。他们很少直接教授，”麻省理工学院的“教学系统实验室”（Teaching Systems Lab）的贾斯汀·赖克（Justin Reich）解释道，“如果你去看看护士、治疗师、神职人员是如何培训的，就会发现他们一直都在练习自己的工作。”

这已经开始改变。弗吉尼亚大学的研究人员正在使用科技公司Mursion创建的虚拟现实模拟器培训本校教育专业的学生。见习教师们体验了几种虚拟实践场景，比如家长会、小组教学和大班教学。一个数字“木偶操纵者”在幕后扮演家长和学生，但开发人员的计划是让该程序最终实现自动化。目前有50多所美国大学在使用这项技术。

萨拉·基斯卡顿（Sarah Kiscaden）是弗吉尼亚大学的一名见习教师，她对这种练习方式很满意。“如果没有这个模拟器，我们就得在每天的课堂上学会所有东西，大家期待我们第二天到校授课时都已经记在了脑子里，还全都用上了。我觉得，如果教你一种技能后，能让你去练习并把它内化，才是现实得多的做法。”模拟器还缓解了第一次在孩子们面前上课的压力。

人工智能或许也能在教师培训中发挥作用。弗吉尼亚大学和伍斯特理工学院（Worcester Polytechnic Institute）的研究人员正在使用机器学习（也就是让计算机通过分析例子来学着执行任务）评估教学视频。目前老师们都是从其他人那里得到反馈，通常是行政人员，他们会来到教室听一节课，然后给老师打分。研究人员希望最终能够运用机器学习来自动为教师评分，让现行的反馈过程更频繁、准确，也更省时间。

尽管疫情扫清了道路，但教育科技仍面临障碍。哈蒙德说，过时的法规可能会限制课堂创新。一些州的标准很严格，甚至规定了必须用于课堂教学的小时数。教育科技还有一个特殊性：它的终端用户通常并不是买家。

买家可能会是学区，用户可能会是老师，而真正的用户是学习者。“很难在这样的混杂之中听到学习者的声音。”哈蒙德说。而且购买通常每学年只发生一次。教育科技创业公司Literably的联合创始人泰勒·博雷克（Tyler Borek）表示，这减少了迭代的机会。尽管如此，像教室设备、让家长能跟踪子女学习进度的应用等许多疫情期间使用的功能仍会保留下来。 ■



Asian supply chains

Japanese companies try to reduce their reliance on Chinese manufacturing

But only a bit

AT THE END of the month the production line of a Toshiba factory in Dalian will come to a halt, 30 years after the Japanese electronics giant opened it in the north-eastern Chinese city. Once a totemic example of global supply chains expanding into China, the closure exemplifies how these are being reconfigured. The short answer is: delicately and at the margin.

Toshiba's plant in Dalian has spanned a sea change in Asian business patterns. When it opened, Japan was the undisputed linchpin of the region's trade and manufacturing networks. By 2019 Japan's \$390bn in intermediate-goods trade with big Asian economies was vying for runner-up status with South Korea and Taiwan. China, with \$935bn-worth, was way ahead.

Hourly wages commanded by Chinese workers have risen tenfold in nominal terms this century, to \$6.20. That is still a quarter of Japanese rates but twice the pay of Thai workers, who were at parity with Chinese ones as recently as 2008. If that were not enough, geopolitical tensions are souring relations between the increasingly heavy-handed Chinese Communist Party and the world's rich democracies.

These trends help explain why China's share of Japan's new outbound foreign direct investment has steadily declined since 2012. The number of manufacturing affiliates that Japanese companies have in China stopped growing almost a decade ago, while new affiliates elsewhere in Asia—notably India, Indonesia, Thailand and Vietnam—have continued to mushroom. Toshiba will offset some of the forgone capacity with expansion in some of its 50 factories back home and also in Vietnam, one of its 30

overseas facilities. It is tapping the Japanese government's year-old subsidy scheme to encourage reshoring and diversification of supply chains (and whose unspoken aim is to reduce reliance on China).

Many other Japanese firms find themselves in a similar situation. This month OKI Electric Industry, a smaller Japanese electronics-maker, announced that its factory in Shenzhen, set up 20 years ago, would stop making printers. That capacity would move to existing factories in Thailand and Japan. Still, most are not rushing to exit China altogether. A survey last year for the Japan External Trade Organisation, a government body, found that 8% of Japanese companies said they were planning to reduce or eliminate their Chinese presence, less than the average for Japanese firms in other countries. Many global companies, from Hasbro (an American toymaker) to Samsung (a South Korean technology giant) are making a similar calculation. Toshiba itself will maintain a second, part-owned factory in Dalian.

Even the most tub-thumpingly patriotic executive would hesitate to sever ties with the world's second-biggest economy. This would disrupt profitable relationships with Chinese suppliers and manufacturing know-how. Such things take years to forge. But at the margin, where companies find themselves pressed by the imperatives to cut costs and guarantee stable future supplies, China no longer looks like the place to be. ■



亚洲的供应链

日本公司试图减少对中国制造的依赖

但只是一点点

本月底，日本电子巨头东芝在大连开设了30年的一家工厂将停产。它曾经是全球供应链扩展到中国的一个典型例子，如今它的关闭又示范了这些供应链正在如何被重新配置。答案一言以蔽之就是：小心翼翼，稍稍调整。

东芝位于大连的这家工厂经历了亚洲商业模式的沧桑巨变。当初它开设时，日本是亚洲贸易和制造网络中无可争议的枢纽。到2019年，日本与亚洲大型经济体之间的半成品贸易为3900亿美元，与韩国和台湾地区争夺亚军位置。中国以9350亿美元的贸易额遥遥领先。

本世纪以来，中国工人的小时工资按名义价值计算已经上升了10倍，达到6.2美元。这仍然只是日本工人工资的四分之一，但却是泰国工人工资的两倍，后者在2008年时还与中国工人持平。不仅如此，紧张的地缘政治局势让日益强硬的中国共产党和世界上富裕的民主国家之间的关系不断恶化。

这些趋势有助于解释为什么自2012年以来，中国在日本新增对外直接投资中的份额稳步下降。几乎在十年前，日本公司在中国的制造分支数量就已经停止增长，而在亚洲其他地方——特别是印度、印度尼西亚、泰国和越南——新的分部继续涌现。东芝将对日本国内和越南的50家工厂的其中一些进行扩产，来弥补一部分在中国放弃的产能，越南是东芝的30处海外生产基地之一。它正在利用日本政府一年前推出的补贴计划，该计划鼓励制造回流和供应链多元化（未言明的目标是减少对中国的依赖）。

许多其他日本公司也发现自己处于类似的境地。本月，规模更小些的日本电子产品制造商冲电气工业株式会社（OKI Electric Industry）宣布，它在深圳设立已20年的工厂将停止生产打印机。这些产能将转移到泰国和日本的现有工厂。不过，大多数公司并没有急于完全退出中国。去年，日本的

政府机构日本贸易振兴机构（Japan External Trade Organisation）的一项调查发现，8%的日本公司表示计划减少或完全放弃在中国的业务，低于对在其他国家业务有此打算的平均比例。从美国玩具制造商孩之宝到韩国科技巨头三星，许多跨国公司都在做类似的筹划。至于东芝，它将保留在大连的第二家工厂，这是一家合资企业。

即使是爱国热情最高涨的企业高管也不会毫不犹豫地与世界第二大经济体断绝往来。这会破坏与中国的供应商和制造技术之间有利可图的关系。这样的关系需要多年时间才能缔造。但就眼前这一步而言，企业发现自己面临削减成本和保证未来供应稳定的紧迫任务，中国看起来不再是最佳选择。 ■



Agriculture and climate change

How to toilet train your cow

And save the planet at the same time

PUPPIES CAN be taught. So can human children, though not for the first couple of years. Now, in the hope of fighting climate change, Dr Jan Langbein, of the Fredrich-Loweffler-Institut in Germany, and his colleagues hope they can train cows to use the toilet, too.

Cow urine contains urea, a nitrogen-rich compound that, when broken down by enzymes in cow faeces, is converted into ammonia. Bacteria in the soil, in turn, convert that ammonia into nitrous oxide. Best known as a dental anaesthetic, the stuff is also a potent greenhouse gas. And agriculture is a big source of it. In the European Union, livestock farming accounts for around 70% of ammonia emissions.

Collecting and treating cow pee before the ammonia can be produced might, therefore, seem like a good idea. But it has proved difficult in the past without confining the cows to small areas, which is bad for their welfare. As Dr Langbein describes in *Current Biology*, this conundrum could be solved if free-roaming cows could be persuaded to voluntarily relieve themselves in a latrine.

But going to the loo is a tricky business, says Dr Langbein. It requires awareness of bladder fullness, self-control to override excretory reflexes, selection of a latrine, and intentional relaxation of the muscles which control the flow of urine. Nevertheless, he has developed a three-stage process to help cows master toilet training.

The first job was to establish the latrine as the correct place to conduct business. Calves were confined to a latrine and rewarded with molasses or

crushed barley after peeing in it. Next, they were given the freedom to roam around an alley outside the latrine. Urinations in the latrine were rewarded; those in the alley were gently punished with a spray of water. Finally, the alley that led to the latrine was extended, to allow the animals to practise self-control for longer, and over a greater distance.

Cows are fairly intelligent animals, and the lessons proved quite effective. Of the 16 calves enrolled in the training process, 11 were considered successfully toilet-trained by the end of it. Their overall performance, say the researchers, was roughly comparable to that of human children. The animals managed to pee in the latrine around 77% of the time.

Dr Langbein is optimistic that his methods can be improved further. One step would be to extend the principle to faeces, which also contains nitrogen, and is another source of nitrous oxide. The effectiveness of the training could be boosted too, perhaps with longer-lasting lessons, or by making adjustments to rewards and punishments. He notes that the success rate increased after repositioning the water-sprayer used to punish errant animals. Four out of eight calves were successfully trained before it was moved, compared with seven out of eight afterwards—though the small sample size means this difference is not statistically significant. More research, as always, is required.

The next step, says Dr Langbein, is to see if cattle on a working farm can be similarly trained. Whether farmers will be keen is another question. Building toilets and training animals costs time and money, after all. But when it comes to climate change, every little helps. ■



农业和气候变化

如何训练你的奶牛上厕所

顺便拯救地球

小狗可以接受训练。小孩也可以，虽然头两三年不行。现在，德国弗里德里希·洛夫勒研究所（Fredrich-Loeffler-Institut）的杨·朗拜因（Jan Langbein）及其同事希望他们也能训练奶牛上厕所，以助力抗击气候变化。

牛的尿液中含有尿素这种富含氮的化合物，被牛的粪便中的酶分解后会转化为氨。土壤中的细菌又会将氨转化为一氧化二氮。这种物质最出名的用途是牙科麻醉剂，它也是一种强效温室气体。而农业正是温室气体的一个重要源头。在欧盟，70%的氨排放来自畜牧业。

因此，在氨产生之前收集和处理牛尿似乎是个好主意。但过去的事事实证明，如果不把奶牛圈在小范围内（这会损害奶牛的福利），就很难做到这一点。正如朗拜因在《当代生物学》（Current Biology）中描述的，如果能说服这些自由漫步的奶牛自愿定点上厕所，这个难题就能得到解决。

但上厕所是件麻烦事，朗拜因说。它需要对膀胱充盈的感知、克服排泄反射的自控力、挑选一处厕所和自觉放松控制尿液流动的肌肉。不过，他已经开发了一个三步流程来帮助奶牛掌握如厕训练。

第一步是把公厕确立为正确的排尿地点。先把小牛关在公厕里，它们在里头排尿后会被奖赏糖浆或大麦碎。下一步，让小牛在厕所外的走廊自由走动。到厕所里排尿会获得奖励，尿在走廊就会受到喷水的温和惩罚。最后，延长通向厕所的走廊，以练习牛群在更长时间和更远距离憋住尿的自控力。

奶牛是相当聪明的动物，事实证明，这些课程成效显著。在16头参加训练的小牛中，有11头被认为在训练结束时成功学会了上厕所。研究人员说，

它们的整体表现与人类孩童大致相当。这些动物在约77%的时间里都做到了在厕所内排尿。

朗拜因乐观地认为他的方法能够进一步完善。其中一步将是把该原理拓展到同样含氮的粪便中，这是一氧化二氮的又一个来源。训练的有效性也可能提升，或许是通过增加课程时长，或者调整奖惩机制。他指出，在改变用于惩罚犯错的喷水器的位置后，成功率提高了。在移动喷水器之前，八头小牛中有四头受训成功，移动后则有七头受训成功。不过，因为样本太小，这一差别在统计学上没有显著的意义。像往常一样，还需要更多的研究。

朗拜因说，下一步是研究农场的牛是否能同样成功受训。农民是否乐意就是另一个问题了。毕竟，建厕所和训练动物都耗时费钱。但涉及到气候变化的挑战时，点滴进展都有意义。 ■



Bail-outs and bedlam

Evergrande's crisis highlights China's shortcomings

Can “common prosperity” lead to financial stability in China?

CHINA'S VAST and opaque financial system has long posed a threat to its economy and the world. The agonies of Evergrande, a property firm with towering debts, are a reminder of how hard it is to manage the risks. The government is attempting to impose an orderly default on some of its creditors but faces the risk of contagion. The episode also highlights a bigger question of whether President Xi Jinping's crackdown on business will make it even harder to create a reformed financial system that is safer, more open and more efficient.

Part of what makes China's financial industry daunting is its size. Banking assets have ballooned to about \$50trn and they sit alongside a large, Byzantine system of shadow finance. Total credit extended to firms and households has soared from 178% of GDP a decade ago to 287% today. The industry suffers from opacity, a lack of market signals and the erratic application of rules. Property is part of the problem. Families funnel their savings into apartments rather than casino stockmarkets or state-run banks. Real-estate developers raise debts in the shadow-banking system in order to finance epic construction booms.

As well as being big, the system is inefficient at allocating capital, dragging down growth. Nor is this a problem the world can ignore. Chinese firms have issued roughly \$1trn of dollar bonds, many of them snapped up by foreign investors. A liquidity crunch in China's economy would hurt global activity, from commodity markets to the sales of luxury goods.

With an illiquid portfolio of property projects financed by \$300bn of

liabilities, 80% of them short-term, Evergrande has a huge liquidity mismatch. It has struggled to cope with new government rules designed to curb excessive borrowing in the real-estate industry but which may now have backfired.

Bailing out financial firms can be distasteful but necessary—just ask the officials who rescued AIG and Citigroup. China's government is worried that a default could cause contagion in the bond market and shadow-banking industry and lead to job losses and stalled projects in the property sector, which underpins a fifth or so of GDP. As we went to press, it was unclear whether the government would blink and rescue the firm.

While the dilemma of “too-big-to-fail” is common, many elements of the Evergrande saga highlight China’s shortcomings. Evergrande’s statements about whether it has missed interest payments have been confusing, leaving investors in the dark. It is unclear if the formal hierarchy of creditors matters or whether the Communist Party’s view of who counts will override it. The sense of opacity and political machination is part of a pattern. Huarong, a state-owned financial firm suffering from fraud, hid a \$16bn loss for months. It was eventually bailed out in August.

Evergrande shows the importance of deeper financial reforms. But what might they look like? Liberal reformers have longed for a clean-up of bad debts, a loosening of controls over prices (including the exchange rate), transparency and independent courts that can enforce property rights. Such a system would allocate capital better and be less prey to moral hazard.

Mr Xi’s authoritarian regime helps financial stability in some ways: he sees excessive borrowing as a security risk and may terrify debt-hungry tycoons into being more cautious. The centralisation of power may make it easier to control crises at sprawling organisations such as Evergrande.

But his broad agenda to reassert control over the economy, information flows, courts and regulators cuts against the thrust of financial reform. Why would he want a more open capital account, which would raise the risk of capital flight following political purges, or private creditors to have stronger rights, or to delegate the role of picking tomorrow's industries to investors? Even if Evergrande escapes calamity, the consequences of Mr Xi's policies for the long-term health of the financial system are only just starting to sink in. ■



【首文】纾困与混乱

恒大危机突显中国短板

“共同富裕”能带来金融稳定吗？

中国的金融体系庞大而不透明，长期对自身经济和整个世界构成威胁。债台高筑的房地产公司恒大陷入困境，再度让人看到管理这种风险的难度。中国政府正试图对部分债权人实施有序违约，但又可能导致违约风险扩散。这起事件还突显出一个更大的问题，即国家主席习近平对商界的打压是否会导致中国更难推进改革以建成更安全、开放和高效的金融体系。

中国的金融业令人望而生畏，规模是一个原因。银行业资产已膨胀到约50万亿美元，而且与之并存的还有一个庞大而错综复杂的影子金融系统。提供给企业和家庭的信贷总额已从十年前占GDP的178%飙升到如今的287%。整个行业受累于不透明、缺乏市场信号，以及规则实施变化无常。房地产是问题的一部分。家庭把积蓄注入房产，而非投向赌场式的股市或者放在国有银行。房地产开发商通过影子银行系统借贷，用这些资金大兴土木。

除了规模大，这个金融体系的资本配置效率低下，拖累了增长。这对全世界也是个不容忽视的问题。中国企业发行了约一萬亿美元的美元债券，很多由外国投资者抢购。假如中国经济出现流动性紧缩，从大宗商品市场到奢侈品销售的全球活动都将遭受损害。

恒大的房地产项目流动性低下，其资金源于3000亿美元的负债，其中80%是短期债务，存在严重的流动性错配。恒大苦于应对政府旨在遏制房地产业过度借贷的新规，而这些规定现在看来可能是事与愿违。

救助金融企业有时令人反感但又实属必要，问问当日给美国国际集团（AIG）和花旗集团纾困的官员就知道了。中国政府担心违约会在债券市场和影子银行业蔓延，并在房地产行业引发失业潮和项目停工——这个部门撑起了中国约五分之一的GDP。截至本期文章付印时，仍不清楚中国政

府是否会手软而救恒大。

虽然“大而不倒”的窘境很常见，但恒大这场持续多日的大戏的许多元素都突显了中国的短板。恒大是否已逾期付息发表的声明措辞含混，让投资者不明就里。目前还不清楚是以债权人的正式求偿等级为准，还是由政府决定债权人孰重孰轻。这种不透明和充满政治谋划的感觉都是一套处理模式的组成部分。受欺诈拖累的国有金融集团华融曾把亏损160亿美元的情况隐瞒了数月。到了8月，政府最终还是出手纾困。

恒大事件显示了深化金融改革的重要性。但会是怎样的改革呢？自由派改革者一直渴望全面清理坏账，放松对价格（包括汇率）的管制，提高透明度，并建立能实施产权保护的独立法院。这样的体系将能更好地配置资本，也更少受道德风险的影响。

习近平的威权体制在某些方面有助于金融稳定性：他视过度借贷为安全隐患，也许能震住那些渴求借贷的大亨，让他们更谨慎行事。中央集权也许更方便控制恒大这类无序扩张的机构酝酿的危机。

但是，他更大的目标是重新加强对经济、信息流动、法院和监管机构的控制，这与金融改革的主旨是矛盾的。他为何要放开资本账户管制呢，假如这会方便资本在政治清洗后外逃的话？他又为什么会想让私人债权人拥有更大的权利？为什么要把未来发展什么产业的选择权交给投资者？即使恒大逃过这一劫，习近平的政策对金融系统长期健康的影响也只是初现端倪。 ■



New frontiers

Climate change will alter where many crops are grown

That means gains for some people, but losses for more

TOM EISENHAUER remembers driving through Manitoba, a province in central Canada, more than a decade ago. Surrounding his car were fields of cold-weather crops, such as wheat, peas and canola (rape). Dense staples such as maize (corn) and soya, which are more profitable, were few and far between. The view is very different now. More than 5,300 square kilometres have been sown with soya and around 1,500 with maize.

Mr Eisenhauer's company, Bonnefield Financial, hopes to benefit from the ways that climate change is changing Canadian agriculture. The company buys fields and leases them to farmers, both in Manitoba and elsewhere in the country. It is betting that a warmer climate will steadily increase how much its assets are worth, by enabling farmers in the places where it is investing to grow more valuable crops than they have traditionally selected. It is far from the only business making such wagers. Climate change could make a cornucopia out of land that was once frigid and unproductive. It could also do great harm to regions that feed millions.

The amount of space used to produce food has been increasing for centuries. Since 1700 areas of cropland and pastureland have expanded fivefold. Most of that growth came before the middle of the 20th century. Starting in the 1960s, the widespread adoption of chemical fertilisers, the development of more productive varieties of grains and rice, along with improved access to irrigation, pesticides and machinery, enabled farmers to make much better use of the fields they already tilled. In recent decades, technologies such as genome editing and better data crunching have helped lift yields even higher.

The rise in global temperatures which began towards the end of the 20th century slowed increases in productivity, but it did not stop them. A recent study by researchers at Cornell University calculates that, since 1971, climate change resulting from human activity has slowed growth in agricultural productivity by about a fifth.

The “headwind” caused by climate change will only become stronger, says Ariel Ortiz-Bobea, one of the study’s authors. Their research found that the sensitivity of agricultural productivity increases as temperatures rise. In other words, each additional fraction of a degree is more detrimental to food production than the last. That is especially bad news for food producers in places, such as the tropics, that are already warm. Another study predicts that for every degree that global temperatures rise, mean maize yields will fall by 7.4%, wheat yields will fall by 6% and rice yields will fall by 3.2%. Those three crops supply around two-thirds of all the calories that humans consume.

In the coming decades there will be more mouths to feed. The Institute for Health Metrics and Evaluation, an American research group, guesses that the global population will rise from around 7.8bn to 9.7bn by 2064 (after which it will fall). Growing middle classes in many developing countries are demanding a wider variety of food, and more of it.

Hence the importance of the changes global warming brings to farming areas. By expanding the tropics, it will change rainfall patterns in the subtropics. By warming the poles especially fast, it is opening up high-latitude land as quickly. The regions to the north of America and China are warming at at least double the global average rate. As Mr Eisenhauer’s experience in Manitoba can attest, crops are already moving polewards in response.

A study by researchers at Colorado State University, published in Nature in

2020, found notable changes in the distribution of several rain-fed crops in the 40 years between 1973 and 2012, as farmers began to make different decisions about which crops were worth planting where. Maize production, for example, spread from America's south-east to its upper-Midwest. Wheat has moved so substantially to the north, with the help of new irrigation methods, that it has outstripped the warming trend: the warmest places where it is grown today are cooler than the warmest places it grew in 1975.

Soyabean account for 65% of all the protein fed to farm animals. The cultivation of these wonder-beans has moved both north and south, as new breeds and other advances have allowed it to expand in tropical regions. The areas in which rice is harvested in China have expanded northward since 1949. Wine grapes and fruit crops have also migrated north.

Mr Eisenhauer says investors are increasingly stumping up for Canadian land as a hedge against climate risks they face elsewhere. Martin Davies of Westchester, a big agricultural investment firm, says he is seeing similar trends in many parts of the world.

The bravest investors spy opportunity in lands that currently support no farming at all. For the moment only about one-third of the world's boreal regions—a biome characterised by coniferous forests that covers vast tracts of land south of the Arctic Circle—boast temperatures warm enough to grow the hardiest cereals, such as oats and barley. This could expand to three-quarters by 2099, according to a study published in 2018 in *Scientific Reports*, a journal (see map). The share of boreal land that can support farming could increase from 8% to 41% in Sweden. It could increase from 51% to 83% in Finland.

Efforts to farm these areas will alarm people who value boreal forests for their own sake. And cutting down such forests and ploughing up the soils

that lie beneath them will release carbon. But the climatic effects are not as simple as they might seem. Northern forests absorb more heat from the sun than open farmland does, because snow-covered farmland reflects light back into space (in forests the snow is underneath the trees and not so directly illuminated). The fact that felling boreal forests may not worsen climate change, though, says nothing about the degree to which it could affect biodiversity, ecosystem services or the lives of forest dwellers, particularly indigenous ones.

Some governments are already keen to capitalise on climate change. Russia's has long talked of higher temperatures as a boon. President Vladimir Putin once boasted that they would enable Russians to spend less money on fur coats and grow more grain. In 2020 a "national action plan" on climate change outlined ways in which the country could "use the advantages" of it, including expanding farming. Since 2015 Russia has become the world's largest producer of wheat, chiefly because of higher temperatures.

Russia's government has started leasing thousands of square kilometres of land in the country's far east to Chinese, South Korean and Japanese investors. Much of the land, which was once unproductive, is now used to grow soyabean. Most are imported by China, helping the country reduce its reliance on imports from America. Sergey Levin, Russia's deputy minister of agriculture, has predicted that soya exports from its far-eastern farmlands may reach \$600m by 2024. That would be nearly five times what they were in 2017. The government of Newfoundland and Labrador, a province on the north-eastern tip of Canada, is also trying to promote the expansion of agriculture into lands covered by forests.

There is a way, in addition to higher temperatures, in which the changes humankind is making to the atmosphere could help such projects along. Carbon dioxide is not just a greenhouse gas; it is also the raw material for

the photosynthesis through which plants grow and feed themselves. For most plants, other things being equal, more carbon dioxide means more growth. The build-up of carbon dioxide over the past century has led to a clearly measurable “global greening” as those plants which benefit most from higher carbon dioxide levels thrive. This effect can help boost crop yields. But it is not an unalloyed good. Bigger crops may not be more nutritious crops.

Moreover, climate change will alter patterns of rainfall. This will not necessarily benefit plans for more farming in northern climes. Many areas that are becoming mild enough to farm may end up lacking water, at least without intensive irrigation. Others may get too much. Crops are not the only organisms whose range expands as temperatures rise: pests and pathogens, which are often killed off by cold winters, spread too. Soil matters as well. The best quality stuff is most commonly found at lower latitudes, not far-northern ones.

Some emerging farmland is near to established farming systems. But transforming remote regions of Siberia, to take one example—where much existing infrastructure is already sinking and breaking apart because of melting permafrost—will be slow and costly. Frontier farms will also have to attract and accommodate many more workers. They will have to rely increasingly on foreign migrants, an idea that voters in many rich countries do not much like.

All told, the northern expansion of farmland will only go some way towards mitigating the damage climate change may do to agriculture. The societies that will benefit from it are mostly already wealthy. Poor places, which rely much more heavily on income from exporting agricultural produce, will suffer.

A much wider range of adaptations will be needed if food is to remain

as copious, varied and affordable as it is today. These will include efforts to help crops withstand warmer temperatures, for example through clever crop breeding, advances in irrigation and protection against severe weather. Rich and poor countries alike should also make it a priority to reduce the amount of food that is wasted (the UN's Food and Agriculture Organisation guesses that more than one-third is squandered). The alternative will be a world that is hungrier and more unequal than it is at present—and than it might have been. ■



开疆拓土

气候变化会改变很多作物的种植地

一些人会从中受益，但更多人会受损【深度】

汤姆·艾森豪尔（Tom Eisenhauer）还记得自己十多年前开车穿过加拿大中部的曼尼托巴省（Manitoba）的情景。两边的大片农田里种着小麦、豌豆和加拿大油菜等耐寒作物。玉米、大豆等更赚钱的高密度主要农作物少之又少。现在的景象大不相同了。大豆的种植面积超过5300平方公里，玉米大约有1500平方公里。

气候变化正在改变加拿大的农业形态，而艾森豪尔的公司Bonnefield Financial希望能从中获益。该公司在曼尼托巴省和加拿大其他地方购买土地，再租给农民。该公司期待，在自己投资的这些土地上，气候变暖能让农民去种植那些比传统作物更有价值的作物，从而让资产稳步升值。下此赌注的企业远远不止这一家。气候变化可能会让曾经寒冷的不毛之地变成丰饶之地。但它也可能对那些养活了千百万人口的地区造成巨大的损害。

几个世纪以来，农业用地的面积一直在增加。自1700年以来，农田和牧场的面积增长了四倍。这些增长大部分发生在上世纪中叶以前。从上世纪60年代开始，得益于化肥的广泛使用、更高产的谷物和水稻品种的开发，以及灌溉技术、农药和农业机械的普及，农民对自己既有土地的利用得到极大改善。近几十年来，在基因组编辑和先进的数据处理等技术的帮助下，农作物产量进一步提高。

自近上世纪末开始的全球气温上升虽然让农业生产率的增速放缓，但并没有让它完全停滞。康奈尔大学的研究人员最近的一项研究估计，自1971年以来，由人类活动导致的气候变化已经使农业生产率的增速放缓了约五分之一。

该研究的作者之一阿里埃尔·奥尔蒂斯-博贝亚（Ariel Ortiz-Bobea）表示，气候变化造成的“逆风”只会变得更猛烈。该研究发现，随着气温升高，农

业生产率对此的敏感度也会提高。也就是说，温度每升高一点，对粮食生产的危害都会比上一次同样幅度的升温更大。对于像热带这样已经很暖和的地方的粮食生产商来说，这更是个坏消息。另一项研究预计，全球气温每升高一度，玉米、小麦和水稻的产量将分别下降7.4%、6%和3.2%。而人类消耗的所有卡路里大约有三分之二来自这三种作物。

未来几十年里，会有更多人口需要养活。美国研究机构健康指标与评估研究所（Institute for Health Metrics and Evaluation）估计，到2064年，全球人口将从现在的约78亿增加到97亿（之后会下降）。在许多发展中国家，不断壮大的中产阶级需要更多样化的食物，需要的数量也越来越大。

因此，全球变暖给农耕地区带来的各种变化就很重要了。它扩大了热带地区的范围，由此将改变亚热带地区的降雨模式。它令两极地区以尤其快的速度升温，从而使高纬度的土地正被同样快地开垦。美国和中国以北地区的温升速度至少是全球平均数的两倍。农作物种植已经开始向极地推移，艾森豪尔在曼尼托巴省的所见就是证明。

科罗拉多州立大学的研究人员于2020年发表在《自然》杂志上的一项研究发现，随着农民开始就如何因地制宜地种植作物做出不同的决定，在1973年至2012年的40年间，几种雨养作物的分布发生了显著变化。例如，玉米产区从美国东南部蔓延到了中西部偏北地区。新的灌溉技术促成小麦种植范围大幅向北转移，甚至超过了全球变暖的影响范围：如今小麦种植地最暖区域的气温比1975年时更低。

在所有家畜的蛋白质饲料来源中，大豆占到65%。随着新品种和其他先进技术的出现，大豆被引种到了热带地区，这种神奇豆子的种植在南北两个方向都有扩展。自1949年以来，中国的水稻产区一直在向北扩展。酿酒葡萄和水果作物也向北方迁移。

艾森豪尔表示，越来越多的投资者买入加拿大的土地，以对冲自己在其他地方面临的气候风险。大型农业投资公司Westchester的马丁·戴维斯（Martin Davies）说，他发现世界上许多地方都有类似的趋势。

最大胆的投资者在眼下根本无法耕作的土地上嗅到了机会。目前，北方气候带（即北极圈以南、大量覆盖针叶林的生态区）只有约三分之一地区足够温暖而可以种植燕麦、大麦等最耐寒的谷物。而根据2018年发表在《科学报告》（*Scientific Reports*）杂志上的一项研究，到2099年这一比例可能会扩大到四分之三（见地图）。在瑞典，可耕地占北方气候带的比例将从8%增加到41%。在芬兰，这一比例可能从51%上升到83%。

开垦这些地区会让那些出于自身利益而珍视北方森林的人感到担心。而砍伐这些森林并翻耕下面的土壤会释放出碳。但这对气候的影响并不像看上去那么简单。北方森林比空旷的农田吸收的太阳热量更多，因为被雪覆盖的农田会把阳光反射回太空（而森林里的雪被树冠遮挡，不受那样直接的照射）。砍伐北方森林虽然可能不会加剧气候变化，但这么说并没有考虑到它对生物多样性、生态系统服务，以及林区居民特别是原住民的生活可能产生的影响。

一些国家政府已经开始积极从气候变化中寻求好处。俄罗斯政府长期以来都把气温升高说成福祉。总统普京曾夸耀说，这会让俄罗斯人减少在毛皮大衣上的支出，并且种植更多粮食。2020年，一项有关气候变化的“国家行动计划”概述了俄罗斯可能如何从中“得益”，其中就包括扩大耕地面积。自2015年以来，俄罗斯已经成为世界上最大的小麦生产国，主要原因就是气温升高。

俄罗斯政府已经开始将本国远东地区数千平方公里的土地租给中国、韩国和日本的投资者。这些曾经的不毛之地现在很多被用来种植大豆，大部分都出口到了中国，帮助中国减轻对美国的进口依赖。俄罗斯农业部副部长谢尔盖·列文（Sergey Levin）预计，到2024年，俄罗斯远东地区出产的大豆出口额可能达到六亿美元。这将是2017年的近五倍。在加拿大东北角的纽芬兰与拉布拉多省（Newfoundland and Labrador），当地政府也在努力推动农业向林地扩张。

除了气温升高，还有一种人类活动导致的大气变化也可能帮助推动这类项

目。二氧化碳不仅仅是一种温室气体，它还是光合作用的原料——植物通过光合作用生长并为自己提供养分。对大部分植物来说，同等条件下，二氧化碳越多，植物生长越快。过去一个世纪里二氧化碳的累积带来了非常显著的“全球绿化”：从更高的二氧化碳水平中受益最多的那类植物茁壮成长。这一效应有助于提高作物产量，但并不完全是件好事。作物长得更大并不代表它们更有营养。

此外，气候变化还会改变降雨模式。这不一定有利于在北方气候带开展更多耕种。许多正在变得气候温和而适宜耕种的地区到头来却可能会缺水，至少没法密集灌溉。另一些地方的雨水又可能过多。农作物并不是唯一随着气温升高而扩大了生长范围的生物：在寒冬原本常常会被冻死的害虫和病原体也会传播。土壤也很重要。质量最好的土壤通常位于纬度更低些的地区而不是极北地区。

一些新开垦的农田靠近已有的耕作系统。但开垦偏远地区的土地将会既耗时又费钱。以西伯利亚偏远地区为例，由于永久冻土的融化，这里许多现有的基础设施已经在下沉和解体。边远地区的农场还必须吸引并安置更多的劳工。这些农场将不得不越来越依赖外国移民，但许多富裕国家的选民不太喜欢这个主意。

总之，农田向北扩张只会在一定程度上减轻气候变化对农业可能造成的损害。日后会从中受益的社会现在大多已经很富裕了。而严重依赖农产品出口收入的贫困地区会遭受冲击。

如果要让食物还像今天这样供应充足、种类多样、价格实惠，将需要有更多得多的应对方法。这包括想办法让作物能耐受更高的气温，比如依靠巧妙的作物育种、改良灌溉技术，以及防御恶劣天气等。不论富国穷国都应重视减少粮食浪费（联合国粮农组织估计超过三分之一的粮食都被浪费掉了）。否则，世界的粮食短缺和不平等问题将比现在更严重，也会比原本可能的情况更严重。 ■



The special sauce

The economy that covid-19 could not stop

Trade and foreign investment helped Vietnam emerge from extreme poverty. Can they make it rich?

HAVING IMPRESSED the world by taming the virus last year, Vietnam is now in the middle of its worst outbreak of covid-19 by far. Parts of the country are in strict lockdown and a swathe of factories, from those making shoes for Nike to those producing smartphones for Samsung, have either slowed or shut down, disrupting global supply chains. Yet integration with global manufacturing has kept Vietnam's economy humming during the pandemic. In 2020 GDP rose by 2.9% even as most countries recorded deep recessions. Despite the latest outbreak, this year could see even faster growth. The World Bank's latest forecasts, published on August 24th, point to an expansion of 4.8% in 2021.

This performance hints at the real reason to be impressed by Vietnam. Its openness to trade and investment has made the country, with GDP per capita of a mere \$2,800, an important link in supply chains. And that in turn has powered a remarkable expansion. It has been one of the five fastest-growing countries in the world over the past 30 years, beating its neighbours hands down (see chart 1). Its record has been characterised not by the fits and starts of many other frontier markets, but by steady growth. The government is even more ambitious, wanting Vietnam to become a high-income country by 2045, a task that requires growing at 7% a year. What is the secret to Vietnam's success—and can it be sustained?

Vietnam is often compared to China in the 1990s or early 2000s, and not without reason. Both are communist countries that, led by a one-party political system, turned capitalist and focused on export-led growth. But

there are big differences, too. For a start, even describing Vietnam as export-intensive does not do justice to just how much it sells abroad. Its goods trade exceeds 200% of GDP. Few economies, except the most resource-rich countries or city states dominated by maritime trade, are or have ever been so trade-intensive.

It is not just the level of exports but the nature of the exporters that makes Vietnam different from China. Indeed, its deep connection to global supply chains and high levels of foreign investment make it seem more like Singapore. Since 1990 Vietnam has received average foreign-direct-investment inflows worth 6% of GDP each year, more than twice the global level—and far more than China or South Korea have ever recorded over a sustained period.

As the rest of East Asia developed and wages there rose, global manufacturers were lured by Vietnam's low labour costs and stable exchange rate. That fuelled an export boom. In the past decade, exports by domestic firms have risen by 137%, while those by foreign-owned companies have surged by 422% (see chart 2).

But the widening gap between foreign and domestic firms now poses a threat to Vietnam's expansion. It has become overwhelmingly dependent on investment and exports by foreign companies, whereas domestic firms have underperformed.

Foreign firms can continue to grow, providing more employment and output. Yet there are limits to how far they can drive Vietnam's development. The country will need a productive services sector. As living standards rise it may become less attractive to foreign manufacturers, and workers will need other opportunities.

Part of the drag on domestic enterprise comes from state-owned firms. Their importance in overall activity and employment has shrunk (see chart 3). But they still have an outsize effect on the economy through their preferential position in the banking system, which lets them borrow cheaply. Banks make up for that unproductive lending by charging other domestic firms higher rates. Whereas foreign companies can easily access funding overseas, the average interest rate on a medium- or long-term bank loan in Vietnamese dong ran to 10.25% last year. Research by academics for the Centre for Economic Performance at the London School of Economics also suggests that productivity gains in the five years after Vietnam joined the World Trade Organisation in 2007 would have been 40% higher without state-owned firms.

To fire up the private sector, the government wants to nurture the equivalent of South Korea's chaebol or Japan's keiretsu, sprawling corporate groups that operate in a variety of sectors. The government is "trying to create national champions", says Le Hong Hiep, a senior fellow at the ISEAS-Yusof Ishak Institute in Singapore, and a former Vietnamese civil servant.

Vingroup, a dominant conglomerate, is the most obvious candidate. In VinPearl, VinSchool and VinMec, it has operations that spread across tourism, education and health. VinHomes, its property arm, is Vietnam's largest listed private firm by market capitalisation.

The group's efforts to break into finished automotive production through VinFast, its carmaker, may become important for the economic development of a country that is usually known for intermediate manufacturing. In July the company's Fadil car, which is based on the design for Opel's Karl make, became Vietnam's best-selling model, beating Toyota's Vios. VinFast has grand ambitions abroad, too. In July it announced that it had opened offices in America and Europe and intended to sell electric vehicles there by March 2022.

Fostering national champions while staying open to investment is not easy, however. VinFast benefits from a bevy of tax reductions, including a large cut in corporation tax for its first 15 years of operation. In August, state media also reported that the government was considering reinstating a 50% reduction in registration fees for locally built cars that expired last year.

But the country's membership of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership, and a range of other trade and investment deals, means that it cannot offer preferential treatment to domestic producers. It must extend support to foreign firms that make cars in Vietnam, too. (By contrast, China's trade policy, which prefers broad but shallow deals, does not constrain domestic policy in quite the same way.)

Vietnam may also hope to rely on another source of growth. The economic boom has encouraged its enormous diaspora to invest, or even to return home. "There aren't a lot of economies that are experiencing the sort of thing that Vietnam is," says Andy Ho of VinaCapital, an investment firm with \$3.7bn in assets. His family moved to America in 1977, where he was educated and worked in consulting and finance. He returned to Vietnam with his own family in 2004. "If I were Korean, I might have gone back in the 1980s, if I were Chinese I might have gone back in 2000." Its successful diaspora makes Vietnam one of the largest recipients of remittances in the world; \$17bn flowed in last year, equivalent to 6% of GDP.

The setback from covid-19 aside, it might seem hard not to be rosy about a country that appears to be in the early stages of emulating an East Asian economic miracle. But no country has become rich through remittances alone. As Vietnam develops, sustaining rapid growth from exports of foreign companies will become increasingly difficult, and the tension between staying open to foreign investment and promoting national champions will become more acute. All of that makes reforming the domestic private sector and the financial system paramount. Without it, the

government's lofty goal of getting rich quick may prove beyond its reach. ■



秘方

新冠不能阻挡的经济

贸易和外国投资帮助越南摆脱了极端贫困，但能帮它致富吗？

越南去年驯服了新冠病毒，给世界留下了深刻印象，但如今却深陷它迄今显然最严重的一轮疫情之中。该国部分地区处于严格封锁状态，而大量工厂——从为耐克生产鞋子的到为三星生产智能手机的——要么减产，要么停工，扰乱了全球供应链。然而，与全球制造业的融合使越南经济在疫情期间保持了繁荣。2020年尽管大多数国家都经历了深度衰退，越南GDP增长了2.9%。虽然最近疫情爆发，但今年的增速可能还会更快。世界银行于8月24日发布的最新预测认为它在2021年将增长4.8%。

这一表现透露出越南令人印象深刻的真正原因。对贸易和投资的开放使这个人均GDP仅2800美元的国家成为了供应链中的重要一环。这反过来又推动了显著的扩张。在过去的30年里，它一直是世界上增长最快的五个国家之一，远超邻国（见图1）。这一履历的特点不是在许多其他前沿市场出现的那种起起落落，而是稳定增长。政府的计划甚至更为宏伟，希望越南到2045年成为高收入国家，而这项任务需要它以每年7%的速度增长。越南成功的秘诀是什么？它能否持续下去？

在1990年代或2000年代初期，越南经常被拿来与中国相比较，这不无道理。两者都是共产主义国家，由一党制政体领导，都转向资本主义并专注于以出口为导向的增长。但两国也有很大的不同。首先，即使将越南描述为出口密集型也不足以体现它在国外的销售量。该国货物贸易额超过了GDP的200%。除了资源最丰富的国家或以海上贸易为主的城市国家之外，很少有经济体在当下或曾经有如此密集的贸易。

越南与中国的不同之处不仅仅在于出口水平，还有出口商的性质。事实上，它与全球供应链的深厚连结和高水平的外国投资使它看起来更像新加坡。自1990年以来，越南每年平均获得的外国直接投资流入量相当于GDP

的6%，是全球水平的两倍多——而且远远超过中国或韩国在任何一段持续时期内达到的记录。

随着东亚其他地区的发展和工资上涨，越南低廉的劳动力成本和稳定的汇率吸引了全球制造商。这推动了一轮出口繁荣。在过去十年中，其国内企业的出口增长了137%，而外资企业的出口飙升了422%（见图2）。

但是，外国和本国公司之间不断扩大的差距如今对越南的扩张构成了威胁。它已变得压倒性地依赖外国公司的投资和出口，而本国公司则表现不佳。

外国公司可以继续增长，提供更多的就业和产出。然而，它们对于推动越南发展的作用是有上限的。该国将需要一个高产出的服务部门。随着生活水平的提高，越南对外国制造商的吸引力可能会降低，而工人将需要其他机会。

国内企业所受的拖累部分来自于国有企业。它们在整体经济活动和就业中的重要性已经下降（见图3）。但在银行系统中享受的优待地位让它们能够以低廉的价格借贷，从而仍对经济产生巨大影响。银行通过向其他国内公司收取更高的利息来弥补这种无益的贷款。即便外国公司可以轻松从海外获得融资，去年越南盾中长期银行贷款平均利率达到了10.25%。伦敦经济学院经济绩效中心的学者的研究还表明，如果没有国有企业，越南在2007年加入世贸组织后的五年内的生产率提升会比实际情况高出40%。

为了激发私营部门的活力，越南政府希望培育相当于韩国财阀或日本经连会那样横跨多个领域的大型企业集团。新加坡东南亚研究所（ISEAS-Yusof Ishak Institute）的高级研究员、前越南公务员黎洪和（Le Hong Hiep）表示，政府正在“努力打造国家领军企业”。

举足轻重的企业集团Vingroup是最显而易见的候选对象。通过VinPearl、VinSchool和VinMec，它的业务遍及旅游、教育和医疗。其房地产部门

VinHomes是越南市值最高的上市民营公司。

该集团通过旗下汽车制造商VinFast进军成品汽车生产，这番努力可能对这个通常以中间制造闻名的国家的经济发展变得重要。7月，该公司基于欧宝Karl品牌设计的Fadil汽车击败了丰田的Vios，成为越南最畅销的车型。VinFast在国外也有远大抱负。7月，它宣布已在美国和欧洲开设办事处，并计划在2022年3月之前在那里开售电动汽车。

然而，在对投资持开放态度的同时培养国家领军企业不容易。VinFast受益于一系列减税措施，包括在它运营的前15年享受大幅削减的公司税。8月，官方媒体还报道说，政府正在考虑恢复去年到期的一项政策，继续为本地制造汽车减免50%的注册费用。

但越南是“全面与进步跨太平洋伙伴关系协定”以及一系列其他贸易和投资协议的成员，这意味着它不能向国内生产商提供优惠待遇。它还必须向在越南制造汽车的外国公司提供支持。（相比之下，中国的贸易政策倾向于广泛但肤浅的协议，并不会以类似的方式限制国内政策。）

越南也可能希望依靠另一个增长来源。经济繁荣鼓励了大量侨民投资母国，甚至回国。拥有 37 亿美元资产的投资公司越资股份（VinaCapital）的安迪·何（Andy Ho，音译）说：“没有多少经济体正在经历越南这种情况。”他随家人于1977年移居美国，他在那里接受教育并从事咨询和金融业。他于2004年与家人返回越南。“如果我是韩国人，我可能会在1980年代回国，如果我是中国人，我可能会在2000年回国。”成功的越南侨民使越南成为世界上最大的汇款接收国之一：去年流入了170亿美元，相当于GDP的6%。

撇开新冠疫情的拖累不谈，对于一个看起来正处于模仿东亚经济奇迹早期阶段的国家，似乎很难不感到乐观。但从来没有哪个国家仅靠汇款致富。随着越南的发展，保持外国企业出口快速增长的难度将越来越大，对外国投资保持开放与培植国家领军企业之间的紧张关系将更加尖锐。所有这些都使得国内私营部门和金融体系的改革成为重中之重。没有这种改革，政

府快速致富的宏伟目标可能无法实现。 ■



Construction techniques

The rise of 3D-printed houses

Your next home could be a printout

A BATCH OF new houses across California is selling unusually fast. In the past two months, 82 have been snapped up, and the waiting list is 1,000 long. That demand should, though, soon be satisfied—for, while it can take weeks to put up a conventional bricks-and-mortar dwelling, Palari Homes and Mighty Buildings, the collaborators behind these houses, are able to erect one in less than 24 hours. They can do it so rapidly because their products are assembled from components prefabricated in a factory. This is not, in itself, a new idea. But the components involved are made in an unusual way: they are printed.

Three-dimensional (3D) printing has been around since the early 1980s, but is now gathering steam. It is already employed to make things ranging from orthopaedic implants to components for aircraft. The details vary according to the products and processes involved, but the underlying principle is the same. A layer of material is laid down and somehow fixed in place. Then another is put on top of it. Then another. Then another. By varying the shape, and sometimes the composition of each layer, objects can be crafted that would be difficult or impossible to produce with conventional techniques. On top of this, unlike conventional manufacturing processes, no material is wasted.

In the case of Palari Homes and Mighty Buildings, the printers are rather larger than those required for artificial knees and wing tips, and the materials somewhat cruder. But the principle is the same. Nozzles extrude a paste (in this case a composite) which is then cured and hardened by ultraviolet light. That allows Mighty Buildings to print parts such as eaves

and ceilings without the need for supporting moulds—as well as simpler things like walls. These are then put together on site and attached to a permanent foundation by Palari Homes' construction workers.

Not only does 3D-printing allow greater versatility and faster construction, it also promises lower cost and in a more environmentally friendly approach than is possible at present. That may make it a useful answer to two challenges now facing the world: a shortage of housing and climate change. About 1.6bn people—more than 20% of Earth's population—lack adequate accommodation. And the construction industry is responsible for 11% of the world's man-made carbon-dioxide emissions. Yet the industry's carbon footprint shows no signs of shrinking.

Automation brings huge cost savings. Mighty Buildings says computerising 80% of its printing process means the firm needs only 5% of the labour that would otherwise be involved. It has also doubled the speed of production. This is welcome news, the construction industry having struggled for years to improve its productivity. Over the past two decades this has grown at only a third of the rate of productivity in the world economy as a whole, according to McKinsey, a consultancy. Digitalisation has been slower than in nearly any other trade. The industry is also plagued, in many places, by shortages of skilled labour. And that is expected to get worse. In America, for example, around 40% of those employed in construction are expected to retire within a decade.

The environmental benefits come in several ways, but an important one is that there is less need to move lots of heavy stuff about. Palari Homes, for instance, estimates that prefabricating its products reduces the number of lorry journeys involved in building a house sufficiently to slash two tonnes off the amount of carbon dioxide emitted per home.

Palari Homes and Mighty Buildings are not, moreover, alone in their

endeavours. Similar projects are being started up all over the place. The vast majority print structures using concrete. 14Trees, a joint venture between Holcim—the world's biggest cement-maker—and CDC Group, a British-government development-finance outfit, operates in Malawi. It says it is able to print a house there in just 12 hours, with a price tag of less than \$10,000. Besides being cheap and quick, 14Trees says this process is green as well. Holcim claims that by depositing the precise amount of cement required and thereby reducing waste, 3D printing generates only 30% as much carbon dioxide as using burnt-clay brick, a common technique in Malawi.

In Mexico, meanwhile, a charity for the homeless called New Story has created a partnership with ICON, a 3D-printing firm, to erect ten houses with floor areas of 46 square metres. Each was printed in around 24 hours (though these hours were spread over several days), with the final features assembled by Échale, another local charity. And in Europe the keys to the continent's first 3D-printed home, in Eindhoven, in the Netherlands (pictured above), were handed over to its tenants on July 30th.

The house in question, the first of five detached, two-bedroom dwellings in a project co-ordinated by Eindhoven's municipal government and the city's University of Technology, is a collaboration between several firms. The Dutch arm of Saint-Gobain, a French building-materials company, developed the concrete mortar needed. Van Wijnen, a construction firm, built the thing, while Witteveen+Bos, a consultancy, was responsible for the engineering. It is being rented out by its owner, Vesteda, a Dutch residential-property investor.

Making the cement involved in projects like this is not, however, a green process. It turns calcium carbonate in the form of limestone into calcium oxide and carbon dioxide, and is reckoned responsible for about 8% of anthropogenic emissions of that gas. A group at Texas A&M University, led

by Sarbajit Banerjee, has therefore developed a way to dispense with it.

Dr Banerjee's new building material was inspired by a project he masterminded some years ago to construct supply roads to remote parts of the Canadian province of Alberta using stuff immediately to hand. The road metal he devised combined local soil with a mulch of wood fibres, and was held together by liquid or water-soluble silicates that then hardened and acted as cement. To build houses he uses whatever clay and rock debris is lying around under the topsoil near the construction site, crushes it into a powder and blends it with silicates. The result can then be squeezed through a nozzle, after which it rapidly consolidates and gains strength, so as to hold its shape and bear the weight of the next layer. The process is thus doubly green. It eliminates both cement and the need to transport to the site, often over long distances, the sand and aggregates used in conventional concrete.

There are limitations to 3D-printed homes. For a start, construction codes need to be tweaked to accommodate them. To this end UL, one of America's largest certifying agencies, has collaborated with Mighty Buildings to develop the first 3D-printing standard. The guidelines will be included in the new International Residential Code, which is in use in, or has been adopted by, all American states save Wisconsin. While this is a welcome boost to a fledgling industry, most governments have yet to come up with country-specific standards. There are also questions about the quality and finish of homes built by 3D printers.

Even so, the direction of travel looks promising. Last year, plans for a 3D-printed apartment building were approved in Germany. This three-floored structure, assembled by Peri, a German construction company, from parts made using printers developed by Cobod, a Danish firm, will contain five flats. Use of the technology is also expanding in the Middle East and Asia. Dubai's government wants a quarter of new buildings in the country to be 3D-printed by 2030, and is dedicating a district on the outskirts of it

eponymous capital to host 3D-printing companies and their warehouses. Saudi Arabia wants to use 3D printing to build 1.5m houses over the next decade. And India's Ministry of Housing and Urban Affairs wants to use 3D printing to address the country's housing shortages.

If successful, building by 3D printing is likely to spread beyond housing. Opportunities also exist in warehousing, offices and other commercial buildings. And beyond earthly structures, NASA, America's space agency, is exploring the use of 3D printing to build landing pads, accommodation and roads on Mars and the Moon. There is no soil on those two celestial bodies, just shattered rock called regolith. Dr Banerjee's group, which is working with NASA, says its approach to 3D printing functions just as well with this material. "We would ultimately like to have property on Mars and the Moon but we're not going to be able to take concrete up there with us," says Dr Banerjee. "We're going to have to work with regolith." ■



建筑工艺

3D打印房屋崛起

你的下一个家可能是打印出来的

加州各地的一批新房正以异常快的速度卖出去。过去两个月里，82套房子被抢购一空，而等候名单上还有1000人。不过，这一需求应该很快就会得到满足，因为虽然建造一栋传统的实体房屋可能需要花上好几周，但这些房子背后的合作者——Palari Homes和Mighty Buildings——不到24小时就能盖完一栋。之所以能如此神速，是因为它们的产品是由工厂预制的部件组装而成的。这本身并不是什么新创意。但这些部件的制造方式非同寻常：它们是打印出来的。

3D打印在上世纪80年代初就已问世，但现在开始发力。它已被用于制造从骨科植入物到飞机零部件等各类物品。技术细节因具体的产品和工艺而异，但基本原理相同。先铺好一层材料，固定在适当位置。在其上铺设另一层。再加一层。再加一层。通过改变每层的形状，有时也改变其构成，可以制作出用传统技术难以或无法生产的物件。除此之外，不同于传统的制造工艺，没有材料被浪费掉。

Palari Homes和Mighty Buildings使用的打印机比制造人造膝盖和翼尖所需的打印机大不少，所用的材料也更粗糙一些。但原理相同。喷嘴挤出一种膏体（在这里是一种复合材料），之后经紫外线照射固化。这让Mighty Buildings无需使用支撑模具就能打印出屋檐和天花板等部件，以及墙壁等更简单的部分。这些部件之后由Palari Homes的建筑工人现场组装起来，固定在永久的地基上。

3D打印不仅能提升制造的多样性和速度，也有望比现有的可能性更节省成本也更环保。这可能会让它成为如今世界面临的两大挑战——住房短缺和气候变化——的一种有效解决办法。约有16亿人——超过地球人口的20%——缺乏充足的住所。而全世界人为的二氧化碳排放有11%来自建筑

业，但该行业的碳足迹并无缩小的迹象。

自动化极大地节约了成本。Mighty Buildings表示，将其打印流程的80%计算机化意味着公司需要的劳动力只相当于原本所需水平的5%。它还将生产速度翻了一番。这是个好消息，建筑业多年来在提高生产率方面进展缓慢。据咨询公司麦肯锡估计，在过去20年间，建筑业的生产率增速仅为世界经济整体生产率增速的三分之一。这个行业的数字化进程几乎比其他所有行业都慢。多地的建筑业也为熟练劳动力短缺所困扰。而且这种情况预计还会恶化。比如在美国，约40%的建筑从业人员预计将在十年内退休。

环境上的益处源于几方面，但其中重要的一点是不大需要搬动大量重物了。例如，Palari Homes估计，预制产品减少了盖一栋房子需要卡车运输的趟数，足以让建造每栋住宅的碳排放量减少两吨。

此外，Palari Homes和Mighty Buildings并非唯一在尝试这种方式的团队。类似的项目在各地都在开展，它们绝大多数都使用混凝土打印建筑物结构。在马拉维经营的14Trees是全世界最大的水泥制造商霍尔希姆（Holcim）和英国政府下属开发融资公司英联邦投资集团（CDC Group）的合资企业。该公司称它能在短短12小时内打印出一栋房子，标价一万美元不到。14Trees还说，除了便宜又快速外，打印过程也十分环保。霍尔希姆声称可以通过精确投放所需的水泥量来减少浪费，因而这种3D打印产生的碳排放仅为使用烧结粘土砖这种在当地常用的方法的30%。

同时，在墨西哥，一家名为新故事（New Story）的援助无家可归者的慈善机构与3D打印公司ICON建立了合作关系，建造了十栋建筑面积为46平方米的房子。每栋房子用时约24小时打印（不过这是分散在几天内的用时总和），最后的部件由当地另一家慈善机构Échale组装而成。而在欧洲，第一栋3D打印房屋位于荷兰的埃因霍温（见上图），钥匙于7月30日交到了房客手上。

这栋房子是由埃因霍温市政府和埃因霍温科技大学联合打造的五幢独栋两

卧住宅的第一幢，是几家企业的合作成果。法国建材公司圣戈班（Saint-Gobain）的荷兰分部研发出所需的混凝土砂浆。建筑公司Van Wijnen完成建造，咨询公司Witteveen+Bos负责工程设计。房主荷兰住宅地产投资商Vesteda把它出租了出去。

然而，制造这类住宅区所需的水泥却不是一道绿色工序。它将石灰岩形式的碳酸钙转化为氧化钙和二氧化碳。据估计，人为排放二氧化碳的8%来自于该工序。因此，得克萨斯农工大学（Texas A&M University）由萨尔巴吉特·班纳吉（Sarbajit Banerjee）领导的一个小组研发了一种免除这道工序的办法。

班纳吉使用新建材的灵感源自他几年前策划的一项工程：就地取材来修建通往加拿大阿尔伯塔省的偏远地区的补给线路。他设计的铺路石把当地的土壤与木质纤维的护根混在一起，由液体或水溶性硅酸盐凝聚起来，之后硬化并用作水泥。在建造房屋时，他利用建筑工地附近表土以下的任何粘土和岩屑，将其压成粉末并与硅酸盐混合。形成的产物可以用喷嘴挤出，之后迅速凝固并增强，以维持形状并承受下一层的重量。因此，这一过程是双倍环保的。它省去了水泥，同时也不再需要把常规混凝土中使用的沙子和骨料运送到工地——通常都还是长距离运输。

3D打印房屋也有其局限性。首先，建筑规范需要调整以适应这些新建筑。为此，美国最大的认证机构之一UL已与Mighty Buildings合作，制定出了首个3D打印标准。这些指导方针将被纳入新的《国际住宅规范》（International Residential Code），目前该法规已在全美除威斯康星州外的所有州实施或被通过。虽然这对于一个新兴行业而言是个有力的助推，但世界上大多数政府尚未出台具体到本国的标准。3D打印机建造的房屋的质量和装修也面临质疑。

即便如此，行进的方向看上去一片光明。去年，一项3D打印公寓楼的规划在德国获批。这座三层建筑由德国建筑公司Peri使用丹麦公司Cobod研发的打印机制作的部件组装而成，将包含五套公寓。在中东和亚洲，3D打印技术的使用也在拓展。迪拜政府希望到2030年该国四分之一的新建筑都由

3D打印而成，并在首都迪拜的郊区专门划出一个区来让3D打印企业及其仓库落户。沙特阿拉伯希望在未来十年间利用3D打印技术建150万套房。而印度住房和城市事务部希望利用3D打印解决本国的住房短缺问题。

如果能成功，3D打印建筑应该还会扩展到住房之外。仓储、办公室及其他商业建筑中也蕴藏着发展机会。而除了地球上的建筑之外，美国国家航空航天局（NASA）正在探索使用3D打印在火星和月球上建造着陆平台、住所和公路。这两个天体上没有土壤，只有被称为“壤”的岩石碎屑。班纳吉的研究团队正在与NASA合作，表示其3D打印方法对这种材料同样有效。“我们最终希望能在火星和月球上拥有住宅，但我们不能把混凝土带上去，”班纳吉说，“我们将不得不利用这些壤。”■



Lights, camera, tax breaks

Britain's film industry is booming

Thanks to some very generous tax breaks

IN “GOOD OMENS”, a fantasy novel by Terry Pratchett and Neil Gaiman published in 1990, Aziraphale, an angel, and Crowley, a demon, set out to sabotage Doomsday and save Earth. A television adaptation by Amazon Studios in 2019 saw the unlikely pair cross paths in a variety of locations, including the Garden of Eden, ancient Rome, medieval England, revolutionary France and Blitz-era London. The filming schedule was equally gruelling, with the crew trekking through a succession of sets in South Africa and southern England.

Season 2 will involve fewer air miles. Production begins this month, alongside “Anansi Boys”, another Amazon Studios adaptation from Mr Gaiman’s back catalogue. Both will be filmed entirely in Scotland. The decision is a vote of confidence in Britain’s high-end television industry. Spending by production companies on this segment has risen from £1.1bn (\$1.5bn) in 2016-17 to £3.5bn in 2020-21, says the British Film Institute.

The boom is driven by streaming services, which demand new content and high production values. Britain, with its global language and deep talent pool, was well placed to benefit. Netflix says Britain is now its third-biggest production site, after America and Canada. It has even won plum productions away from other countries. In August Amazon announced that the second season of its “The Lord of the Rings” prequel series will be shot in Britain, after two decades in which Middle Earth meant New Zealand.

Tax incentives play a big part in film-makers’ decisions. In Britain they can claim up to 180% of their actual spending against tax. And if that results in

an overall loss, they can take 25% of it as cash. Sweeteners are on offer even if global productions do only minimal work, such as soundtrack recording, in Britain. On top of all this, last October the government launched a scheme to spend £500m encouraging film and television production to restart as the pandemic eased. Production companies are “almost too incentivised”, says one producer. “But it’s brilliant.”

One result is a scramble for studios. Some have been booked out for years, and new ones are being built. In August Sunset Studios, a Hollywood company, said it would be spending £700m on a new studio in Hertfordshire. John Madocks Wright of Savills, an estate agent, says he now markets warehouses for rent not just to logistics firms but to film-makers.

Demand is rippling out from the south-east, a trend encouraged by yet more incentives from local film bodies. Streaming services are moving into cities where national broadcasters have long been required by government rules to make some content, says Tom Harrington of Enders Analysis, a research firm. Film executives say they are seeing a shift from crews popping up for a week to shoot on location to productions entirely on-site. Screen Yorkshire was founded in 2002, but started to need a films office only in 2018, when demand boomed. Caroline Cooper Charles, its head of creative, says congestion in the south-east gives Yorkshire a competitive advantage: more parking spaces.

These new studios are often built on old industrial sites. FirstStage Studios in Leith Docks, Edinburgh, which opened last year, was built on the site of a wave-power plant that went bust in 2014. It received a grant of £1m from Screen Scotland and will soon host “Anansi Boys”. Belfast Harbour Studios, which opened in 2017 in a former glass-bottle factory, recently underwent an expansion costing £45m. “The School for Good and Evil”, a Netflix show, is being filmed there. A 38-acre studio in Digbeth, an industrial part of Birmingham, will be part of a swanky new media city, conveniently located

next to a stop on the planned HS2 high-speed rail line.

Regional politicians hope new studios will increase employment, as cash flows out from film sets into hotels, catering and restaurants. “Game of Thrones” contributed more than £50m to Northern Ireland’s economy in 2018. Many sets now run apprenticeship schemes for local youths. Generous tax breaks mean any new jobs will come at considerable cost to the Treasury, but at least more of them will be where they are most needed. ■



灯光、摄像、减税

英国的电影产业蓬勃发展

多亏了一些非常慷慨的减税政策

在特里·普拉切特（Terry Pratchett）和尼尔·盖曼（Neil Gaiman）1990年出版的奇幻小说《好兆头》（Good Omens）中，天使亚茨拉菲尔（Aziraphale）和恶魔克劳利（Crowley）着手挫败世界末日，拯救地球。2019年，亚马逊影业（Amazon Studios）将这部小说改编成了电视剧，在剧中，这对不可思议的组合在很多地方不期而遇，包括伊甸园、古罗马、中世纪的英国、大革命时期的法国和闪电战时期的伦敦。拍摄日程安排同样折腾，剧组要在南非和英格兰南部的一系列外景地长途跋涉。

第二季就不需要这么多长途飞行了。拍摄将于本月开始，同时开机的还有亚马逊影业根据盖曼旧作改编的另一部电视剧《蜘蛛男孩》（Anansi Boys）。这两部剧集都将完全在苏格兰拍摄。这样的决定体现了对英国高品质电视产业的信任。英国电影协会（British Film Institute）表示，制片公司在这一块的支出已从2016年至2017年的11亿英镑（15亿美元）升至2020年至2021年的35亿英镑。

这一快速增长由流媒体服务驱动，这些平台需要新内容和高制作价值。英国凭借其全球性语言和深厚的人才资源处于有利竞争地位。奈飞（Netflix）表示，英国现在是它的第三大制作地，仅次于美国和加拿大。英国甚至还从其他国家手中抢得了人人艳羡的制作项目。8月，亚马逊宣布《指环王前传》第二季将在英国拍摄，而过去20年里“中土世界”一直都位于新西兰。

税收激励对电影制作人的决策有着重要影响。在英国，他们可以申请最高相当于实际支出180%的应税所得减免。如果这导致整体亏损，他们可以获得相当于亏损额25%的减税。即使全球制片公司在英国只做很少的工作，比如配音录制，也能享受些好处。除此之外，去年10月英国政府启动

了一项计划，要支出5亿英镑鼓励在疫情缓解后重启电影和电视制作。制作公司“获得的激励也太多了”，一位制片人说，“不过这太棒了。”

结果之一是对制片厂的争夺。有些制片厂已被预订多年，而新的制片厂还在建设中。8月，好莱坞电影公司日落影业（Sunset Studios）表示将花7亿英镑在赫特福德郡（Hertfordshire）新建一个制片厂。房地产代理公司第一太平戴维斯（Savills）的约翰·麦多克斯·莱特（John Madocks Wright）说，他现在不仅在向物流公司推销可租用的仓库，也在向电影制作人推销。

需求正从东南部蔓延开来，这一趋势受到了地方影视机构更多激励措施的鼓励。研究公司Enders Analysis的汤姆·哈灵顿（Tom Harrington）说，在流媒体服务正在进入的一些城市，长期以来政府规定国家广播公司必须在这些地方制作一些内容。影业高管们说他们看到了一种变化：以前是剧组突然出现在当地拍摄一周，现在是完全在当地制作。约克郡银幕（Screen Yorkshire）成立于2002年，但直到2018年需求旺盛起来才设立了一个电影办公室。该公司的创意主管卡罗琳·库珀·查尔斯（Caroline Cooper Charles）说，东南部的拥堵让约克郡获得了一个竞争优势：停车位更多。

这些新制片厂常常建在旧的工业用地上。位于爱丁堡利斯码头（Leith Docks）的FirstStage制片厂去年开业，它所在的位置过去是一座波能发电厂，于2014年倒闭。它获得了苏格兰银幕（Screen Scotland）100万英镑的拨款，不久将开拍《蜘蛛男孩》。2017年，贝尔法斯特港制片厂（Belfast Harbour Studios）在一家原来做玻璃瓶的工厂里开业，最近耗资4500万英镑完成扩建。奈飞的电影《善恶学校》（The School for Good and Evil）正在那里拍摄。在伯明翰的迪格贝斯（Digbeth）工业区，一座占地38英亩的制片厂将成为这个时髦的新媒体城市的一部分，它紧邻筹建中的HS2高速铁路的一个站点，非常方便。

地方上的政客们希望新制片厂能增加就业，因为现金会从片场流向酒店和餐饮业。2018年，《权力的游戏》为北爱尔兰的经济贡献了超过5000万英

镑。许多片场现在为当地年轻人提供学徒计划。慷慨的税收减免意味着任何新增就业都需要财政部付出相当高的成本，但至少更多的新岗位会出现在最需要它们的地方。 ■



Climate change and evolution

The effects of a warmer world are visible in animals' bodies

Hundreds of species show signs of adapting to a warming climate

FOR HUMANS, adapting to climate change will mostly be a matter of technology. More air conditioning, better-designed houses and bigger flood defences may help ameliorate the effects of a warmer world. Animals will have to rely on changing their bodies or their behaviour. In a paper published in Trends in Ecology & Evolution, a team led by Sara Ryding, a PhD candidate at Deakin University, in Australia, shows that is already happening. Climate change is already altering the bodies of many animal species, giving them bigger beaks, limbs and ears.

In some species of Australian parrot, for instance, beak size has increased by between 4% and 10% since 1871. Another study, this time in North American dark-eyed juncos, another bird, found the same pattern. Similar trends are seen in mammals, with species of mice, shrews and bats evolving bigger ears, tails, legs and wings.

All that dovetails nicely with evolutionary theory. "Allen's rule", named for Joel Asaph Allen, who suggested it in 1877, holds that warm-blooded animals in hot places tend to have larger appendages than those in temperate regions. Such adaptations boost an animal's surface area relative to its body volume, helping it to shed excess heat. Being richly endowed with blood vessels, and not covered by insulating feathers, beaks make an ideal place for birds to dispose of heat. Fennec foxes, meanwhile, which are native to the Sahara desert, have strikingly large ears, especially compared with their Arctic cousins.

Ms Ryding examined museum specimens, comparing their bodies to those

of their modern counterparts. She is not the first researcher to take that approach. But it is hard, when dealing with individual species, to prove that climate change was the cause of an anatomical alteration. All sorts of other factors, from changes in prey to the evolving reproductive preferences of males or females, might conceivably have been driving the changes.

Looking at the bigger picture makes the pattern clearer, says Ms Ryding. Her team combined data from different species in different places. Since they have little in common apart from living on a warming planet, she says, climate change is the most plausible explanation.

For now, at least, the increase is small, never much more than 10%. That may change as warming accelerates. Since any evolutionary adaptation comes with trade-offs, it is unclear how far the process might go. Bigger beaks might interfere with feeding, for instance. Larger wings are heavier, and bigger legs cost more energy to grow.

And there are other ways to adapt, too. Researchers have already seen changes in the geographical range of many species, from insects to fish. Another evolutionary rule-of-thumb, Bergmann's rule, holds that animals in hotter places tend to have smaller bodies, another way to boost the ratio between surface area and volume. Other animals may alter their behaviour as well as their bodies, such as by seeking shelter at hot times of the day.

Studying a broader range of animals will help firm up exactly what is happening. Much of Ms Ryding's data concern birds, with less information available for other taxa. But it seems clear that the world of the future is not just going to be hotter than humans are used to. The animals living in it will look different, too. ■



气候变化与进化

从动物形貌的变化看全球变暖

成百上千个物种显现出适应气候变暖的迹象

对人类来说，适应气候变化将主要依靠技术手段。使用更多空调、设计更好的房屋、建设更大规模的防洪设施——这些手段可能有助于减轻全球变暖带来的影响。动物就只能靠改变自己的身体或行为来适应了。在发表于《生态学与进化趋势》（*Trends in Ecology & Evolution*）上的一篇论文中，澳大利亚迪肯大学（Deakin University）的博士研究生萨拉·瑞丁（Sara Ryding）带领的研究团队指出，这种情况已经在发生。气候变化已经改变了许多动物种类的体型体貌，使它们演化出了更大的喙、四肢和耳朵。

例如，自1871年以来，某些种属的澳大利亚鹦鹉的喙已经增大了4%至10%。另一项对北美黑眼灯芯草雀的研究也发现了同样的情况。类似的趋势也出现在哺乳动物身上，小鼠、鼩鼱和蝙蝠等物种进化出了更大的耳朵、尾巴、腿和翅膀。

所有这些都与进化论高度吻合。乔尔·阿萨夫·艾伦（Joel Asaph Allen）在1877年提出的“艾伦法则”认为，生活在炎热地区的温血动物往往比温带地区的温血动物有更大的躯体延伸部位。这种适应表现增加了动物相对于自身身体体积的体表面积，有利于释放多余的热量。喙上有丰富的血管，又没有保温的羽毛覆盖，是鸟类散热的理想部位。又比如，原产于撒哈拉沙漠的耳廓狐有着大得惊人的耳朵，与它们的北极表亲形成强烈对比。

瑞丁研究了博物馆的标本，将它们的身体与现代同类做比较。她并不是第一个采用这种方法的研究人员。但在研究单个物种时，很难证明气候变化是身体结构改变的原因。这是因为还有其他各种各样的因素也可能引发这些变化，从猎物的变化，到雄性或雌性不断演变的繁殖偏好等。

瑞丁表示，从更宏观的角度能够更清晰地看出变化规律。她的团队汇总了

来自不同地区的不同物种的数据。她说，这些生物除了共同生活在一个正在变暖的星球上之外，几乎没有共同点，所以气候变化是最可信的解释。

至少在目前看来，这类身体面积的增幅还很小——没有明显超过10%的。随着气候变暖的加速，这或许会改变。由于任何进化适应都伴随着取舍和代价，尚不清楚这个过程会发展到何种程度。例如，更大的喙可能会妨碍进食。更大的翅膀会更重，而长出更大的腿需要耗费更多能量。

还有其他的适应方式。研究人员已经发现，从昆虫到鱼类的许多物种的地域分布都发生了变化。另一个进化论的经验法则伯格曼法则（Bergmann's rule）认为，生活在炎热地区的动物往往个头更小，这是另一种提高体表面积与体积之比的方法。还有些动物在改变身体的同时也在改变行为，比如在一天中的炎热时段寻找遮蔽。

把更多种类的动物纳入研究将有助于确定到底发生了什么。瑞丁的大部分数据都来自鸟类，其他物种的信息较少。但是很显然，未来的世界不仅会让人类感觉更炎热。生活在其中的动物的模样也会变得不一样。 ■



Range anxiety

New, 800V, electric cars, will recharge in half the time

Pump up the voltage!

ELECTRIC VEHICLES (EVs) are becoming commoner. Some 750,000 of them were sold in the first quarter of 2021 according to JATO Dynamics, a British consultancy. JATO reckons EVs now account for just over 4% of new-car sales, up from 2% in the same quarter last year. Yet many potential buyers still suffer from “range anxiety”, a wariness about having to interrupt a long journey while an EV’s battery is recharged. The good news is that the time required to do this is about to be slashed.

Most EVs operate at 400 volts (400V). But a number of producers and their component suppliers are now gearing up to introduce 800V drive systems. Higher voltages supply the same amount of power with less current, which means electric cables can be made lighter—the consequent weight saving helping to increase a vehicle’s range, says Christoph Gillen, a technology director for GKN Automotive, a British components group which recently announced that it is accelerating its development of 800V drive systems. As most cabling is made from copper, the price of which has been soaring, this should also save carmakers money.

What drivers are most likely to notice, though, according to Dr Gillen, is that vehicles with 800V drive systems will be able to make greater use of some of the latest fast chargers. For instance, Ionity, a German company backed by a number of carmakers, is building a network of 350kW fast chargers across Europe. These automatically optimise charging speed to the maximum that a vehicle can handle. Using one of these, an EV with an 800V system will be able to recharge about twice as quickly as a similar vehicle with a 400V system.

Fast chargers are also more efficient. All chargers take electricity from the grid, which uses an alternating current (AC). When an EV is plugged into a standard charging point, its systems convert AC into direct current (DC), which is what a battery needs to store electricity. Fast chargers bypass the vehicle's converter, using their own beefier bits of kit to pump a DC charge directly into the battery.

The first EV to use an 800 V drive system was the Porsche Taycan, a luxury sports saloon. This was launched in 2019. According to Porsche, by using a fast-charger the Taycan's huge 93k Wh battery can, in a little more than five minutes, gather enough juice for the car to travel 100km.

Two South Korean producers, Hyundai and its partner Kia, launched their first 800V vehicles this year. Kia says the 77kWh battery in its EV6, which went on sale on August 2nd, can be recharged from 10% to 80% in 18 minutes. (The last 20% of capacity is charged at a slower rate in most EVs, to prevent damage to the battery. Hence a full recharge is typically carried out overnight on a standard charger.) Others have 800V vehicles in the works, too. They include General Motors, Volvo, BYD and Stellantis (a large shareholder in which, for full disclosure, also has a stake in The Economist's parent company).

Turning an EV's battery from a 400V to an 800V system is fairly straightforward. Principally, it involves wiring up more of the battery's cells in series. But the associated electronics need additional re-engineering. The main reason why the current generation of EVs use 400V is that semiconductors able to handle higher voltages have not been readily available.

Now that EV sales are growing strongly, though, specialist chipmakers are investing in semiconductors that can operate at 800V. Instead of using transistors made from pure silicon, those employed by these chips are made

from silicon carbide, which is more robust. Safety systems in vehicles, such as automated circuit breakers which isolate the battery in the event of a crash, also need to be upgraded.

What all this means is that, as more 800V EVs come onto the market, and batteries continue to improve with increased capacity, more motorists are likely to be persuaded to go electric. Much, however, will depend on the availability of fast-charging infrastructure. If stations are easy to find, and topping up batteries takes only the amount of time required to pick up a coffee, then the malady of range anxiety will at last be laid to rest. ■



里程焦虑

新型800伏电动车的充电速度快一倍

风驰“电”掣！

电动汽车日益普及。据英国咨询公司JATO Dynamics统计，2021年第一季度电动汽车总销量约达75万辆。它估计电动汽车目前在新车销售中的占比略超过4%，高于去年第一季度的2%。不过，许多潜在买家仍放不下“里程焦虑”——担心在长途出行的中途要停下来给电动汽车的电池充电。好消息是，充电所需的时间即将大大缩短。

大多数电动汽车的工作电压为400伏特。但一些制造商及其零部件供应商正准备引入800伏的驱动系统。英国汽车配件供应商吉凯恩（GKN Automotive）最近宣布正在加快开发800伏的驱动系统。公司技术总监克里斯托夫·吉伦（Christoph Gillen）表示，提高电压可以用较低的电流提供同样多的电力，这意味着可以采用更轻的电缆，从而减轻车身重量，有助于增加续航里程。由于大部分电缆都由铜制成，而铜价持续飙升，这应该也会为汽车制造商节省成本。

不过吉伦表示，对于驾车者而言，最直接的感受是搭载800伏驱动系统的车将能更好地利用一些最新的快充电桩。例如，获得多家汽车公司支持的德国公司Ionomy正在欧洲建设一个350千瓦的快充网络，其充电桩可以根据汽车的充电能力自动优化到最高充电速度。使用这种设备时，800伏系统的充电速度将比400伏系统的同类电动汽车快一倍左右。

快充电桩的运作效率也更高。所有的充电设备都要从电网取电。电网使用交流电，而电池储电需要直流电。当电动汽车接入标准充电桩时，系统会将交流电转换为直流电。快充电桩跳过了车辆的转换器，使用自身更强大的器件将直流电直接充入电池。

第一款使用800伏驱动系统的电动汽车是保时捷的豪华跑车Taycan。该车型于2019年发布。保时捷称，使用快充电桩为Taycan的93千瓦时大容量电池

充电，只需五分钟多一点就能实现100公里的续航。

现代及其合作伙伴起亚这两家韩国汽车公司今年也首次推出了自己的800伏车型。起亚表示，8月2日上市的EV6搭载77千瓦时的电池，只需18分钟便可将电量从10%充到80%。（大多数电动汽车会以较慢的速度充完最后20%的电以免损坏电池，因此这一步通常会在夜间使用标准充电桩完成。）其他公司也在开发800伏车型，包括通用汽车、沃尔沃、比亚迪和Stellantis（该公司一个大股东同时持有本刊母公司的股份）。

将电动汽车的电池从400伏转为800伏系统相当简单。基本上就是将更多电芯串联起来。但是相关的电子器件需要另外做重新设计。当前一代电动汽车使用400伏系统的主要原因是缺乏能够承受更高电压的半导体。

不过，随着电动汽车销量强劲增长，专业芯片制造商正在投资制造能在800伏电压下工作的半导体。这些芯片的晶体管不再使用纯硅制成，而是采用更强固的碳化硅。汽车的安全系统也需要升级，例如在发生碰撞时隔离电池的自动断路器。

这些都意味着，随着更多的800伏电动车型上市，以及电池容量不断提高，越来越多的驾车者可能会被电动汽车打动。然而，很大程度上这将取决于快速充电基础设施的普及程度。如果充电站随处可见，而且去买杯咖啡的工夫就能充好电，那么里程焦虑这块心病总算可以放下了。■



The Economist Film

Smart cities: Boston

American innovators are anticipating data-driven technologies that could help predict problems...before they even happen.



经济学人视频

智慧城市：波士顿

美国创新者希望由数据驱动的技术能够帮助预防社会问题...在它们尚未发生前。



Shifting foundations

The Gates Foundation's approach has both advantages and limits

Data isn't everything, even for the world's most powerful charity

THE JANICKI OMNI PROCESSOR, a \$2m machine paid for by the Bill & Melinda Gates Foundation, turns human waste into water and electricity. In poor cities such as Dakar in Senegal, where it has been piloted, the hope is that people will send sewage to sanitation plants to be processed, rather than chucking it into the streets.

The Omni Processor exemplifies the Gates Foundation's approach to philanthropy. Mr Gates likes to apply business principles to doing good, which means focusing on innovative, often technological, solutions with quantifiable results. The processor's inputs and outputs can be counted. The first version, which arrived in Senegal in 2015, was not designed to deal with sewage filled with sand and rocks as it is in Dakar. It was made of materials that corroded quickly in the city's sea air. These glitches have been fixed in the "OP 2.0", which arrived in Dakar this year.

Mr Gates has championed the foundation's data-driven style of philanthropy. But his ex-wife, now known as Melinda French Gates, is thought to have tempered his relentless focus on efficiency, arguing that number-crunching methods cannot resolve the complex causes of poverty on their own. That difference in emphasis, in turn, raises questions about whether the couple's divorce, announced this year, will set the world's most powerful charitable foundation on a novel course.

The foundation's influence is immense. Its \$50bn endowment comes from contributions from Mr Gates, the co-founder of Microsoft, Ms French Gates and Warren Buffett, a billionaire investor and friend. In 2019 it gave out

\$4.1bn, according to the OECD, a club of rich countries, more than 11 times as much as the next-largest private American development foundation. If it were a government, it would be the 12th-biggest disburser of foreign aid, between Italy and Switzerland (see chart 1).

The Gates foundation is the second-biggest donor to the World Health Organisation, behind only the American government. It is a founding member of Gavi, a public-private partnership that provides vaccination programmes in poor countries. It has committed more than \$1.8bn to fighting covid-19.

It is not the first to embrace a businesslike approach to charitable giving. In 1889 Andrew Carnegie, a steel magnate, wrote in “The Gospel of Wealth”: “One of the serious obstacles to the improvement of our race is indiscriminate charity.” He cautioned against giving people money without scrutinising how they spent it. He and other industrialists such as Henry Ford and John D. Rockefeller set up large foundations with big boards to give away their money, mostly late in life.

In recent decades the centre of gravity for American philanthropy has shifted from the east coast to the west. Rich tech founders are giving away their wealth while young and taking a keen interest in how it is spent. Many take their cues from the Gates Foundation in terms of which causes to support and how to do so, says Nick Tedesco, a former Gates employee who is now head of the National Centre for Family Philanthropy in Washington, DC. “The influence of the Gates Foundation”, he says, “is outsized.”

Established in 2000, the foundation employs 1,750 people, mostly in Seattle. Mr Gates, who stepped down from his day-to-day role at Microsoft in 2008, takes a hands-on approach to its work. He and Ms French Gates pick causes on which they believe they can have the most impact, from improving education in America to eradicating diseases such as polio and malaria.

They hire academics, former management consultants and mandarins to dish out grants, often referred to as “investments”. The return on grants is measured precisely. A malaria project might be judged on bed-nets distributed; one on education might track attendance rates or test scores. Unsuccessful ventures are dropped.

Not all rich benefactors operate in this way. Some simply give vast sums of money to charities they like, leaving them to spend it as they wish. MacKenzie Scott, the ex-wife of Jeff Bezos, founder of Amazon, has announced over \$8bn in donations since July 2020 in an approach she calls “seeding by ceding”. She has hired Bridgespan Group, a consultancy, to help her pick grantees. Her gifts come without prescriptions or demands for reports on progress.

The Gates Foundation promotes data-driven, tech-based fixes for discrete problems. Mr Gates’s first charitable effort was to buy computers for libraries in poor parts of America and connect them to the internet. His work in health initially focused on technological solutions, like vaccines, for particular infectious diseases.

In other areas, however, that hyper-efficient, outcomes-oriented approach gets you only so far. Counting vaccines is easy; putting a number on a woman’s freedom is not. Mr Gates and Ms French Gates expected global health to be the trickiest part of their portfolio, says Patrick Methvin, who works on education in America for the Gates Foundation. But they found that education projects were more complicated, in part because evaluating what children have learnt—and what they should learn—is far from straightforward. “Education is fundamentally a social-values-based enterprise,” Mr Methvin says.

As Adam Moe Fejerskov, author of “The Gates Foundation’s Rise to Power”, puts it: “Quantification is really about reducing the messiness of the world

to formulae and numbers.” The trickiest problems cannot be solved by technology and numbers alone. When the first Omni Processor arrived in Dakar, almost a third of the city’s 3m inhabitants did not live in homes connected to sewers. Public understanding of sanitation is limited. Shortly after the machine appeared, rumours that water extracted from sewage was being added to the city’s drinking water caused uproar. Speak Up Africa, a Gates-funded policy-and-advocacy group, was called on to launch a public-information campaign.

The point of evaluating projects is to steer money away from those that do not work. The foundation says that it does so slowly, winding programmes down gradually. But this trial-and-error method can cause problems.

Early on, the foundation backed the small schools movement in America which suggested that students learn better in small groups getting more individual attention. But running extra-curricular activities and programmes for pupils who needed help with English or special needs was difficult with a smaller student body. With fewer teachers, small schools had to limit their curriculums. The foundation honoured existing grants but channelled new funds into other education reforms. Schools were left struggling for cash and children faced unnecessary upheaval. “We fell short,” Mr Gates wrote in 2009.

For grantees, the level of monitoring and evaluation marks a big difference between the Gates Foundation and other donors. Programme officers oversee their work. That can be helpful. At Speak Up Africa, which has been awarded some \$33m in multiple grants since 2015, the team says its monthly virtual meetings with Gates staff in Seattle offer a chance to discuss new ideas and meet international experts.

But the administrative burden can be overwhelming for small groups unused to working with a demanding, global foundation. Askaan Santé, a

non-profit organisation in Dakar focused on public health with a staff of 13, received \$900,000 in funding after its founder, Fatou Fall Ndoye, met a Gates staffer at a conference. The foundation helped her craft her proposal. But the application took eight months. “It’s a long process,” Ms Ndoye says.

This explains in part why the foundation tends to fund organisations based in the rich world rather than those in developing countries where the money is needed most. An analysis of the foundation’s grants database by The Economist and David McCoy, a professor of global public health at Queen Mary University of London, suggests that grantees with headquarters in Africa and Asia have received just 5.3% and 5.6% of its grants respectively since 1999, though their share has risen (see chart 2).

There are many reasons for this asymmetry. Grantees based in America or Europe often have branches in poorer countries and pass funding on to sub-grantees elsewhere. Fewer people are doing cutting-edge research in sub-Saharan Africa. But it is also difficult for a small organisation in the poor world to get the attention of a Gates staffer. And the paperwork can be intimidating. Those that manage to win Gates funding often know someone at the foundation or have worked at an organisation backed by the foundation and so understand the process. Ms Ndoye had both.

Initially the thought was that the foundation would use its resources for innovation to come up with “breakthroughs”, and leave it to others to ensure they reached the right people, says Mark Suzman, its chief executive. “The wake-up call which hits a lot of people who come into philanthropy is that that doesn’t necessarily work.”

Instead the foundation is now focusing on making sure that its innovations work in the real world. This involves messy social changes that are difficult to track. It has invested \$4bn in the Global Polio Eradication Initiative,

including vaccines. But in Nigeria, the only African country where the disease remained endemic, it has also mapped villages in the conflict-ridden north which were missed in immunisation campaigns. The continent was declared free of wild polio last year.

In family planning the foundation is not simply distributing cheap contraceptives. Women in a low-income country, like India, might not feel comfortable going to a clinic to get condoms or a pill. The Gates-backed Centre for Social and Behaviour Change at Ashoka University near New Delhi tries to understand these social dynamics. It is supporting groups that help women build their confidence in such matters. Confidence is hard to quantify.

The unmeasurable side to philanthropy has drawn on the temperament and insights of Ms French Gates. Richard Horton, editor of the Lancet, a British medical journal, says she takes a “more holistic approach” to development, encompassing women’s rights and the capacity of health systems. “She humanised the foundation in a remarkable way,” he continues. Chris Eide, who founded Teachers United, an American advocacy group that received a Gates grant in 2011, describes two separate meetings with the pair. Ms French Gates, he says, asked him to bring a group of teachers and asked “open and earnest questions” about their work. Mr Gates met him one-on-one and grilled him on education policy. “The way he took notes from our conversation, it was almost like he was building a machine,” says Mr Eide.

The question now is whether Ms French Gates’s influence will outlast the pair’s divorce. If in two years they no longer want to work together, she will resign as a trustee and receive a payout from him to continue her philanthropic work elsewhere. That would require the foundation to find a new way to get the most out of Mr Gates’s data-driven method. ■



流动的根基

盖茨基金会的方法既有优点也有局限性

数据不是一切。这对世界上最强大的慈善机构也不例外【深度】

由比尔和梅琳达·盖茨基金会出资 200 万美元打造的Janicki Omni处理机将人类排泄物转化为水和电。它在塞内加尔的达喀尔等贫困城市进行了试点，希望让人们将污水送进处理厂处理，而不是排到街道上。

Omni处理机体现了盖茨基金会做慈善的方式。盖茨喜欢将商业原则应用于行善，这意味着专注于具有可量化结果的创新解决方案，而此类方案往往是技术性的。处理机的输入和输出可以计量。第一个版本于 2015 年抵达塞内加尔，当时它的设计并不适合达喀尔充满沙石的污水。它所用的材料会迅速被那里的海洋空气腐蚀。这些毛病已在今年抵达达喀尔的“OP 2.0”中解决。

盖茨支持该基金会以数据为导向的慈善事业。但据信他的前妻（现在被称为梅琳达·弗兰奇·盖茨）缓和了他对效率的不懈关注，认为单靠数字运算的方法无法解决导致贫困的复杂原因。这种关注点的差异继而引发了一个问题：两人在今年早些时候宣布离婚，这是否会把世界上最具影响力的慈善基金会引向新路。

这个基金会的影响是巨大的。其 500 亿美元的捐赠来自微软联合创始人盖茨、梅琳达和亿万富翁投资者、两人的朋友沃伦·巴菲特的捐款。根据富裕国家俱乐部经合组织的数据，2019 年它派发了 41 亿美元，是美国第二大私人发展基金会的 11 倍多。如果它是一个政府，将是排在意大利和瑞士之间的第 12 大外援支出国（见图 1）。

盖茨基金会是世卫组织的第二大捐助者，仅次于美国政府。它是全球疫苗免疫联盟（Gavi）的创始成员，这是一个公私合作组织，为贫穷国家提供疫苗接种计划。它已承诺投入超过 18 亿美元用于对抗新冠肺炎。

它不是第一个采用类似经营企业的方法开展慈善捐赠的组织。1889年，钢铁大亨安德鲁·卡内基在《财富福音》（The Gospel of Wealth）中写道：“人类进步的严重障碍之一是不分青红皂白的慈善事业。”他告诫不要在没有仔细审查人们会如何使用善款的情况下就给他们钱。他和亨利·福特、约翰·D·洛克菲勒等其他实业家都建立了具有庞大董事会的大型基金会来捐出自己的钱，其中大部分是在晚年捐出的。

近几十年来，美国慈善事业的重心已经从东海岸转移到了西部。富有的科技业创始人在年纪轻轻时就捐赠财富，并对如何使用财富保有浓厚的兴趣。盖茨的前手下、现华盛顿特区国家家庭慈善中心（National Centre for Family Philanthropy）负责人尼克·泰德斯科（Nick Tedesco）表示，许多人从盖茨基金会那里学习了支持哪些事业以及如何操作。“盖茨基金会的影响力，”他说，“是巨大的。”

该基金会成立于2000年，雇有1750名员工，大部分在西雅图。盖茨于2008年辞去微软的日常职务，亲身参与基金会的很多工作。他和梅琳达选择了他们认为可以产生最大影响的事业，从改善美国的教育到根除脊髓灰质炎和疟疾等疾病。他们聘请学者、前管理顾问和政界要员来发放赠款（通常被称为“投资”）。捐赠的回报被精确地衡量。疟疾项目可以根据分发的蚊帐数来评判，针对教育的投资则可能跟踪出勤率或考试成绩。不成功的尝试会被放弃。

并非所有富有的慈善家都以这种方式运作。有些人只是简单地向他们喜欢的慈善机构捐赠大量资金，让他们随心所欲地花钱。亚马逊创始人杰夫·贝佐斯的前妻麦肯齐·斯科特（MacKenzie Scott）自2020年7月以来已总共宣布捐赠超过80亿美元，她把自己的方式称为“捐助后退隐”。她聘请了咨询公司布利吉斯潘集团（Bridgespan Group）来帮助她挑选受助方。她的捐赠没有具体安排，也没有要求报告进展。

盖茨基金会提倡用数据驱动、基于技术的方案来解决特定问题。盖茨的第一个慈善活动是为美国贫困地区的图书馆购买电脑，并将它们连接到互联网。他在健康方面的工作最初侧重于技术解决方案——例如疫苗——对抗

特定传染病。

然而，在其他领域，这种超高效、结果导向的方法有其局限性。数一数疫苗很容易，用一个数字来评估一名女性拥有多少自由则不然。盖茨基金会负责美国教育工作的帕特里克·梅思文（Patrick Methvin）表示，盖茨和弗伦奇·盖茨女士本以为全球健康将成为其投资组合中最棘手的部分，但他们发现教育项目更为复杂，部分原因是评估孩子们学到了什么以及该学什么远非易事。“教育从根本上说是一项以社会价值观为基础的事业。”梅思文说。

正如《盖茨基金会的崛起》（The Gates Foundation's Rise to Power）一书的作者亚当·莫·费杰斯科夫（Adam Moe Fejerskov）所说：“量化说到底是将世界的混乱简化为公式和数字。”仅靠技术和数字无法解决最棘手的问题。当第一台Omni处理机抵达达喀尔时，该市 300 万居民中几乎有三分之一住在没有下水道的房屋里。公众对卫生的理解有限。该机器出现后不久，有关从污水中提取的水被添加到该市饮用水中的传言激起了轩然大波。盖茨资助的政策和倡导组织“非洲发声”（Speak Up Africa）被要求发起一项公共信息宣传活动。

评估项目的目的是把资金抽离那些行不通的项目。该基金会表示它在这方面放慢步调，只会逐步缩减终结项目。但是这种试错的方法可能会导致问题。

早期，该基金会支持美国的学校小型化运动，认为学生在能得到更多个人关注的小班里会学习得更好。但是，学生人数较少时，为英语需要帮助或有特殊需求的学生开展课外活动和课程变得很困难。由于教师较少，小型学校不得不限制开设的课程数量。基金会兑现了已承诺的赠款，但将新资金用于其他教育改革。这导致学校资金吃紧，而孩子们面临着不必要的动荡。“我们没有做好。”盖茨在2009年写道。

对于受助者而言，监测和评估的水平标志着盖茨基金会与其他捐助者之间的巨大差异。项目负责人会监督他们的工作。这可能会有所帮助。自 2015

年以来，非洲发声已获得总计约3300万美元的多项赠款，该团队表示，每月与西雅图的盖茨员工举行的虚拟会议提供了一个讨论新想法和会见国际专家的机会。

但对于不习惯与要求苛刻的全球基金会合作的小团队来说，行政负担可能难以承受。位于达喀尔的非营利组织“阿斯坎健康”（Askaan Santé）雇有13名员工，专注于公共卫生。在其创始人法图·法尔·恩多耶（Fatou Fall Ndoye）在一次会议上会见了盖茨的一名员工后获得了90万美元的资金。基金会帮助她起草了提案。但申请耗时八个月。“这是一个漫长的过程。”恩多耶说。

这在一定程度上解释了为什么该基金会倾向于资助位于富裕国家的组织，而不是那些最需要资金的发展中国家的组织。本刊和伦敦玛丽皇后大学全球公共卫生学教授大卫·麦考伊（David McCoy）对基金会赠款数据库的分析表明，自1999以来，位于非洲和亚洲的受赠方分别仅获得了5.3%和5.6%的赠款，尽管其所占份额已有上升（见图表2）。

造成这种不对称的原因有很多。位于美国或欧洲的受赠组织通常在较贫穷的国家设有分支机构，并将资金转给其他地方的次级受赠人。在撒哈拉以南非洲从事前沿研究的人越来越少。贫穷国家的一个小组织也很难引起盖茨员工的注意。文书工作可能令人生畏。那些设法赢得盖茨资助的人通常认识基金会的某个人，或者曾在基金会支持的组织工作过，因此了解这个过程。恩多耶两者兼备。

基金会首席执行官马克·苏兹曼（Mark Suzman）表示，最初的想法是，基金会将利用其创新资源来实现“突破”，而留给其他人去确保这些创新会覆盖到合适的人群。“让很多从事慈善事业的人警醒的是，这不一定奏效。”

相反，基金会现在专注于确保其创新在现实世界中发挥作用。这涉及难以追踪的混乱的社会变化。它已向“全球根除脊髓灰质炎倡议”投资了40亿美元，其中包括疫苗。但在非洲唯一仍然流行这种疾病的国家尼日利亚，基金会发现免疫运动遗漏了冲突频发的北部村庄。去年，非洲大陆被宣布

消灭了野生的脊髓灰质炎。

针对计划生育，基金会不仅仅是分发廉价的避孕药具。印度等低收入国家的女性可能不大愿意去诊所领取避孕套或避孕药。在新德里附近的阿育王大学（Ashoka University），由盖茨支持的社会和行为改变中心试图了解这些社会动态。它正在支持那些帮助妇女在此类问题上建立信心的团体。而信心很难量化。

慈善事业难以计量的一面得益于梅琳达的性情和洞察力。英国医学杂志《柳叶刀》的编辑理查德·霍顿（Richard Horton）说，她对发展采取“更全面的方法”，涵盖了女性权利和卫生系统的能力。“她以非凡的方式让基金会人性化。”他说。克里斯·艾德（Chris Eide）是美国倡导组织“教师联合会”（Teachers United）的创始人，该组织于 2011 年获得了盖茨的资助。他描述了自己曾与盖茨夫妇二人分头会面。他说，梅琳达让他带上了一群老师，并就他们的工作提出了“坦诚而真诚的问题”。盖茨与他进行了一对一的会面，并就教育政策盘问了他很久。“他在我们谈话时做笔记的方式简直就像他在制造一台机器。”艾德说。

现在的问题是，梅琳达的影响力是否会持续到两人离婚之后。如果两年后他们不想再在一起工作，她将辞去受托人的职务，并从他那里获得一笔款项以继续她在其他地方的慈善工作。如果是这样，那基金会就得找到一种新的方法来充分利用盖茨那套数据驱动的方法了。 ■



Schumpeter

Peter Thiel, scourge of Silicon Valley

A venture capitalist reinvents the military-industrial complex

FOR A MAN who wants to live for ever, Peter Thiel has already done enough in his 53 years to leave mere mortals exhausted—and mostly frustrated. The venture capitalist, techno-Utopian and scourge of the liberal left is a myriad of contradictions.

He co-founded PayPal, a payments platform that, as a young libertarian, he hoped would undermine the world's monetary system. Instead it gave him the money to bestride Silicon Valley, a place he disdains. He was the earliest outside investor in Facebook, a tech giant on whose board he remains, though he mocks social media. As a hedge-fund manager, he bet on an economic meltdown in America ahead of the financial crisis of 2007-09, but called the bottom of the market too soon. He was one of the most prominent financiers to throw his weight behind Donald Trump's bid for the presidency in 2016. Yet his efforts to populate the Trump administration with radical-thinking acolytes failed.

Max Chafkin, who trawls through this litany of inconsistencies in a new book, "The Contrarian", writes fluently. But he fails to find an explanation that ties the threads together. At his most charitable, he praises Mr Thiel as a creator of immense wealth because of the tech firms he has backed (besides PayPal and Facebook, they include sharing-economy giants such as Airbnb and Lyft, plus a host of other blitzscaling platforms). At his most damning, he portrays his subject as a tax-avoiding "nihilist" whose right-leaning ideology is mostly aimed at increasing his wealth and power.

And yet strangely Mr Chafkin, a business writer, only obliquely refers to

the most intriguing business story. Between the lines, a picture emerges of an erratic visionary whose work, however creepy, isn't done. Mr Thiel is applying the radicalism that inspired PayPal to cryptocurrencies and decentralised payment platforms. The "Make America Great Again" schtick that drew him to Mr Trump has led to investments in military, surveillance and space technology that have helped double his net worth in the past year. His yearning to reclaim Silicon Valley from software-loving peaceniks and return to its roots in the cold-war military-industrial complex is bearing fruit—and spreading beyond California.

In short, his peculiar brand of libertarianism appears to have a new lease of life. With one hand, he wants to free individuals from government shackles by enabling them to create their own currencies. With the other, he is selling technology to a strong security establishment so that it can protect them from potential enemies. It is enough to make Silicon Valley's mixture of hippies and yuppies hyperventilate on their yoga mats.

It is not the first time a man described by Mr Chafkin as socially awkward has built a movement of like-minded people bent on shaking up the tech industry. The PayPal mafia that he helped bring together at the turn of the century continues to flourish. Besides him, its best-known member is Elon Musk, whose SpaceX rocket company is backed by Mr Thiel's Founders Fund, a venture-capital (VC) firm. Last valued at \$74bn, on September 18th it returned the first-ever civilian crew from orbit. It is in the vanguard of America's re-energised aerospace industry.

Others, too, have stuck by Mr Thiel for decades and share his security obsessions. Palantir, a data-analytics firm worth \$52bn, is used by the American armed forces, immigration authorities and numerous police departments. It was co-founded by Mr Thiel in 2003 and is run by an old friend, Alexander Karp (who used to sit on the board of The Economist's parent company). In the run-up to its initial public offering last year, Mr

Karp told potential investors the company, though born in Silicon Valley, shared few of its values. “Our software is used to target terrorists and keep soldiers safe...we have chosen sides,” he said.

Anduril, a startup defence contractor also backed by Mr Thiel, is building pilotless drones for military surveillance. Marc Andreessen of Andreessen Horowitz, a VC firm (who is also a Facebook director), has written of the emergence of a new generation of Silicon Valley-style defence companies. “There are some in our industry who view serving such agencies and missions as controversial. We do not,” he wrote in 2019, announcing a co-investment with Mr Thiel’s Founders Fund in Anduril. It was last valued at about \$4.6bn.

Even without Mr Trump, Mr Thiel continues to mix business and politics. This year he joined forces with Narya, a vc fund led by J.D. Vance, the author of “Hillbilly Elegy”, to invest in Rumble, a video platform popular among right-wingers. He is backing Mr Vance in the Republican Senate primary in Ohio. Blake Masters, Mr Thiel’s co-author on “Zero to One”, a bestseller published in 2014, hopes to represent the Republicans in the Arizona Senate race. The New Yorker has speculated that “The Rise of the Thielists” could provide the Republican Party with a post-Trump ideology.

If that is the case, it would probably involve continued pillorying of big-tech firms, especially Google, which Mr Thiel has long accused of being a monopoly. The new ideology would be anti-China, a country Mr Thiel portrays as using artificial intelligence (AI) to centralise control over the economy. “If AI is communist, crypto is libertarian,” he wrote last year. It would look favourably on cryptocurrencies and blockchains. He is a big backer of Block.one, a blockchain-software company whose crypto unit, Bullish, is planning to go public via a \$9bn reverse merger with a special-purpose acquisition company.

All this takes tech investing beyond Silicon Valley into new realms, some of them menacing to many observers. That will not worry Mr Thiel. Palantir is named after a “seeing stone” most often used by Sauron, ruler of J.R.R. Tolkien’s evil empire of Mordor in “The Lord of the Rings”. Evidently Mr Thiel, ever the contrarian, does not view Mordor as harshly as most Tolkien fans do. As he once told a friend: “I’d rather be seen as evil than incompetent.” ■



熊彼特

彼得·蒂尔，硅谷之祸

一名风险资本家重塑军工复合体

对于一个想要永生的人来说，彼得·蒂尔（Peter Thiel）在他活过的53年里所做的事已经足以让肉身凡胎们精疲力尽——且沮丧不已。这个风险投资家、技术乌托邦主义者、自由主义左派眼中的祸害就是一个矛盾集合体。

他是PayPal的创始人之一。当年他作为一个年轻的自由意志主义者，曾希望这个支付平台会瓦解世界货币体系。事实却是PayPal让他挣了大钱，在硅谷这个为他所不齿的地方呼风唤雨。尽管他蔑视社交媒体，他却是Facebook最早的外部投资者，如今仍是这家科技巨头的董事会成员。作为一名对冲基金经理，他早在2007到2009年金融危机发生前就押注美国经济要崩溃，但又过早地估计了市场触底时间。他是支持特朗普在2016年竞选总统的最受瞩目的金融家之一。但他试图把他那些思想激进的追随者塞进特朗普政府的努力以失败告终。

马克斯·查夫金（Max Chafkin）在新书《逆势者》（The Contrarian）中清楚流畅地罗列出了这一连串的矛盾之处。但是他没找到一个能把它们全部连结起来的解释。在口吻最宽容的段落，他称赞蒂尔是巨大财富的创造者，因为他支持了众多科技公司（除了PayPal和Facebook，他还投资了爱彼迎和Lyft这样的共享经济巨头，以及其他许多采用闪电式扩张模式的平台）。而在笔触最贬损之处，他将自己的主人公描绘成逃税的“虚无主义者”，其右倾意识形态主要是为了增加自己的财富和权力。

然而奇怪的是，身为商业作家的查夫金只拐弯抹角地提了下最有趣的商业故事。字里行间浮现出一个让人捉摸不定的远见家——此人的工作无论多么令人胆寒，都还没有完成。蒂尔正在将激发了PayPal灵感的激进主义运用到加密货币和去中心化支付平台上。“让美国再次伟大”的把戏把他推向了特朗普，并促使他投资军事、监视和太空技术，这使他的净资产在过去

一年里翻了一番。他渴望从热爱软件的反战分子手中夺回硅谷，使之回归存在冷战时期军工复合体里的根基。他的这种渴望正在开花结果——并扩展到加州以外。

简而言之，他自成一格的自由意志主义似乎重获新生。一方面，他想让个人能够创造自己的货币，从而将他们从政府的枷锁中解放出来。而另一方面，他正把技术出售给一个强大的安全机构，以保护他们免受潜在敌人的攻击。这足以让硅谷的嬉皮士和雅皮士在瑜伽垫上大口吸气。

在查夫金的叙述中，一个不擅社交之人发起了一场志同道合者一心撼动科技行业的运动。这也不是第一次发生了。蒂尔在世纪之交协助组建的“PayPal帮”风头有增无减。除了他之外，其最著名的成员就是伊隆·马斯克，他的火箭公司SpaceX得到了蒂尔的风投公司创始人基金（Founders Fund）的支持。该公司最近一次估值是740亿美元。9月18日，它从轨道上送回了第一批平民机组人员。它是重振美国航空航天工业的先锋。

其他一些人也追随蒂尔几十年，和他一样对安全着魔。市值520亿美元的数据分析公司Palantir的主顾有美国武装部队、移民管理机构和众多警察部门。这家公司由蒂尔等人于2003年联合创立，目前由他的老朋友亚历山大·卡普（Alexander Karp，曾是本刊母公司的董事会成员）管理。在去年IPO之前，卡普告诉潜在投资者说，Palantir虽然诞生于硅谷，但和硅谷的价值观几乎没有交集。他说，“我们的软件被用来锁定恐怖分子，保护士兵的安全……我们已经选好了站在哪一边。”

同样获得蒂尔支持的国防承包商创业公司安杜里尔（Anduril）正在制造用于军事侦察的无人机。风投公司安德森-霍洛维茨（Andreessen Horowitz）的马克·安德森（Marc Andreessen，也是Facebook的董事）曾写过出现新一代硅谷式国防公司的趋势。“我们行业中的有些人觉得服务于这样的机构和任务会引发争议。我们不觉得。”他在2019年这样写道，宣布与蒂尔的创始人基金共同投资安杜里尔。该公司上一次估值约为46亿美元。

即使特朗普已经下台，蒂尔仍将商业和政治搅在一起。今年，他与《乡下人的悲歌》（Hillbilly Elegy）一书的作者J. D.万斯（J. D. Vance）领导的风投基金Narya联手，投资了在右翼人士中很受欢迎的视频平台Rumble。他正在支持万斯参加俄亥俄州联邦参议员共和党初选。他在2014年出版的畅销书《从0到1》（Zero to One）的合著者布莱克·马斯特斯（Blake Masters）希望在亚利桑那州参议员议席竞选中代表共和党。《纽约客》曾猜测，“蒂尔派的崛起”可能会为共和党提供一种后特朗普的意识形态。

果真如此的话，这可能意味着大型科技公司会持续受到抨击，尤其是一直被蒂尔指责为垄断企业的谷歌。新的意识形态将是反中国的，按照蒂尔的描述，中国是个运用人工智能（AI）来集中控制经济的国家。“如果AI是共产主义的，那加密技术就是自由意志主义的。”他去年写道。这个意识形态会看好加密货币和区块链。他大手笔投资了Block.one，这是一家区块链软件公司，其加密部门Bullish正计划通过与一家特殊目的收购公司反向合并上市，估值90亿美元。

所有这些让科技投资走出硅谷，进入了新的领域，其中一些令许多观察人士感到险恶。蒂尔却不会担心这个。Palantir这个名字出自托尔金的《指环王》中的“魔眼石”，邪恶帝国摩多的统治者索伦常使用它。显然，一向跟人唱反调的蒂尔并不像大多数托尔金迷那样憎恶魔多。正如他曾经对一个朋友所说的，“我宁愿人们觉得我邪恶，也不愿他们觉得我无能。”■



Curiouser and curiouser

Adventures in DeFi-land

Can decentralised finance lay the foundations for an open digital economy?

43 which group transactions together and verify the bundle via the blockchain, reducing demand and therefore the energy needed to verify transactions.

With such workarounds still being developed and attempts to create platforms in their infancy, it is speculative to think that decentralisation will take off. The problems of DeFi—not just the energy intensity of blockchains but the rampant speculation, the potential to be flooded with dirty money and the apparent resistance to regulation—all stand to deter mass adoption. Yet the potential gains from payment and digital content platforms owned and governed by their users, a more open digital economy and a more efficient financial system are vast. The hope is that it is not all just a dream. ■



越来越新奇

梦游DeFi仙境

去中心化金融能否为开放的数字经济奠定基础？【深度】

头像大多是卡通版的人。它们都在一个形似漏斗的游泳池里来回转悠，虚拟的水流消失在漏斗颈深处。用户操作键盘来移动自己的位置。这些按键对那些少年时代都花在了打游戏上的人都再熟悉不过了：W、A、S、D分别是向前、向左、向后、向右走；空格键是跳跃。泳池旁的标识写着“可以潜水”。笔者按下了W，她那亚麻色头发的化身攀爬上红色跳水板的边缘，跃入水池中央。

这就是进入“散境”（Decentraland）的情景。它是一个建立在以太坊区块链上的虚拟现实平台，也叫“元宇宙”，里头的虚拟店铺出售数字收藏品和代币。当你第一次听到开发人员要把你在网上所做的一切都“分散化”时，那感觉着实很像跳水“掉进兔子洞”时的迷失感。越来越多开发者正寻求用区块链（分布在众多计算机上的数据库，通过加密保持安全）重建金融系统和互联网经济。其最终目标是用建立在网络之上的软件取代全球银行和科技平台等中介机构，将这些网络产生的价值送回拥有和运营它们的用户。

在所有数字活动中，朝向金融去中心化的努力是最为先进的。与华尔街自我膨胀的野心全然不同，“分散式金融”（DeFi，或称“去中心化金融”）寻求的是乌托邦式的众包控制。应用和功能不是由单个中央实体或公司，而是由用户操作的“分散化自治组织”（DAO）运营。“我将只是一个普通的社区成员，”DeFi组织MakerDAO的创始人鲁内·克里斯滕森（Rune Christensen）说，“归根结底，它主要关乎你如何参与，而非你是谁。”

围绕区块链、DAO和元宇宙的讨论听起来叫人一头雾水、不知所云，你可能都不想再听“DeFi人”的噪音。实际上，这项新兴技术的成功确实远非板上钉钉。但是，一种新型经济正通过各种区块链上的应用一块块搭建起

来。每添加一块，其整体都愈发有可能成为某种有意义且具有强大颠覆性的事物。

近年来，DeFi在规模和范围上都有了巨大的增长。支撑大部分DeFi活动的以太坊区块链在2021年第二季度完成了价值2.5万亿美元的交易，包括用于促成买卖和放贷的支付和交易。（支付巨头Visa在同一时期的结算金额大致相同；证券交易所纳斯达克的交易额是其六倍。）约900亿美元的抵押品被用于各种DeFi功能，而在2018年初还不到10亿美元。其中超过一半用于五个最受欢迎的DeFi应用，但开发人员正在创建其他一百多个应用，其中有几十个正在迅速积累资产。自动化做市商、套利系统和自稳定货币机制等创新已经在拓展金融科技的疆界。

DeFi的承诺是它可以带来一种更好的金融模式：一个更快捷、便宜、透明也更少依赖强大中央机构的系统。它还可以支撑一种不那么被少数科技巨头主导的数字经济。但这条道路上存在很多陷阱，尤其是在DeFi世界中发生着大量投机活动，以及它有可能充斥着黑钱，或因区块链的巨大能耗而蒙上阴影。

DeFi的机遇源自中心化产生的问题。诚然，相比让一群分散的个体来验证交易，建立一个由人人信任的实体（比如美联储）运行的金融结算系统的成本更低廉。但政府基础设施会僵化。而私营网络可能趋于垄断，助长反竞争行为和抽租。

例如，美联储采用一个即时支付系统的速度极为缓慢。而万事达卡和Visa卡等卡网络运营商的毛利在60%到80%。科技巨头能够以反竞争或用户不喜欢的方式使用自己的市场影响力。苹果改变了其平台与第三方合作的方式以阻止Facebook跟踪用户；Facebook自己则随心所欲地改变内容推荐算法；YouTube可以由着性子不让某些内容创作者变现。它们每家都拿走了与其网络相关的利润的大头。

去中心化提供了另一种选择：可互操作、透明、通常都很高效的系统，通过分散对软件的控制来防范权力集中。这种去中心化系统的第一个例子是

比特币，这是一种通过区块链验证的数字支付网络，于2009年创建，旨在取代中央发行货币。但自那时起技术已经发展演变，而比特币如今基本上成了一种杂音。人们“拿关于钱的部分大做文章，要么把它美化成一种新型货币体系……要么抨击它是对经济稳定的威胁。”风险投资公司安德森霍洛维茨（Andreessen Horowitz）的马克·安德森（Marc Andreessen）写道。该公司已筹集了约30亿美元用于投资加密技术。他们没有抓住重点，他写道，“加密代表的是技术运作方式以及由此导致的世界运作方式的架构转变。”

这种转变即分布式共识——让一个网络中的众多“去中心化”参与者建立信任的能力。2015年以太坊区块链创建后有一点变得更清晰了，那就是这种转变有可能促进的事物不止于支付（见图表1）。这种区块链上存储和记录着包含整个程序的一行行计算机代码，它们对所有人可见。这使得构建智能合约成为可能。所谓智能合约是自动执行的协议，当某些条件被满足时会触发一连串行动。它们是自动执行的，且不能篡改。

以太坊区块链和卡尔达诺（Cardano）等旨在存储代码的区块链也发行和使用自己的代币，分别叫以太币（ether）和艾达币（ADA）。要在以太坊区块链上验证一笔交易，你必须用以太币支付一笔额度不定的“燃油费”（gas）。

使用区块链的优势在于它就像一种新型计算机。一台实体计算机是一种存储数据并根据一组指令（即“程序”）处理数据的方式。以太坊区块链也是一种存储数据并对其进行操作的方式，就像是一台在实体计算机网络之上运行的虚拟计算机。其结果是，用安德森的加密基金的发起人克里斯·迪克森（Chris Dixon）的话说，它确保了“这台计算机会持续按设计运行”。

在区块链之外，每台计算机都由某个个人或组织控制，他们可以改变主意。有时他们在实物和硬件层面这么做：从许多方面来看，苹果保有对其销售的设备的广泛控制，这是通过它推送软件更新的能力来实现的（它就是用这种方式阻断了Facebook的追踪器）。更重要的是，这会对所有的网

页和应用起作用。例如，每次有人登录Facebook，他们都依赖这家公司运营的用来托管其网站的服务器。通过控制硬件，企业可以随心所欲地更改软件。

然而，在区块链上，这种关系是颠倒的：软件管理硬件，并且可以做出保证。由区块链技术控制的计算机，用迪克森的话说，就是“可以做出承诺的计算机”。

一旦存储和执行代码的去中心化基础铺设完毕，就可以在其上构建任何东西——比如资产或应用（见图表2）。唯一的限制是开发者的想象力。存在各种各样的“代币”，也就是资产的数字化代表。有些代币类似于支撑金融的工具，如股票、债券和通常与传统货币挂钩的“稳定币”。其他是治理代币，充当投票来决定DAO的运行方式。而“不可替换”代币或称非同质化代币（NFT）代表着独一无二的资产，如一幅图像或一段视频。这类产品的市场在过去一年里蓬勃发展。现在存在价值约230亿美元的NFT。

代币可以通过“协议”交换或借出。这些协议即管理交易应如何发生的规则。它们由DAO管理，只能通过共识被更改。之后用户就可以通过一个基于Web浏览器的界面连接到协议来购买和交换代币。

要进入一个去中心化的世界，必须创建一个钱包来存储代币。一类钱包由中心化交易所管理，例如Coinbase。另一类，如MetaMask，让用户拥有自己的私钥。中央系统让人感觉很熟悉：它们有用户名和可以重置的密码。它们还为用户代持代币，这使它们成为了攻击目标。已经有不诚实或不称职的交易所运营商弄丢了客户的资产或导致客户资产被盗。相比之下，MetaMask或其他类似钱包的用户可以完全控制自己的资产。但如果他们弄丢了密钥，代币就永远丢失了。MetaMask目前拥有一千万活跃用户，一年前还只有约60万。

创建一个钱包会创建一个独特的在线身份，让你可与任何DeFi应用交互，包括像“散境”这样的元宇宙。之后你可以存入代币以赚取利息、把它们换成其他代币，或在元宇宙商场里购物。在DeFi领域也在发生真正的创新，

可能改善现实世界的金融系统。这里有三个尤其突出的例子。

一是去中心化交易所。鉴于中心化交易所易遭攻击和盗窃，开发人员已着手在区块链上构建替代方案。这不同于把资产存入Coinbase让它来代表你交易，而是通过智能合约来执行交易。交易双方都在同一个不可分割的交易中履行交易。这就不再需要第三方托管服务和中央合约方清算所等中介机构。最大的去中心化交易所之一UniSwap是交换基于以太坊的代币的热门地。它每天交易的代币价值约达10亿美元。

第二个例子与发行可靠的稳定币的难度有关。稳定资产很有用处：与美元或其他货币挂钩的代币促成了其他代币间交易，并为金融合约提供了基础。早期的解决方案依赖中央控制，这使得要确定它们受充分抵押是有难度的。两大稳定币泰达币和USD Coin合共发行了约1000亿美元的代币。其抵押品是现金和短期公司债的混合，它们不是保存在一个区块链上，而是存储在银行或经纪账户中。两家公司都会决定如何支撑自己的稳定币以及何时发布账户现状。3月，纽约州总检察长办公室发现泰达公司在2017年和2018年期间抵押不足，对其处以1850万美元罚款。（泰达否认有不当行为。）

确定一种稳定币受到完全支撑的方法之一是把抵押品保存在透明的开放区块链上，并存储在智能合约中。问题是抵押品必须保存在一种区块链原生资产中，如比特币或以太币，而这些资产的波动性很大。但有一个巧妙的解决方法。最大的“链上”稳定币是dai，由克里斯滕森的MakerDAO运营。任何人都可以创建新的dai币，只要他们在智能合约中锁定足够的抵押品，通常是以太币。

由于以太币不稳定，该协议要求用户对他们创建的代币做过度抵押。如果一名用户的抵押品价值低于未偿还dai币价值的150%，智能合约就会自动拍卖抵押品以抵消dai币债务。要收回抵押品，必须返还dai币，再加上少量不定值的“稳定”费（以dai币支付）——抵押品的价值波动越大，金额往往就越高。

Dai兑美元的汇率非常稳定。只在2020年以太币大幅下跌时曾经脱钩，dai在12小时内下跌了约10%。发生这种情况的部分原因是开发人员在协议中设定了一个稳定费封顶。为补充资金和恢复挂钩又发行了新的治理代币，这稀释了当前持有者手头的治理代币价值。接下来的几个月里，持有治理代币的人达成的共识解决了编码问题。2021年，当以太币再次崩盘时，dai保持了稳定。目前共存在约65亿美元的dai。

创新的第三个例子是借贷协议。因为用户可以保持匿名，为了从贷方借款，他们必须首先存入一些代币——比如dai——作为抵押。然后他们就可以凭借这些抵押品借入另一种代币。但开发者想出了一种方法，在即时发放和结算的“闪贷”中免去了存入代币作抵押这一步。

区块链上的交易要最终敲定，必须等待被称为区块的新的交易包被整个网络承认。添加区块需要时间——比特币约需要十分钟，以太坊约13秒。在以太坊上闪贷时，借款人在同一个区块内申请和偿还贷款，外加0.09%的费用。如果借款人未能偿还，整个交易会被取消，因此资金也就从未借出。贷方根本不冒任何风险。这类贷款主要用于发生在代币交易平台间的套利机会。巴塞尔大学的法比亚·夏（Fabian Schär）说，自这类贷款被创造出来，大多数代币市场都变得更高效了。以太坊区块链上提供闪贷的两个最大的贷款协议是Aave和Compound，分别借出了约160亿美元和110亿美元的代币。

所有这些服务都是高效又富创意的财务问题解决方案。自动化交易所——比如通过UniSwap构建的交易所——以及使无缝套利成为可能的闪贷提高了金融管道的效率。dai内置的自动稳定器是解决难题的巧妙方案。而DAO是对监督着几十亿美元交易和借贷的实体施行民主化治理的有趣实验。问题是，到目前为止，它们都被用来为一个无形的赌场提供便利。这些应用多数都被用于比特币和以太币这类不稳定代币的投机交易。

如果DeFi要超越投机，它必须实现两种场景之一。首先是扩展到传统金融领域。目前DeFi中的大部分能量都用于为“链上”宇宙融资。这是可以理解的：那些弥合这个链上世界与现实世界的鸿沟的部分，比如中心化交易所

和稳定币的发行方，一直都是黑客和欺诈的源头。但若要对抵押贷款等日常金融产生用处，DeFi必须横跨虚拟和现实世界。

例如，NFT可能会变得更普及。今天它们是数字收藏品的所有权主张，但理论上它们可以代表对房产的所有权主张。然后抵押贷款可以被捆绑成单一、高效的一个包：“惠特本镇的红砖房”NFT的所有者将与买方交换它，买方把它存入如Aave或Compound的自动抵押贷款平台。买家将收到代币作为交换，然后代币会被自动转移给卖家。为了再次持有这一NFT，买家会随时间推移在平台上存入足够的稳定币来偿还贷款。

由于代币可以是几乎任何事物的数字代表，因此它们可以成为各种金融问题的有效解决方案。银行存款账户可能很昂贵；股票结算系统很缓慢。相比之下，稳定币交易几乎实时结算，且完全不产生费用或费用很低。然而，为了让DeFi成为现实世界问题的解决方案，法律体系必须在“链下”世界中强制执行链上结果，而监管必须防止欺诈和滥用。

在没有身份核查的情况下把传统货币转换为代币通常都是个棘手问题。大多数把美元兑换成以太币或比特币的服务，比如Coinbase，都会展开“了解你的客户”的核查以遏止洗钱。然而，一旦进入链上世界，任何人都可以轻松地挪动代币，这自然引发了人们对犯罪分子用DeFi洗钱和转移赃款的担忧。

监管机构希望金融中介机构留意可疑交易，但DeFi拒绝扮演这一角色。例如，监管部门试图在美国的一项基础设施法案中纳入模糊不清但似乎还算温和的条款来规范该行业，引发了DeFi人群的愤怒回应。对监管的强烈抵制只会加剧认为它图谋不轨的看法，也可能让监管机构更想要遏阻资金流入链上世界。

如果DeFi不与链下金融业合并，它可能会在一个建立于区块链之上的独特世界中蓬勃发展。科幻作者长期以来都在探索这样的前景：人们有朝一日会在“散境”等线上元宇宙中生活，在那里购物或去虚拟办公室上班等。如果中心化技术平台被去中心化的竞争对手取代，这样的平行虚拟世界也可

能会发展起来。

例如，想象一下YouTube的一个竞争对手平台奖励其用户各种代币：上传视频会获得奖励以吸引内容创作者，奖励的多少根据视频受欢迎的程度增减；发放治理代币以确定平台如何运行。如果该平台流行起来，这些代币可能会升值，奖励早期用户并吸引新用户。这种模式之所以成为可能，是因为区块链能让组织机构信守关于其平台如何运作的承诺。

你还可以继续想象适用于各种行业的新模式。一旦一位艺术家出售了一件作品，她与这件作品的价值就再无关系。如果她日后声名大噪，作品的升值部分将全部归买家所有。而如果她出售一幅NFT图像，她可以在智能合约中编码设定自己在该作品未来的销售额中持有份额，比如拿到任何成交额的一成。如果没有这样一个在透明的区块链上的智能合约，这将太过昂贵而难以执行。

模特艾米莉·拉塔伊科夫斯基（Emily Ratajkowski）就以这种方式发布了一幅自拍照NFT。她曾写道，由于摄影师拥有所摄照片的所有权利，她无法保有对自己照片的所有权。音乐人开始发行专辑NFT或创建代币来向粉丝出售独家商品和演出前排座位，这些从粉丝群获利的方式都不需要中介了。如果这类活动蓬勃发展，那么支撑它的金融体系将变得至关重要。

这并不是说答案总是去中心化。“要问的问题是：为什么我不能只使用中央化数据库就好了？它要比去中心化系统简单得多，也快捷得多。”斯坦福大学的丹·博纳（Dan Boneh）说。但对于某些问题，去中心化是个好办法。“如果没有哪一方是人人都信任的，那么去中心化是一个不错的选择，”但是，他承认，“随之而来的是复杂度增加。”

最大的问题是通过共识来做验证会减慢系统速度。比特币和以太坊都使用名为“工作证明”（proof of work）的过程来验证交易，这可能消耗大量能源。改进系统的一种方法是使用其他证明机制。还有其他的变通办法。“今天的大部分关注点是可扩展性，这靠尽可能减少触及底层区块链来实现。”博纳说。

提升效率的动机可能会自我强化。随着人们更多使用DeFi，对区块链验证的需求也在攀升，推动了燃油费上涨。这已促使开发人员追求诸如“汇总”（roll-up）之类的功能，将交易打包并通过区块链成批验证，以减少验证需求，从而也减少验证的耗能。

由于这类变通方法仍在开发，而创建平台的尝试也才刚刚开始，因此认为去中心化会大行其道还只是一种揣测。DeFi存在的问题——区块链的耗能强度、猖獗的投机、脏钱泛滥的可能性，以及对监管的明显抵制——都将阻碍它被大规模采用。但是，由用户拥有并管理的支付和数字内容平台、更开放的数字经济和更高效的金融体系的潜在收益是巨大的。希望这一切不只是一个梦。 ■



The car industry

A troubled road lies ahead for German carmakers

The all-powerful automotive sector faces a challenging future

SAARLAND IS NO stranger to transition, jokes Thorben Albrecht, policy director for the IG Metall trade union. The second-smallest of the 16 states, for a century Saarland bounced back and forth between Germany and France, establishing itself inside the federal republic only in 1957. Coal deposits and steel made it rich, but also left it exposed to job losses when globalisation came knocking in the 1970s. A booming car-parts industry provided a cushion, but Saarland now faces a third shift, as industrial transformation and climate policy come after its two big sources of jobs: cars and what remains of steel.

The government wants 14m electric vehicles (EVs) on German roads by 2030, up from 1m today. But the slow death of the internal combustion engine undercuts the business model of gearbox, cooling-system or fuel-injection pump makers—suppliers that dot Saarland and other states. Almost 20,000 people work in Saarland's car industry, mostly in small and medium-sized firms. The state has neither a large company headquarters nor a big city with a thriving service sector. "A huge reduction in car-sector jobs will mean social problems of a very large order," says Hans-Christian Herrmann, who charted previous waves of deindustrialisation as the chief archivist in Saarbrücken, the state capital. An IG Metall survey found that 42% of German car workers fear for their future.

Workers at steel plants, which account for around 6% of German carbon emissions, are as worried. "You can see my grey hairs", chuckles Stephan Ahr, who chairs the works council at Saarstahl, a steelmaker in Völklingen. The plant has already lost tens of thousands of jobs. The main

decarbonisation plan, in which polluting coke is ditched in favour of hydrogen obtained from renewables, will require far fewer workers. Other developments, including uncertainty over the carbon price and EU policy on steel imports, add to Mr Ahr's worries. "Everything affects us without us having any influence," he says. "It's take it or die."

Germany's industrial model rests on the full employment that buys consensus between firms, workers and government. Labour relations are harmonious. But the impulses to create what unions call a "just" transition can lead to ruinously expensive deals like the "coal exit" agreed in 2019: a €40bn programme to manage the slow elimination by 2038 of the final coal mines, which employ 20,000 people, slightly fewer than the country's yoga teachers.

The transition is also a challenge to big companies. If carmakers were late to the electric game, Volkswagen, which has almost 300,000 employees in Germany, is scrambling to make up for lost time (and perhaps to repair the damage to its reputation from the diesel-emissions scandal in 2015). Under its charismatic boss, Herbert Diess, and with an eye on Tesla, soon to open a battery gigafactory outside Berlin, VW has gone all-in on electric. It says EVs will account for half its vehicle sales by 2030. By 2035 VW, which reckons to account for 2% of global carbon emissions, will cease selling petrol-powered cars in Europe.

EU rules and climate targets are forcing tough decisions. But talk to VW insiders and you see how deep the shift has gone. To power the next generation of cars, VW plans by 2030 to build six lithium-ion battery plants in Europe. Entire plants are given over to EV production. The "MEB" chassis (or platform) will be spread across models, ensuring cars are built around batteries rather than vice versa, and may be licensed to other manufacturers.

“Think of this as a system, with suppliers, batteries, services and infrastructure,” says Andreas Walingen, VW’s chief strategy officer. “Only then will customers go electric”. Mr Diess has also linked executives’ bonus payments to VW’s share price, a decision one employee says “changed the DNA of the governance.” VW’s profits surged in the first quarter of 2021, and investors seem satisfied.

The car industry faces the biggest disruption in its history, says Ferdinand Dudenhöffer, head of the Centre Automotive Research in Duisburg. Electrification is just a start. Audi, a VW brand, is trying a car-subscription model aimed at younger drivers, a growing market that could upend revenue models. Software systems require digital skills and fresh ways of working. “We are strong on the hardware side of cars, not so good on data and AI,” says Danyal Bayaz, the Green finance minister of Baden-Württemberg, another big car state. Some fear VW will never catch up with Tesla—or the Chinese firms muscling in. Fully autonomous vehicles, should they arrive, may bring the biggest change yet.

As for the jobs, the scares are overblown, insists Mr Diess (who faces powerful unions and workers’ councils). “Seats remain seats, steel remains steel, wheels remain wheels, brakes remain brakes,” he recently told the German Press Agency. A study by the Boston Consulting Group and the German think-tank Agora Verkehrswende projects no net loss of jobs by 2030, although other surveys are less sanguine. But the headline figure conceals massive churn, as component making gives way to battery production and coding. Almost half the country’s 1.7m car workers will need reskilling, especially the SME suppliers. This, warns the study, will mean “considerable expense” for firms and workers.

And for the state, too. Carmakers rely on the government to set carbon targets, roll out EV charging infrastructure and tweak regulations to make it easier to harmonise refuelling payment systems across the country. Until

2025 the federal government will subsidise EV buyers to the tune of €6,000 per car. The incentives have lifted the share of EVs and hybrids to over a fifth of all new sales, but they are regressive and expensive. Deutsche Bank calculates that each EV could over its lifespan cost the state €20,000 in subsidies and taxes forgone.

Beyond the jobs churn, Saarland looks hopefully to new industries spawned by industrial transformation, rather as cars provided a safety net during the previous wave of deindustrialisation. SVolt, a Chinese battery maker, plans two plants in the state which it says could create 2,000 jobs, although locals are sceptical. Hydrogen, an untested fuel central to the government's climate plans, is another hope. One thing everyone agrees on is that the transition needs to be oiled with public money. The industry reckons some €30bn will be required to make the full transition to decarbonisation. Some politicians pledge that climate protection will be the next engine of prosperity. At least in Saarland, many are unconvinced. "We have just eight years to change a region," says Ralf Reinsteadtler at IG Metall. "That's tomorrow." ■



汽车产业

德国车厂前路崎岖

叱咤风云的汽车业面对充满挑战的未来

萨尔州（Saarland）对变迁可不陌生，德国五金工会（IG Metall）的政策主管托本阿尔·布雷希特（Thorben Albrecht）玩笑道。这个德国16个州中第二小的州曾被德国和法国反复争夺了一个世纪，直到1957年才正式归于德国。这里的煤矿和钢铁让它成为富饶之地，却也让它在70年代全球化的冲击下遭遇工作岗位流失。那时新兴的汽车零部件产业提供了缓冲，但现在萨尔州又面临第三次转变：产业转型和气候政策正在冲击汽车产业和残留的钢铁产业这两大就业来源。

德国政府希望到2030年，国内电动汽车保有量将从现在的100万辆增加到1400万辆。但内燃机慢慢退出舞台，导致变速箱、冷却系统或燃油喷射泵制造商的商业模式受到冲击——在萨尔州和其他州这类供应商比比皆是。萨尔州的汽车产业雇用了近2万人，大部分在中小企业。这个州既没有大企业的总部，也没有拥有繁荣服务业的大城市。州首府萨尔布吕肯（Saarbrücken）的首席档案管理员汉斯-克里斯蒂安赫尔曼（Hans-Christian Herrmann）记录了前几波的去工业化浪潮，他表示：“汽车行业就业岗位的大幅减少将意味着巨大的社会问题。”五金工会的一项调查发现，42%的德国汽车产业工人对未来感到忧虑。

在约占德国碳排放量6%的钢铁行业，工人们同样忧心忡忡。“看看我，头发都白了。”斯蒂芬·阿尔（Stephan Ahr）苦笑道。他是位于弗尔克林根（Völklingen）的钢铁制造商撒斯特（Saarstahl）的劳资会议主席。这家工厂已经流失了数万个工作岗位。它主要的脱碳计划将放弃高污染的焦炭，转而采用由可再生能源制得的氢，这将使得所需的工人数量大大减少。其他一些形势变化也让阿尔更添焦虑，比如碳价和欧盟钢铁进口政策的不确定性。“这一切都对我们有切身影响，但我们却完全无能为力，”他说，“要么接受，要么被淘汰。”

德国的产业模式以充分就业为基础，在企业、工人和政府之间达成共识。劳动关系很和谐。但如果冲动地打造出工会口中的“公正”转型，可能会引向昂贵到无法承受的协议，比如2019年达成的“淘汰煤炭”协议：这项计划耗资400亿欧元，设法在2038年前逐渐淘汰最后一批煤矿；这些煤矿雇用了2万人，比全德国的瑜伽教练人数略少一点。

这种转变对大企业来说也是个挑战。如果说汽车制造商在电气化竞逐中起步晚了，那么在德国拥有近30万名员工的大众汽车正在争分夺秒地追赶上（或许也是为了修复2015年的柴油门丑闻对自己声誉的损害）。在它极富魅力的老板赫伯特·迪斯（Herbert Diess）的领导下，以特斯拉为追赶目标的大众即将在柏林郊外开设一个电池超级工厂，全力向电动汽车转型。该公司表示，到2030年电动汽车将占其汽车销量的一半。到2035年，约占全球碳排放总量2%的大众汽车将停止在欧洲销售燃油汽车。

欧盟法规和气候目标正迫使企业做出艰难的决策。但与大众内部人士聊聊，就会发现这种转变已经深入人心。大众计划到2030年在欧洲建设六家锂离子电池工厂，为新一代汽车提供动力来源。所有工厂都将生产电动汽车。“MEB”底盘（或称平台）将用于各个车型，确保以后将围绕电池来造汽车，而不是反过来，而且还可能会授权给其他制造商。“你可以把它看作是一个包含了供应商、电池、服务和基础设施的系统，”大众首席战略官安德烈亚斯·瓦林根（Andreas Walingen）表示，“只有这样，我们的顾客才会转向电气化。”迪斯还将高管的奖金与大众股价挂钩。一名员工称这个决定“改变了公司治理的DNA”。大众2021年一季度的利润大幅飙升，投资者看来相当满意。

杜伊斯堡的汽车研究中心（Centre Automotive Research）主任费迪南德·杜登霍夫（Ferdinand Dudenhöffer）表示，汽车产业正面临自身历史上最大的一场颠覆。电气化只是一个开端。大众旗下品牌奥迪正在尝试一种面向年轻驾驶者的汽车订阅模式，这个市场正不断增长，可能会颠覆营收模式。软件系统需要掌握数字技能和全新的工作方式。“我们在汽车硬件方

面有优势，但在数据和人工智能方面不太行。”另一个汽车产业大州巴登-符腾堡州（Baden-Württemberg）的财政部长、绿党的丹亚尔·巴亚兹（Danyal Bayaz）表示。一些人担心大众永远赶不上特斯拉——或者强势崛起的中国企业。全自动驾驶汽车一旦问世，更是会带来空前的变化。

说到就业，要面对强大的工会和劳资会议的迪斯坚称人们过于担心了。“座椅还是座椅，钢铁还是钢铁，车轮还是车轮，刹车还是刹车。”他最近对德新社说道。波士顿咨询公司和德国智库阿格拉交通转型（Agora Verkehrswende）的一项研究预计，在2030年前不会发生工作岗位的净流失，尽管其他调研结果没这么乐观。但总体数字掩盖了大量岗位流动，因为原来的零部件制造要让位给电池生产和软件编程。德国的170万汽车工人中有近一半将需要再培训，尤其是中小型供应商。该研究警告说，这意味着企业和工人需要“相当大的付出”。

对政府来说也一样。汽车制造商依赖政府设定碳排放目标、部署电动汽车充电基础设施，以及调整法规来帮助该行业统一全国各地的充电支付系统。到2025年之前，联邦政府将为每辆电动汽车的购买者提供高达6000欧元的补贴。相关激励措施已经让电动和混动汽车在新车销售中占到了五分之一以上，但这种政策是递减性的，而且代价高昂。据德意志银行估计，在每辆电动汽车的使用年限内，政府可能要承担2万欧元的补贴和税收减免。

除了岗位转换外，萨尔州寄希望于产业转型将催生出新行业，就像在上一轮去工业化浪潮中汽车产业发挥了安全网的作用一样。中国电池制造商蜂巢能源计划在该州开设两家工厂，称这将创造2000个岗位，但当地人对此表示怀疑。氢能提供了另一个希望，这种尚未得到验证的燃料是政府气候计划中的关键能源。所有人都同意的一件事是这轮转型需要公共资金的扶持。业内估计完全脱碳大约需要300亿欧元。一些政客承诺说气候保护将成为下一个推动繁荣的引擎。至少在萨尔州，很多人并不信服。“我们只有八年时间来改变整个地区，”五金工会的拉尔夫·莱恩斯泰德勒（Ralf Reinsteadtler）说，“这一眨眼就过去了。”■



Removing carbon dioxide from the air

The world's biggest carbon-removal plant switches on

Despite high prices, customers are lining up

SHORTLY AFTER 6pm on September 9th, the Orca carbon-capture plant, just outside Reykjavik in Iceland, switched on its fans and began sucking carbon dioxide from the air. The sound was subtle—a bit like a gurgling stream. But the plant's creators hope it will mark a big shift in humanity's interaction with the climate.

Orca is, for now, the largest installation in the infant “direct air capture” industry, which aims to remove CO₂ from the atmosphere. When sealed underground such CO₂ counts as “negative emissions”—an essential but underdeveloped method for tackling global warming. To stop temperatures rising by 1.5°C or even 2°C above pre-industrial averages, as per the Paris climate agreement, hundreds or thousands of billions of tonnes of CO₂ will have to be removed from the atmosphere in the second half of the century.

Currently, the only means of doing that is planting trees, an option that is not entirely without drawbacks. Trees burn in wildfires and can be cut down. When this happens, much of the carbon they store escapes. The Orca plant shows another way. Climeworks, the company that owns it, has developed chemical filters which snag CO₂ when air passes through them. When heated they release the CO₂ again, generating a stream of gas that is handed to another firm called Carbfix.

Carbfix pipes the gas to nearby wells, mixes it with water and pumps the resulting carbonated water into the bedrock. In Iceland that consists almost entirely of volcanic basalts, which contain minerals that react with carbon dioxide to form calcium carbonate, a white crystal that is the main

ingredient in limestone. Thus, the full operation extracts CO₂ from air and turns it to rock. Trials have shown that Icelandic basalts can sequester CO₂ in solid rock within two years. Power comes from a nearby geothermal power station.

One catch is volume. Orca will capture 4,000 tonnes of carbon dioxide a year, out of around 35bn tonnes produced by burning fossil fuels. Climeworks is “confident” it can reach millions of tonnes before the decade is out. (A previous, eye-popping ambition to grab 1% of emissions by 2025 is no longer on the cards.)

Another is cost. It costs Orca somewhere between \$600-800 to sequester one tonne of carbon dioxide, and the firm sells offset packages online for around \$1,200 per tonne. The company thinks it can cut costs ten-fold through economies of scale. But there appears to be no shortage of customers willing to pay the current, elevated price. Even as Orca’s fans revved up, roughly two-thirds of its lifetime offering of carbon removals had already been sold. Clients include corporations seeking to offset a portion of their emissions, such as Microsoft, Swiss Re (and *The Economist*), as well as over 8,000 private individuals.

Climeworks is not alone in having spotted the opportunity. Using different chemistry, Carbon Engineering, a Canadian company, is gearing up to switch on its own carbon-scrubbing facilities. It will take more than these pioneer engineers and financiers to build a gigatonne-sized industry. But the fans are turning. ■



从大气中除碳

世界最大的吸碳工厂投产

要价虽高，但顾客盈门

九月九日下午六点刚过，位于冰岛首都雷克雅未克城外的奥卡（Orca）碳捕获工厂启动了风扇，开始从空气中吸收二氧化碳。风扇的声音不大，有点像汩汩的流水声。但这家工厂的创建者希望这将是人类与气候的关系中一个重大的转捩点。

想要从大气中去除二氧化碳的“直接空气捕获”行业正处于萌芽阶段，奥卡目前是此类工厂中规模最大的一间。捕获到的二氧化碳被封存于地底之后，就被记作“负排放”——这是应对全球变暖的一种重要但尚不成熟的方法。根据《巴黎气候协定》，为了避免气温比工业化前平均水平升高1.5甚至2摄氏度，必须在本世纪下半叶从大气中移除数千亿乃至上万亿吨的二氧化碳。

目前唯一能吸收二氧化碳的办法就是植树，但这种做法并非万无一失。树木会被野火烧毁，也会被砍伐。这个时候它们储存的大部分碳都会逃逸。奥卡工厂为人们指出了另一条道路。工厂的所有者Climeworks公司开发了一种化学过滤器，可以在空气通过时截留二氧化碳。然后在加热时再次释放二氧化碳，形成气流，由另一家名为Carbfix的公司继续处理。

Carbfix用管道把这些气体输送到附近的井中，与水混合，然后将产生的碳酸水泵入基岩中。在冰岛，基岩几乎全都是火山玄武岩，其中含有的矿物质与二氧化碳反应形成碳酸钙，这种白色晶体是石灰石的主要成分。这样一来，整个处理过程就从空气中提取出二氧化碳并将其转化为岩石。试验表明，冰岛的玄武岩可以在两年内将二氧化碳封存到坚硬的岩石中。工厂所用电力来自附近的地热发电站。

一个难题是规模。世界每年燃烧化石燃料约产生350亿吨二氧化碳，而奥卡每年只能捕获4000吨。Climeworks公司“有信心”在这个十年内让捕获

量达到百万吨级。（之前它曾提出令人瞠目的宏伟目标——到2025年捕获总排放量的1%，如今已不大可能实现了。）

另一个问题是成本。奥卡每封存一吨二氧化碳要花费600到800美元，它在网上出售碳中和指标的价格约为每吨1200美元。该公司认为，通过规模经济可以将成本降低十倍。但即使目前价格高昂，似乎也不缺愿意掏腰包的客户。就在奥卡的风扇开始转动之时，它已经售出了其整个寿命周期内可提供脱碳量的约三分之二。其客户包括微软、瑞士再保险（以及本刊）等寻求抵消部分碳排放的企业，另外还有8000多名个人。

Climeworks并不是唯一看到商机的公司。加拿大公司Carbon Engineering正准备启动自己的除碳工厂，它使用了不同的化学工艺。要让这个产业达到十亿吨级规模，光靠这些先行的工程师和金融家是不够的。但起码风扇已经转起来了。 ■



Neutral but not idle

IMEC offers neutral ground amid chip rivalries

The brain trust at the heart of the \$550bn semiconductor industry

LEUVEN IS PERHAPS best known to the general public as the birth place of Stella Artois. Among chipmakers the Belgian city's biggest claim to fame sits in a squat building not far from the Leuven Institute for Beer Research. Metal banding lends its facade the glittering look of a silicon wafer etched with microcircuitry. Inside, its lower floors hum with the noise of \$3bn-worth of some of the most complex equipment humanity has ever devised. The offices above house hundreds of the planet's keenest semiconductor engineers dreaming up the future of chipmaking.

The building (pictured) is the headquarters of the Interuniversity Microelectronics Centre. IMEC, as it is better known, does not design chips (like America's Intel), manufacture them (like TSMC of Taiwan) or make any of the complicated gear in its basement (like ASML, a Dutch firm). Instead, it creates knowledge used by everyone in the \$550bn chip business. Given chips' centrality to the modern economy—highlighted by the havoc wrought by current shortages—and increasingly to modern geopolitics, too, that makes it one of the most essential industrial research-and-development (R&D) centres on the planet. Luc Van den hove, IMEC's boss, calls it the “Switzerland of semiconductors”.

IMEC was founded in 1984 by a group of electronics engineers from the Catholic University of Leuven who wanted to focus on microprocessor research. In the early days it was bankrolled by the local Flemish government. Today IMEC maintains its neutrality thanks to a financial model in which no single firm or state controls a big share of its budget. The largest chunk comes from the Belgian government, which chips in some

16%. The top corporate contributors provide no more than 4% each. Keeping revenue sources diverse (partners span the length and breadth of the chip industry) and finite (its standard research contracts last three to five years) gives IMEC the incentive to focus on ideas that help advance chipmaking as a whole rather than any firm in particular.

A case in point is the development of extreme ultraviolet lithography (EUV). EUV is a delicate process involving high-powered lasers, molten tin and ultra-smooth mirrors. The bus-sized machines that generate EUV are today all made by ASML and used by TSMC and Samsung, a South Korean chipmaker. It took 20 years of R&D to turn the idea into manufacturing reality. IMEC acted as a conduit in that process. That is because EUV must work seamlessly with kit made by other firms. Advanced toolmakers want a way to circulate their intellectual property (IP) without the large companies gaining sway over it. The large companies, meanwhile, do not want to place all their bets on any one experimental idea that is expensive (as chipmaking processes are) and could become obsolete.

IMEC's neutrality allows both sides to get around this problem. It collects all the necessary gear in one place, allowing producers to develop their technology in tandem with others. And everyone gets rights to the IP the institute generates. Mr Van den hove says that progress in the chip industry has been driven by the free exchange of knowledge, with IMEC acting as a "funnel" for ideas from all over the world.

This model has lured ever more contributors. Today "several hundred" are active at IMEC at any one time, the institute says. They range from startups to the stars of the chipmaking firmament, from ASML to TSMC. Pat Gelsinger, Intel's newish boss, is effusive in his praise for the outfit. Even as their number has grown, individual partners have also become more generous, in part to keep pace with the rising price of all the chipmaking equipment that IMEC must procure (even if it gets a lot of it from

collaborators at reduced rates). As a result, IMEC's revenues, which come from the research contracts and from prototyping and design services, doubled between 2010 and 2020, to €678m (\$773m). Its annual takings are already on the order of those of giant charities such as the Ford Foundation or the American Cancer Society, and growing roughly in line with the booming chip business (see chart).

The deepening rift between America, home to some of the industry's biggest firms, and China, which imported \$378bn-worth of chips last year, threatens IMEC's spirit of global comity. China's chip industry is increasingly shielded by an overbearing Communist Party striving for self-sufficiency, and ever more ostracised by outsiders as a result of American and European export controls. All this limits the extent to which IMEC can work with Chinese semiconductor companies.

It is a matter of public record that IMEC has worked with Chinese firms in the past, including Huawei, a telecoms-gear giant with a chip division that has been hobbled by American sanctions, and SMIC, China's biggest chipmaker. Chinese make up 3.5% of people working at IMEC, the fifth-largest group and ahead of Americans at 1.5%. IMEC has a unit in Shanghai. Still, no Chinese tools are visible in its basement. IMEC would not comment on individual partnerships but says it has "a few engagements with Chinese companies, however not on the most sensitive technologies, and always fully compliant with current European and US export regulations and directives". Mr Van den hove adds that IMEC has no "major partnerships" with up-and-coming Chinese toolmakers.

Less chipmaking know-how flowing to China and less streaming out of it means that Chinese engineers' ideas can no longer be integrated with the global technology base of which IMEC is the custodian. There is little that IMEC can do about the growing distance between the Western and Chinese

techno-spheres. So it is focusing instead on what it does best: pushing the cutting-edge of chip manufacturing.

A hulking machine made by SUSS MicroTec, a German firm, scans chips to create a 3D image so that multiple processors can be aligned and affixed—fiddly business at nanometre scales. Elsewhere in the building Peter Peumans, who runs IMEC's health-tech portfolio, hands over a prototype developed during the pandemic that uses a custom silicon chip to cut DNA-sequencing times from hours to minutes. Xavier Rottenberg is developing semiconductor-based ultrasound sensors that can be printed out using the technology to make flat-screen TVs, which may lead to scanners much larger than today's handheld ones and able to capture the whole body at once at a higher resolution. Such work keeps IMEC's neutral ideas factory awhir. Maintaining Swiss-like neutrality in chip geopolitics will be tougher. ■



中立但忙碌

在芯片对抗中，IMEC提供了中立地带

这个智库位居价值5500亿美元的半导体产业的核心

鲁汶最为世人所熟知的可能是它是时代啤酒（Stella Artois）的起源地。而在芯片制造商的圈子里，这座比利时城市最有名的地方是距鲁汶啤酒研究所（Leuven Institute for Beer Research）不远处的一栋低矮宽阔的建筑。金属镶嵌的外墙让它看上去像蚀刻了微型电路的硅片一样闪闪发光。走入其中，底下几层回荡着嗡嗡声，这声响由一批总价约30亿美元的机器发出，它们是人类发明的其中一批最复杂的设备。上层的办公室里聚集着几百名世界上最有力的半导体工程师，他们在这里构想着芯片制造的未来。

这座建筑（如图）是微电子研究中心（Interuniversity Microelectronics Centre）的总部。该研究中心通常被称为IMEC，它并不设计芯片（如美国的英特尔）或制造芯片（如台湾的台积电），也不生产它地下楼层里的那些复杂设备（如荷兰的ASML）。但它创造出来的知识被5500亿美元的芯片产业中的每个人所使用。鉴于芯片在现代经济中的核心作用——当前芯片短缺造成的混乱突显了这一点——以及在现代地缘政治中日益关键的影响力，IMEC的这一功能让它成为了世界上最重要的工业研发中心之一。IMEC的老板吕克·范登霍夫（Luc Van den hove）称它为“半导体界的瑞士”。

IMEC成立于1984年，由一群来自天主教鲁汶大学（Catholic University of Leuven）、希望专注于微处理器研究的电子工程师创办。它在早期得到了弗拉芒地方政府的资助。今天的IMEC保持中立地位，靠的是没有任何一个公司或国家在其预算中占到大头的财务模式。它最大的一笔预算来自比利时政府，约占16%。排名前列的出资企业里每一家的份额都不超过4%。保持收入来源的多元（其合作伙伴遍及芯片业的各个环节）和时效性（其研究合同通常为期三至五年）激励着IMEC专注于那些能推动整个行业而

非任何特定公司的创意。

极紫外光刻（EUV）的研发就是个很好的例子。EUV是一项涉及高功率激光器、熔锡和超光洁镜面的精密工艺。和一辆巴士差不多大小的EUV光刻机目前都由ASML制造，再提供给台积电和韩国芯片制造商三星使用。从想法到实际投产，其间的研发花了20年时间。而在整个过程中，IMEC起到了中间桥梁的作用。这是因为EUV必须与其他公司生产的设备实现无缝对接。领先的设备制造商希望能让自己的知识产权在不受大公司控制的情况下流通。与此同时，大公司也不想把所有赌注都押在任何一个投入巨大（芯片制造工艺就是这样）且可能会过时的试验性想法上。

IMEC的中立性让双方的问题迎刃而解。它将所有必要的设备集中在一起，便于生产商与他人协同开发技术。各方都能享用IMEC的知识产权。范登霍夫表示，芯片行业的进步是由知识的自由交流推动的，IMEC在其中充当了一个汇聚全世界各种想法的“漏斗”。

这种模式吸引了越来越多的参与者。IMEC表示，如今，任何时候都有“几百家”参与者活跃其中——从创业公司到芯片制造领域的明星企业，包括ASML和台积电等。英特尔新任老板帕特·盖尔辛格（Pat Gelsinger）对IMEC不吝赞美。不仅参与者的数量增加了，单个合作伙伴出手也更大方了，某种程度上是为了跟上设备涨价的步伐，好让IMEC能购置它所必需的所有芯片制造设备（即使它从合作伙伴那里以折扣价获得了大量设备）。因此，IMEC的收入——来自研究合同、样机制造和设计服务——在2010年至2020年间翻了一番，达到6.78亿欧元（7.73亿美元）。它的年度收入已经接近于福特基金会（Ford Foundation）和美国癌症协会（American Cancer Society）等大型慈善机构，并与蓬勃发展的芯片行业大致保持同步增长（见图表）。

美国拥有业内最大的一些公司，而中国去年进口了价值3780亿美元的芯片，这两个国家之间日益加深的裂痕危及到了IMEC秉承的全球友好精神。中国的芯片业因专横的共产党力求自给自足而获得越来越多保护，同

时又因美欧的出口管制而日益被外部世界排挤。所有这些都限制了IMEC与中国的半导体公司可能开展的合作。

众所周知，IMEC曾与中国公司合作过，包括电信设备巨头华为（它的芯片部门因美国制裁而步履艰难）和中国最大的芯片制造商中芯国际。中国人是IMEC员工中的第五大群体，占总人数的3.5%，高于美国人的1.5%。IMEC在上海设有一家分公司。不过，在它总部的地下部分看不到中国的芯片制造设备。IMEC不愿就某一个合作关系置评，但它表示自己“与中国企业有一些合作，但不是在最敏感的技术上，并且一直完全遵守欧美当前的出口法规和指令”。范登霍夫补充说，IMEC与新冒头的中国芯片设备制造商没有“重大合作”。

外部的芯片制造经验难以流入中国，中国的经验也更少流出，这意味着中国工程师的创意无法再与IMEC所管理的全球技术基地接轨。对于西方和中国的技术圈之间日益扩大的隔阂，IMEC无能为力。因此，它转而专注于自己最擅长的领域：推进芯片制造的前沿。

德国公司SUSS MicroTec制造了一台庞大的机器，能扫描芯片生成3D图像，这样就可以把多个处理器对齐固定——这是纳米级的高精度作业。在大楼内的另一处，IMEC的健康技术系列主管彼得·珀曼斯（Peter Peumans）移交了一个在新冠疫情期间研发的样机，它使用的定制芯片把DNA测序时间从几小时缩短到了几分钟。泽维尔·罗滕伯格（Xavier Rottenberg）正在开发一款基于半导体的超声波传感器，可以用制造平板电视的技术印制出来，由此可能会造出比今天的手持式扫描仪大得多的扫描仪，能以更高的分辨率一次性把整个人体扫描下来。这样的研究让IMEC这个中立的“点子工厂”呈现出一派繁忙景象，但要在芯片地缘政治中保持瑞士式的中立将会更加困难。■



Do me a solid

Japanese companies want to win back their battery-making edge

They think that solid-state technology will help them do so

WHEN YOSHINO AKIRA, a Japanese chemist, worked on rechargeable batteries in the 1980s, it was with a view to powering portable devices. His Nobel-prizewinning research led to the first commercial lithium-ion (Li-ion) battery. These now power everything from smartphones to electric vehicles (EVs). But the Japanese firms that, building on Mr Yoshino's work, dominated the Li-ion business early on have lost their edge. CATL, China's battery giant, and the energy arm of LG, a South Korean group, have eclipsed Japan's Panasonic as the world's largest suppliers of EV batteries. Others are catching up in the production of materials and components.

Japanese battery-makers want to regain their rightful place at the head of the pack. To do so they are betting on solid-state batteries. These still shuttle lithium ions between the anode and the cathode to charge and discharge, but the electrolyte where this shuttling happens is solid not liquid. That makes the batteries more stable and potentially more powerful. It also dispenses with the need for bulky cooling systems, required for fast-charging Li-ion systems. Cars equipped with solid-state batteries could be lighter, which increases range.

Japan submits more battery-tech patents a year than any other country; second-ranked South Korea files half as many. Japanese firms and inventors accounted for more than one in two solid-state-related patents between 2014 and 2018. More are coming. Japan's government is pouring money into research, including a centre headed by Mr Yoshino. Industrial and chemicals firms, of which Japan has plenty, are gearing up to make the materials needed to bring the technology to market.

Murata, a big manufacturer which bought Sony's battery division in 2017, plans to begin mass-producing smaller solid-state batteries this autumn. Nakajima Norio, Murata's boss, sees "lots of potential in wearables", since the batteries do not burn or get hot (which is why they are already used in things like pacemakers). Last month Toyota announced plans to invest \$13.5bn by 2030 in next-generation car batteries, including the solid-state variety. Honda and Nissan, two other carmakers, are also eyeing the technology.

Naturally, if making solid-state batteries were easy, manufacturers would be churning them out. It isn't. Water mucks up the materials, so factories must be kept ultra-dry. Mitsui Kinzoku, an engineering firm, has been testing mass production of solid electrolytes and found that it is "indeed a very difficult process", in the words of Takahashi Tsukasa, who is involved in the project. Toyota hopes to begin manufacturing in the mid-2020s, but even its technology chief, Maeda Masahiko, has cautioned that "we can't be optimistic yet".

Even if they can get the technology right, Japanese firms are not running unopposed, as they had been in Li-ion's early days. Most big carmakers, including Ford, Hyundai and Volkswagen, have solid-state cars in the works. They may want to make the batteries themselves. Volkswagen has a big stake in QuantumScape, an American solid-state-battery startup backed by Bill Gates. In August a group of British organisations, including Johnson Matthey, a big chemicals firm, and Oxford University formed a consortium to work on the technology. That's some solid competition. ■



结结实实推一把

日本公司希望夺回电池制造优势地位

它们认为固态电池技术将能帮助自己实现这一目标

日本化学家吉野彰在上世纪80年代研究可充电电池时，目的是为了给便携式设备供电。他这项研究获得了诺贝尔奖，带来了全球第一批商业化生产的锂电池。这种电池如今已广泛用于从智能手机到电动汽车的各种设备。但是，虽然日本公司依靠吉野彰的研究在早期雄霸了锂电池市场，如今却已优势尽失。中国的电池巨头宁德时代和韩国LG集团的能源部门已经超越日本的松下，成为世界上最大的电动车电池供应商。其他公司在材料和部件生产方面也在迎头赶上。

日本电池制造商希望夺回在该行业应有的领头羊地位。为此它们正在押注固态电池。这类电池同样靠锂离子在阳极和阴极之间来回移动充电放电，但传输锂离子的电解质是固态而非液态的。这使得电池更稳定，也可能更强大，此外也不必配备笨重的冷却系统（这一点是快充锂电池系统所必需的）。搭载固态电池的汽车可以更轻量，从而提高续航里程。

日本每年提交的电池技术专利申请比其他任何国家都多，排在第二的韩国只有它的一半。在2014年至2018年间提交的固态电池相关专利申请中，日本公司及发明家占了一半还多。以后还会有更多。日本政府正大举投资研发，其中就有由吉野彰领导的一个研究中心。日本众多的工业和化学品公司正积极行动，准备制造把相关技术推向市场所需的材料。

2017年收购了索尼电池部门的大型制造商村田制作所计划从今秋开始量产小型固态电池。村田的社长中岛规巨看到了“在可穿戴设备上的巨大潜力”，因为这种电池不会燃烧或发烫（因此已被应用于心脏起搏器等设备）。9月，丰田宣布计划在2030年前投资135亿美元，研发包括固态电池在内的新一代汽车电池。另两家汽车制造商本田和日产也对该技术虎视眈眈。

要是固态电池容易制造的话，制造商自然已经在大批量生产了。它并不好造。其中的材料一沾水便失效，所以工厂必须保持超干燥。日本工程公司三井金属已在测试量产固体电解质，但发现它“确实是非常难的工序”，参与该项目的高桥司说。丰田希望在2025年前后开始生产这类电池，但就连它的首席技术官前田昌彦也提醒说，“我们还不能太乐观。”

即使能把技术难题处理好，日本公司也不会像锂离子面世之初那样一骑绝尘。包括福特、现代和大众在内的大多数大型汽车制造商都在研发固态电池汽车。它们可能想自产电池。QuantumScape是盖茨投资的一家美国固态电池创业公司，大众是它的大股东。8月，大型化学品公司庄信万丰（Johnson Matthey）等英国公司和牛津大学组成了财团来共同研究这项技术。这将是一场硬核竞争。 ■



Low-hanging fruit

China pledges to stop financing coal plants abroad

Will it have more to offer at the climate summit in Glasgow?

IN A SPEECH by video-link, Xi Jinping, China's president, told the UN on September 21st that his country would stop supporting new coal-power projects overseas. Since 2013, 95% of the funding for coal-fired power plants that came from outside the countries where the plants are located has come from China, Japan and South Korea. In April South Korea vowed to end state-backed financing of coal plants abroad; in June Japan pledged to do the same. Climate campaigners are celebrating China's decision to follow suit.

By some estimates, 70% of all coal plants being built today rely to some degree on China's cash. Cutting off this source will hobble the building and operation of such projects in poor countries, where demand for power is often difficult to meet without foreign help. But by mentioning only overseas coal, Mr Xi glossed over China's own dependence on the stuff. Last year, the country's power plants produced over half the world's coal-generated electricity. It continued adding new coal-fired power capacity at a pace of roughly a new coal plant a week. China is already moving away from funding coal plants abroad anyway, mostly because of the falling price of renewable energy.

However, the gesture is at least a sign that China does not want to be seen as a spoiler of global climate-change efforts. John Kerry, President Joe Biden's climate envoy, had been urging China to make a pledge of this kind. But China had warned that climate-change co-operation with America could be jeopardised by tension in the two countries' relationship. Now tongues are wagging about whether China might have more good news to announce at COP26, the UN climate summit that is due to be held in Glasgow in

November. (Mr Xi is unlikely to attend in person—since the pandemic began, he has shunned travel abroad.)

The speculation mainly surrounds China's plans for cutting emissions of greenhouse gases. The most tantalising possibility is that the country will move forward the date by which it aims for its carbon emissions to reach a peak: currently 2030. (A year ago, Mr Xi also said China would strive for "carbon neutrality"—a balance between carbon emissions and carbon reduction—by 2060). Given that China is the world's largest emitter, an earlier peak could make a big difference to the world's climate prospects, especially if it is followed by a marked decline.

Many analysts argue that China could, with effort, achieve an emissions peak in 2025. But Li Shuo, an analyst for Greenpeace, an environmental NGO, says China is unlikely to make a formal commitment to this effect. It would require shutting down many coal plants and overhauling the current five-year economic plan, which took effect this year.

A G20 summit in July gave a flavour of things to come. Italy presided over the event and was keen to extract a commitment to phase out coal power. China, among others, was reluctant. It also resisted a push for faster decarbonisation to prevent more than 1.5°C of global warming above preindustrial temperatures (the Paris agreement on climate change, reached in 2015, calls for the stabilisation of temperatures somewhere between 1.5°C and "well below" 2°C). But with thermometers showing roughly 1.1-1.2°C of warming already, it would take a Herculean effort to achieve that goal. China knows much of the task would fall on its shoulders. ■



可轻松摘取的成果

中国承诺不再资助海外煤电项目

在格拉斯哥举行的气候峰会上，中国还会做出更多承诺吗？

九月二十一日，中国国家主席习近平以视频形式在联合国大会上发言，宣布中国将不再新建境外煤电项目。自2013年以来，燃煤电厂从其所在国以外获得的资金中有95%来自中国、日本和韩国。今年4月，韩国承诺将终止对海外燃煤电厂提供国家公共资金；6月，日本做出了同样的承诺。现在，气候活动人士欢庆中国也跟进的决定。

据一些估计，目前在建的所有燃煤电厂中有70%在一定程度上依赖中国的资金。切断这一资金来源将阻碍在贫穷国家建设和运营这类项目——这些地区在没有外国帮助的情况下往往难以满足用电需求。但习近平只提到了海外煤炭，避而不谈中国自己对这些资源的依赖。去年，中国发电厂的燃煤发电量占全世界的一半以上。它仍在以大约每周新建一座燃煤电厂的速度增加煤电装机容量。中国原本就已经在逐渐停止为海外燃煤电厂提供资金，主要是因为可再生能源的价格不断下跌。

不过，这一姿态至少表明，中国不想被认为是全球气候变化应对计划的破坏者。美国总统拜登的气候特使约翰·克里（John Kerry）一直在敦促中国做出这类承诺。而中国也警告说中美关系紧张可能会损害两国在气候变化方面的合作。至于在11月将于格拉斯哥举行的联合国气候变化大会COP26上，中国是否会宣布更多好消息，目前仍众说纷纭。（习近平本人不太可能到场，自新冠疫情爆发以来他一直避免出国。）

这些猜测主要围绕中国削减温室气体排放的计划。最激动人心的可能性是中国会把它碳达峰的时间提前；目前设为2030年。（一年前，习近平也表示中国将努力在2060年前实现“碳中和”，即碳排放量和减排量达到平衡。）因为中国是世界上最大的排放国，碳达峰提前可能会对世界气候前景产生重大影响，特别是碳排放量随后显著下降的话。

许多分析人士认为，中国努努力，就有可能在2025年实现碳达峰。但环保非政府组织绿色和平的分析师李硕表示，中国不太可能对此做出正式承诺。这需要关闭许多燃煤电厂，还要对今年起生效的新的五年经济规划做全面调整。

7月召开的一次G20峰会让人一瞥未来的形势。意大利主持了这次会议，迫切想让各国就逐步淘汰煤炭发电做出承诺。中国和其他一些国家都不大情愿。中国也拒绝了加快脱碳以争取把全球升温控制在比工业化前高1.5°C以内的提议（2015年达成的针对气候变化的《巴黎协定》呼吁将升温幅度控制在1.5°C和“远低于”2°C之间）。但温度计显示全球温度已经上升了约1.1°C至1.2°C，要实现这样的目标需要付出巨大的努力。中国明白很大一部分任务会落到自己肩上。 ■



The future of warfare

Tomorrow's soldiers will have their reality augmented

Relevant data will appear on their view of the battlefield

SUCCESS OR FAILURE in war often hinges on how much soldiers know about the enemy and the areas in which it operates. Tactical intelligence of all sorts helps. Locations of culverts where bombs may lie hidden. Spots from which snipers have scored kills. Water sources likely to have been polluted by agricultural runoff after heavy rain. Identities of locals suspected of aiding insurgents. Armed forces compile such intelligence and store it on computers. But making full use of it in the heat of battle has never been easy. This is now poised to change, thanks to display technology known as augmented reality (AR).

AR is the art of superimposing computer graphics on a view of the real world. It is popular in applications ranging from video games to selling furniture. America's army would like tactical intelligence pertinent to a soldier's mission to pop up similarly on a transparent visor attached to his helmet, no hands required. And for this capability, it is spending big. In March it announced a deal with Microsoft to build such a system. This could, over the course of a decade, cost a staggering \$21.9bn.

The army has dubbed the kit IVAS (Integrated Visual Augmentation System). David Marra, who runs Microsoft's end of the project, describes it as a holographic computer. The displays produced, he says, appear "locked to the real world", even as a wearer moves and shifts gaze.

IVAS pulls off this wizardry by crunching and synthesising several types of data. A GPS receiver locates the wearer within centimetres. Instruments fitted with accelerometers and gyroscopes provide information on how he

is moving around. Cameras track eye movements. IVAS must also be aware of a soldier's environment. This relies on lidar, an optical equivalent of radar. An array of sensors record the time it takes infrared laser pulses bounced off nearby objects to return. That allows those objects' distances to be calculated. Machine-vision software that recognises those objects then keeps track of how they move. Mr Marra describes the process as a "continuous rendering of the xyz co-ordinates of everything".

IVAS must calculate with extraordinary speed where on a headset's visor to display graphics. A latency of just seven milliseconds risks causing vestibular ocular discomfort, a type of dizziness that has long plagued the development of realistic displays of augmented and virtual reality. In most circumstances, Mr Marra says, IVAS operates well within that limit.

To build the system, Microsoft has modified an AR headset called HoloLens that it has so far sold mostly to businesses and research outfits. The militarised version of this has been "ruggedised" and souped up with a computing and battery "puck", a bit bigger than a smartphone, that the user carries on his chest.

Tactical intelligence can be uploaded before an operation, with updates transmitted wirelessly as needed. AR text and graphics guide soldiers through unfamiliar terrain, highlight the whereabouts of friendly forces and mark the enemy's known and suspected positions. The headsets will also employ facial-recognition technology to append information on possible persons of interest who come into view. As Susan Fung, the army's deputy head of IVAS technology at Fort Belvoir, in Virginia, puts it, soldiers freed of the need to look down at a screen will be able to "focus on moving and engaging targets".

IVAS will also exchange data with Azure, Microsoft's computing cloud. This will permit additional features, such as language interpretation, to be

included. Production of the headsets, which weigh about a kilogram, has begun. The first of an expected 120,000 or so units are to be deployed this year.

Others besides the army are also interested. America's marine corps is a partner in the IVAS programme. Undisclosed allies are seeking to join. And modified HoloLenses may also see use on warships. Britain's Royal Navy has paid \$25.5m to BAE Systems, a local defence giant, to adapt them to show pictures currently displayed on screens on the bridge to officers elsewhere on a vessel.

The benefits of AR may be even greater inside tanks, from which crew typically peer at the world through periscopes. That, says Daniel Covzhun, chief technologist at Limpid Armor, an AR firm in Kiev, Ukraine, is like viewing the world "through a length of metal pipe". Limpid's system, dubbed LPMK, superimposes graphics on video images collected by cameras and infrared sensors mounted on an armoured vehicle, and will soon be able to do the same for images relayed by nearby flying drones.

A handful of armoured vehicles belonging to Ukraine's army have already been fitted with test versions of LPMK. Before an operation, these are fed intelligence from a battle-management system. Commanders choose what they wish to be marked with icons, says Colonel Vadym Slyusar of the Central Scientific Research Institute of Armament and Military Equipment, in Kiev. Options include sewers and other underground infrastructure, preferred landing zones for medical-evacuation helicopters, culturally important buildings, and spots where attacks have been recorded or are feared. The systems start at about \$50,000. Ukraine recently ordered more than 50 for delivery this autumn. The United Arab Emirates and an undisclosed Asian country have placed orders with Limpid, too.

AR can also expand the capabilities of optical gear already used by soldiers.

In September 2019 the American army began to use a new AR feature added to its Enhanced Night Vision Goggle—Binoculars (ENVG-B), which are attached to a soldier's helmet and flip down over his eyes when needed. The new feature, made by L3 Harris, a firm in Florida, highlights sources of heat and amplifies what light is available to render objects visible in the dark.

ENVG-B works out the portion of the world within its wearer's field of view. It then superimposes icons on things like friendly and enemy troops, or the route to a rally point, drawing their co-ordinates from a wireless network called Nett Warrior. Soldiers especially like an AR mode called "rapid target acquisition", says Lynn Bollengier, head of "integrated vision" at L3 Harris. This pulls data from an inertial-measurement unit in a soldier's rifle to place crosshairs over whatever it is pointing at. That means a soldier can shoot from behind a corner without sticking his head out to put an eye to the rifle's sight. America's army and marine corps have bought more than 6,000 of the systems..

This is heady stuff. Even so, enhancing combat operations with AR will remain, for some time, beyond all but the most technologically sophisticated armies. Marcel Baltzer, of the Fraunhofer Institute's campus in Wachtberg, who co-chairs an AR-research team for Germany's armed forces, believes that even the European armies most advanced in the art (which are, by his reckoning, those of Britain, Germany, Lithuania, the Netherlands and Norway) will need another decade. Using AR for training, and for the maintenance and design of military hardware, he adds, is easier and will become common sooner.

Ambition, at any rate, is not lacking. Mojo Vision, a new Californian firm that has received money from DARPA, an American government military-research agency, is developing an AR system embedded in contact lenses. Tiny batteries power sensors that track a wearer's gaze and the movement of objects in view. An array of LEDs roughly the size of a grain of sand projects

images received via a wireless link onto the wearer's retina. The brightness of these is adjusted according to the ambient light. Steve Sinclair, Mojo's head of marketing, expects a usable version of the system to be ready in a few years' time.

Whether or not that proves feasible, the use of AR of any sort in combat will introduce risks. Designers must identify the point at which further visual augmentation will lead to confusing information overload—and what happens in training may not mirror the messiness of real battle. An imprecise data overlay could lead to a blunder. And if an AR system proves hackable, soldiers could be tricked by the enemy, with grim consequences.

A different sort of pitfall also looms. AR will make it easier for distant commanders to tell soldiers in battle what to do. The risk is that officers sitting far away from the fight will "feel like they've got puppets on the ground", says Axel Dyèvre, of Avisa Partners, a consultancy based in Paris that has studied AR for France's defence ministry. He calls the phenomenon a "squashing of chains of command" which robs troops of the degree of autonomy needed to fight effectively. AR for combat, then, offers perils as well as promise. ■



战争的未来

明天的士兵将进入增强的现实

有用数据会出现在他们眼前的战场中

战争的成败往往取决于士兵对敌人及其活动区域的了解程度。各种战术情报都有帮助，比如可能藏有炸弹的涵洞的位置；狙击手成功击杀过的地点；可能在大雨过后被农业径流污染的水源；涉嫌帮助叛乱分子的当地人的身份，等等。武装部队收集此类情报并存储在计算机上。但要在激烈的战场上充分利用这些情报从来都不容易。现在，有了被称为增强现实（AR）的显示技术帮忙，这势将发生改变。

AR是将计算机图像叠加在现实视野上的技术。它被广泛应用于从电子游戏到家具销售的各种领域。美国陆军想把与一名士兵的任务有关的情报以类似的方式显示在他头盔上的透明护目镜上，且无需用手操作。为获得这项技术能力，陆军正在大举投钱。今年3月，它宣布与微软达成了协议来建立这样一个系统。未来十年里，支出可能达到令人咋舌的219亿美元。

陆军方面称该装备为“集成视觉增强系统”（Integrated Visual Augmentation System，简称IVAS）。微软方面负责该项目的大卫·马拉（David Marra）则把它描述为一台全息计算机。他说，其生成的展示看起来就像是“长在了现实世界上”，即便佩戴者移动和跳转视线也不受影响。

IVAS有这样的魔法是因为它可以处理和合成几种类型的数据。GPS接收器定位佩戴者，精确至几厘米内。装有加速计和陀螺仪的仪器提供佩戴者如何移动的信息。摄像头跟踪眼球运动。IVAS还必须清楚士兵所处的环境，这要依赖激光雷达这种光学雷达。一系列传感器记录红外激光脉冲从附近物体反射回来所需的时间，从而计算出这些物体距佩戴者多远。然后，识别这些物体的机器视觉软件会跟踪它们的移动。马拉将这个过程称为“对

所有物体在三维坐标上连续渲染”。

IVAS必须执行超高速运算来实时决定在护目镜上的哪个位置展示图形。哪怕7毫秒的延迟也可能导致眼部前庭不适，这种头晕目眩的感觉长期困扰着增强现实和虚拟现实技术中“真实感显示”的发展。马拉说，在大多数情况下，IVAS的延迟都远低于7毫秒。

为了构建该系统，微软改装了一款名为HoloLens的AR头显，目前这款头显主要销售给企业和研究机构。它的军用版进行了“强化”，并加装了一个比智能手机略大的计算和电池配件，让使用者揣在胸前。

战术情报可以在军事行动前上传，并根据需要来无线更新。AR文字和图形引导士兵穿越陌生地形，提示友军行踪，标记敌军的已知或疑似位置。头显还将采用面部识别技术来对视野内出现的可能相关人员加注信息。弗吉尼亚州贝尔沃堡（Fort Belvoir）陆军IVAS技术副主管苏珊·冯（Susan Fung）说，士兵不需要低头看屏幕了，他们将能够“专心移动位置和攻击目标”。

IVAS还将与微软的计算云Azure交换数据。这可以为系统增加语音翻译之类的功能。这些重约一公斤的头显已经投产。第一批预计在12万套左右，将在今年部署使用。

对这个系统感兴趣的不止美国陆军。美国海军陆战队是IVAS项目的合作伙伴之一。未公开的盟友也在寻求加入。经改装的HoloLenses也可能在军舰上使用。英国皇家海军已向本国国防巨头BAE系统（BAE Systems）支付了2550万美元，用于改装HoloLens，将目前显示在舰桥屏幕上的图像展示给船上其他位置的军官。

AR在坦克内的用处可能更大，坦克兵通常通过潜望镜观察外部情况。乌克兰基辅的AR公司Limpid Armor的首席技术专家丹尼尔·考夫尊（Daniel Covzhun）说，这就像“通过一根金属管子”看世界。Limpid的系统名叫LPMK，它将图形叠加在装甲车上的摄像头和红外传感器收集的视频图像上，并且很快也能用到在附近飞行的无人机传来的图像。

乌克兰军队的少数装甲车已经安装了LPMK的测试版。在行动之前，军队会向LPMK上传来自战斗管理系统的情报。基辅的中央武器和军事装备科学研究所（Central Scientific Research Institute of Armament and Military Equipment）的瓦迪姆·斯柳萨（Vadym Slyusar）上校说，指挥官选择他们想要添加标记的内容。可选项包括下水道和其他地下基础设施、医疗后送直升机的首选着陆点、具有重要文化意义的建筑，以及曾经发生过或可能发生袭击的地点。这些系统起价约5万美元。乌克兰近期订购了50多套，将于今秋交付。阿联酋和一个未公开的亚洲国家也向Limpid下了订单。

AR还可以扩展士兵已经在使用的光学装备的功能。2019年9月，美国陆军开始在其双筒增强型夜视仪（ENVG-B）中加入一个AR新功能。这台夜视仪安装在士兵的头盔上，有需要时可下拉到眼前。佛罗里达公司L3 Harris研发的AR新功能可以突显热源，并可增强可以利用的光线，让物体在黑暗中也能被看到。

ENVG-B计算出佩戴者的视野内看到的那部分外部环境。然后，它会对友军、敌军或通往集结点的路线等目标加上标记，这些目标的坐标从一个名为Nett Warrior的无线网络中获取。在L3 Harris负责“集成视觉”的林恩·波林吉尔（Lynn Bollengier）表示，士兵们特别喜欢一种名为“快速目标获取”的AR模式。该模式从士兵步枪上的惯性测量装置中提取数据，将准星对准步枪所指的任何物体。这意味着士兵可以躲在角落里射击，而无需伸出头来盯着步枪的指向。美国陆军和海军陆战队已经购买了6000多套该系统。

这些东西很让人兴奋。不过即便如此，在未来一段时间内，只有技术最先进的那些军队才会借助AR来加强作战行动。弗劳恩霍夫协会瓦赫特贝格分会（Fraunhofer Institute in Wachtberg）的马赛尔·巴尔兹（Marcel Baltzer）是德国武装部队一个AR研究小组的联合负责人，他认为即使在AR技术上最领先的欧洲军队（他估计是英国、德国、立陶宛、荷兰和挪威的军队）也需要再经过十年的发展。他补充说，将AR用于训练以及军事硬件的维护和设计要更容易些，也会更快普及。

雄心壮志总是不缺的。新创办的加州公司Mojo Vision从美国政府军事研究机构国防部高级研究计划局（DARPA）那里获得资金，正在开发一种嵌入隐形眼镜的AR系统。它使用微型电池为传感器供电，可跟踪佩戴者的视线和视野中物体的运动。约一粒沙子大小的LED阵列把通过无线传输接收到的图像投射到佩戴者的视网膜上。图像亮度可根据环境光调整。Mojo的营销主管史蒂夫·辛克莱尔（Steve Sinclair）预计该系统的可用版本将能在几年内问世。

无论该系统是否可行，在战斗中使用任何类型的AR都会引入风险。设计者必须明确一个临界点，过了这个点，更多的视觉增强会导致信息过载，令人陷入混乱。而且训练中的场景可能无法反映真实战斗中的混乱情形。一次不精确的数据叠加可能会导致犯错。而如果AR系统能够被攻破，士兵可能会受敌人蒙骗，导致严重后果。

还存在另一种隐患。AR将让远方的指挥官更容易向战斗中的士兵发出指令。其风险是坐在远离战斗地点的军官会“感觉他们是在操控战场上的牵线木偶”，巴黎咨询公司Avisa Partners的阿克塞尔·戴夫尔（Axel Dyèvre）说，该公司曾为法国国防部研究AR。他称这种现象为“指挥链的挤压”，它剥夺了部队有效作战所必需的一定程度的自主性。因此，用于战事的AR带来的不止希望，还有危险。 ■



Schumpeter

How bosses should write books

CEOs are at risk of giving business writing a good name

CHIEF EXECUTIVES are not, it goes without saying, the world's most natural writers. They do not rise to the top without laserlike ambition, a trait that rarely leads to literary reflection. To achieve success, they have to murder their straight-talking selves and master corporate twaddle instead. They need neither fame nor fortune—the main reasons writers go through the agonies that they do. And when they do write, as a business publisher admits, you often “weep for the trees”. Think only of Jack Welch’s paean to great (ie, his own) leadership called “Winning”. Its first pearl of wisdom is: “Winning in business is great, because when companies win, people thrive and grow.”

So it is with trepidation that Schumpeter celebrates the flourishing of a genre at which most book-lovers would shudder: the CEO memoir. True, it has its drawbacks. The authors are mostly white, male and middle-class. They are neither Hemingways nor Dostoevskys. There is no sex, drugs and only middle-of-the-road rock ‘n’ roll. And they can afford the best ghostwriters so it is hard to tell how much is their work anyway.

That said, the genre has many things going for it—especially when the authors are founders of successful firms who, by definition, have mastered the art of telling a good story. It has recently hit its stride with books by Phil Knight, who co-founded Nike, in 2016 and Stephen Schwarzman, co-creator of Blackstone, in 2019. Its newest addition is “Play Nice but Win”, the story of how Michael Dell built the PC company named after him that would eventually change the way computers were made and sold. Ignore the boy-scout title. The book is acidly funny, nail-biting and fast-paced. It is also

blessed with a villain from central casting: Carl Icahn, activist investor and publicity hound, whose sparring with Mr Dell gives the story its bite.

Moreover, for those interested in business, such accounts provide a ringside seat for observing some of the big dilemmas of recent decades: staying private or going public; prioritising shareholders or stakeholders; building hardware or software. In a world of unreadable business books and overpriced business schools, it is worth taking CEO memoirs seriously. If nothing else they help expose what most self-styled business gurus get wrong.

The first trait the books celebrate is competitiveness. The memoirs bristle with it. These are not win-win firms created to make the world a better place. Business, as Mr Knight puts it, is “war without the bullets”, fought one sale at a time, which someone inevitably has to lose. In 1988, when Mr Dell was 23 years old and Compaq was his biggest rival, he placed a billboard outside its headquarters in Houston, Texas, with an arrow pointing west towards Austin, where his own four-year-old company was based. “158 miles to opportunity”, it read. In “Shoe Dog”, Nike’s former boss writes about the importance of being first into China to gain an advantage over its competitors. “What a coup that would be,” he writes. “One billion people. Two. Billion. Feet.”

The second factor is how character affects business. In most such books, personality is overshadowed by bloodless abstractions: visions, narratives, missions. In reality, businesses are built by people with flesh-and-blood strengths and weaknesses. Of course, all entrepreneurs crave success. But part of Mr Dell’s genius lay in realising that his triumph would come from complementing his cocky young self with colourful elder statesmen who understood the pitfalls of building a business at lightning speed. The laconic Mr Knight’s sidekick was Jeff Johnson, an oddball so enthusiastic about selling trainers that he wrote endless letters to his exasperated boss.

He never got a response, yet the affection between the two men helped make Nike what it is. A cast of Wall Street characters brightens Mr Schwarzman's book. One of the most memorable is Jimmy Cayne, boss of Bear Stearns, who pigheadedly refused to write a cheque that could years later have saved the bank from collapse.

Third comes candour. Be honest about failure as well as success. Founding a business always comes with what Mr Schwarzman calls "the moment of despair": when you think you are a master of the universe, but no one else does. In Mr Knight's case it was the word uttered by his banker that ran through his head as he punched his pillow at night: "equity", ie, cold, hard cash he needed to inject into his firm. He had none. For Mr Dell, it was the frustration of having Mr Icahn, a master of the soundbite, accusing him of grossly undervaluing Dell when attempting to take it private in 2013. He likens it to being "smacked in the face with a flounder".

Finally, context. The books all channel the cacophony that surrounds business, coming from employees, customers, competitors, lenders, investors and regulators. This makes keeping a single-minded focus on success so hard. When Dell temporarily goes private in 2013, Mr Dell silently waves goodbye to the "legions of whiners, back-seat drivers, kerbside experts, rear-view-mirror thinkers, and second guessers". Mr Knight takes issue with what he calls the "bland, generic banner" of business itself. "What we were doing felt like so much more. Each new day brought 50 new problems, 50 tough decisions...and we were always acutely aware that one rash move, one wrong decision, could be the end."

The lure of self-aggrandisement remains. Mr Schwarzman ends his book with pages of name-dropping. Mr Dell descends into pieties about doing good for the world. Refreshingly, Mr Knight, who in later life studied creative writing, finishes before his tale becomes a dull one of Nike's success. And the genre has room to develop. Soon, the west coast's middle-

aged tech barons will be itching to tell their stories. The world may wince less if the CEO scribes remember the four Cs: competitiveness, character, candour and context. And if they need a ghostwriter, remember the business hacks who, unlike superstar bosses, toil in obscurity. ■



熊彼特

老板们该如何写书

首席执行官们可能会给商业写作带来好名声

不用说也知道，首席执行官并不是世界上最有写作天分的人。如果没有目标极明确的抱负心，他们不可能升到这个位置，但这样的特质很少会催生出具有文学性的反思。为了成功，他们不得不扼杀那个实话实说的自我，转而打起官腔，胡说八道。他们不缺名气也不缺财富——而这两样正是作家经受痛苦的主要原因。而等到他们真的动手写起来，也常常会像一位商业出版人承认的那样，“抱树啼哭，假模假式”。只消想想杰克·韦尔奇（Jack Welch）对伟大的（也就是他自己的）领导能力的赞歌《赢》（Winning）就明白了。这本书的第一则金玉良言是：“在商场中赢是很棒的，因为当公司赢了，人就会茁壮成长。”

因此，笔者是带着几分惶恐来庆祝一个让大多数爱书人都脊背发毛的流派开始繁荣，那就是首席执行官回忆录。没错，这类书有其缺点。作者大多是中产阶级白人男性。他们不是海明威，也不是陀思妥耶夫斯基。他们的书里面没有性和毒品，只有温吞的摇滚乐。而且他们请得起最好的影子写手，所以也很难说他们的作品多大程度是自己的手笔。

话虽如此，这类书也有许多值得称道之处，特别是如果作者本身是成功企业的创始人的话，那么他们本身就已经掌握了讲好一个故事的技艺。近年来这个流派屡添力作，开始展现魅力：耐克的联合创始人菲尔·奈特（Phil Knight）和黑石的联合创始人苏世民（Stephen Schwarzman）分别在2016年和2019年出版了回忆录。这类书最新的成员是《要友善，但要赢》（Play Nice but Win），讲述了迈克尔·戴尔如何建立起以他的名字命名的个人电脑公司，最终改变了电脑的生产和销售方式。别介意它童子军色彩的书名，这本书其实趣味十足，扣人心弦，节奏明快。它幸运地拥有一个反派人物典型：卡尔·伊坎（Carl Icahn），一个爱出风头的维权投资者，他与戴尔的角力让这则故事引人入胜。

此外，这类记述也让那些对商业感兴趣的人得以近距离观察近几十年来的一些重大的两难困境：保持私有还是公开上市；股东优先还是利益相关者优先；构建硬件还是软件。在一个商业书籍难以卒读、商学院学费过高的世界里，CEO回忆录还得值得认真对待一下的。就算没有别的用处，它们起码可以曝露出大多数自封的商业大师出错的地方。

这些著述大书特书的第一点是竞争力。这几本回忆录三句话不离竞争力。这些公司并不是为了让世界变得更美好而创立的互惠互利的公司。正如奈特所言，商业是“没有硝烟的战争”，每次销售都是一次战役，免不了有人要输。1988年戴尔23岁时，康柏是他最大的竞争对手。他在康柏位于得州休斯顿的总部外立了一块广告牌，上面写着“前方距离机遇158英里”，一个箭头指向奥斯汀——他自己成立四年的公司的所在地。在《鞋狗》（Shoe Dog）中，耐克前老板谈到率先进入中国以获得相对于竞争对手的优势有多么重要。“那会是一个多么难得的成就，”他写道，“十亿人。二，十，亿，只，脚。”

第二个因素是人格如何影响生意。在大多数这类书中，个性被愿景、叙事、使命这种苍白的抽象概念掩盖住了。事实上，企业是由有血有肉的人建立起来的，他们有长处也有弱点。当然，所有的企业家都渴望成功。但戴尔的天才之处一定程度上在于他能意识到，若要取胜，自己的年轻自负要有年长的多面手政治家作为补充——他们了解闪电式创业面临什么陷阱。言辞简洁的奈特有个怪咖副手杰夫·约翰逊（Jeff Johnson），他对卖运动鞋满腔热情，给他焦头烂额的老板写了无数封信。他从未得到回音，但两人彼此间的友爱帮助成就了今天的耐克。形形色色的华尔街人物给苏世民的书增色不少。其中最令人难忘的是贝尔斯登（Bear Stearns）的老板吉米·凯恩（Jimmy Cayne），他固执地拒绝开出一张支票，而这张支票本可以在几年后挽救这家银行免于倒闭。

第三是坦诚。对成功和失败都要诚实。创业总是伴随着苏世民所说的“绝望时刻”：当你觉得自己是宇宙的主宰，但其他人都不觉得。奈特的绝望时刻就是夜里猛捶枕头时，脑海中闪过他的金主说过的一个词：“股本”，即实实在在的现金，他需要给公司注资。但他没钱。戴尔的绝望时刻是金

句大师伊坎指责他在2013年试图将戴尔私有化时严重低估了公司价值，这令他分外沮丧。他把这比作“被人用比目鱼啪啪打脸”。

最后是情境。这些书中汇集了围绕商业的各路杂音，它们来自员工、客户、竞争对手、贷款人、投资者和监管机构。这让一心一意追求成功变得极为困难。当戴尔公司在2013年暂时私有化时，戴尔默默地挥别了“一大帮矫情鬼、后座司机、马路牙子专家、后视镜思想家和事后诸葛亮”。奈特对“商业”这个他口中“寡淡、笼统的名词”提出了异议。“感觉我们做的事可比这多多了。每天都会冒出来50个新问题，要做50个艰难的决定……我们始终都清楚地知道，一个轻率的举动，一个错误的决定，都可能是完结。”

自吹自擂的诱惑依旧难以抵挡。苏世民在书的最后几页显摆起人脉来。戴尔逐渐一派虔诚地探讨起为这个世界行善。好在晚年研究创意写作的奈特在他的讲述变成耐克乏味的成功故事前及时停笔，令人神清气爽。这个写作流派还有发展的空间。很快，西海岸的中年科技大亨们也会心痒痒地要讲一讲自己的故事。如果CEO文士们谨记这四个“C”：竞争力（competitiveness）、人格（character）、坦率（candour）和情境（context），那他们的大作可能就不会让世人那么敬而远之了。如果他们需要代笔的话，记得还有在籍籍无名中摸爬滚打、和超级明星老板们迥乎不同的商业写手。 ■



The shortage economy

The world economy's shortage problem

Scarcity has replaced gluts as the biggest impediment to global growth

FOR A DECADE after the financial crisis the world economy's problem was a lack of spending. Worried households paid down their debts, governments imposed austerity and wary firms held back investment, especially in physical capacity, while hiring from a seemingly infinite pool of workers. Now spending has come roaring back, as governments have stimulated the economy and consumers let rip. The surge in demand is so powerful that supply is struggling to keep up. Lorry drivers are getting signing bonuses, an armada of container ships is anchored off California waiting for ports to clear and energy prices are spiralling upwards. As rising inflation spooks investors, the gluts of the 2010s have given way to a shortage economy.

The immediate cause is covid-19. Some \$10.4trn of global stimulus has unleashed a furious but lopsided rebound in which consumers are spending more on goods than normal, stretching global supply chains that have been starved of investment. Demand for electronic goods has boomed during the pandemic but a shortage of the microchips inside them has struck industrial production in some exporting economies, such as Taiwan. The spread of the Delta variant has shut down clothing factories in parts of Asia. In the rich world migration is down, stimulus has filled bank accounts and not enough workers fancy shifting from out-of-favour jobs like selling sandwiches in cities to in-demand ones such as warehousing. From Brooklyn to Brisbane, employers are in a mad scramble for extra hands.

Yet the shortage economy is also the product of two deeper forces. First, decarbonisation. The switch from coal to renewable energy has left Europe, and especially Britain, vulnerable to a natural-gas supply panic that at one

point this week had sent spot prices up by over 60%. A rising carbon price in the European Union's emissions-trading scheme has made it hard to switch to other dirty forms of energy. Swathes of China have faced power cuts as some of its provinces scramble to meet strict environmental targets. High prices for shipping and tech components are now triggering increased capital expenditure to expand capacity. But when the world is trying to wean itself off dirty forms of energy, the incentive to make long-lived investments in the fossil-fuel industry is weak.

The second force is protectionism. Trade policy is no longer written with economic efficiency in mind, but in the pursuit of an array of goals, from imposing labour and environmental standards abroad to punishing geopolitical opponents.

This week Joe Biden's administration confirmed that it would keep Donald Trump's tariffs on China, which average 19%, promising only that firms could apply for exemptions (good luck battling the federal bureaucracy). Around the world, economic nationalism is contributing to the shortage economy. Britain's lack of lorry drivers has been exacerbated by Brexit. India has a coal shortage in part because of a misguided attempt to cut imports of fuel. After years of trade tensions, the flow of cross-border investment by companies has fallen by more than half relative to world GDP since 2015.

All this might seem eerily reminiscent of the 1970s, when many places faced petrol-pump queues, double-digit price rises and sluggish growth. But the comparison gets you only so far. Half a century ago politicians got economic policy badly wrong, fighting inflation with futile measures like price controls and Gerald Ford's "whip inflation now" campaign, which urged people to grow their own vegetables. Today the Federal Reserve is debating how to forecast inflation, but there is a consensus that central banks have the power and the duty to keep it in check.

For now, out-of-control inflation seems unlikely. Energy prices should ease after the winter. In the next year the spread of vaccines and new treatments for covid-19 should reduce disruptions. Consumers may spend more on services. Fiscal stimulus will wind down in 2022: Mr Biden is struggling to get his jumbo spending bills through Congress and Britain plans to raise taxes. The risk of a housing bust in China means that demand could even fall, restoring the sluggish conditions of the 2010s. And an investment boost in some industries will eventually translate into more capacity and higher productivity.

But make no mistake, the deeper forces behind the shortage economy are not going away and politicians could easily end up with dangerously wrong-headed policies. One day, technologies such as hydrogen should help make green power more reliable. But that will not plug shortages right now. As fuel and electricity costs rise, there could be a backlash. If governments do not ensure that there are adequate green alternatives to fossil fuels, they may have to meet shortages by relaxing emissions targets and lurching back to dirtier sources of energy. Governments will therefore have to plan carefully to cope with the higher energy costs and slower growth that will result from eliminating emissions. Pretending that decarbonisation will result in a miraculous economic boom is bound to lead to disappointment.

The shortage economy could also reinforce the appeal of protectionism and state intervention. Many voters blame empty shelves and energy crises on the government. Politicians can escape responsibility by excoriating fickle foreigners and fragile supply chains, and by talking up the false promise of boosting self-reliance. Britain has already bailed out a fertiliser plant to maintain the supply of carbon dioxide, an input for the food industry. The government is trying to claim that labour shortages are good, because they will raise economy-wide wages and productivity. In reality, putting up barriers to migration and trade will, on average, cause both to fall.

Disruptions often lead people to question economic orthodoxies. The trauma of the 1970s led to a welcome rejection of big government and crude Keynesianism. The risk now is that strains in the economy lead to a repudiation of decarbonisation and globalisation, with devastating long-term consequences. That is the real threat posed by the shortage economy.





【首文】短缺经济

世界经济的短缺问题

稀缺已取代过剩成为全球增长的最大障碍

全球金融危机爆发后的十年里，世界经济的问题是支出不足。家家户户忧心忡忡，把钱用来偿还债务；政府推行紧缩政策；企业小心谨慎，不敢投资，特别是不敢投资实体产能，同时劳动力供应却似乎源源不绝。如今，随着各国政府推出经济刺激措施，消费者不再捂紧钱包，支出显著回升。需求的增长如此迅猛，令供应难以跟上。货运公司提供高额签约奖金招揽司机，大批货船停泊在加州港外等待进港卸货，能源价格暴涨。通胀上升令投资者胆战心惊，2010年代的供应过剩已经让位给了短缺经济。

直接原因是新冠疫情。全球已推出约10.4万亿美元的经济刺激措施，引发了非常强劲但不平衡的反弹，消费者的商品支出超过正常水平，令长期投资不足的全球供应链疲于应付。疫情期间对电子产品的需求大增，但这些设备所需的微芯片已经短缺，冲击台湾等出口经济体的工业生产。德尔塔变种病毒的传播迫使亚洲部分地区的服装厂停工。在富裕国家，人口迁移减少，刺激福利金充实了银行账户，没有足够多的劳动者愿意从变得萧条的部门（比如在城里卖三明治）转向仓储等需求大增的岗位。从美国布鲁克林到澳大利亚布里斯班，雇主们都在疯狂争夺人手。

但这种短缺经济也是两种更深层力量的产物。第一是脱碳。从煤炭到可再生能源的转型令欧洲（尤其是英国）易于发生天然气供应恐慌，近期天然气现货价格就因此一度上涨超过60%。欧盟排放交易体系内的碳价格不断上涨，令市场难以转用其他高污染能源。中国一些省份急于达到严格的环保目标，引发大片地区出现限电停电。目前航运和科技设备元件价格飙升，用以扩大产能的资本支出随之上升。但由于全世界都在努力摆脱对高污染能源的依赖，对化石燃料行业做长期投资的动力不足。

第二是保护主义。如今在制定贸易政策时考虑的不再是提高经济效率，而

是追求各种目标，包括在国外施加某些劳工和环境标准、惩罚地缘政治对手等。

拜登政府最近确认将维持特朗普对中国商品征收平均19%关税的政策，只承诺企业可申请豁免（这要与联邦官僚机构斗法，祝君好运）。在世界各地，经济民族主义正在导致短缺加剧。英国脱欧给国内的卡车司机荒火上浇油。印度缺煤，一定程度是因为此前不明智地削减了燃料进口。在多年的贸易关系紧张之后，自2015年以来，企业跨境投资流量占全球GDP的比重已下降超过一半。

这一切可能会让人不安地回想起上世纪70年代的景象，当时很多地方的加油站大排长龙，物价涨幅达到两位数，经济增长低迷。但相似之处仅止于此。半个世纪前，政客们采用了极其糟糕的经济政策，用价格管控和时任美国总统福特发起的“鞭笞通胀”运动（呼吁人们自己种菜）等徒劳的措施来对抗通胀。今天，美联储正就如何预测通胀争论不休，但有一个共识：央行有能力和责任控制通胀。

就目前来看，通胀不太可能失控。能源价格在冬季过后应该会趋向缓和。明年，随着疫苗接种和新冠肺炎新疗法的进一步普及，疫情对经济的干扰应该会减弱。消费者支出可能会向服务倾斜。财政刺激措施将在2022年逐渐退出：拜登的巨额支出法案在国会遭遇阻力；英国计划加税。中国的房地产业危机甚至可能导致需求下降，回到2010年代的低迷状态。而某些行业的投资增长最终将转化为产能和生产率的提升。

但毫无疑问，短缺经济背后的深层力量并不会消失，而政客们最终又容易诉诸于危险的错误政策。终有一日，氢能等技术应该会让绿色电力变得更可靠，但这解决不了眼前的短缺。随着燃料和电力成本上升，民意可能强烈反弹。假如政府无法确保提供足够的绿色能源来取代化石燃料，就可能不得不通过放宽排放目标及重拾高污染能源来应对短缺。因此，各国政府必须细致规划，以应对减排导致的能源成本上升及增长放缓问题。佯装脱碳将带来奇迹般的经济繁荣必然导致失望。

短缺经济也可能进一步增强保护主义和政府干预的吸引力。许多选民把商品短缺和能源危机归咎于政府。政客们可能为逃避责任而痛斥外国人出尔反尔、供应链不堪一击，并大力鼓吹促进自力更生的莫须有的好处。英国已出手救助一家化肥厂以维持二氧化碳的供应（这是食品行业的原料）。英国政府试图把劳动力短缺说成一桩好事，声称整个经济的工资水平和生产率将因而提升。但实际上，平均而言，对移民和贸易设限只会导致这两者都下降。

突发的混乱往往会让质疑当下的主流正统经济理念。上世纪70年代的创伤促使人们开始抵制大政府和简单粗暴的凯恩斯主义，这是喜闻乐见的转变。现在的风险是经济压力可能导致人们否定脱碳和全球化，长期后果不堪设想。这是短缺经济的真正威胁所在。 ■



Free exchange

Just how Dickensian is China?

Inequality is better than it was. But it doesn't feel that way

WITH ITS fast trains, super-apps, digital payments and techno-surveillance, China can seem like a vision of the future. But for some scholars, such as Yuen Yuen Ang of the University of Michigan, it is also reminiscent of the past. Its buccaneering accumulation of wealth and elaborate choreography of corruption recall America's Gilded Age at the end of the 19th century, an era that takes its name from a novel by Mark Twain and Charles Warner.

China, including Hong Kong and Macau, now has 698 billionaires, according to Forbes, almost as many as America (724). The habits of the new rich could fill a novel in the spirit of Twain. Even the non-fiction accounts are outlandish. One billionaire, according to the book "Red Roulette" by Desmond Shum, offered the author's well-connected wife a \$1m ring as a gift. When she refused, he bought two anyway. One businessman remarked to Ms Ang that his neighbour's dog will only drink Evian. Meanwhile, over 28% of China's 286m migrant workers lack a toilet of their own. And in parts of rural China, 16-27% of pupils suffer from anaemia, according to a 2016 study, because they lack vitamins and iron.

None of this makes Xi Jinping, China's ruler, happy. According to a leaked account by a professor who grew up with him, he is "repulsed by the all-encompassing commercialisation of Chinese society, with its attendant nouveau riche". Mr Xi has begun to talk more frequently about "common prosperity". In January, he declared that "we cannot allow the gap between the rich and the poor to continue growing...We cannot permit the wealth gap to become an unbridgeable gulf."

Measuring China's gaps and gulfs is tricky. The most common gauge of income inequality is the Gini coefficient, which has become popular despite being hard to interpret. One way to make sense of it is with a thought experiment. Suppose two people in a country are to meet at random. What will be the expected income gap between the two? If you know the income of everyone in the country, you can guess by calculating the average gap from every possible pairing. That expected gap can be expressed as a percentage of the society's average income. Cut that percentage in half (to get to a number between 0 and 100) and you have the Gini coefficient. China's official Gini is 46.5%, meaning that the expected gap will be 93% (ie, twice the Gini) of China's average disposable income. Since average disposable income was 30,733 yuan (\$4,449) in 2019, the expected gap would be about \$4,138.

China's official Gini is higher than that of many advanced countries, including America and Britain. An alternative calculated by the World Bank looks better (38.5% in 2016), because it takes account of cheaper prices in rural areas. Another source, the World Inequality Database overseen by Thomas Piketty and his colleagues, reports higher figures, because they look at pre-tax income and because they take extra pains to ferret out the unreported income of the rich. But, as Martin Ravallion of Georgetown University points out, the poor may also have unreported resources, which may be large relative to their paltry reported incomes.

Although the level of inequality differs between these measures, they all agree on one striking point. Inequality in China today is not as bad as it was about a decade ago. Indeed, some scholars have remarked on the "great Chinese inequality turnaround".

Why then has concern about inequality turned up, even as inequality itself has turned around? Twain may offer one answer. One of the protagonists of "The Gilded Age" comforts himself with the thought that although he and

his wife have to “eat crusts in toil and poverty”, his children will “live like the princes of the Earth.” Similarly, many Chinese may tolerate life on the lower rungs of society, if they think they or their children can climb up the ladder.

But that kind of social mobility seems to be slowing. Yi Fan and Junjian Yi of the National University of Singapore and Junsen Zhang of Zhejiang University have tried to calculate the persistence of income from one generation to the next. Chinese born in the 1970s inherited about 39% of any economic advantage enjoyed by their parents. Those born in the 1980s inherited over 44%. That is, if you knew one set of parents was 1% richer than an otherwise similar set of parents, you would expect their children to earn 0.44% more in their own careers than the other parents’ kids.

Inequality may also be more conspicuous than it was. As Mr Ravallion and Shaohua Chen of Xiamen University have pointed out, the decline in Chinese inequality since 2008 does not reflect softer divisions within cities. It results instead from a narrower gap between urban and rural China. People tend to be more conscious of social fault-lines within a city than they are of disparities between one far-flung place and another.

Mr Ravallion suggests another reason why China’s great inequality turnaround has gone unnoticed: people do not think in Ginis or percentages but in yuan and fen, dollars and cents. The expected income gap between two random Chinese may have declined from 98% of average income at inequality’s peak in 2008 to 93% now. But because average income has risen in that time, the expected gap in yuan terms is still far larger. The income per person of the top fifth of households was 10.7 times that of the bottom fifth in 2014. That ratio has since fallen a bit. But the gap in yuan has increased from 46,221 yuan in 2014 to 69,021 yuan in 2019.

The professor who grew up with Mr Xi speculated that if he became leader Mr Xi would “aggressively” tackle China’s gilded decadence, even “at the

expense of the new monied class". Mr Xi has already browbeaten some billionaires into public acts of philanthropy. The gestures will do little to shift the Gini coefficient. But they will make redistribution more conspicuous. Deng Xiaoping, one of Mr Xi's predecessors, famously said that he did not care if cats were white or black as long as they caught mice. Mr Xi's main opinion about cats is that he does not like them fat. ■



自由交流

中国的贫富差距到底有多严重？

不平等较从前有所改善，但感觉上不是这样

拥有高速铁路、超级应用、数字支付和高科技监控，中国俨然是一幅人类未来的景象。但对于密歇根大学的洪源远等一些学者来说，它也让人联想起过去。它掠夺式的财富积累和错综复杂的腐败让人回想起美国19世纪末的“镀金时代”，这个名字来自马克·吐温和查尔斯·华纳（Charles Warner）合著的一部小说。

据《福布斯》杂志统计，包括香港和澳门在内，中国现在有698名亿万富翁，几乎和美国（724名）一样多。这些新富阶层的生活方式足以用马克·吐温的笔调写成一部小说。即使是非虚构的记述也非比寻常。沈栋在《红色轮盘》一书中写道，一个亿万富翁要送他人脉广泛的妻子一枚价值100万美元的戒指，她拒绝了，结果他还是一次性买下了两枚。一名商人告诉洪源远，他邻居的狗只喝依云矿泉水。而与此同时，中国2.86亿农民工中超过28%没有自用卫生间。2016年的一项研究显示，由于维生素和铁摄入不足，中国部分农村地区有16%到27%的小学生患有贫血。

所有这一切都让中国领导人习近平不悦。据传一位和他一起长大的教授曾说，习近平“对中国社会无所不在的商业化以及随之而来的暴发户感到厌恶”。习近平已经开始更加频繁地谈论“共同富裕”。今年1月，他宣称“我们决不能允许贫富差距越来越大……决不能在富的人和穷的人之间出现一道不可逾越的鸿沟”。

衡量中国的贫富差距是件棘手的事。基尼系数是衡量收入不平等最常用的指标，虽然难以解读但十分流行。要理解基尼系数，一个方法是做一项思维实验。假设从一个国家里随机抽两个人放在一起，他们之间的收入差距预计会是多少？如果知道该国每个人的收入，就可以通过计算所有可能的配对的差距平均数来猜出结果。这一差距可以表达为占社会平均收入的百

分比。将这个百分比减半（得到一个0和100之间的数字），便得到基尼系数。中国官方的基尼系数为46.5%，也就是说，这个预计差距将达到中国人均可支配收入的93%（基尼系数的两倍）。由于2019年人均可支配收入为30,733元（4449美元），则预计差距约为4138美元。

中国的官方基尼系数比英美等许多发达国家都高。世界银行计算的基尼系数考虑了农村地区物价更低的因素，得出的结果更好看些（2016年为38.5%）。还有一个来源是由托马斯·皮凯蒂及其同事管理的世界不平等数据库，它报告的数字更高，因为统计的是税前收入，而且他们还不辞辛苦地搜集了富人未申报的收入数据。但是，正如乔治城大学的马丁·拉瓦雷（Martin Ravallion）指出的，穷人可能也有未申报的收入来源，而且相对于他们微薄的申报收入而言可能还相当可观。

尽管这些衡量指标所反映的不平等程度有所不同，但它们都就一个显著的点达成了共识。今天中国的不平等状况已经不像十年前那么严重。事实上，有些学者已经在谈论“中国不平等的巨大转变”。

那么，在不平等状况已经逆转之时，对不平等的担忧为何反而更加强烈了？也许马克·吐温可以给出一种解释。《镀金时代》里的一位主人公自我安慰地想到，虽然他和妻子不得不“辛劳贫苦，吃糠咽菜”，但他的孩子们将“过上人间王子般的生活”。同样，许多中国人只要觉得自己或孩子能够有机会出人头地，他们可能也会忍耐在社会底层的生活。

但这样的社会流动似乎正在放缓。新加坡国立大学的樊漪、易君健和浙江大学的张俊森曾经尝试计算代际之间的收入持续性。1970年代出生的中国人继承了父母所享有经济优势的39%左右。而1980年代出生的人继承了44%以上。也就是说，如果已知一对父母比另一对其他各方面都相似的父母富1%，那么可以预期前者的孩子在职业生涯中会比后者的孩子多挣0.44%。

不平等也可能比过去更加明显。正如拉瓦雷和厦门大学的陈少华所指出的，2008年以来中国贫富差距的缩小并非缘于城市里贫富分化的缓和。它

更多是中国城乡差距缩小的结果。人们往往更容易察觉到同一座城市里的社会断层，而不是偏远地区之间的差异。

拉瓦雷提出了中国不平等的巨大转变未被察觉的另一个原因：人们并不是用基尼系数或百分比来想收入差距问题的，而是用人民币和美元等钞票。随机挑出的两个中国人之间的预期收入差距在不平等最高峰时的2008年为平均收入的98%，现在已下降到93%。但由于人均收入在这段时间内的增长，以人民币计算的预期差距还是大了很多。2014年，收入最高五分之一家庭的人均收入是最低五分之一家庭的10.7倍。之后该比例略有下降。但以人民币计算，这一差距已从2014年的46,221元扩大到2019年的69,021元。

与习近平一起长大的那名教授曾推测，一旦成为领导人，习近平将“大力”打击中国镀金时代的纸醉金迷，甚至“不惜牺牲新富阶层”。在习近平的震慑之下，一些亿万富翁已在大张旗鼓地做慈善。这些姿态几乎无助于改变基尼系数。但它们会让财富再分配更加显眼。前最高领导人邓小平曾有一句名言：不管白猫黑猫，捉到老鼠就是好猫。而习近平对猫的主要看法是不能长太肥了。■



The beef with beef

Treating beef like coal would make a big dent in greenhouse-gas emissions

Cattle are a surprisingly large producer of greenhouse gases

FEW DISHES whet more palates than a juicy cut of beef. One poll in 2014 found that steak was Americans' favourite food. Unfortunately, by cooking so many cows, humans are cooking themselves, too.

The impact of food on greenhouse-gas (GHG) emissions can slip under the radar. In a survey in Britain last year, the share of respondents saying that "producing plants and meat on farms" was a "significant contributor" to climate change was the lowest among ten listed activities. Yet two papers published this year in *Nature Food* find that food, especially beef, creates more GHGs than previously thought. Forgoing steaks may be one of the most efficient ways to reduce your carbon footprint.

In 2019 the UN's Intergovernmental Panel on Climate Change estimated that the global food system was responsible for 21-37% of GHG emissions. This March researchers from the European Commission and the UN's Food and Agriculture Office released a study with a central estimate near the top of this range. It attributed 34% of GHGs produced in 2015 to food.

This elevated share stems in part from accounting choices. The paper assigns the full impact of deforestation to the agriculture that results from it; includes emissions after food is sold (such as from waste and cooking); and counts non-food crops like cotton. But even when the authors excluded embedded emissions from sources like transport and packaging, they still found that agriculture generated 24% of GHGs. According to the World Resources Institute, a research group, cars, trains, ships and planes produce

a total of 16%.

Another recent paper, by Xiaoming Xu of the University of Illinois at Urbana-Champaign and eight co-authors, allocates this impact among 171 crops and 16 animal products. It finds that animal-based foods account for 57% of agricultural GHGs, versus 29% for food from plants. Beef and cow's milk alone made up 34%. Combined with the earlier study's results, this implies that cattle produce 12% of GHG emissions.

Relative to other food sources, beef is uniquely carbon-intensive. Because cattle emit methane and need large pastures that are often created via deforestation, they produce seven times as many GHGs per calorie of meat as pigs do, and around 40% more than farmed prawns do. This makes beef a bigger outlier among foods than coal is among sources of electricity: burning coal generates just 14% more GHGs than burning oil, another common fuel. ■



牛肉之怨

视牛肉如煤炭将大大减少温室气体排放

肉牛的温室气体排放量惊人

很少有哪道菜比美味多汁的牛肉更让人垂涎三尺。2014年的一项民意调查发现，牛排是美国人最喜欢的食物。不幸的是，人们在烹煮那么多牛肉的同时也在“烹煮”自己。

食品的温室气体排放可能会逃过人们的眼睛。英国去年的一项调查中，在罗列的十类活动中把“在农场种植植物及生产肉类”选为气候变化“重要成因”的受访者最少。但今年在《自然·食品》(Nature Food)上发表的两篇论文发现，食品——尤其是牛肉——产生的温室气体之多超乎人们之前的想象。弃绝牛排可能是减少你的碳足迹最有效的方法之一。

2019年，联合国政府间气候变化专门委员会估计，全球食品生产的温室气体排放占到总量的21%至37%。今年3月，欧盟委员会和联合国粮农组织的研究人员发布的一份报告显示，中心估值接近上述区间的高位：2015年有34%的温室气体排放源自食品生产。

比例接近高位一定程度上是受所选核算方法的影响。该研究把砍伐森林的排放全算到随后的农业开发上，还计入了食品出售后的排放（例如浪费和烹煮过程的排放），棉花等非粮食作物也被算了进去。但就算不计算来自运输和包装等方面的隐藏排放，研究人员仍发现农业的温室气体排放占比高达24%。研究组织世界资源研究所（World Resources Institute）的数据显示，汽车、火车、轮船和飞机加起来的排放占比为16%。

伊利诺伊大学厄巴纳-香槟分校的徐晓明与其他八位合著者近期发表的另一篇论文研究了171种作物和16种动物性食品的温室气体排放比例，发现动物性食品生产占农业温室气体的57%，植物性食品占29%。单是牛肉和牛奶就占了34%。结合前一研究的结果，这意味着温室气体排放中有12%来

自养牛。

相比其他食物，牛肉的碳密集度可谓无可比拟。牛会排放甲烷，而且需要大片牧场，而这些牧场往往是通过砍伐森林而来。因此，牛肉每提供一卡路里热量而产生的温室气体是猪肉的七倍，是养殖对虾的约1.4倍。这样，牛肉的温室气体排放在食品中鹤立鸡群，突出程度更甚于煤炭相对其他电力来源：燃烧煤炭产生的温室气体仅比燃油（另一常用燃料）高14%。 ■



Precautionism

In search of resilience

The quest for resilience involves reaching for facts, friends and fortification

WHEN COVID-19 led to a scramble for face masks, Lloyd Armbrust saw America's shortage as "a really dumb problem to have". But after his company's first face mask came off the production line in Austin, Texas, he faced problems of his own. A small sensor went down, halting operations, and he realised that a replacement would take five days to arrive from Taiwan. He found himself competing for American customers with Chinese companies selling masks for less than they cost to ship. Without government intervention, he warned that America would again face shortages of crucial protective equipment. "We need to make some of this locally," he says. "We just do."

Mr Armbrust is not alone in thinking supply chains warrant government intervention. The virus came with a flurry of export restrictions on medical products and a plunge in Chinese exports that raised doubts over whether its production clusters had exposed the world to excessive risk. The private sector promises to adapt. Jacob Wallenberg of the European Round Table for Industry reports more plan Bs in place than two years ago, as well as supply-chain issues appearing on boardroom agendas. But inflation has now popped up as often as logistics, so the emphasis on just-in-case rather than just-in-time may prove fleeting.

Policymakers are unlikely to leave everything to private companies. Indeed, the Biden administration has blamed some vulnerabilities on the drive for corporate efficiency, and a goal of greater resilience now frames its trade policy. Luz María de la Mora, Mexico's undersecretary for foreign trade, says "there's a reassessment of how far we can go in this globalisation." That

means looking at strengthening domestic industry according to criteria beyond just the market. In Japan officials are considering how to maintain industrial bases in sensitive technologies and industries. The European Commission has adopted resilience as a “new compass for EU policymaking”, persuading even champions of open trade to fret about “strategic dependence”.

The rhetoric around greater resilience is further advanced than any concrete action. And over time, some will turn out to be little more than hype, or window-dressing for policies that were planned already. Many poor countries worry that the pandemic has exposed long-standing vulnerabilities that are hard to fix, most obviously their dependence on tourism. But in richer places the policy responses will involve a grab for three things: facts, friends and fortification.

The urge to gather information has taken the form of a wave of supply-chain reviews. The Biden administration is doing one, as is the British government, which has a secretive “Project Defend” to identify supply-chain vulnerabilities. These reviews seek to dig into individual industries and identify sources of supply so concentrated that they justify intervention. Such investigations can be hard, requiring data that often do not exist. The extent of dependence will vary according to domestic production, the concentration of foreign sourcing and the availability of close substitutes. The American review found that the Food and Drug Administration did not know how many pharmaceutical ingredients were sourced from abroad, only the number of registered facilities. As important as knowing what is made and imported is knowing what could be made or procured in a pinch. Such information is even harder to find.

Some results are trickling in. A review by the European Commission identified 137 of 5,000 imported products with a dominant foreign supplier.

Of those, only around 34 were hard to substitute by using other suppliers, representing just 0.6% of EU imports by value. That sort of finding has prompted Simon Evenett of Global Trade Alert, a trade watchdog, to describe the problem of resilience as “a bit like a Russian doll—there’s less and less there.” Such exercises may understate the problem, however. The sensor Mr Armbrust needed was worth more to his operation than the \$5 it cost him. And if a single-sourced input is processed in different places, a buyer may miss a key vulnerability. In June the G7 floated the idea of supply-chain stress tests, rather like those that are now carried out for banks.

The information gathering will continue—and with it demands on private companies to share data. Policymakers appear to be coalescing around a set of products of particular concern. In a review of critical supply chains that was published in June, the Biden administration honed in on electric vehicles, active pharmaceutical ingredients, semiconductors and rare earths. (In 2019 Taiwan accounted for 92% of high-end semiconductor production.) The European Commission emphasised lithium batteries for electric vehicles, active pharmaceutical ingredients, semiconductors and raw materials (including rare earths), as well as cloud and edge computing.

The second strand of actions to foster resilience involves bolstering alliances between like-minded allies, to diversify and “friend-shore” production away from China. Some of this has an air of performance, though after four years of Donald Trump badmouthing America’s allies, some public schmoozing may be welcome. But much responds to problems that have been recognised for years, such as the heavily concentrated business of mining and processing rare earths. Possible collaborations include one between America, Australia and Japan to increase processing capacity outside China, and another between the EU and Canada to match investors with potential projects.

Much of this co-ordination is only at an early stage. In June a long-running

dispute over aircraft subsidies between America, Britain and the EU was settled by creating two new co-operative frameworks, to analyse jointly “non-market practices”—that means Chinese subsidies—“with the goal of establishing the basis for joint or parallel action in the future”. Other links are meant to manage a shift of supply chains, like the agreement in April between Japan and America to collaborate over semiconductors.

The third prong of governments’ quest for greater resilience involves fortifying domestic economies. This implies sharpening defensive trade tools. In May Katherine Tai, the US trade representative, called for new defensive tools to deal with prospective damage to American business from foreign competition rather than responding only after the fact. Britain is also reviewing trade remedies, out of concern that in 2020 33% of goods exports were potentially in competition with companies benefiting from state subsidies, up from 7% in 2010. And the EU is creating defences in its single market against foreign subsidies.

It also implies an inward turn. The “Buy America” laws that the Biden administration hopes to strengthen will further reduce foreign access to a massive public-procurement market. Mr Armbrust has heard that help from the government is coming; the innovation and competition bill before Congress includes a supply-chain resilience programme to reshore production of personal protective equipment and medicines. In China, where the authorities were rattled by American restrictions on exports of some technologies, the government has reportedly issued new procurement guidelines setting local content requirements of up to 100% for 315 items, including medical equipment and seismic instruments. The government’s 14th five-year plan in March included a strategy to increase self-reliance by raising spending on research by 7% a year.

This fits with a general tilt towards industrial policy. In the pandemic, the fear was that foreign suppliers might protect national interests at the

expense of trade flows. When British and American cash for vaccine-makers came on condition that production would go first to their populations, other countries like Australia, Canada, South Africa and South Korea that wanted to secure supplies invested in the final stage of production. In July the WTO valiantly published a list of vaccine inputs, to help governments assess which trade flows not to impede. Many politicians now believe that in a crisis foreign suppliers are unreliable.

The semiconductor industry is being vigorously chased by government cash, in part because of the perception that existing production sites arose from public subsidy. The Biden administration's review noted that the Taiwanese government covers 50% of land costs and 45% of construction and facility costs for semiconductor fabrication facilities; and that South Korean subsidies cut the cost of owning a semiconductor manufacturing facility by 25-30%. A bill to support semiconductor manufacturing to the tune of \$52bn is currently going through Congress. Japan is dangling financial incentives to entice TSMC, a Taiwanese company, to set up a facility. EU members are similarly eyeing a partnership with Intel.

It remains to be seen how far such spending might spread. The European Commission has funnelled €6bn (\$7bn) to a pan-European research and innovation project to support the battery supply chain since December 2019, but it faces sharp budget constraints. Japan has allocated up to ¥457bn (\$4.2bn) in grants for companies to diversify supply chains, with little enough effect to show how expensive incentives can be.

Mr Evenett worries that these behind-the-border measures will further distort trade. Places already comfortable with the idea of localising production may be emboldened. Trudi Hartzenberg of the Trade Law Centre, a South African think-tank, says the pandemic has bolstered the resolve to develop productive capacity in South Africa, which is linked to the government's push to waive intellectual-property provisions in WTO rules.

In April 2020, as part of its resilience drive, India introduced “production-linked incentives”, first for large-scale electronics manufacturing and pharmaceutical ingredients, and from November for ten other industries, including textiles, car parts and solar modules. If qualifying companies increase sales by a certain amount, they receive cash equal to 4-6% of the gain.

If governments successfully foster critical industries, their alliances will go from nice to necessary. For when supply shoots up, prices crash and everyone tries to export the same subsidised products, trade tensions quickly increase. That was the lesson from Mr Armbrust's complaints about Chinese competitors, and indeed from the fight between America and the EU over aircraft subsidies. ■



预防主义

寻求韧性

增强韧性的行动包括追求事实、盟友和防御【深度】

当新冠疫情引发口罩争夺战时，劳埃德·安布拉斯特（Lloyd Armbrust）认为美国会发生口罩短缺“实在是非常蠢的问题”。但等到他公司的第一个口罩从德州奥斯汀的生产线上下来后，他自己也碰到了问题。一个小传感器坏了，生产不得不暂停，而他意识到新的传感器需要五天时间才能从台湾运抵。他发现自己正在与中国公司争夺美国客户，而对手的口罩售价比运输成本还低。他警告说，如果没有政府干预，美国将再次面临关键防护设备短缺。“我们需要在本地制造一些，”他说，“我们真的需要。”

认为供应链需要政府干预的人不止安布拉斯特。病毒引发了对医疗产品的一系列出口限制；中国出口大幅下降让人们质疑它的生产集群是否令世界承受额外风险。私营部门承诺做出调整。欧洲工业圆桌会议（European Round Table for Industry）的雅各布·瓦伦贝格（Jacob Wallenberg）的报告显示，企业现在制定了比两年前更多的次选方案，供应链议题也频繁出现在董事会议程上。但眼下浮现的通胀问题和物流问题一样多，所以强调有备无患而非“零库存”的模式可能也只会转瞬即逝。

政策制定者不太可能把一切都留给私营企业去解决。实际上，拜登政府将某些软肋归咎于追求企业效率，而他现在以韧性为目标来打造他的贸易政策。墨西哥负责外贸的经济副部长卢斯·玛丽亚·德拉莫拉（Luz María de la Mora）表示，“我们正在重新评估我们在目前的全球化体系中能走多远。”这意味着要加强国内产业而不仅仅以市场为导向。在日本，官员们正在审视如何保持敏感技术和行业的工业基础。欧盟委员会已将韧性作为“欧盟决策的新指南针”，哪怕是开放贸易的拥护者都被说服来担心“战略依赖”问题。

围绕增加韧性的言论走得比任何具体行动都远。而随着时间推移，有些将

被证明不过是炒作，或者是为已经规划好的政策装点门面。许多穷国担心疫情暴露了它们长期存在而难以被纠正的脆弱之处，最明显的就是对旅游业的依赖。但在更富裕的地区，应对政策将主要从三个方面入手：事实、盟友和防御。

收集信息的迫切需要掀起了一轮审查供应链的浪潮。拜登政府正在做这件事。英国政府也是——它有一个秘密的“防守项目”（Project Defend）来找出供应链的脆弱之处。这些审查试图深入个别行业来确定哪些供应源过于集中而需要被干预。此类调查可能难以推进，所需数据通常并不现成可得。依赖的程度将根据国内生产、国外采购的集中度和相近替代品的可得性而有所不同。美国的审查发现，美国食品和药物管理局（FDA）并不清楚有多少药物成分是从国外采购，只知道注册设施的数量。知道制造和进口了哪些商品很重要，而同样重要的是知道在紧要关头可以制造或采购到什么。有关后者的信息更难获得。

一些审查正逐步得出结论。欧盟委员会的一项调查确定了5000种进口商品中有137种只有一个主导的外国供应商，其中又有大概34种难以用其他供应商替代，全部仅占欧盟进口价值的0.6%。这样的发现使得贸易监督机构“全球贸易预警”（Global Trade Alert）的西蒙·伊文尼特（Simon Evenett）形容韧性问题“有点像俄罗斯套娃——越拆越小”。然而，这样的计算可能低估了问题。安布拉斯特需要的传感器对他的生产运营的价值要超过购买它花费的5美元。而如果一个单一来源的材料要在不同地方加工，买家就可能忽视掉一个重要的脆弱性。6月，G7提出了供应链压力测试的想法，类似现在对银行开展的那类测试。

这种信息收集将持续——随之而来的是要求私营公司共享数据。政策制定者似乎正围绕一系列特别值得关注的产品联合行动。在6月发表的一项对关键供应链的审查报告中，拜登政府聚焦于电动汽车、活性药物成分、半导体和稀土。（2019年台湾贡献了高端半导体产量的92%。）欧盟委员会则强调电动车锂电池、活性药物成分、半导体和原材料（包括稀土），以及云计算和边缘计算。

增强韧性的第二方面行动是加强志同道合的盟友间的联合，以实现分散化并将生产从中国转移到“友岸”。这其中不乏作秀的成分，但在特朗普对美国的盟友恶言相向了四年后，一些公开的套近乎可能也是需要的。但很大部分行动是针对已经发现多年的问题，比如高度集中的稀土开采和加工业务。可能的协同行动包括美国、澳大利亚和日本间的一项合作以增加在中国以外的加工能力，以及欧盟和加拿大之间另一项匹配投资者和潜在项目的合作。

这类协同行动大多仍处于早期阶段。6月，美国、英国和欧盟之间达成了两个新的合作框架，平息了长期存在的飞机补贴争端。这一框架将共同分析“非市场行为”——意指中国的补贴——“以求建立未来联手或并行行动的基础”。其他协作旨在管理供应链的转移，例如日本和美国在4月就半导体相关合作达成的协议。

政府寻求更多韧性的第三方面是加强国内经济。这意味着磨砺防御性贸易工具。5月，美国贸易代表戴琪（Katherine Tai）呼吁采用新的防御工具来应对外国竞争可能对美国企业造成的损害，而不只是在事后做出反应。英国也在检视自己的贸易救济措施，因为它发现在2020年有33%的商品出口可能与受益于国家补贴的公司竞争，高于2010年的7%。而欧盟正在其单一市场中建立对抗外国补贴的防御措施。

这也意味着向内转。拜登政府希望加强“购买美国货”法律的力度，进一步减少外资进入庞大的政府采购市场的机会。安布拉斯特听闻政府的帮助即将到来：提交国会审议的创新和竞争法案中包括了一项供应链韧性计划，寻求让个人防护设备和药品的生产回流。在中国，美国对某些技术的出口限制令当局感到不安，据报道政府已发布了新的采购指南，对包括医疗设备和地震仪器在内的315项产品设定了最高100%的本地采购比例。中国政府3月公布的第十四个五年规划包括了一项战略，通过将研发支出每年增加7%来提高自力更生水平。

这与向产业政策倾斜的普遍趋势相一致。在疫情中，人们担心外国供应商可能会牺牲贸易流量来维护国家利益。当英国和美国为疫苗生产商提供资

金时，提出了生产出来的疫苗首先要提供给它们国家的民众的条件；而澳大利亚、加拿大、南非和韩国等其他希望确保疫苗供应的国家则在生产的最后阶段注资。7月，世贸组织果敢地公布了一份疫苗投入清单，以帮助各国政府评估不应阻碍哪些贸易流动。许多政客现在认为，在危机期间外国供应商是靠不住的。

政府资金正在大力追逐半导体产业，部分原因是人们认为既有的半导体生产基地就是靠着公共补贴才发展起来的。拜登政府的审查报告指出，台湾当局承担了半导体代工设施50%的土地成本和45%的建设和设施成本；韩国的补贴让半导体制造设施的持有成本降低了25%到30%。一项斥资520亿美元支持半导体制造的提案目前正在国会审议中。日本正在用财务激励吸引台湾企业台积电赴日设厂。欧盟成员国同样在寻求与英特尔建立合作伙伴关系。

这类支出可能会扩大到什么程度还有待观察。自2019年12月以来，欧盟委员会已向一个泛欧研究和创新项目投入60亿欧元（70亿美元）来支持电池供应链，但它现在面临预算严重吃紧。日本已向企业拨款高达4570亿日元（42亿美元）以实现供应链多元化，但至目前收效甚微，还无法说明激励措施需要付出多大成本。

伊文尼特担心这些境内措施会进一步扭曲贸易。那些本就欢迎生产本地化理念的地方可能会大受鼓舞。南非智库贸易法中心（Trade Law Centre）的特鲁迪·哈岑伯格（Trudi Hartzenberg）表示，疫情加强了南非发展产能的决心，南非政府正因此而向世贸组织寻求某些知识产权条款豁免。印度在2020年4月推出了“生产相关激励措施”，这是政府增强韧性的行动的一部分，起先针对大规模电子制造和药物成分，自11月起扩展到其他十个行业，包括纺织、汽车零部件和太阳能模块等。符合条件的公司若能将销售额增加一定数量，将获得相当于增长部分4%到6%的现金奖励。

如果政府成功培植了关键产业，它们相互间的结盟就会从锦上添花变为必不可少。因为当供应激增、价格暴跌、各方都试图出口相同的受补贴产品时，贸易紧张会迅速加剧。从安布拉斯特对中国竞争对手的抱怨，乃至美

国和欧盟在飞机补贴上的争端中都可以得出这样的教训。■



Trade law

A fraying system

In global trade, power increasingly trumps rules

MICHAEL TAYLOR, an Australian winemaker, got advice from his agent when he tried to uncork the Chinese market in the 1990s: “it’s all about relationships.” But after Australia became China’s top wine supplier in 2019, this fruitful relationship soured. In November 2020 the Chinese government imposed tariffs on wine from Australia of more than 200%, allegedly because it was being “dumped” on its market at excessively low prices, but in reality as a response to the Australian government’s call for an investigation into the origins of covid-19. Mr Taylor lost a third of his export sales. He reckons the Chinese were sending a message to the world: “don’t upset us.”

This is by no means the first time that China has flaunted its market power. But today’s context is different. Over the past few years, even as China has defied the spirit, if not the letter, of the WTO’s rules, America has also broken the organisation’s dispute-settlement mechanism, brandished tariffs against allies and imposed trade restrictions for national security. As the two giants have become locked in economic conflict, both have flouted the underlying principle of the multilateral system, which is that trade should be governed by rules not power.

America has long been central to the system, as both an architect and an enforcer. Despite flirting with unilateralism in the 1970s and 1980s, it accepted that a more stable trade system served its interests. After helping to write the WTO rules in the early 1990s, it beckoned China into the club in 2001. And it worked to preserve the WTO’s core principle of non-discrimination. Between 1995 and early 2017 American governments filed

114 complaints against other countries at the WTO, over four-fifths of them for problems that affected other members too. (For comparison, over half of the 434 disputes filed by other countries were purely bilateral.)

Yet critics always said this permissive approach hurt American workers. And in 2017 they came to power. Robert Lighthizer, a former United States Trade Representative (USTR), reckons one of the Trump administration's big contributions to trade politics was its interest in matters other than maximising company profits. In 2017, rejecting the idea that rules-based dispute settlement serves American interests, it began blocking appointments to the WTO's appellate body. If the government thought another country was undermining its interests, it would decide unilaterally on suitable punishment. France received tariff threats after proposing to tax American tech giants, and China was hit with tariffs.

Mr Lighthizer says the second contribution was to see that "China is an adversary and not a friend." China's economic model, with its murky relations between state and private sector, had long strained the legalistic WTO system. The autocratic tendency of China's president, Xi Jinping, shifted American thinking. Under the Obama administration, China's prosperity was thought to be good for America and the world, but now it was often seen as conflicting with the goal of maintaining American military, technological and economic supremacy. That implied less open trade and more investment screening, plus tariffs and export controls.

The Biden administration is chummier towards allies. But on China and the WTO, it is not much different from its predecessor. Enforcement of rules through the WTO does not seem to be part of its plan, so it continues to block appointments to the appellate body. Based on a narrow view of self-interest, this may seem to make sense, as it has no big offensive disputes to win, and faces defensive ones it might lose. (One example is China's complaint about America's tariffs, which the Trump administration sent

into legal limbo by appealing against it last October.) There is a perception that European-minded lawyers in Geneva read more into rules than America wishes, and have been too eager to constrain its use of defensive trade remedies. “It’s not going to be a quick fix,” comments a USTR official.

Nor does a tougher approach to China include efforts to update multilateral rules. There is little appetite in America to join the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), which has provisions on state-owned enterprises and competition policy once aimed at China. Trilateral talks between America, the EU and Japan to rewrite rules against subsidies that China might sign up to have stalled. One USTR official says the path from either the CPTPP or the trilateral process to a change in China’s behaviour is “very amorphous”, and “agreeing to rules among ourselves is not imposing those rules on China.”

All this makes the future of trade relations between the world’s two biggest economies extraordinarily murky. For now, American tariffs are in place on hundreds of billions of dollars of Chinese imports. (Mr Lighthizer calls this a defence against Chinese subsidies.) On October 3rd the Biden administration announced frank conversations with its Chinese counterparts about their delivery of the deal forged by the Trump administration. If those talks go badly, it promised no action would be off the table. An official also pledged to address the harm caused by Chinese industrial policies “as we see fit”. That could mean even more trade restrictions.

As economic relations sour, the distinction between them and national security concerns grows blurrier. The conception of risk over China has broadened from narrow concerns of military rivalry and intelligence gathering to include American technological leadership. Acting on such a broad front is hugely complicated. Stephanie Segal of the Centre for Strategic and International Studies (CSIS), a Washington-based think-tank,

points out that, in areas America's allies are unlikely to join, or where China is already at or near the technological frontier, disengagement can be self-defeating. If Chinese companies can simply buy elsewhere, the only result will be lower American profits and less innovation.

This is tricky for firms eager to sell in China. Export controls appear to have become a bit more predictable under the Biden administration, but Craig Allen of the US-China Business Council (USCBC) still concludes that "it's becoming very, very difficult for American companies to figure out who they can do business with in China." Scott Kennedy, also from the CSIS, blames the conflict for the Chinese expanding their own techno-nationalist approach. A survey of USCBC members found that 39% thought that American-Chinese trade frictions had accelerated preferential support for China's private and state-owned enterprises.

The Chinese government forcefully rejects the idea that it is anything less than a responsible stakeholder in the multilateral global trading system. Last year it signed the Regional Comprehensive Economic Partnership (RCEP) trade deal and agreed the EU-China Comprehensive Agreement on Investment (CAI). In September it formally asked to join the CPTPP. But China is in no rush to loosen its grip at home. The RCEP is shallow, a hoochah over sanctions has put the CAI into the deep freeze, and existing members of the CPTPP are well aware of China's divergence from their standards. China is also beefing up its own unilateral defences, with new laws to punish those people and companies that comply with foreign sanctions.

Elsewhere in the world, many see America and China brawling outside the WTO's rule-based system, and braying to allies to join in support. China is too central to Asian supply chains for this to be wise. Shortly before America's vice-president, Kamala Harris, met Pham Minh Chinh, the Vietnamese prime minister, in late August, Mr Chinh had pointedly

promised the Chinese ambassador that his country would not pick sides. Moon Chung-in, a senior adviser to South Korea's president, says American pressure on South Korean companies to move away from China would be an "outright violation of WTO norms and principles".

Yet security-minded thinking is spreading. In 2020 Japan opened an economic section in its national security secretariat, where officials consider how to counter the economic statecraft of countries with different values. Louise McGrath of the Australian Industry Group, a business association, says there are more briefings from Australian security agencies, as "they realise they can't just keep saying that China is a threat without actually talking to business." Since the start of 2020 the United Nations counted at least 25 countries and the EU reinforcing screening regimes for foreign investment or adopting new ones. As many as 34 countries, accounting for 50% of global direct investment flows, now screen them.

Those with the heft and inclination are arming themselves. The Biden administration has paused but not rescinded planned retaliation to European digital services taxes. Even ardent multilateralists in the European Commission recognise that, if such a threat re-emerges, they cannot wait 18 months for the result of a WTO action. China's harsh treatment of Australia has not gone unnoticed, nor its threats to EU members for their negative attitude to Huawei. Officials are exploring a new anti-coercion tool to deter bullying of individual EU countries. In July 2020 Britain tweaked its legislation to avoid the need for authorisation under international law to raise tariffs during a trade dispute.

Many would prefer America to repair the WTO's dispute-settlement system. Mr Moon says the WTO is "one of the greatest inventions of the human race, but we are destroying it." Some 121 WTO members, including China, make monthly appeals to America to restore appointments to the appellate body. Damien O'Connor, New Zealand's trade minister, calls this the only way to

ensure fairness, and warns of a return to a lawlessness “that allowed the big countries to simply dominate and often destroy opportunities for others.” Fully 25 WTO members, including China and the EU, have tried setting up their own appeal system. But big traders like Britain, Japan, India, Russia and South Korea have not joined up, so as of June it was being used in only seven of 60 active disputes.

In a world without secure dispute settlement, the risk of miscommunication or of trade being dragged into geopolitical fights has risen. Industries affected by trade sanctions account for half of Australian exports to China. Dan Tehan, Australia’s trade minister, wishes his Chinese counterparts would explain their concerns. The danger is that trade disputes descend into politically toxic accusations of bullying. The WTO is not perfect, but as a mutually agreed set of rules it has more legitimacy than a system based on warring giants carving up trade as they see fit. ■



贸易法

正在崩塌的体系

在全球贸易中，实力日益压过规则【深度】

在1990年代，澳大利亚酿酒师米切尔·泰勒（Mitchell Taylor）试图打开中国市场时，他的代理商建议说：“一切都得靠关系。”但在澳大利亚于2019年成为中国最大的葡萄酒供应商后，这个硕果累累的关系恶化了。2020年11月，中国政府对来自澳大利亚的葡萄酒征收超过200%的关税，据称是因为它以过低的价格在其市场上“倾销”，但实际上是为了回击对澳大利亚政府要求调查新冠病毒起源的呼吁。泰勒损失了三分之一的出口销售额。他认为中国人正在向世界发出一个信息：“别惹我。”

这绝不是中国第一次炫耀其市场实力。但今天的背景有所不同。过去几年里，在中国无视世贸规则的精神（如果没有违反文字的话）的同时，美国也打破了该组织的争端解决机制，对盟国征收关税，并以国家安全为由实施贸易限制。随着两大巨头陷入经济冲突，双方都已违背了该多边体系的基本原则，即贸易应受制于规则而非实力。

作为这个体系的架构师和执行者，美国长期以来一直是它的核心。尽管在上世纪七八十年代曾尝试单边主义，但它认识到更稳定的贸易体系才符合自身利益。在1990年代初帮助制定了世贸规则后，它在2001年把中国召唤进了这个俱乐部。而且它致力于维护世贸组织非歧视的核心原则。从1995年到2017年初，美国政府向该组织提交了114项针对其他国家的申诉，其中超过五分之四所涉问题也影响到其他成员。（相比之下，其他国家提出的434起申诉中有一半以上是纯粹的双边争端。）

然而批评者总说这种姑息纵容的做法伤害了美国工人。2017年，批评者上台了。前美国贸易代表（USTR）罗伯特·莱特希泽（Robert Lighthizer）认为，特朗普政府对贸易政治的重大贡献之一是其对最大化公司利润以外的事情感兴趣。2017年，它拒绝了基于规则解决争端符合美国利益的观点，

开始阻止世贸组织上诉机构的任命。如果该政府认为另一个国家正在损害其利益，它就会单方面决定适合采取什么惩罚措施。法国在提议对美国科技巨头征税后受到关税威胁，而中国则遭受关税打击。

莱特希泽说，第二个贡献是看到“中国是对手而不是朋友”。中国的经济模式由于其国有部门和私营部门之间的模糊关系，长期以来都让死抠条文的世贸组织体系备感压力。中国国家主席习近平的威权倾向改变了美国的想法。在奥巴马政府时期，中国的繁荣被认为有利于美国和世界，但现在却常常被视为与维持美国军事、技术和经济霸权的目标相冲突。这意味着更少的开放贸易和更多的投资审查，以及关税和出口管制。

拜登政府对待盟友的态度更加亲密。但在中国和世贸组织的问题上，它与前任政府并没有太大区别。通过世贸来执行规则似乎不在它的计划中，因此它继续阻止对上诉机构的任命。从狭隘的利己观来看，这似乎是有道理的，因为它没有大的申诉争端要赢，而被诉的争端则可能会输掉。（一个例子是中国对美国关税的投诉，特朗普政府去年10月通过上诉将其拖进了法律僵局。）有一种看法是，日内瓦那些欧式思维的律师拘泥条文的程度比美国希望的要高，而且过于急切地限制美国使用防御性贸易救济措施。“这不会是一个快速解决方案。”一位USTR官员评论道。

对中国采取更强硬的态度也不包括更新多边规则的努力。美国没有多少兴趣加入跨太平洋伙伴关系全面进步协定（CPTPP），该协定中对国有企业和竞争政策的规定曾经针对中国。美国、欧盟和日本之间关于改写规则来打击中国可能签署的补贴的三边谈判已经停滞。一位USTR官员表示，从CPTPP或三边进程到改变中国行为的路径“非常不明确”，“在我们之间就规则达成一致并不能将这些规则强加给中国。”

所有这一切都让世界两大经济体之间贸易关系的未来变得异常晦暗。目前，美国对价值数千亿美元的中国进口商品征收关税。（莱特希泽称这是针对中国补贴的一种防御。）10月3日，拜登政府宣布与中国同行就履行特朗普政府达成的协议进行坦诚对话。如果这些谈判进展不顺利，它承诺不放弃采取任何行动的可能。一位官员还承诺“按照我们认为合适的方式”

解决中国产业政策造成的危害。这可能意味着更多的贸易限制。

随着经济关系恶化，它们与国家安全问题之间的分野变得越来越模糊。有关中国风险的概念已经从对军事竞争和情报收集的狭隘担忧，扩大到包括美国的技术领先地位。在此如此广泛的战线上采取行动是非常复杂的。华盛顿智库战略与国际研究中心（CSIS）的斯蒂芬妮·西格尔（Stephanie Segal）指出，在美国盟友不太可能加入的领域，或者中国已经处于或接近技术前沿的领域，脱离接触可能会弄巧成拙。如果中国公司可以简单地去别处购买，唯一的结果将是美国利润下降和创新减少。

对于渴望打进中国市场的公司来说，这很棘手。在拜登政府的领导下，出口管制似乎变得稍微可预测了些，但美中贸易全国委员会（USCBC）的克雷格·艾伦（Craig Allen）仍然得出结论说，“对美国公司来说，要弄清楚自己在中国可以和谁做生意变得非常、非常之难。”同样来自CSIS的斯科特·肯尼迪（Scott Kennedy）将冲突归咎于中国扩大自己的技术民族主义操作。对USCBC成员的一项调查发现，39%的人认为美中贸易摩擦加速了对中国对私营和国有企业的优惠支持。

中国政府坚决不同意说它算不上多边全球贸易体系中负责任的一方。去年，它签署了区域全面经济伙伴关系（RCEP）贸易协议，并达成了中欧全面投资协定（CAI）。9月，它正式要求加入CPTPP。但中国并不急于放松对国内的控制。RCEP是肤浅的，关于制裁的吵闹使CAI深陷冻结，而CPTPP的现有成员很清楚中国与它们的标准存在分歧。中国也在加强自己的单方面防御，制定新的法律来惩罚那些遵守外国制裁的人和公司。

在世界其他地方，许多人看到美国和中国在世贸组织基于规则的体系之外争吵，并张罗让盟友加入支持自己的队伍。中国对亚洲供应链来说太重要了，这么做实在不明智。在8月下旬会见美国副总统卡马拉·哈里斯之前不久，越南总理范明政明确向中国大使承诺越南不会选边站。韩国总统的高级顾问文正仁表示，美国对韩国公司施压使其离开中国将“完全违反世贸组织的规范和原则”。

然而，从安全出发的思维方式正在蔓延。2020年，日本在其国家安全秘书处设立了一个经济部门，其官员思考如何应对抱持不同价值观的国家的经济政策。商业协会澳大利亚工业集团的路易斯·麦格拉思（Louise McGrath）表示，澳大利亚安全机构提供了更多简报，因为“他们意识到自己不能在不实际与企业交谈的情况下一直说中国是个威胁。”自2020年初以来，联合国统计至少有25个国家和欧盟加强了对外国投资的审查机制或采用了新的审查制度。多达34个国家（占全球直接投资流量的50%）现在对它们进行筛查。

那些有实力又有意愿的国家正在武装自己。拜登政府已暂停但并未完全废除对欧洲数字服务税的报复计划。即使是欧盟委员会中热烈支持多边主义的人也认识到，如果这种威胁再次出现，他们不能巴巴地等待世贸组织的行动在18个月后出结果。人们不是没有看到中国是如何严酷地对待澳大利亚，又如何因为欧盟成员国对华为的负面态度而威胁它们。官员们正在探索一种新的反胁迫工具，以阻止欺凌个别欧盟国家。2020年7月，英国调整了立法，以避免在贸易争端期间需要根据国际法获得授权来提高关税。

许多人更希望美国修复世贸组织的争端解决机制。文正仁说世贸组织是“人类最伟大的发明之一，但我们正在摧毁它。”包括中国在内的大约121个世贸组织成员每月都向美国发出呼吁，要求恢复对上诉机构的任命。新西兰贸易部长达米安·奥康纳（Damien O'Connor）称这是确保公平的唯一途径，并警告有可能回到“大国可以随便欺行霸市，并经常破坏其他国家的机会”的无法无天的状态。包括中国和欧盟在内的25个世贸组织成员都尝试建立自己的上诉制度。但英国、日本、印度、俄罗斯和韩国等大型贸易方尚未加入，因此截至6月，在60起未决争端中只有7起使用了它。

在一个没有安全解决争端的方式的世界里，沟通不畅或贸易被拖入地缘政治斗争的风险已经上升。受贸易制裁影响的行业占到澳大利亚对华出口的一半。澳大利亚贸易部长丹·特汉（Dan Tehan）希望他的中国同行能够解释他们的关切所在。危险在于，贸易争端会演变成在政治上影响恶劣的欺凌指控。世贸组织并不完美，但作为一套共同商定的规则，它比交战的巨人按照自认为合适的方式瓜分贸易的体系更具合法性。■



The new rules

A changed world

International commerce needs firmer underpinnings

WHAT IS THE biggest threat to world trade? Stressed supply-chain managers might say new logistical bottlenecks that have seen the cost of shipping rocket recently. Macroeconomists could offer demand change, notably the depressive effect of a possible renewed pandemic. But those taking a longer view might point to the new order of trade policy, which involves more intimidation, discrimination and ultimately, isolation. In short, the very foundations of the multilateral trading system are under assault, from several directions at once.

Some of this reflects adaptation to changed political objectives, such as new concerns to respond to human-rights abuses or to climate change. A back-of-the-envelope calculation based on estimates by the OECD suggests that a carbon tariff based on a CO₂ price of \$75 a tonne may represent an average extra cost of only around 2%. That seems manageable. When the risk of shocks is rising, whether from natural disasters, pandemics or the willingness of foreigners to weaponise their economic clout, it makes sense to work up strategies for coping. That could mean diversification through trade deals, constructive co-ordination over standards, or sensible stockpiling.

But as well-intentioned governments try to co-ordinate new ways to add non-trade goals to commerce, the risk of mismanagement or the proliferation of special interests is high. Economic nationalism crafted behind trade barriers could coddle companies, impede technology transfer or limit the profits available for research and development. Subsidies could distort trade flows and generate tensions between allies as they fight over

who should bear the cost of supply that is greater than demand. Over the long run, the extra anxiety around international supply chains could mean that national borders come to matter more in practice than they should do in theory.

Push all this to its limits, and there is a risk that the forces of globalisation could even go into reverse. That supply chains now so often criss-cross international borders actually raises the cost of trade barriers. If the EU had cut off vaccine exports to Britain in early 2021 amid a heated row over scarce supplies, it might have jeopardised crucial inputs for its own production. But that could be changing. Reshoring supply chains may, ironically, increase the likelihood of new trade barriers in future as it makes them less costly. And that could raise the incentive to start unravelling today's close economic relationships.

If global leaders are to prove the trade pessimists wrong, they need to offer clearer answers to three big questions. First, where are the limits to what trade tools can achieve? Sometimes there is a tendency "to overload the boat a bit", comments Mr Dombrovskis, the EU's trade commissioner, warning of the need for a balance between the idea of setting new tests for trade deals and the feasibility of passing them. Some humility when it comes to unilateralism may be in order. If countries trying to export their standards or to exert their power are only a slice of suppliers' markets, they may do little to produce change in rich countries while disrupting business in poor ones.

Second, what happens when the increasingly complex stew of non-trade objectives has internal contradictions? Those eager for greater resilience or most worried about human-rights abuses may argue for trade barriers against solar-panel imports, to shift sourcing from China. But that could conflict with short-run efforts to fight climate change with cheap renewable energy. Bernard Hoekman, an academic at the European University

Institute, who is leading a project on the effects of EU trade policy on non-trade policy goals, warns of misdirected resources, away from aid that goes directly towards improved economic governance or telecoms and logistics links.

Third, how should the consequences of new trade barriers be managed and contained? That job was for some years done by the WTO, which allowed limited retaliation if governments were in breach of their obligations. In its absence, governments should know that protection has consequences, if only in the form of possible retaliation. Since 2016, there is evidence of a rise in the share of global trade that is subject to trade restrictions, even excluding those related to the US-China trade war.

If and when answers to these three questions emerge, the trading system that they suggest may be quite like the one that is now slowly being dismantled. It ought to include mutually agreed rules overseen by independent arbiters, to deliver legitimacy and stability. It must allow clearly defined exceptions, to prevent abuse and allow adaptation. It needs to respect the use of trade tools to help deliver geopolitical, security, environmental and human-rights goals. But it should also recognise the risks of asking trade to do too much. And it would, logically, point to revitalising and reinforcing the WTO, rather than undermining it further, as several members are continuing to do. ■



新规则

世界变了

国际商贸往来需要更坚实的基础

世界贸易面临的最大威胁是什么？心力交瘁的供应链经理可能会说是导致近期运输成本飙升的新物流瓶颈。宏观经济学家可能会认为是需求变化，特别是如果疫情再次抬头、带来抑制作用的话。但那些从更长远的角度来考虑这个问题的人可能会指出最大的威胁是贸易政策的新秩序，它用到了更多的恐吓、歧视，最终带来孤立。简而言之，多边贸易体系的基石正同时遭受来自多个方向的攻击。

其中一些反映出因政治目标改变而做出的调整，例如新的应对侵犯人权或气候变化的关切。以经合组织的估计为基础的一项粗略计算发现，按照每吨二氧化碳75美元的价格来收取碳关税，可能平均仅会增加2%左右的成本。这似乎可以接受。当发生危机的风险上升——无论是因为自然灾害、大流行病，还是因为外国人有意将自身经济影响力用作武器——制定应对策略是合情合理的。具体方案可能是通过贸易协议实现多元化，对不同标准做建设性协调，或合理囤积物资。

但当政府出于好意试图协调新的做法来为商业添加非贸易目标时，管理不善或特殊利益大量滋生的风险飙高。在贸易壁垒背后炮制经济民族主义可能会骄惯一些公司、阻碍技术转移，或限制可用于研发的利润。补贴可能会扭曲贸易流动，引发盟友间争论谁该承担供大于求的成本，导致关系紧张。长远来看，围绕国际供应链的焦虑增加可能使得国界的实际影响比理论上应有的水平更大。

这一切都推向极限时，全球化的力量甚至有可能逆转。供应链现在经常跨越国界，实际上增加了贸易壁垒的成本。如果欧盟在今年初围绕稀缺物资供应而起的激烈争论中切断了对英国的疫苗出口，可能就会危及自身生产所需的关键原料。但情况可能正在改变。讽刺的是，把供应链迁回国内降

低了贸易壁垒的成本，所以可能导致未来出现新的壁垒。而这可能会推动很多国家去瓦解今天密切的经济关系。

如果全球领导人要证明贸易悲观主义者错了，他们就需要对三大问题给出更明确的答案。首先，贸易工具的作用的上限在哪里？欧盟贸易专员东布罗夫斯基斯（Dombrovskis）说，有时人们会倾向于“让船有点超载”，他则警告，需要在想给贸易协议设置新的测试与通过测试的可能性之间取得平衡。在诉诸单边主义时可能还是需要谦逊一些。如果试图输出本国标准或运用自身影响力的国家只占供应商市场的一小部分，那么它们可能不会给富国造成多少变化，同时却会扰乱穷国的商业。

第二，当成分日益复杂的非贸易目标“大炖锅”出现内部矛盾时会如何？那些渴望增强韧性或最担心人权侵犯的人可能会主张对太阳能电池板进口设置贸易壁垒，将采购活动从中国转移到其他国家。但这可能与用廉价可再生能源应对气候变化的短期努力相冲突。欧洲大学研究所（European University Institute）的学者伯纳德·霍克曼（Bernard Hoekman）正在主持的一项研究分析欧盟贸易政策对非贸易政策目标的影响，他警告说资源投入可能会被错误地移出用于直接改善经济治理的援助或电信和物流链路。

第三，新贸易壁垒造成的后果要如何管控？这项工作在过去多年里由世贸组织负责，它允许在有政府违反其义务时做出有限的报复。在该组织缺位的情况下，政府应知道贸易保护有其后果，即使只是可能的报复。2016年以来，有证据表明全球贸易中受贸易限制的那部分占比有所上升，这甚至还不包括与中美贸易战相关的贸易限制。

如果这三个问题的答案有一天能浮出水面，它们指向的贸易体系可能跟现在正被慢慢瓦解的这个体系很像。它应该会包括双方一致达成的规则，由独立仲裁方监督，以确保合法性和稳定性。它必须有界定明晰的豁免情形，以防滥用规则，也便于做出调适。它需要尊重运用贸易工具来帮助实现地缘政治、安全、环境和人权目标的做法，但也应认识到让贸易发挥过大作用的风险。从逻辑上讲，它将指向重振和加强世贸组织这条路，而不

是像一些成员国不停在做的那样，进一步去破坏它。 ■



The history of science

A new biography explains the genius of John von Neumann

His peers transformed science. He transformed daily life

The Man from the Future. By Ananyo Bhattacharya. Allen Lane; 368 pages; £20. To be published in America in February by W.W. Norton & Company; \$30

IN 1945, WHILE in a state of exhaustion, the mathematician John von Neumann had a kind of stammering premonition. He was in Los Alamos, working on the atom bomb, and he told his wife Klari that the “energy source” he was helping to develop would make scientists “the most hated and also the most wanted citizens of any country”. Then he informed her that his other ongoing project, the computer, would one day be even more important—and potentially even more dangerous.

Good biographies of some of the greatest mathematical minds are rare: because they were polymaths, biographers who can interpret their manifold achievements for the ordinary mortal are themselves thin on the ground. This has been von Neumann’s fate, and the upshot is that he has not had the recognition he deserves. Ananyo Bhattacharya, a science journalist formerly at *The Economist*, sets out to correct that injustice, and so fill a yawning gap in the history of science.

Von Neumann belonged to a small group of brilliant Hungarians, of mainly Jewish backgrounds, who in the 1930s fled Nazism for America, where they were dubbed “the Martians” because of their strange language and even stranger brains. All would transform science, but von Neumann would transform daily life, and he did so in varied and profound ways. He was undoubtedly a genius, and reading this book gives you an inkling of what

that overused word really means. More than one highly intelligent acquaintance remarks that it was as if von Neumann was the only person who was really awake.

The problem facing the biographer of a mathematician is that conveying mathematical concepts in mere words risks either boring the cognoscenti or bemusing the uninitiated. Rather like the books of Stephen Hawking or Carlo Rovelli, though, this one is rewarding on different levels. Everyone can grasp the significance of the puzzles posed, and if readers want to follow the genius through the steps of his solutions then Mr Bhattacharya is a clear and authoritative guide.

Perhaps it was because he was fluent in the language of the universe that von Neumann flitted so easily between disciplines. While still a young man he made important contributions to quantum mechanics. Later he played a seminal role in the Manhattan Project that built the bomb, and devised the architecture for the first programmable computers. He laid the foundations of game theory (introducing the term “zero-sum” along the way), stimulating revolutions across the social sciences and biology. At times he was in such demand that a US Air Force plane was kept on standby to whisk him from one top-secret government lab to another.

He was equally comfortable in basic and applied research, sitting with pencil and paper in his dining room in Princeton or debating with top military brass out in the New Mexico desert; but his interests were clearly linked. He needed programmable computers to calculate the size and force of shock waves from explosions, and game theory to address the thorny question of nuclear deterrence. The years of the second world war were especially productive for him, as if he were propelled by the destruction of the “perfect intellectual setting” that was the Central Europe of his youth, not to mention the deaths of millions of its inhabitants.

And yet, Mr Bhattacharya argues, the reputation that von Neumann acquired as the coldest of cold warriors was undeserved. He knew the depths to which humankind could sink, but he was by nature more co-operative than competitive. The man from the future had seen for himself that science could be used for both good and bad, and considered the only legitimate response to be the exercise of intelligent judgment. “For progress,” he wrote, “there is no cure.” ■

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科学史

一本新传记解读天才约翰·冯·诺依曼

他的同行变革了科学。他变革了日常生活【《来自未来的人》书评】

《来自未来的人》。阿南尤·巴塔查亚著。艾伦·莱恩出版社；368页；20英磅。明年2月由诺顿出版社在美国出版；30美元。

一九四五年，数学家约翰·冯·诺依曼（John von Neumann）在精疲力竭的状态中生出了某种说不清道不明的可怕预感。当时他正在洛斯阿拉莫斯（Los Alamos）研究原子弹，他告诉妻子克拉里（Klari），他正在帮助的“能源之源”将让科学家成为“在所有国家都最令人痛恨也最被争抢的公民”。他还告诉她，他正在推进的另一个项目计算机有朝一日还会更重要——也可能会更危险。

介绍一些最伟大的数学大师的优秀传记很少见，因为以他们的博学程度，能向普通人解读他们多方面成就的传记作者本就寥寥。冯·诺依曼就曾面临这般命运，结果就是他并未获得应有的声誉。本刊前科学记者阿南尤·巴塔查亚（Ananyo Bhattacharya）打算修正这种不公，由此填补了科学史上一个巨大的空白。

20世纪30年代，一小群才华横溢、大多为犹太背景的匈牙利人逃离了纳粹，奔赴美国，冯·诺依曼就在其中。在美国，他们因为奇怪的语言和更奇怪的头脑被称为“火星人”。他们人人都推动了科学的变革，但冯·诺依曼以多样又深刻的方式改变了日常生活。他无疑是个天才，读这本书会让你领略“天才”这个被滥用的词的真正含义。认识他的高智识人群中不止一位曾说过，那感觉就好像冯·诺依曼是唯一真正清醒的人。

数学家的传记作者面临的问题是，若仅靠文字来传达数学概念，内行可能会觉得索然无味，而外行看得一头雾水。不过，这本书与霍金或卡洛·罗韦利（Carlo Rovelli）的作品很像，在不同层面上都值得一读。人人都能领会书中提出的数学谜题的重要性，而如果读者想通过他的解答步骤追随

这位天才，那么巴塔查亚就是一位思路清晰的权威向导。

也许正是因为对数学这门“宇宙语言”的精通，冯·诺伊曼在各个学科间穿梭自如。在他还年轻时，他就为量子力学做出了重要贡献。后来，他在制造原子弹的曼哈顿计划中发挥了举足轻重的作用，并为第一台可编程计算机设计了架构。他奠定了博弈论的基础（过程中引入了术语“零和”），激发了社会科学和生物学的革命。时不时地，他抢手到甚至有一架美国空军一号随时待命，以便把他从一个绝密的政府实验室送到另一个。

他在基础研究和应用研究领域同样游刃有余，能手持纸笔坐在普林斯顿的饭厅里潜心学术，也能在新墨西哥州的沙漠里与军方高层辩论。但他的各种志趣显然互相关联。他需要可编程的计算机来计算爆炸产生的冲击波的大小和威力，还需要博弈论来解决核威慑这一棘手的问题。第二次世界大战期间他的成果尤其丰硕，似乎是受到他年少时中欧那个“完美的学术环境”被毁于一旦的刺激，更不用说那片土地上数百万民众的死亡了。

不过，巴塔查亚认为，冯·诺依曼得到“最冷酷的冷战分子”这一名声有失公允。他知道人类可以堕落到何种程度，但他天生更重合作超过竞争。这个来自未来的人亲眼目睹了科学既能造福人类，也能危害世界，并认为唯一的应对办法就是作出明智的判断。“要推动进步，”他写道，“世上并无万能灵药。”





Getting to zero

The first big energy shock of the green era

There are grave problems with the transition to clean energy power

NEXT MONTH world leaders will gather at the COP26 summit, saying they mean to set a course for net global carbon emissions to reach zero by 2050. As they prepare to pledge their part in this 30-year endeavour, the first big energy scare of the green era is unfolding before their eyes. Since May the price of a basket of oil, coal and gas has soared by 95%. Britain, the host of the summit, has turned its coal-fired power stations back on, American petrol prices have hit \$3 a gallon, blackouts have engulfed China and India, and Vladimir Putin has just reminded Europe that its supply of fuel relies on Russian goodwill.

The panic is a reminder that modern life needs abundant energy: without it, bills become unaffordable, homes freeze and businesses stall. The panic has also exposed deeper problems as the world shifts to a cleaner energy system, including inadequate investment in renewables and some transition fossil fuels, rising geopolitical risks and flimsy safety buffers in power markets. Without rapid reforms there will be more energy crises and, perhaps, a popular revolt against climate policies.

The idea of such a shortage seemed ridiculous in 2020 when global demand dropped by 5%, the most since the second world war, triggering cost-cutting in the energy industry. But as the world economy has cranked back up, demand has surged even as stockpiles have run dangerously low. Oil inventories are only 94% of their usual level, European gas storage 86%, and Indian and Chinese coal below 50%.

Tight markets are vulnerable to shocks and the intermittent nature of some

renewable power. The list of disruptions includes routine maintenance, accidents, too little wind in Europe, droughts that have cut Latin American hydropower output, and Asian floods that have impeded coal deliveries. The world may yet escape a severe energy recession: the glitches may be resolved and Russia and OPEC may grudgingly boost oil and gas production. At a minimum, however, the cost will be higher inflation and slower growth. And more such squeezes may be on the way.

That is because three problems loom large. First, energy investment is running at half the level needed to meet the ambition to reach net zero by 2050. Spending on renewables needs to rise. And the supply and demand of dirty fossil fuels needs to be wound down in tandem, without creating dangerous mismatches. Fossil fuels satisfy 83% of primary-energy demand and this needs to fall towards zero. At the same time the mix must shift from coal and oil to gas which has less than half the emissions of coal. But legal threats, investor pressure and fear of regulations have led investment in fossil fuels to slump by 40% since 2015.

Gas is the pressure point. Many countries, particularly in Asia, need it to be a bridge fuel in the 2020s and 2030s, shifting to it temporarily as they ditch coal but before renewables have ramped up. As well as using pipelines, most import liquefied natural gas (LNG). Too few projects are coming on stream. According to Bernstein, a research firm, the global shortfall in LNG capacity could rise from 2% of demand now to 14% by 2030.

The second problem is geopolitics, as rich democracies quit fossil-fuel production and supply shifts to autocracies with fewer scruples and lower costs, including the one run by Mr Putin. The share of oil output from OPEC plus Russia may rise from 46% today to 50% or more by 2030. Russia is the source of 41% of Europe's gas imports and its leverage will grow as it opens the Nord Stream 2 pipeline and develops markets in Asia. The ever-present risk is that it curtails supplies.

The last problem is the flawed design of energy markets. Deregulation since the 1990s has seen many countries shift from decrepit state-run energy industries to open systems in which electricity and gas prices are set by markets, supplied by competing vendors who add supply if prices spike. But these are struggling to cope with the new reality of fossil-fuel output declines, autocratic suppliers and a rising share of intermittent solar and wind power. Just as Lehman Brothers relied on overnight borrowing, so some energy firms guarantee households and businesses supplies that they buy in an unreliable spot market.

The danger is that the shock slows the pace of change. Earlier this month Li Keqiang, China's premier, said the energy transition must be "sound and well-paced", code for using coal for longer. Public opinion in the West, including America, supports clean energy, but could shift as high prices bite.

Governments need to respond by redesigning energy markets. Bigger safety buffers ought to absorb shortages and deal with the intermittency of renewable power. Energy suppliers should hold more reserves, just as banks carry capital. Governments can invite firms to bid for backup-energy-supply contracts. Most reserves will be in gas but eventually battery and hydrogen technologies could take over. More nuclear plants, the capture and storage of carbon dioxide, or both, are vital to supply a baseload of clean, reliable power.

A more diverse supply can weaken the grip of autocratic petrostates such as Russia. Today that means building up the LNG business. In time it will require more global trade in electricity so that distant windy or sunny countries with renewable power to spare can export it. Today only 4% of electricity in rich countries is traded across borders, compared with 24% of global gas and 46% of oil. Building subsea grids is part of the answer and converting clean energy into hydrogen and transporting it on ships could

help, too.

All this will require capital spending on energy to more than double to \$4trn-5trn a year. Yet from investors' perspective, policy is baffling. Many countries have net-zero pledges but no plan of how to get there and have yet to square with the public that bills and taxes need to rise. A movable feast of subsidies for renewables, and regulatory and legal hurdles make investing in fossil-fuel projects too risky. The ideal answer is a global carbon price that relentlessly lowers emissions, helps firms judge which projects would make money, and raises tax revenues to support the energy transition's losers. Yet pricing schemes cover only a fifth of all emissions. The message from the shock is that leaders at COP26 must move beyond pledges and tackle the fine print of how the transition will work. All the more so if they meet under light bulbs powered by coal. ■



【首文】降到零

绿色时代的第一次大规模能源荒

向清洁能源电力的过渡存在严重问题

世界各国领导人下月将聚首联合国气候变化大会COP26，规划路径以求全球到2050年实现净零碳排放。正当他们准备对这项30年事业作出自己那部分承诺之时，绿色时代的首场重大能源恐慌正在他们眼前蔓延。自5月以来，石油、煤炭和天然气的一揽子均价飙升了95%。COP26峰会的东道主英国已重启燃煤发电厂，美国的汽油价格升至每加仑三美元，停电潮席卷中国和印度，普京刚刚提醒欧洲它的燃料供应依赖俄罗斯的友善。

这场恐慌提醒人们，现代生活需要充裕的能源，否则人们将用不起水电煤，家中冷如冰窖，企业无法开工。它也暴露了全球在向清洁能源系统过渡的过程中面对的深层次问题，包括对可再生能源和一些过渡性化石燃料投资不足、地缘政治风险上升，以及电力市场的风险缓冲机制薄弱。若不迅速改革，将会出现更多能源危机，还可能导致民众反对气候政策。

眼前的能源短缺放在2020年似乎是可以想象的，当时全球需求下降了5%，是第二次世界大战以来的最大降幅，引发能源行业寻求削减成本。但随着世界经济复苏，需求已经激增，而与此同时库存降至危险水平。目前石油库存降至常规库存量的94%，欧洲的天然气降至86%，印度和中国的煤炭不足50%。

吃紧的市场易受突发事件影响，也受制于一些可再生电力供应时断时续的特性。干扰因素包括日常维护、意外事故、欧洲风力不足、拉美旱灾导致水电锐减，以及亚洲洪灾冲击煤炭生产。这一次，全球也许还不至于陷入严重的能源衰退，因为相关故障或许能被解决，而俄罗斯和欧佩克可能会不情不愿地提高石油和天然气产量。然而，世界至少要付出通胀上升、增长放缓的代价。而且类似的能源紧张可能会接续而来。

这是因为三个日渐突出的问题。首先，要在2050年达到净零排放，目前的

能源投资只达到所需水平的一半。对可再生能源的投入需要提升。高污染化石燃料的供需要同步下调，以免造成危险的错配。化石燃料目前满足了83%的一次能源需求，需要将这一比例降至零。同时，能源组合必须从煤炭和石油转向天然气，因为天然气的排放不到煤炭的一半。但自2015年以来，法律风险、投资者压力，再加上对监管的担忧已导致市场对化石燃料的投资下降了40%。

天然气是症结所在。许多国家，特别是亚洲国家，需要天然气来充当接下来20年里的“桥梁”燃料，在它们舍弃煤炭但可再生能源产能仍需提升之时暂时转向天然气。除了管道天然气，大多国家还进口液化天然气（LNG）。但即将投产的项目太少了。研究公司盛博的数据显示，全球LNG产能缺口目前占需求的2%，到2030年可能升至14%。

第二个问题是地缘政治。随着富裕民主国家放弃化石燃料的生产，供应转移到了顾虑少、成本低的专制国家，包括普京治下的俄罗斯。欧佩克和俄罗斯目前占到全球石油产出的46%，到2030年可能上升至50%或以上。俄罗斯供应了欧洲天然气进口的41%，随着北溪二号管道的开通以及对亚洲市场的拓展，俄罗斯的影响力会越来越大。俄罗斯限制供应的风险始终挥之不去。

最后一个问题是能源市场存在机制缺陷。许多国家自上世纪90年代开始放松管制，从颓败的国营能源体制转向开放体系，其中电力和天然气价格由市场决定，由相互竞争的供应商供应，它们会随价格上升增加供应。但这一切难以应对当下的新现实：化石燃料产量下降，供应商专制独断，供应不稳定的太阳能和风能的占比日益增加。就像雷曼兄弟公司依靠隔夜贷款一样，一些能源公司依赖从不靠谱的现货市场采购来保证对家庭和企业的能源供应。

危险在于这场能源荒会拖慢变革的步伐。中国总理李克强在本月稍早时表示，能源过渡必须“合理有序”，暗示会继续使用煤炭更长时间。在包括美国在内的西方国家，公众舆论是支持清洁能源的，但人们也可能会在高能源价格的刺激下转变态度。

政府需要重新设计能源市场来应对问题。建立更大的安全缓冲区应该能缓冲短缺的冲击，并应对可再生能源的间歇性供应问题。能源供应商应加大储备，就像银行储备资本那样。政府可邀请企业竞标备用能源供应合同。能源储备大多会是天然气，但最终可由电池和氢气来替代。建设更多核电站或捕获和储存二氧化碳（或是两者并举）对于清洁、可靠的基荷电力供应至关重要。

更分散多元的供应渠道可以削弱俄罗斯这类专制产油国的影响力。在目前这意味着要扩展LNG业务，日后则须扩大全球电力贸易，让那些风力或阳光充足的遥远国度可以出口富余的再生电力。今天，富裕国家只有4%的电力用于跨境交易，而天然气和石油的跨境交比例分别为24%和46%。建设海底电网是一个办法，把清洁能源转化为氢气以便船运也可能有所帮助。

这一切将需要能源资本支出翻一倍不止，达到每年四、五万亿美元。然而在投资者看来，相关政策令人困惑。许多国家承诺要实现净零排放，但没有相应的方案，而且在提高能源税费方面尚未取得公众理解。对可再生能源的补贴流动盛宴，加上监管和法律方面的障碍，令投资化石燃料项目的风险过大。理想的答案是订立全球碳价，促使人们竭力减排，帮助企业判断哪些项目能赚钱，并增加税收以支撑能源转型中的输家。但各种定价机制目前只涵盖所有排放量的五分之一。这次能源荒传递的信息是，参加COP26峰会的领导人不能光做承诺，还必须着手解决实施转型中的细节问题。如果他们开会时用的还是煤电照明，那就更要抓紧了。■



Free exchange

The Nobel prize in economics celebrates an empirical revolution

David Card shares this year's award with Joshua Angrist and Guido Imbens

A “CREDIBILITY REVOLUTION” has transformed economics since the 1990s. Before that, theory ruled the roost and empirical work was a poor second cousin. “Hardly anyone takes data analysis seriously,” declared Edward Leamer of the University of California, Los Angeles, in a paper published in 1983. Yet within a decade, new and innovative work had altered the course of the profession, such that the lion’s share of notable research today is empirical. For enabling this transition David Card of the University of California at Berkeley shares this year’s economics Nobel prize, awarded on October 11th, with Joshua Angrist of the Massachusetts Institute of Technology and Guido Imbens of Stanford University.

The messy real world can often defy economists’ attempts to establish causality. Working out how a rise in the minimum wage affects employment, for example, is complicated by the fact that some other influence (a chronically weak labour market, say) may have contributed to changes in both policy and employment. In other fields researchers establish causation by designing experiments where subjects are randomly assigned to different groups, only one of which receives a particular treatment, so that the effect of the treatment can be clearly seen. More economists are also using randomised controlled trials—indeed, the Nobel prize in 2019 rewarded such efforts. But many questions cannot be studied this way for reasons of politics, logistics or ethics.

This year’s prizewinners surmounted such hurdles by using “natural experiments”, in which some quirk of history has an effect similar to an intentional trial. In a landmark paper published in 1994, Mr Card and Alan

Krueger studied the impact of a minimum-wage increase in New Jersey by comparing the change in employment there with that in neighbouring Pennsylvania, where the wage floor was unchanged. Although theory predicted that a minimum-wage rise would be followed by a sharp drop in employment, such an effect, strikingly, did not seem to hold in practice. The paper inspired further empirical work and injected new energy into thinking about labour markets. Krueger, who died in 2019, would probably have shared the prize had he lived.

The use of natural experiments quickly spread. Mr Card analysed another unique circumstance—Fidel Castro’s decision in 1980 to allow emigration out of Cuba—to examine the effects of immigration on local labour markets. About half the 125,000 Cubans who fled to America settled in Miami. By comparing the city’s experience with that in four other places which were similar in many respects, but which did not receive an influx of migrants, Mr Card found that neither the wages nor the employment of native workers suffered as a result of the migration.

Mr Angrist, together with Krueger, used a similar technique to examine the impact of education on labour-market outcomes. Because students of a more scholastic disposition are likely both to spend more time in school and to earn more in work, what looks like a return to education could in fact reflect natural aptitude. In order to determine causality, the researchers made use of odd characteristics of America’s educational system. Although laws typically allowed students to drop out of school when they turned 16, all students born in the same year began school on the same date, regardless of their birthday. Those born in December, therefore, received more schooling, on average, than those born in January—and, the researchers found, also tended to earn more. Since the month of a student’s birth may be assumed to be random, they concluded that the added education caused the higher earnings.

The study of schooling found that an extra year of education raised subsequent wages by 9%. Such an effect seemed implausibly large to many economists. But that reflected a difference in definition, concluded Mr Angrist in work with Mr Imbens. The two scholars noted that the effect of a “treatment” was not the same for everyone in a natural experiment. If the age at which students could drop out were raised from 16 to 17, for example, some would be forced to receive another year of schooling; others, who had always intended to stay in school, would be unaffected.

Together, the researchers developed methods to make the conclusions from natural experiments more useful. Economists refer to the quirky factor used in natural experiments (like the birth month of a student) as an “instrument”. Messrs Angrist and Imbens explained the assumptions that need to hold for an instrument’s use to be valid: it must, for instance, influence only the outcome being studied (earnings, in this case) through its effect on the treatment (years of schooling), and not other channels. By laying out these assumptions, the researchers allowed for more sophisticated analysis: the estimated boost to earnings in Messrs Angrist and Krueger’s work, for instance, applies only to students who drop out as soon as they can. The benefits to those who choose to study longer cannot be observed. Moreover, the methodology also improved the transparency of research. The reader of a paper can judge for themselves whether an instrument satisfies the needed assumptions, and discount the result accordingly.

The credibility revolution, like any big upheaval, has had its excesses. Critics point to careless work and the mining of data in search of results that seem meaningful. Scholars are occasionally too eager to extrapolate findings from a particular natural experiment in ways that may not be justified, given the uniqueness of the circumstances. Yet the innovations developed by this year’s prizewinners unquestionably changed the field for the better, illuminating questions once shrouded in darkness and forcing economists

to push theory in directions that better describe real-world experience—a cause, indeed, for celebration. ■



自由交流

诺贝尔经济学奖表彰实证革命

大卫·卡德与约书亚·安格里斯特和吉多·因本斯共享今年的诺奖

自上世纪90年代以来，“可信度革命”已经改变了经济学。在此之前，理论研究占据主导地位，而实证研究只是个小配角。“没什么人把数据分析当回事。”加州大学洛杉矶分校的爱德华·利默（Edward Leamer）在1983年发表的一篇论文中写道。然而，在此后十年里，新的创新性研究改变了这个行业的进程，如今大部分受关注的研究都是实证性的。加州大学伯克利分校的大卫·卡德（David Card）因为在推动这一转变上的成就，于10月11日同麻省理工学院的约书亚·安格里斯特（Joshua Angrist）和斯坦福大学的吉多·因本斯（Guido Imbens）一道获颁诺贝尔经济学奖。

错综复杂的现实世界往往让经济学家难以确立因果关系。例如，要弄清楚最低工资上涨对就业的影响就很困难，因为其他一些因素（比如长期疲软的劳动力市场）也可能导致政策和就业变化，从而让问题变得复杂。在其他领域，研究人员通过设计实验来确立因果关系，将受试者随机分组，其中只有一组能接受某种待遇，以便可以清楚地看到这种待遇的效果。越来越多的经济学家也在使用随机对照试验——事实上，2019年的诺贝尔奖表彰的就是这种尝试。但由于政治、实验安排组织或伦理方面的原因，许多问题无法做这样的研究。

今年的诺奖得主通过“自然实验”克服了这些障碍，即认为历史上一些偶发特殊事件的作用类似于专门设计的试验。在1994年发表的一篇具里程碑意义的论文中，卡德和艾伦·克鲁格（Alan Krueger）比较了提高了最低工资的新泽西州和没有调整最低工资的邻州宾夕法尼亚的就业变化，以研究提高最低工资对新泽西州的影响。尽管理论预测最低工资上涨会导致就业水平急剧下降，但令人意外的是，在实践中似乎并没有这种效果。这篇论文激发了进一步的实证研究，并为有关劳动力市场的见解注入了新的活力。克鲁格于2019年逝世，如果他还健在，很可能会共享今年的经济学奖。

自然实验迅速得到推广。卡德分析了另一个独特的情形，即古巴领导人卡斯特罗在1980年允许国民移民的决定，来研究移民对接收国劳动力市场的影响。偷渡到美国的12.5万名古巴人中约有一半选择定居迈阿密。通过比较与迈阿密在其他许多方面相似但没有移民涌入的四个城市的情况，卡德发现，本地工人的工资和就业都没有因移民的到来而受到影响。

安格里斯特和克鲁格一起用一种类似的方法来研究教育对人们在劳动力市场上收入水平的影响。因为学习天分更好的学生可能受教育时间更长，并在工作中赚钱更多，所以收入看似是对教育投入的回报，但实际上可能反映的是天资的差异。为了确定其中的因果关系，研究人员利用了美国教育体系的一个奇怪特点。尽管法律通常允许学生在满16岁后退学，但在同一年出生的所有学生都是在同一天开始上学。因此，平均而言，与1月出生的人相比，12月出生的人接受学校教育的时间更长，而且研究人员发现，他们往往也挣得更多一些。由于学生的出生月份可以被认为是随机的，因此他们得出结论，更长的受教育时间导致了更高的收入。

对学校教育的研究发现，多接受一年的教育，日后工资提高了9%。对于许多经济学家来说，这种影响似乎大得令人难以置信。但这反映了定义上的差异，安格里斯特在与因本斯合作的研究中总结道。两位学者指出，在自然实验中，“待遇”在每个人身上的效果并不相同。例如，如果把学生可以退学的年龄从16岁提高到17岁，有些人将被迫再接受一年的教育，而其他本来就打算继续上学的人并不受影响。

两位经济学家研究出了让自然实验得出的结论更有用处的方法。他们把自然实验中用到的特殊因素（比如学生的出生月份）称为“工具”。安格里斯特和因本斯解释了要有效使用“工具”所需的假设。例如，“工具”必须是通过它对待遇（在此案例中是受教育年限）的作用而非通过其他途径来影响研究结果（收入）。列出这些假设后，他们推进了更复杂细致的分析，比如他们要考虑到，在安格里斯特和克鲁格的研究中所估计的教育对收入增长的推动仅适用于一到年龄就退学的学生，至于对那些选择继续上学的人的好处则不能被用作观察对象。此外，该研究方法还提高了研究的透明度。论文的读者可自行判断所用“工具”是否满足所需的假设，并由此决定

对研究结果接受多少。

与任何巨变一样，可信度革命也有过过犹不及的时候。批评者指出，为了找到看似有意义的结果，可能会出现研究不够细致和挖掘数据的情况。研究人员有时会过于急切地想从某个自然实验中推断出结果，但由于情况的独特性，推论过程可能站不住脚。然而，今年诺奖得主推动的创新无疑改进了这个领域，照亮了那些曾经笼罩在黑暗中的问题，并迫使经济学家把理论向更能描述现实世界经验的方向推进——这确实值得嘉奖。 ■



Xi's premium

Chinese companies suffer an intense cash crunch in offshore bond markets

Spreads on junk bonds are at their highest ever

GLOBAL INVESTORS are all too aware of the discount on the valuations of mainland firms as a result of Xi Jinping's aim to lower leverage, house prices and inequality in China. Borrowers, for their part, must contend with a "Xi premium" on sorely needed capital. The Chinese leader's policies may have led to a perilous credit crunch for many companies, especially property developers, in global markets.

Regulators have shaken the foundations of China's property market by toughening up on the amount of leverage developers can take on. This has pushed Evergrande, a home builder with more than 1,000 projects across China and \$300bn in liabilities, towards collapse. It has missed five payments on offshore-dollar bonds in the past month. Several rivals have followed suit. Fantasia defaulted on offshore bonds on October 4th. Sinic Holdings said on October 11th that it would probably default soon. Modern Land and Xinyuan Real Estate are hoping to delay payments on offshore bonds.

This wave of distress has led to a crunch in the offshore junk-bond market. Spreads (ie, yields compared with the risk-free rate) have reached nearly 17 percentage points, the widest gap on record. The market has for the most part shut to developers hoping to refinance their debts in October, says Sandra Chow of CreditSights, a research firm. One investment manager at a global institution says even non-property companies are being priced out, noting that "this is the definition of contagion."

The problems run much deeper than the string of missed payments. One fear is that Chinese authorities are pressing companies to ignore the interests of creditors and to sell offshore assets and siphon cash back home, in a desperate attempt to ensure that unfinished properties that have already been sold to Chinese people are completed. The leading theory among investors goes that Evergrande is buying time to prevent its offshore assets being frozen by offshore creditors. A “privately negotiated” resolution on a yuan bond was announced on September 22nd in order to prevent an instant cross-default on dollar bonds. Although the group has since missed dollar-bond payments, a 30-day grace period gives the group until October 23rd before it is deemed to be in default and creditors can move to seize its offshore assets. In the meantime, it is selling all it can, including a large stake in its property-services unit and its offices in Hong Kong.

Other groups may be considering a similar strategy. In recent weeks developers such as Fantasia and Sinic have been reluctant to pay offshore coupons. Some instances have surprised investors, suggesting that companies may be able but not willing to make these payments, says Arthur Lau of PineBridge, a Hong Kong-based investment manager.

If such behaviour is tolerated, or even encouraged, by the authorities, the impact could be devastating for the \$1trn market for dollar bonds issued by Chinese companies. More defaults could come if yields stay high. Having crushed many private conglomerates that sought to buy overseas assets, and impeded Chinese share sales in New York, Mr Xi may now be putting his stamp on the offshore-bond market. ■



习溢价

中国企业在离岸债券市场遭遇严重现金危机

垃圾债券的利差达到有史以来最高水平

全球投资者都非常清楚，由于习近平要降低中国的杠杆率、房价和不平等状况，中国大陆企业的估值都打了折扣。而对于借款的企业来说，在寻求急需的资金时必须多付一笔“习溢价”。这位中国领导人的政策可能已导致许多公司在全球市场上面临危险的信贷紧缩，尤其是房地产开发商。

监管机构收紧了开发商可以运用的杠杆水平，动摇了中国房地产市场的基础。这已将开发商恒大推向崩溃的边缘。它在中国有1000多个地产项目，背负3000亿美元的债务。在过去一个月里，它已经五次错过离岸美元债券的兑付期限。几个竞争对手也步其后尘。花样年在10月4日未能按期兑付离岸债券。新力控股10月11日表示可能很快就会违约。当代置业和鑫苑置业希望能延迟兑付离岸债券。

这波兑付危机导致离岸垃圾债券市场出现紧缩。利差（即债券收益率与无风险利率之差）已接近17个百分点，为有记录以来最高水平。研究公司CreditSights的桑德拉·周（Sandra Chow）表示，10月份，市场在很大程度上已对希望进行债务再融资的房地产开发商关上了大门。一家全球机构的投资经理表示，即使是非房地产公司也面临过高的融资成本，指出“这就是典型的传染效应”。

这些问题远比那一连串的违约要深重得多。有一种担忧是，中国当局正在向那些企业施压，让它们无视债权人的利益，出售离岸资产，将现金抽回国内，以极力确保那些已经出售给中国人的在建地产项目能够完工。投资者中的主流看法是，恒大正在争取时间，防止其离岸资产被离岸债权人冻结。恒大9月22日宣布通过“私下协商”就一笔人民币债券达成了解决方案，以防止美元债券随即出现交叉违约。尽管恒大此后错过了美元债券的还款期限，但还有30天的宽限期，到10月23日才会正式被视为违约，届时

债权人可以采取行动扣押其离岸资产。与此同时，恒大正在出售所有能变卖的资产，包括其物业子公司的大量股权和香港的总部大楼。

其他地产集团可能正在考虑类似的策略。最近几周，花样年和新力等开发商一直不愿支付离岸息票。一些让投资者始料不及的情形透露出有些公司可能有能力却不愿还债，香港投资管理公司柏瑞投资（PineBridge）的刘曙明表示。

如果政府默许甚至鼓励这种行为，那么对中国公司发行的一万亿美元债券市场来说，冲击可能是毁灭性的。如果收益率保持高位，可能会出现更多的违约。习近平打压了许多寻求购买海外资产的私营企业集团，并阻碍中国公司在纽约上市，现在他可能正在离岸债券市场上打下自己的烙印。■



The Double Asteroid Redirection Test

An exploration of Earth's defences will launch next month

It will check how far it is possible to deflect an incoming asteroid

THE DEPARTURE of Lucy, on October 16th, if all goes well, is not the only forthcoming mission with asteroids as its destination. On November 24th DART should follow. The Double Asteroid Redirection Test, though, has a more practical purpose than Lucy. It will assess the feasibility of changing an asteroid's path, should one be discovered that threatens to collide with Earth.

DART, a probe weighing 600kg, is intended to crash, in September 2022, into Dimorphos, a tiny asteroid in orbit around a larger one, Didymos, at a velocity of 6.2km per second. The intention is to alter the speed of Dimorphos's orbit by about half a millimetre a second, thus shortening its orbital period, now 11.9 hours, by about ten minutes.

Didymos is 780 metres across. According to the project's lead investigator, Andrew Cheng of Johns Hopkins University, in Baltimore, if an object that size hit Earth it could devastate half a continent, causing firestorms and a subsequent cooling of the climate that might last for years. But even something the size of Dimorphos, only 160 metres across, would do a lot of damage. Its impact would create an explosion equivalent to 400-600 megatonnes of TNT. By comparison, the Tunguska bolide that exploded over Siberia in 1908, flattening more than 2,000km² of forest, released something like 20 megatonnes. And recently published evidence suggests that an explosion of similar size to Tunguska destroyed Tall el-Hammam, a city in the Jordan valley, in about 1650BC.

There are, moreover, a lot of unknown asteroids out there. NASA's Near-

Earth Object Observation Programme, intended to discover 90% of asteroids larger than 140 metres across that have orbits near Earth's, is reckoned to have so far found less than half of them. None yet located is seen as a threat. But if such a threat were identified, the question would be whether anything could be done about it.

If collision with Earth was imminent, the answer is probably "no". But if it were years or decades away, a nudge of the sort DART will give Dimorphos could change a space rock's path enough for it to miss Earth after all—even a tiny alteration in such a body's orbit will grow over time.

Dimorphos's behaviour after DART hits it will thus be the subject of intense scrutiny. The impact itself will be monitored by LICIACube (Light Italian CubeSat for Imaging of Asteroids). This is a small craft, built by Italy's space agency, which will be launched along with DART and separate from it shortly before impact. After that, Didymos and Dimorphos will be tracked by ground-based telescopes. Then, in 2024, the European Space Agency will launch a follow-up craft called Hera that will arrive at the double asteroid in 2026, for a more detailed inspection. All these data will then be crunched to find out just how feasible an asteroid-deflection mission would be.

With luck, no such mission will ever be needed. But if one is, DART may prove to be the most important space probe ever to have flown. ■



双小行星重定向测试

一场保卫地球的探索将于下月启动

要看看有多大可能让来袭的小行星改道

“露西号”（Lucy）飞船在10月16日发射升空，这不是唯一一个以小行星为目的地的任务。接下来还有将于11月24日启动的“双小行星重定向测试”（Double Asteroid Redirection Test，简称DART）。不过，DART背负比“露西号”更实际的任务。它将要评估，如果发现可能与地球相撞的小行星，改变其轨迹的可行性如何。

DART探测器重600公斤，计划在2022年9月以每秒6.2公里的速度撞向迪莫弗斯（Dimorphos），这是一颗微型小行星，围绕着一颗更大一些的小行星迪蒂莫斯（Didymos）运行。撞击的目标是给迪莫弗斯的绕轨速度造成每秒约0.5毫米的改变，从而将它目前11.9小时的轨道运行周期缩短约10分钟。

迪蒂莫斯直径780米。该项目的首席研究员、在位于巴尔的摩的约翰·霍普金斯大学任职的安德鲁·程（Andrew Cheng）解释说，如果一个如此大小的天体撞击地球，可能会摧毁半个大陆，引发火风暴，导致气候变冷，这种情况可能持续多年。但即使是像迪莫弗斯这样直径只有160米的天体撞击地球，也会造成很大的破坏。它的冲击力相当于四到六亿吨TNT炸药爆炸。相比之下，1908年发生在西伯利亚上空的通古斯大爆炸夷平了2000多平方公里的森林，其威力相当于约2000万吨TNT炸药爆炸。另外，最近公布的证据表明，大约在公元前1650年，一场与通古斯差不多规模的爆炸摧毁了约旦河谷中的城市塔哈曼（Tall el-Hammam）。

而且太阳系中有大量未知的小行星。美国国家航空航天局（NASA）的近地天体观测项目（Near-Earth Object Observation Programme）意图找到直径大于140米且轨道与地球接近的小行星中的九成，而据估计到目前为止只发现了不到一半。在已被定位的小行星中还没有观测到威胁。但一旦发

现这样的威胁，问题就成了能不能做点什么。

如果马上就要与地球碰撞，答案很可能是“不能”。但如果离撞击还有几年或几十年，那么像DART将要给迪莫弗斯的那种轻轻一推有可能改变一块太空巨石的路径，足以让它和地球擦肩而过——这样一个天体的运行轨道即使略微改变，也会随时间不断扩大。

因此，在被DART撞击后，迪莫弗斯的动向将被密切观测。意大利轻型小行星成像立方体卫星（Light Italian CubeSat for Imaging of Asteroids，简称LICIACube）将监测这次撞击过程本身。这颗由意大利航天局建造的小型卫星将与DART一起发射，并在快要撞击前与DART分离。之后，地面望远镜会跟踪迪蒂莫斯和迪莫弗斯。然后，在2024年，欧洲航天局将发射一艘名为赫拉（Hera）的航天器，它将在2026年抵达这两颗小行星做更详细的观测。接下来研究人员将分析处理所有收集到的数据，以确定偏转小行星的任务的可行性。

如果幸运，以后将永远不需要执行这样的任务。但万一需要，DART可能会被证明是有史以来最重要的太空探测器。■



Girls uninterrupted

Femtech firms are at last enjoying an investment boom

Not a moment too soon

A HORMONE CALLED relaxin helps loosen up pregnant women's hips. Without it, the pain of delivery would be unbearable. Its job done, however, relaxin lingers in female bodies for up to a year, when softer ligaments make new mothers more prone to injury, as Jessica Ennis-Hill, an Olympic champion heptathlete, discovered in training after giving birth in 2014. Five years later Dame Jessica started Jennis, a fitness app to help other women perform safe post-natal workouts. It now lets users optimise workouts for the different phases of their menstrual cycles, and has just concluded a successful funding round.

Dame Jessica's startup is part of a wave of "femtech" firms coming up with ways for women to overcome health problems specific to their sex. The market could more than double from \$22.5bn last year to more than \$65bn by 2027, reckons Global Market Insights, a research firm. Having ignored it for years—in 2020 femtech received only 3% of all health-tech funding, and a modest \$14bn has been invested in it globally to date—venture capitalists are at last waking up to the opportunity. So far this year they have invested nearly \$1.2bn in the industry, nearly half as much again as the annual record in 2019 (see chart 1).

Last year Bayer, a big German drugmaker, paid \$425m to buy KaNDy, a British developer of a non-hormonal treatment for menopause symptoms, and Bill Gates, Microsoft's billionaire co-founder, backed BIOMILQ, a startup that has produced cell-cultured human breast milk and aims to bring both parents closer to their newborns. In August Maven Clinic, an American startup which began as a femtech but has expanded to other areas of health,

raised \$110m and achieved “unicorn” status, with a valuation of more than \$1bn. In September Elvie, another British firm, raised \$97m from venture-capital firms.

Unlike health tech aimed at men, which often focuses on erectile dysfunction, a condition that afflicts perhaps one in ten potential users, femtech offers products like period trackers, which could be of value to virtually all of the world’s 4bn women at some point in their lives. Moreover, women are 75% likelier than men to adopt digital tools for health care. That makes for a huge potential market.

A big reason femtech has been slow to grow has to do with the underlying medical science. For conditions that affect all humans, men are more commonly studied, largely owing to misplaced worries that women’s hormonal fluctuations can confound results (male mice are favoured for the same reason). In the few more inclusive studies, results are seldom disaggregated by sex, obscuring how diseases—and the drugs used to treat them—affect women differently. “We have been operating as if women are just smaller versions of men,” observes Alisa Vitti, a hormone expert whose work on the 29-day “infradian” body clock, which affects everything from metabolism to sensitivity to pain and is a uniquely female phenomenon, underpins many period trackers.

As a result, plenty of woman-specific health issues have, despite their ubiquity, been routinely neglected. Femtechs help fill this research gap. Noting that eight in ten women suffer from premenstrual pain but no treatments have been specifically designed to allay it, founders of Daye, a British startup, designed a tampon laced with cannabidiol, after observing that the vaginal canal has more cannabinoid receptors than any other part of the female body.

Hertility Health, also of Britain, offers non-invasive tests which can help diagnose nine common gynaecological conditions. Elvie's silent wearable breast pump is a best-seller in America and Britain; its app-controlled pelvic-floor trainer reduces the chances of the typical intervention, whereby surgeons insert "a fishing net and lift up your pelvic organs because they are falling out of your vagina", says Tania Boler, the firm's founder.

That is welcome progress. But too many femtechs face an uphill struggle. Helen O'Neill, who runs Hertility Health, calls the \$5.7m funding round her firm closed in June a "soul-destroying" process. "It was predominantly grey-haired men saying they are not sure there is a market for this," she says. Never mind that all women with a reproductive system require gynaecological help at some point. ■



乘风破浪的女孩

女性科技公司终于迎来投资热

姗姗来迟

松弛素是一种有助于放松孕妇臀部肌肉的激素。如果没有它，分娩的痛苦将不堪忍受。然而在完成使命后，松弛素最长会在女性体内存留一年，而变软的韧带会导致她们更易受伤。2014年，女子七项全能奥运冠军杰西卡·恩尼斯-希尔（Jessica Ennis-Hill）在产后恢复训练时发现了这个问题。五年后，她创办了一款名为Jennis的健身应用，帮助其他女性开展安全的产后锻炼。现在，这款应用可以针对用户生理期的不同阶段优化锻炼内容，并于近期成功完成了一轮融资。

恩尼斯-希尔爵士的创业公司赶上了“女性科技”企业潮，这类公司想办法来解决女性特有的健康问题。据研究公司全球市场洞察（Global Market Insights）估计，到2027年，这一市场将从去年的225亿美元增长逾一倍，达到650多亿美元。女性科技受冷落多年，2020年仅占所有健康科技融资的3%，迄今为止的全球投资额不过140亿美元。如今，风险投资人总算是嗅到了其中的商机。今年截至10月，他们已向该行业投资近12亿美元，比2019年创纪录的全年额度增长了近50%（见图表1）。

去年，德国大型制药商拜耳斥资4.25亿美元收购了KaNDy，这家英国公司开发了一种针对更年期症状的非激素疗法；微软的亿万富翁联合创始人比尔·盖茨资助了BIOMILQ，这家创业公司生产细胞培养母乳，致力于让父母双方都增进与新生儿的连结。今年8月，美国创业公司Maven Clinic融资1.1亿美元，成为估值超过10亿美元的“独角兽”，它最初是一家女性科技公司，但已扩展到其他健康领域。9月，另一家英国企业埃尔薇（Elvie）获得了9700万美元的风投融资。

针对男性的健康科技通常专攻勃起功能障碍，可能有十分之一的潜在用户受到这种疾病的困扰。女性科技提供的则是经期追踪器之类的产品，全世

界40亿女性中的几乎所有人到了人生某个阶段都用得着它们。而且女性采用数字医疗保健工具的可能性比男性高75%。这就造就了一个巨大的潜在市场。

女性科技增长缓慢的一大原因与基础医学有关。对于一些影响全人类的疾病，男性通常是研究对象，这主要是由于人们错误地担心女性的荷尔蒙波动会干扰研究结果（雄性小鼠因而同样更受欢迎）。在少数更具包容性的研究中，结果也很少按性别分类，模糊了疾病及治疗药物对女性的不同影响。激素专家艾丽莎·维蒂（Alisa Vitti）指出，“我们的研究一直都把女性看作小号的男性。”她研究了29日“亚日”生物钟，这是一种女性特有的现象，影响着从新陈代谢到疼痛敏感性等各种生理特性。她的研究构成了许多经期追踪器的生理学基础。

因此，尽管许多女性特有的健康问题普遍存在，却经常被忽视。女性科技有助于填补这一研究空白。英国创业公司Daye的几名创始人注意到，八成女性有经前疼痛问题，但没有专门的疗法来缓解这种疼痛。在他们发现女性阴道腔内的大麻素受体比在身体其他部位更多后，设计了一款添加了大麻二酚的卫生棉条。

同样来自英国的Hertility Health公司提供无创检测，能够诊断九种常见的妇科疾病。埃尔薇推出的可穿戴静音吸乳器在英美两国畅销；该公司生产的用手机应用控制的盆底肌训练器减少了实施常规干预措施的几率，也就是由外科医生插入“一张状如渔网的东西，来撑起快要滑脱出阴道的盆腔器官”，该公司的创始人塔尼娅·博勒（Tania Boler）说。

这是可喜的进展。但太多的女性科技公司都将需要迎难而上。Hertility Health的CEO海伦·奥尼尔（Helen O'Neill）称，她的公司在6月完成的那轮570万美元的融资过程让人“心力交瘁”。她说，“基本就是一群头发花白的男性在那里质疑是否有市场前景”。仿佛人们忘记了，凡是有生殖系统的女性，到了人生某个时刻总会需要妇科方面的帮助。 ■



Climate change and innovation

Hydrogen's moment is here at last

After decades of doubts the gas is coming of age

HYDROGEN HAS been controversial ever since the tragedy of the Hindenburg, an airship filled with it that went down in flames in 1937. Boosters say that the gas is a low-carbon miracle which can power cars and homes. The hydrogen economy, they hope, will redraw the energy map. Sceptics note that several hydrogen investment drives since the 1970s have ended in tears as the gas's shortcomings were exposed. As we explain, the reality lies in between. Hydrogen technologies could eliminate perhaps a tenth of today's greenhouse-gas emissions by 2050. That is a sliver—but, considering the scale of the energy transition, a crucial and lucrative one.

Hydrogen is not a primary source of energy like oil or coal. It is best thought of as an energy carrier, akin to electricity, and as a means of storage, like a battery. It has to be manufactured. Low-carbon energy sources such as renewables and nuclear power can be used to separate water (H_2O) into its constituents of oxygen and hydrogen. This is inefficient and expensive, but costs are falling. Hydrogen can also be made from dirty fossil fuels but this emits a lot of pollution unless it is coupled with technologies that capture carbon and sequester it. Hydrogen is flammable and bulky compared with many fuels. The implacable laws of thermodynamics mean that converting primary energy into hydrogen and then hydrogen into usable power leads to waste.

All this explains the gas's tricky history. The oil shocks of the 1970s led to research into hydrogen technologies but they never went far. In the 1980s the Soviet Union even flew a hydrogen-powered passenger jet—the maiden flight lasted just 21 minutes.

Today climate change is causing another wave of enthusiasm. More than 350 big projects are under way and cumulative investment could reach \$500bn by 2030. Morgan Stanley, a bank, reckons that annual sales of hydrogen could be worth \$600bn by 2050. That is up from \$150bn of sales today, which come mainly from industrial processes, including making fertilisers. India will soon stage auctions for hydrogen and Chile is holding tenders for its production on public lands. Over a dozen countries including Britain, France, Germany, Japan and South Korea have national hydrogen plans.

Amid the excitement, it is worth being clear about what hydrogen can and cannot do. Japanese and South Korean firms are keen to sell cars using hydrogen fuel cells, but battery cars are roughly twice as energy efficient. Some European countries hope to pipe hydrogen into homes, but heat pumps are more effective and some pipes cannot handle the gas safely. Some big energy firms and petrostates want to use natural gas to make hydrogen without capturing the associated carbon effectively, but that does not eliminate emissions.

Instead, hydrogen can help in niche markets, involving complex chemical processes and high temperatures that are hard to achieve with electricity. Steel firms, spewing roughly 8% of global emissions, rely on coking coal and blast furnaces that wind power cannot replace but which hydrogen can, using a process known as direct reduction. Hybrit, a Swedish consortium, sold the world's first green steel made this way in August.

Another niche is commercial transport, particularly for journeys beyond the scope of batteries. Hydrogen lorries can beat battery-powered rivals with faster refuelling, more room for cargo and a longer range. Cummins, an American company, is betting on them. Fuels derived from hydrogen may also be useful in aviation and shipping. Alstom, a French firm, is running hydrogen-powered locomotives on European tracks.

Last, hydrogen can be used as a material to store and transport energy in bulk. Renewable grids struggle when the wind dies or it is dark. Batteries can help, but if renewable power is converted to hydrogen, it can be stored cheaply for long periods and converted to electricity on demand. A power plant in Utah plans to store the gas in caverns to supply California. Sunny and windy places that lack transmission links can export clean energy as hydrogen. Australia, Chile and Morocco hope to “ship sunshine” to the world.

With so much money piling into hydrogen the list of uses for it may expand. Much of the work is up to the private sector but governments can do their bit. One task is to crack down on greenwashing: hydrogen made from dirty fuels without high-quality carbon capture will not help the climate. New rules are needed to measure and disclose the life-cycle emissions arising from producing hydrogen and, given that it will be traded across borders, these need international agreement.

Government should also encourage hubs where different hydrogen users cluster, minimising the need to duplicate infrastructure. These are already emerging in Humberside in Britain and Rotterdam in the Netherlands. Hydrogen has its limitations, but it can play a vital role in bringing about cleaner energy. ■



【首文】气候变化与创新

氢时代终于到来

在受质疑数十年之后，氢气终于要大显神通了

自兴登堡号的悲剧以来，氢能一直备受争议。1937年，充满氢气的兴登堡号飞艇在一片火光中坠毁。支持者说，这种气体是低碳奇迹，可以为汽车和家居生活提供动力。他们希望氢经济能改写能源地图。怀疑论者则指出，自20世纪70年代以来，随着氢气缺点的暴露，几次氢气投资热潮都以失败告终。要我们说，现实介于两者之间。到2050年氢技术或许能让目前的温室气体排放量减少十分之一。这比例不大，但考虑到能源转型的规模，却仍然至关重要且有利可图。

氢不像石油或煤炭那样是一种主要能源。最恰当的看法是它是一种能量载体，好比电力，以及一种储能方式，就像电池。它需要被制造出来。可以用可再生能源和核能等低碳能源把水分解成氧和氢。这个过程低效又昂贵，不过成本正在下降。氢也可以从不那么清洁的化石燃料中提炼出来，但会产生大量污染，除非配上碳捕获和封存技术。与许多燃料相比，氢易燃且体积庞大。铁一般的热力学定律意味着将一次能源转化为氢气、再将氢气转化为可用动力会导致浪费。

所有这些都解释了氢气坎坷的历史。20世纪70年代的石油危机引发了对氢技术的研究，但这类技术一直没能走多远。80年代，苏联甚至试飞了一架氢动力客机——首航仅持续了21分钟。

今天，气候变化正引发又一波氢能热。目前有350多个大型项目正在进行中，到2030年累计投资可能达到5000亿美元。摩根士丹利估计，到2050年，氢的年销售额可能达到6000亿美元。目前的销售额为1500亿美元，主要来自化肥制造等工业生产。印度很快将举行氢能拍卖，智利正对公共土地上的氢生产项目进行招标。包括英国、法国、德国、日本和韩国在内的十几个国家都有国家级氢能计划。

在一片兴奋之情中，有必要明确氢能做什么，不能做什么。日本和韩国的公司都热衷于销售使用氢燃料电池的汽车，但相比之下电动汽车的能源效率约高一倍。一些欧洲国家希望用管道将氢气输送到家庭，但热泵效率更高，而且有些管道无法安全输送氢气。一些大型能源公司和石油生产国希望用天然气生产氢气，但无法有效地捕获由此产生的碳，也就不能消除排放。

不过，氢在利基市场上有用武之地，比如涉及复杂化学过程的地方，或是需要电力难以达到的高温时。排放量约占全球8%的钢铁企业仰赖焦煤和高炉，风能无法取代，但通过名为“直接还原”的方法，氢气可以取代它们。今年8月，瑞典财团Hybrit售出了世界上首批用这种方式制造的绿色钢材。

另一个利基市场是商业运输，特别是在运输距离超过电池续航里程时。相比电动卡车，氢能卡车补充燃料速度更快、载货空间更大、行驶里程更长。美国公司康明斯（Cummins）就在押注氢能。航空和海运或许也能以氢为燃料。法国公司阿尔斯通正在欧洲的铁路上运行氢动力列车。

最后，氢还可以用于大量储存和运输能量。没有风或阳光时，可再生能源的电网就无法运转。电池能帮助储能，但如果将可再生能源转化为氢气，就可以长久且低成本地储存这些能量，并且在有需要的时候转化为电力。犹他州的一家发电厂计划将氢储存在洞穴中以向加州供电。阳光充足、风力充沛但缺少输电线路的地方可以以氢的形式输出这些清洁能源。澳大利亚、智利和摩洛哥希望向世界“运送阳光”。

随着大量资金投入氢能领域，它的用途可能会增加。大部分工作要靠私营部门完成，但政府也可以尽一份力。任务之一是打击“漂绿”行为：用不清洁的燃料生产氢气，而不配以高质量的碳捕捉，这对抗击气候变化无益。需要制定新规则来计算并公开氢的整个生产周期中的排放，而考虑到氢会被跨境交易，这些规则需要达成国际协议。

政府还应该鼓励打造汇聚各类氢能用户的枢纽，尽量减少基础设施的重复

建设。这样的枢纽已在英国的亨伯赛德郡（Humber）和荷兰的鹿特丹出现。氢有其局限性，但它在带来更清洁的能源上可以扮演重要角色。





Schumpeter

What if firms were forced to pay for frying the planet

If governments get serious, a swinging carbon tax is almost inevitable

MANY QUESTIONS are on the minds of business leaders in the run up to the UN's COP26 climate summit from October 31st to November 12th. For CEOs making the trip to Glasgow, they range from the mundane (travel by train? eat only plant-based food?) to the profound (why am I going in the first place?). The most important question, though, is barely asked: what would happen if governments agreed, sooner or later, to commitments serious enough to limit global warming to 1.5-2.0°C above pre-industrial levels, as stipulated in the Paris climate agreement of 2015? This question has an answer most multinationals shy away from. It would send shock waves through their entire business models.

Businesses, as a rule, do not like being forced to do anything. They prefer to make voluntary gestures—just enough to keep governments off their backs. Right now they are throwing around promises to cut carbon emissions to “net zero” like confetti, on the grounds that such vows attract investors, employees and customers. It is a step in the right direction. And yet some of those pledges are paper-thin. Of more than 4,200 firms in the G20 club of big economies that have disclosed their climate ambitions, only a fifth have committed to so-called science-based targets that would keep the world on track to meet the Paris agreement’s goal. That requires firms to start slashing emissions within years, not decades. For big emitters this poses an instant threat to profitability. It strains credulity to think that altruism is enough to convince firms to act. Governments will have to apply the thumbscrews.

Even business folk realise that the best way to apply pressure is by imposing a global system of carbon taxes, with some form of redistribution to ease

the pain on the poorest thumbs. The trouble is that only about one-fifth of global emissions is covered by a price on carbon. As a result the global average price is just \$3 per tonne of carbon dioxide. To meet the ambitions of the Paris agreement, the IMF says the global carbon price needs to rise to \$75. Others believe it should be almost double that. For some heavy emitters covered by the European Union's emissions-trading system, it is already above €60 (\$69). In China's new (limited) scheme, by contrast, it is a pittance. America has no federal scheme of any kind.

A higher global price would affect all businesses—albeit unevenly. For now, it is treated as too much of a long shot to take seriously. But assume for the moment it actually happened.

The first important thing would be to separate out the heavy emitters from the rest. Early adopters of bold emissions targets come from industries such as retail, where abating is relatively easy. In countries like Britain, where the grid is decarbonising fast anyway, that may require no independent effort on the part of energy users. A small number of sectors responsible for the bulk of listed companies' emissions—power utilities, oil and gas firms, steel- and cement-makers—have a much harder challenge. As demand for carbon-intensive stuff collapses, they would have to find new ways to generate cashflows. Some are dabbling in renewables. Some see a future in low-carbon plastics and materials. But if they cannot turn these swiftly into huge sources of income, they would be better shutting down operations and returning cash to shareholders. Western firms may hope they can sell off their dirtiest assets to state-owned companies in the developing world. Yet these, too, would be subject to a truly global carbon tax. For some, the sooner they start lightening their carbon load, the better.

For a broader set of businesses, supply chains would be the main issue. Standard Chartered, a bank, says almost three-quarters of multinationals' emissions come from their suppliers. Tackling those is an immense task.

Take coal-addled China, where many of them are based. Guido Giacconi of the EU Chamber of Commerce in China says that though the country is investing heavily in renewables, it is “difficult if not impossible” to guarantee that a firm’s energy use is free from coal, because of the opacity of the electricity grid. That makes it hard for firms like Apple to certify that their supply chains in China (where iPhones are made) are carbon-neutral. If its Chinese suppliers were consequently subject to a carbon tax, it might have to raise prices of iGadgets.

Moving supply chains out of China would bring costs, too. In some Asian alternatives, such as Vietnam or Indonesia, fossil fuels are more prevalent than in China. In emerging markets with a lot of clean energy, such as Brazil, the costs of bad infrastructure and red tape are unappealing. Reshoring is unpalatable for many Western firms; the costs of rich-world labour are just too high.

This feeds into a third problem: consumption. A high carbon tax is bound to push up prices, which will change consumer behaviour, especially among lower earners. The tourism industry, for instance, would have to rely less on customers arriving by cheap flights. Supermarkets would need to provide more local foods. People might start tracking the carbon trail of some things they buy, creating headaches for retailers like Amazon.

The flip side would be more innovation. The International Energy Agency, which represents energy-consuming countries, said last year that investments in low-carbon research and development had barely budged since 2012, and was a fifth of what was spent on health and defence. This is pitiful. A carbon tax would change that. Think of hyperloops for long-distant transport; eating bugs, seaweed and lab-grown meat; an endless stream of virtual-reality entertainment as people stay at home rather than consume goods that become less affordable owing to the carbon bill.

Inevitably, some firms which fail to see the writing on the wall will die. But others will swiftly realise that the future is “adapt or perish”. This is not a mantra CEOs will chant at COP26. It should be. When it comes to action on the climate, they are all-too-keen to show off their halos. The thumbscrew is a less appealing accoutrement—but a far more necessary one. ■



熊彼特

企业若被迫为烤热地球买单，会怎样

如果各国政府动真格，巨额碳税几乎不可避免

联合国气候变化大会COP26将于10月31日至11月12日召开，此时此刻许多问题在商业领袖们的脑海中盘旋。对那些准备要动身前往格拉斯哥的CEO们，问题形形色色，有琐碎的（坐火车去吗？只吃植物源性食品吗？），也有艰深的（我到底去干嘛？）。然而，一个最重要的问题却很少被想到：如果各国政府迟早都会一致严肃承诺，要按2015年《巴黎协定》的规定，把全球变暖幅度限制在比工业化前高出1.5至2.0°C的水平，那会发生什么？这是一个大多数跨国公司都会躲闪的问题，因为答案会给它们的整个商业模式带来冲击。

一般来说，企业不喜欢被强迫去做任何事情。它们更喜欢做出自愿的姿态——能让政府不找自己的麻烦就够了。如今，它们像撒五彩纸屑一样，到处承诺要把碳排放减至“净零”，因为这样的誓言能吸引投资者、员工和客户。这一步的方向是正确的。但其中一些誓言如纸屑般无力。在大经济体俱乐部G20的4200多家已公布气候行动目标的企业中，只有五分之一在致力推进所谓基于科学的、将让世界朝着实现《巴黎协定》目标的方向前进的减排目标。这要求企业在几年而不是几十年内开始大幅削减排放。对排放大户来说，这会立即威胁它们的盈利能力。很难相信只凭利他主义就能说服企业采取行动。政府将不得不用上拇指夹这个刑具。

就连商界人士也意识到，最佳施压方式就是强制实施全球碳排放征税体系，并通过某种形式的再分配来减轻最羸弱的手指的疼痛。问题是全球只有大约五分之一的碳排放为碳定价机制所覆盖。由此带来的结果是，全球平均碳价仅为每吨二氧化碳三美元。国际货币基金组织（IMF）表示，要达到《巴黎协定》的目标，全球碳价需要涨到75美元。还有机构认为应该在这一价格上差不多再翻一倍。对一些被欧盟排放交易体系覆盖的高排放企业来说，碳价已经超过了60欧元（69美元）。相比之下，中国新（且有

限的）的机制中的碳价低太多。而美国没有任何形式的联邦碳定价机制。

全球碳价上涨将影响所有企业——尽管影响有大有小。就目前而言，人们认为这种情况真的发生的可能性非常小，还不必认真考虑。但我们暂且假设它真的发生了。

第一件重要的事是把高排放企业从其他企业中分离出来。早早制订大胆减排目标的企业都来自零售业等减排相对容易的行业。英国等一些国家的电网正在快速脱碳，可能也就不需要能源用户自己多费心了。产生上市公司大部分碳排放的少数几个行业——电力企业、石油和天然气公司、钢铁和水泥制造商——面临的挑战则要大得多。随着对碳密集型产品的需求暴跌，它们将不得不寻找产生现金流的新方式。一些公司开始涉足可再生能源。一些公司看好低碳塑料和材料。但如果它们不能迅速将这些转化为巨大的收入来源，那它们最好还是关门大吉，把现金还给股东。西方企业可能希望把自己污染最严重的资产出售给发展中国家的国有企业。然而，后者也必须缴纳实打实的全球碳税。对一些企业来说，着手减轻自己的碳负荷是越早越好。

对更多企业来说，供应链会是个主要问题。渣打银行表示，跨国公司近四分之三的碳排放来自它们的供应商。解决这些碳排放是一项艰巨的任务。以煤炭污染严重的中国（这些供应商很多就来自中国）为例。中国欧盟商会（EU Chamber of Commerce in China）的贾可尼（Guido Giacconi）表示，尽管中国正在大力投资可再生能源，但由于其电网的不透明性，要保证一家企业的耗能已经脱碳“即使不可能，也很难”。这使得苹果等公司难以证明它们在中国（iPhone在这里生产）的供应链做到了碳中和。如果它的中国供应商因此被征收碳税，苹果可能不得不提高自家电子产品的价格。

将供应链移出中国也会产生成本。在其他一些亚洲国家，比如越南或印尼，化石燃料的使用比中国更普遍。而在巴西等拥有大量清洁能源的新兴市场，糟糕的基础设施和繁琐的办事流程引发的成本让人望而却步。对许多西方公司来说，回流本土是难以接受的，因为发达国家的劳动力成本实

在太高了。

这就引发了第三个问题：消费。高碳税势必会推高物价，这将改变消费者的行为，尤其是低收入群体。例如，旅游业将不得不减少依赖买低价机票来访的游客。超市需要提供更多本地食品。人们可能会开始追踪自己购买的某些商品的碳足迹，给亚马逊这类零售商带来麻烦。

在事情的另一面，更多创新将涌现。代表能源消费国的国际能源署（IEA）去年表示，自2012年以来，在低碳研发上的投资额几乎没有变化，仅为医疗和国防支出的五分之一。这少得可怜。碳税将改变这种状况。可以想象一下用于长途运输的“超级高铁”；人们吃昆虫、海藻和实验室培育的肉；源源不断的虚拟现实娱乐供应——因为人们都足不出户，减少消费因碳价变得难以负担的商品。

一些后知后觉的公司免不了要倒闭。但其他公司将很快意识到，未来是“不适应，就灭亡”。CEO们不会在COP26上呼喊这样的口号。但它应该被呼喊。当涉及到应对气候变化的行动时，他们都太热衷于炫耀自身光环。手上套着的拇指夹不是什么好看的装饰，却是必不可少的一件。■



A reckoning in Glasgow

Broken promises, energy shortages and covid-19 will hamper COP26

It is the most important climate conference in years

LAST-MINUTE APPEALS are common in the weeks preceding the COP, the UN's annual climate summit. Green groups urge world leaders to promise bold action. Poor countries ask rich ones for money. Ahead of this year's event, which starts in Glasgow on October 31st, a group representing indigenous people is asking for donations of jackets, wellies and waterproofs. It notes that Amazonian indigenous folk who plan to attend "have not experienced a climate like a Scottish winter".

This year's summit is COP26—the 26th Conference of the Parties to the UN Framework Convention on Climate Change. It marks the most important climate talks since 2015, when the Paris agreement was signed. That is largely because of what countries promised they would do by this point. All countries are supposed to have announced tough new targets for reducing emissions. Rich countries are supposed to be helping poor ones finance green schemes. On both fronts, the world is coming up short. The proceedings in Glasgow may be chilly indeed.

The Paris agreement was adopted by the vast majority of countries. They promised to try to keep the increase in the Earth's mean surface temperature to "well below" 2°C compared with pre-industrial levels, and ideally to no more than 1.5°C. In terms of the detrimental impact of global warming, the gap between those two targets is large. But temperatures have already risen by 1.1-1.3°C since the invention of the steam engine. So limiting heating to 1.5°C is a colossal task. To have a good chance of achieving it, the world must make net emissions of carbon dioxide 45% lower in 2030 than they were in 2010, and reduce them to zero by the middle of this century.

The Paris agreement did not demand such cuts—nor could it have done so. Instead countries pledged themselves to emission-reduction strategies known as Nationally Determined Contributions (NDCs). The NDCs brought to the table in Paris did not match the agreement's lofty aims. They put the world on track to be around 3°C hotter than the pre-industrial baseline by 2100. But the treaty required that every five years all parties should up their game with new, more ambitious NDCs. The Glasgow conference (which is taking place a year later than planned, because of covid-19) is the due date for the first round of beefed-up pledges.

Governments began announcing new pledges last year. Rich countries have been more ambitious than poor ones. The European Union (EU) promises that by the end of the decade it will have cut emissions by 55% compared with 1990 levels. It had previously promised only a 40% decline. America says that by 2030 it will have cut emissions by 50-52% from 2005 levels. It had previously proposed only a 26-28% cut by 2025. These two parties account for 23% of the world's carbon-dioxide emissions.

Australia is an outlier among rich countries. Its original NDC was not particularly ambitious. Nor is its new one. Meanwhile many emerging economies have set lax targets. Russia and Indonesia are promising no new effort. By employing some creative carbon accounting, Mexico and Brazil have produced new strategies that are less ambitious than their original plans.

India, which is responsible for 7% of carbon-dioxide emissions, has not yet published a fresh climate strategy. Nor has China, which accounts for 28%. Last year it said that it planned to make its emissions peak “before” 2030, having previously said only that it would reach this milestone “around” that time. Many would like it to bring this date forward, but Li Shuo of Greenpeace thinks that is unlikely to happen soon. He says there is more chance China might strengthen its pledge by declaring an absolute figure

above which its annual emissions will not rise.

Taken together, the new targets underwhelm. Promises made by the middle of this year give a 50% chance of keeping warming below 2.1°C but only a 5% chance of keeping it under 1.5°C, according to the International Energy Agency (IEA), a forecaster (see chart). And this assumes that all the pledges are honoured, which is far from guaranteed.

On the tail of these lacklustre announcements is a failure relating to funding for developing countries. In 2009 rich countries vowed that by 2020 they would be providing poor ones with \$100bn in climate finance each year. Roughly equal amounts were to go towards adaptation and to reducing emissions. The figure is a fraction of the \$2trn annual investment that the IEA believes developing countries need. But the promise is supposed to signal the willingness of richer countries to make sacrifices for the good of the planet.

In 2019 only \$80bn was provided, according to the OECD, a club of rich countries. This year a last-minute whip-round could perhaps see the total rise above \$100bn before the conference. But poor countries are miffed. The original deadline was 2020—when, because of the pandemic, the total was probably lower even than in 2019. And only about 25% of the cash is financing ways of adapting to climate change, instead of the 50% promised.

All these disappointments will cause hand-wringing at the summit. Rich countries may re-emphasise their willingness to lend. They may offer an aggregate figure over several years, such as \$500bn between 2020 and 2025. But no country is likely to swiftly adjust its new NDC. Designing them takes months of work and co-ordination across government departments.

Instead, progress in Glasgow will probably have to come from agreements struck in narrower debates, the outcomes of which will help countries

implement their existing climate strategies, and make them more likely to increase their ambitions in the future. One job is to agree on rules for international carbon markets, such as what double-counting means when it comes to carbon credits.

A second debate is about “loss and damage”, meaning how far countries that will suffer most from climate change should receive compensation. The topic is taboo among rich countries. In Paris they eventually allowed the concept to be mentioned in the agreement, but resisted language that might actually lead to something being done. Poor countries hope to move it up the agenda and to lay the groundwork for more concrete discussions in the future.

Third comes the effort to get governments to sign up to sector-level pledges, such as to stop burning coal, ban the sale of internal-combustion engines and halt deforestation. The Global Methane Pledge, a promising new pact, calls for cutting global methane emissions by at least 30% from 2020 levels by 2030. Its backers include America and the EU. Measured over 20 years, a tonne of methane causes 86 times more warming than a tonne of carbon dioxide but the gas is naturally removed from the atmosphere much faster than CO₂. The Climate and Clean Air Coalition, made up of governments and lobby groups, says cutting human-made methane emissions in half by 2050 could lower temperatures by about 0.2°C.

The fourth topic is what Helen Mountford of the World Resources Institute, a think-tank, calls “keeping 1.5°C alive”. Green groups and some governments want countries to acknowledge that the world is failing to slow global warming, and to state explicitly that they wish to keep the increase under 1.5°C. China and India refused to back a similar statement at the G20 summit in July. They feel that if the temperature targets are revised the same should happen to the climate-finance goals.

A global energy shortage provides an unfortunate backdrop to the discussions. In Asia coal shortages are forcing factories to curb output. European gas and power prices have gone berserk. Governments are watching Joe Biden try to get legislation containing support for clean-energy firms through Congress. The wrangling is a reminder of the difficulties democratic countries face when they seek to enact big climate reforms.

Covid-19 has increased the costs and risks of getting negotiators to the summit. Poor countries, in particular, may send fewer than usual. Even in normal times they are at a disadvantage to rich places, which can send hordes of technocrats. The fact that many rich countries appear to be past the worst of the pandemic, while poor ones are still struggling through it, will only make such inequalities rankle more.

All this could deepen the usual factionalism. Delegations attending the COP typically form three blocks. Poor countries ask rich ones for more ambition and more money. Rich countries try to convince emerging ones, which account for the lion's share of the growth in emissions, to pollute less. And emerging economies try to tell rich countries that they are in fact part of the poor and vulnerable group, while also reminding rich countries that they got where they are today by polluting.

Yet there are some signs that these old alliances are loosening. Emerging economies have less excuse for inaction than they did when Donald Trump was in the White House, says Laurence Tubiana of the European Climate Foundation, a lobby group (Mr Trump pulled America out of the Paris agreement; it rejoined in February). Some, such as South Africa, are becoming more ambitious. In September China said it would no longer finance new coal-fired power stations outside its borders. Natural disasters in rich countries, such as floods in Germany that killed almost 200 people, may bring a new sense of urgency.

Any progress made at COP26 will probably be incremental, not a “big leap” of the sort John Kerry, America’s climate envoy, has promised. That will enrage grassroots activists. And it hardly matches the scale of the challenge. Two years from now a “Global Stocktake” scheduled under the Paris agreement will examine how well governments are implementing their climate plans. If their most recent climate promises are any indication, the stocktake could reveal a rather bare cupboard. ■



格拉斯哥清算

违背承诺、能源短缺及新冠疫情将拖累COP26

这是几年来最重要的气候峰会【深度】

“最后的呼声”在联合国年度气候峰会COP召开前的几周里很常见。环保组织敦促各国领导人承诺采取果敢行动。穷国请求富国提供援助。今年的峰会将于10月31日在格拉斯哥召开，一个代表原住民利益的团体在会议前夕请求捐赠夹克、长筒雨鞋和防雨衣物。它指出，计划参加峰会的亚马逊原住民“没有经历过像苏格兰冬天那样的天气”。

今年的峰会名为COP26，也就是《联合国气候变化框架公约》缔约方第26次会议。它是自2015年《巴黎协定》签署以来最重要的气候会议，主要是因为各国之前都承诺过到此时要做什么。所有国家按说都已经公布了严格的减排新目标。富国应该正在帮助穷国为绿色计划融资。但在这两方面，实际进展都不及预期。这次在格拉斯哥举行的会议可能真的会寒风瑟瑟。

绝大多数国家都签署加入了《巴黎协定》，承诺努力把地表平均温度较工业化前水平的升幅控制在“远低于” 2°C ，最好不超过 1.5°C 。就全球变暖造成危害而言，这两个目标之间的差距相当之大。但自蒸汽机发明以来，气温已经上升了 1.1°C 至 1.3°C 。所以，把最终升温幅度控制在 1.5°C 以下是个无比艰巨的任务。若想要有较大的机会实现它，全球二氧化碳净排放量到2030年必须比2010年降低45%，到本世纪中叶须减至零。

《巴黎协定》没有提出这样的减排要求，也不可能做此要求，而是由各国承诺采取名为“国家自主贡献”（Nationally Determined Contributions，以下简称NDC）的减排战略。但当时定下的那些NDC很可能会令全球温度在2100年比工业化前的基线上升约 3°C ，与《巴黎协定》的远大目标并不匹配。不过该协定要求所有缔约方每五年更新一次NDC，做出更大胆的减排承诺。这次格拉斯哥峰会（因疫情推迟了一年举行）就是拿出第一轮升级承诺的截止期。

各国政府自去年开始宣布新承诺。富国的抱负比穷国大。欧盟承诺到2030年其排放将比1990年减少55%，而此前的承诺是减少40%。美国表示，到2030年其排放将比2005年减少50%至52%。它之前的目标是到2025年仅减排26%至28%。这两方的二氧化碳排放占了全世界的23%。

澳大利亚是富国中的异类。它最初的NDC目标就不算高，新目标依然如此。与此同时，许多新兴经济体设定的目标宽松无力。俄罗斯和印度尼西亚没有做出新承诺。墨西哥和巴西挖空心思调整碳核算方法，制定出的新战略比原来的目标还低些。

碳排放占比为7%的印度尚未公布新的气候战略。占比28%的中国也一样。去年，中国表示将在2030年“之前”实现碳达峰，而此前的说法是在2030年“前后”达到这一目标。许多人希望中国能把期限提前，但绿色和平组织的李硕认为这在近期不太可能实现。他说，中国强化其承诺的方式更有可能是宣布一个年排放量的绝对上限。

总体而言，这些新目标令人失望。据国际能源署（IEA）预测，在今年年中之前做出的承诺能令升温低于2.1°C的几率为50%，低于1.5°C的几率仅为5%（见图表），前提是所有承诺都兑现，而这一点远不能保证。

在这些乏善可陈的新目标的背后，存在着对发展中国家资助不足的问题。2009年，富国承诺在2020年之前每年向发展中国家提供1000亿美元的“气候融资”。这笔钱会差不多分成两半，分别投向适应气候变化和减排。国际能源署认为发展中国家每年需要2万亿美元的投资，相比之下这笔资助只是个零头。但这一承诺本应是一种表态，显示更富裕的国家愿意为整个地球的利益做出牺牲。

富国俱乐部经合组织的数据显示，2019年提供的这笔资助仅为800亿美元。今年，赶在气候峰会召开前的最后一刻再凑一凑的话，资助总额可能会超过1000亿美元。但穷国有些不满。原本的最后期限是2020年，但受疫情影响，这一年间的资助可能比2019年还少。而且只有约25%的资金投向适应气候变化，而非之前承诺的50%。

这些令人失望之处将在峰会上引发焦虑。富国可能会重申自己愿意提供贷款。它们可能会提出在未来几年里的一个贷款总数，例如在2020年至2025年出借5000亿美元。但应该不会有哪个国家因而迅速调整自己的NDC新目标，毕竟这需要政府部门花费几个月时间做工作和相互协调。

相反，在格拉斯哥取得的进展也许只能源自于范围更小的议题上达成协议，帮助各国贯彻既有的气候战略，并使其更有可能在未来提高行动目标。其中一项议程是就国际碳市场的规则达成协议，例如界定在碳信用额度中何谓“重复计算”。

第二个议题是关于“损失和损害”，也就是那些将因气候变化承受最大冲击的国家能在多大程度上得到赔偿。这是富国的禁忌话题。最终它们同意在《巴黎协定》中提及这个概念，但不同意任何指向实际行动的陈述。穷国希望把这个问题提上议程，为未来更具体的讨论打下基础。

第三个议题是要让各国政府签署行业级承诺，如停止使用燃煤、禁止销售内燃机和停止砍伐森林。予人希望的新协议《全球甲烷减排承诺》（Global Methane Pledge）呼吁在2030年前把全球甲烷排放量在2020年的水平上降低30%。该协议的支持者包括美国和欧盟。超过20年的测量数据显示，一吨甲烷造成的升温效应是一吨二氧化碳的86倍，但甲烷从大气中自然消失的速度比二氧化碳快得多。由政府和游说团体组成的气候和清洁空气联盟（Climate and Clean Air Coalition）表示，如果到2050年人为甲烷排放能减半，气温可降低约0.2°C。

第四个议题是智库世界资源研究所（World Resources Institute）的海伦·芒福德（Helen Mountford）所说的“让1.5°C的目标屹立不倒”。环保组织和一些国家的政府希望各国能承认世界未能减缓全球变暖并能明确表态要把升温幅度控制在1.5°C以下。在今年7月举行的G20峰会上，中国和印度拒绝同意一项类似的声明。它们觉得如果要改变升温上限目标，气候融资的目标也应随之改变。

眼下的全球能源荒给这些讨论蒙上了一层阴影。在亚洲，煤炭短缺迫使工

厂减产。欧洲的天然气和电力价格疯涨不止。各国政府都在盯着看拜登要如何让一项法案在国会通过，它包含了对清洁能源企业的支持措施。这当中长期的争执不下又一次昭示了民主国家在大举实施气候改革时面对的困难。

疫情加大了派代表出席峰会的成本和风险。穷国代表尤其可能少于往年。即使在正常时期穷国也处于劣势，毕竟富裕地区可以派出大批技术官员。许多发达国家似乎已走出了疫情最严重的时期，穷国却依然焦头烂额，这只会加深上述不平等状态带来的积怨。

这一切可能会加剧一贯存在的派系争斗。参加气候峰会的代表团通常分为三大阵营。穷国要求富国加大减排力度和增加资助。富国试图说服在排放增量中占大头的新兴国家减排。新兴经济体则对富国表示自己实属脆弱的穷国，并提醒富国别忘了它们是一路大肆排污走到了今天。

不过，也有一些迹象显示这些旧有联盟开始松动。游说团体欧洲气候基金会（European Climate Foundation）的劳伦斯·图比亚纳（Laurence Tubiana）指出，相比特朗普执政时期，新兴经济体不作为的借口减少了（美国在特朗普治下退出了《巴黎协定》，今年2月又重新加入）。其中南非等国在减排上变得愈发雄心勃勃。9月，中国表示将不再投资新建境外煤电项目。富国发生的自然灾害（比如在德国造成近200人死亡的洪灾）也许会带来新的紧迫感。

COP26可能只会取得渐进式的进展，而非美国气候特使约翰·克里（John Kerry）承诺的那种“大飞跃”。这将激怒民间活动人士。而且这样的进展也与气候挑战的严峻性全不相称。两年后，按《巴黎协定》安排的“全球盘点”将审视各国政府执行自身气候计划的情况。如果说各国最近的气候承诺显露了什么端倪的话，那就是两年后的盘点也许会发现成果寥寥无几。





The new Anthropocene diet

Technology can help deliver cleaner, greener delicious food

Whether consumers want it is another question, says Jon Fasman

“TELL ME WHAT kind of food you eat, and I will tell you what kind of man you are,” wrote Jean Anthelme Brillat-Savarin, a French lawyer and epicure, in the early 19th century. The epigram opens “The Physiology of Taste,” one of those delightfully dilatory, observational works at which his age excelled.

The food that most people eat—especially in rich countries, but increasingly in poor- and middle-income ones, too—reveals them to be inhabitants of a highly globalised economy, spectacularly rich in choices. Peruse the shelves of a rich-world supermarket and you will find salmon from Norway, prawns from Vietnam, mangoes from India, strawberries from Turkey, cured meats from Italy and cheeses from France. Meat, a luxury for most people through much of history, is available in such affordable abundance that, in the rich world, most who do not eat it regularly forgo it as a matter of choice, not necessity. Much of it is laced with chemical additives that reduce spoilage, enhance flavour or serve some other need on the part of the producer.

Such a diet has only become possible in a very particular world, one in which a large proportion of the planet’s surface is given over to farms and pasture, food production is energy-intensive, pesticides abundant, intercontinental shipping cheap and food processing an advanced industrial undertaking. It is only possible, that is to say, at a time when human desires, and the economies built around them, rank among the planet-shaping forces of nature: a period that has come to be known as the Anthropocene.

The Anthropocene diet that the world’s well-off inhabitants enjoy would

amaze all previous generations. But like most remarkable modernities, it is not without its costs. Meat is cheap because it is produced with great cruelty. Billions of animals spend brief, miserable and often pain-racked lives crammed together in airless sheds. They are ripped from their mothers; pumped with drugs; castrated without anaesthetic; eviscerated while alive; or all of the above.

Picking berries and lettuce is backbreaking labour; the people who do it often lack health insurance, job protections and a living wage. Many of the world's fisheries run on slave labour. Depleted soils are chemically tarted up into a fecund semblance of health with nutrients straight from the factory. Fertiliser and animal-waste runoff create algal blooms that strip the oxygen from ever more, ever larger dead zones in littoral seas. Few human activities emit more greenhouse gases than raising animals—particularly cattle, for which ranchers cut down vast swathes of forest. The processing that serves to make food cheap, tasty and addictive strips out nutrients while adding fats, sugars and salt.

It would be easy to conclude, per Brillat-Savarin's maxim, that the Anthropocene diet's consumers are cruel to animals and indifferent to both their planet's future and their own—because the Anthropocene diet is all of those things. That would be far too harsh. Taking a moral inventory of every food's inputs is a lot to ask of, say, a mother on a tight budget, on her way home from work, who just wants a dinner that makes her children happy. That does not mean she does not care, or would not prefer a system that does better by her family and the world.

Many have begun to alter their dining choices to help bring about such a system. The amount of meat eaten in the world is growing, but less so in richer countries than poorer ones. The share of people who identify as vegetarian, vegan or "flexitarian"—meaning their diet is centred on plants but that they do not entirely eschew the eating of animals—is rising. In

Britain, the number of vegans more than quadrupled from 2014 to 2019.

In America, sales of organic food—which people take to be better both for themselves and for the environment—rose from \$13.3bn in 2005 to \$56.4bn in 2020; Europe saw a similar rise. Restaurant menus often name the farms that supply their food, giving diners a greater sense of connection to what they are eating. The word “locavore”, coined in 2005, was an American dictionary’s “word of the year” by 2007.

There is a performative aspect to much of this. People want what they eat to say good things about them—both to others and to themselves. This is neither an ignoble desire nor a new one. The dietary restrictions set down in Leviticus and Deuteronomy, as the late Hayim Halevy Donin, a rabbi, explained in his book “To Be a Jew”, offer “a good example of how Judaism raises even the most mundane acts...into a religious experience.” Eating, common to all people, becomes an act of Jewish self-definition.

Flexitarian, locavorous and organic eating are not religious. But they make a moral statement: the belief that participating in the hyper-rationalised, hyper-calorific, hyper-processed industrial first-world food system is wrong. What they do not in themselves provide is a way to set that system right, in part because they do not properly assess its flaws. The raising of organic food, for example, typically requires more land than other methods, and can often produce greater greenhouse-gas emissions. A personal devotion to the legume over the nugget or the aubergine over the burger may save you from direct complicity in the suffering of chicken and cow; but it does not stop the suffering.

But what if the system itself could be changed? What if people who shared the distaste for today’s food system could encourage the building, seed by seed and cell by cell, of ways to provide a delicious, healthy, diverse array of

foods with markedly less cruelty and environmental damage?

This report will survey an array of technologies being touted as ways of transforming the world's food-production system not by doing old forms of agriculture in a less cruel and more sustainable way, but by doing things that have never been done before.

Heretofore niche proteins, such as insects and seaweeds, are being explored not just for their gourmet potential—which is higher than most might believe—but also as ways to refashion food chains. Yeasts are being programmed to grow proteins that make a soy-protein patty cook and bleed in the way a minced cow does. Inland saline aquaculture promises to provide fresh seafood to people thousands of miles from an ocean. Crops are being grown in soil-free shipping containers just blocks from the city dwellers who will eventually eat them, rather than half a world away. Cells taken from a living animal in a simple biopsy are being used to grow meat in bioreactors, providing familiar sources of protein without the need for slaughter or industrial-scale farming and the cruelty and health hazards those things entail.

Immense hurdles remain. It is one thing to grow a hamburger in a tank, another to get people to eat it, and a third to provide competitively priced tankburgers by the billion. Growing vegetables in skyscrapers might be environmentally beneficial, but field-based agriculture remains much cheaper. Practical and necessary improvements to today's farms, such as regenerative farming techniques, could be sidelined in favour of incoherent and unsustainable Utopian neophilia that offers niche feel-good foods for a few, but little if anything for the many—or for the suffering animals. Some technologies which currently seem beneficial will turn out to incur unforeseen costs and harms, just as cheap meat has.

Yet there is something undeniably inspiring about this attempt to turn

Brillat-Savarin on his head: deciding first what sort of person you want to be, and what sort of planetary settlement you want to embody, and then changing the world so that the kind of food it provides for you to eat fits that self-conception.

The movement has a recognisable, hard-to-resist ferment: a hype-heady nose and feel redolent of the terroir in which California raises its new technology. One starry-eyed Californian faux-meat scientist enthuses that the field feels like working in Silicon Valley in the 1970s: optimistic, dynamic and buzzy. The quest to change the world's food system, though, begins in a grungy town at the other end of the state. And the story starts with a pea. ■



人类世新膳食

技术可以帮助提供更清洁、更环保的美味食物

消费者是否想要是另一回事，乔恩·法斯曼说【专题《人类世新膳食》系列之一】

“告诉我你吃什么样的食物，我就能告诉你你是什么样的人。”法国律师兼美食家让·安特尔姆·布里亚特-萨瓦林（Jean Anthelme Brillat-Savarin）在19世纪早期写道。这个警句为《味觉生理学》（The Physiology of Taste）一书开篇，这是他那个年龄段的人擅长的那类舒缓闲适的观察性作品。

如今大多数人吃的食品都暴露出他们是一个高度全球化经济体系中的居民，选择极其丰富。富裕国家的民众尤其是这样，但在贫困和中等收入国家也日益如此。仔细看看富裕世界的超市货架，你会发现来自挪威的鲑鱼、越南的大虾、印度的芒果、土耳其的草莓、意大利的腌肉和法国的奶酪。肉类在历史上大部分时期对大多数人都是奢侈品，但如今供应如此丰富，价格如此实惠，以至于在富裕国家，大多数不经常吃肉的人是主动选择而不是被迫放弃它的。大部分肉类都含有化学添加剂，可以减少腐坏、增强风味，或满足生产者的一些其他需求。

这种饮食唯在一个非常特殊的世界中才成为了可能：在这个世界里，地球表面的很大一部分都被用作农场和牧场，粮食生产是能源密集型的，大量使用农药，洲际运输便宜，食品加工是一项先进的工业任务。也就是说，人类的欲望以及围绕它们建立的经济体成为了塑造地球的自然力量之一：这个时期被称为人类世。

世界上富裕的居民所享受的人类世饮食会让所有前人惊叹不已。但就像大多数卓越的现代特征一样，它不无代价。肉之所以便宜，是因为它的生产过程非常残酷。数十亿只动物挤在不透气的棚子里，过着短暂、悲惨且常常饱受痛苦的生活。它们被从母亲身边夺走，灌注大量药品，未经麻醉而阉割，还活着时就被去除内脏，或经历以上所有。

采摘浆果和生菜的劳动很艰苦，劳动者往往缺乏健康保险、工作保障和足

以维持生活的工资。世界上许多渔场都使用强迫劳动。直接来自工厂的化学养分给耗竭的土壤披上了健康的外衣。化肥和动物排泄物的径流造成藻华大量繁殖而耗尽氧气，让濒海死区越来越多、越来越大。很少有人类活动比饲养动物排放的温室气体更多了，尤其是养牛，牧场主为此砍伐了大片森林。用于使食物便宜、美味和令人上瘾的加工过程在去除营养的同时添加了脂肪、糖和盐。

按照布里亚特-萨瓦林的警句，我们很容易得出结论，人类世饮食的消费者对动物很残忍，对这个星球和他们自己的未来都漠不关心——因为人类世饮食就带着所有这些特征。这样说太苛刻了。对每一样食物的成分都进行道德盘点对很多人来说要求太高了，想想一位需要精打细算的母亲，她在下班路上不过是想着弄一顿能让自己的孩子开心的晚餐。这并不意味着她不在乎，或者不喜欢一个对她的家人和世界更好的体系。

许多人已经开始改变他们的用餐选择，以帮助实现这样的体系。全球肉类食用量在增加，但在富国的增长比穷国慢。自认素食主义者、纯素食主义者或“弹性素食主义者”（即饮食以植物为中心，但并不完全避免食用动物）的人数正在上升。在英国，纯素食主义者的数量从2014年到2019年翻了两番多。

在美国，人们认为有机食品对自己和环境都更好，其销售额从 2005 年的 133 亿美元上升到 2020 年的 564 亿美元；欧洲也出现了类似的增长。餐厅菜单中常常会写出供应食物的农场，让用餐者对自己所吃的东西有更强的连结感。2005 年创造的“locavore”（本地膳食主义者）这个词到 2007 年成为了美国词典的“年度词汇”。

这其中有很大的表演成分。人们希望吃的东西让自己脸上有光——无论是在他人还是自己看来。这种欲望无可厚非，也并不新奇。正如已故的拉比海姆·哈莱维·多宁 (Hayim Halevy Donin) 在他的书《成为犹太人》(To Be a Jew) 中解释的那样，《圣经·利未记》和《申命记》中规定的饮食限制提供了一个很好的例子，说明犹太教如何将最平凡的行为……升华为宗

教体验。”吃，对所有人来说都是共通的，却成为犹太人定义自我的行为。

弹性素食、本土膳食和有机饮食不是宗教性的。但它们传达出一种道德信念：它们认为参与到运转极高效、超高热量、高度加工的第一世界工业食品体系之中是错误的。它们本身并没有提供修正这一体系的方法，部分原因是它们没有正确评估其缺陷。例如，有机食品的种植通常比其他方法需要更多的土地，并且往往会排放更多的温室气体。个人热爱豆类而非鸡块，或是热爱茄子而非汉堡或许可以让你免于直接成为造成鸡和牛的痛苦的同谋；但它并没有终结这种痛苦。

但是如果这个体系本身可以被改变呢？如果对今天的食物体系怀有同样厌恶的人们可以一粒种子一粒种子、一个细胞一个细胞地鼓励建立一些途径，提供美味、健康、多样化的食物，同时显著减少残忍和环境破坏呢？

本专题报道将调查一系列号称能改变世界食物生产系统的技术——不是通过以不那么残酷和更可持续的方式开展旧形式的农业，而是通过做以前从未做过的事情。

迄今为止，人们正在探索昆虫和海藻等小众蛋白质，不仅仅是因为它们的美食潜力——比大多数人想象的要高——同时也因为可以用它们重塑食物链。酵母正在被修改以生长蛋白质，让大豆蛋白“肉”饼能像碎牛肉一样烹饪和流血。内陆咸水养殖有望为与海洋相距千里的人们提供新鲜的海鲜。农作物被种植在无土的运输容器中，距离最终会吃掉它们的城市居民只有几个街区，而不是半个地球。利用简单的活检从活体动物身上提取的细胞被用于在生物反应器中种植肉类，提供熟悉的蛋白质来源，而无需屠宰动物或开展工业规模的农业，也免于这些事情带来的残忍和健康危害。

巨大的障碍仍然存在。在罐子中种植汉堡包是一回事，让人们吃它是另一回事，而提供具有价格竞争力的 10 亿个“罐堡包”是又一回事。在摩天大楼里种植蔬菜可能对环境有益，但田间种植的农业仍然便宜得多。对当今农场的实际和必要的改进，例如再生农业技术，可能会被搁置一边，转而支

持七零八落、不可持续的乌托邦式新欢——它们为少数人提供让他们感觉良好的小众食物，但对大多数人（或受苦的动物）来说几乎毫无影响。一些目前看似有益的技术将导致无法预料的代价和危害，就像廉价肉类那样。

然而，不可否认，这种试图把布里亚特-萨瓦林的话颠倒过来的尝试有一些鼓舞人心的地方：首先决定你想成为什么样的人，你希望自身展现何种行星家园的面貌，然后改变世界，使它为你提供的食物符合这种自我认知。

这场运动有一种容易识别的、难以抗拒的骚动：对炒作敏感的嗅觉和感知，让人想起加州涌现新技术的风土。一位想入非非的加州人造肉科学家热情洋溢地说，在这个领域感觉就像在1970年代的硅谷工作：乐观、充满活力，振奋人心。然而，改变世界食物体系的探索始于该州另一端一个脏兮兮的小镇。故事从一颗豌豆开始。 ■



Free exchange

How soaring energy costs could hobble the covid-19 recovery

Past shocks have raised inflation and induced economic slumps

FUEL PRICES over the past month show the same vertiginous upward slope as a covid-19 case count during a particularly brutal wave. Coal and gas prices have touched all-time highs. Asian spot prices for gas have jumped by nearly 1,000% in the past year. The cost of oil has soared as shortages of other fuels have pushed up demand for crude.

Surging energy costs are in many respects an expression of the same phenomenon driving supply-chain backlogs all over the world. An unexpectedly strong rebound in demand has run headlong into stagnant supply. Disruptions, such as shortfalls in hydroelectric-power production caused by droughts, have exacerbated the shortages. So has the rush to boost low inventories in response to the energy crunch. But surging fuel prices are also more ominous than supply-chain woes. Past energy shocks have been associated not only with inflation, but deep recessions, too, as exemplified by the economic travails of the 1970s. What does the latest crunch hold in store?

The inflationary consequences of costly energy are already apparent. In the euro area, headline annual inflation jumped to 3.4% in September, thanks to a 17.4% leap in energy costs. Underlying “core” inflation (which excludes food and energy prices) rose by a more modest 1.9%. In America underlying inflation ran hotter in September, at 4%. But a 24.8% increase in energy costs pushed the headline rate up even higher, to 5.4%. These figures are likely to rise further in coming months, since rocketing fuel prices in October have not yet made their way into the statistics.

The contribution of energy to inflation will begin to fade once prices plateau—as they may in coming months, and even sooner if winter proves no colder than usual. Recent analysis by economists at Goldman Sachs, a bank, suggests that the effect of energy costs on America’s year-on-year inflation rate stood at 2.15 percentage points in September and will likely rise to 2.5 percentage points by the end of this year—taking the headline rate to 5.8%, holding other components constant—before eventually turning slightly negative by the end of 2022.

What about the damage to growth? The predominant factor, in the near term at least, is the effect on consumption and investment. Over short time horizons, households and firms cannot easily cut energy use in response to rising costs, leaving less to spend on other goods and services. This effect, according to work by Paul Edelstein of State Street, a bank, and Lutz Kilian of the Federal Reserve Bank of Dallas, is concentrated in the consumption of durable goods; a rise of 10% in the price of energy is associated with a 4.7% decline in spending on durables (and a particularly large drop in purchases of vehicles).

Yet the researchers also note that consumption tends to fall by more in response to rising fuel costs than you might expect given the share of energy in budgets. That seems to be because energy shocks tend to depress sentiment. James Hamilton of the University of California, San Diego, studies historical oil shocks and finds that a 20% rise in the real price of energy is associated with a 15-point drop in an index of consumer confidence. (A gauge of American sentiment collected by the University of Michigan has fallen by nearly 17 points since April 2021.)

An energy-induced slump could be mitigated if consumers meet higher bills by drawing on savings. By the end of 2020, households across large rich economies had accumulated “excess”, or above-normal, savings equivalent to more than 6% of GDP. Nonetheless, analysts at Goldman reckon that

costly energy will reduce the growth rate of consumption in America by 0.4 percentage points this year, and by 0.5 points in 2022. Those inclined to see the petrol tank as half full may note that slower consumption growth could help ease strains on supply chains, which have been stressed by especially strong demand for durable goods. Those who grumble that it is half empty may worry that power cuts in places like China could result in still more shortages.

Crucially, the toll of the shock will depend on how central banks respond. Fuel prices tend to feed through to households' expectations of inflation. That will be unwelcome news for central bankers, who are already worrying about high inflation. Research by Mr Kilian and Xiaoqing Zhou, also of the Dallas Fed, suggests that energy prices mainly influence short-term expectations, rather than those further out. Those expectations could adjust just as quickly when energy prices fall. Some central banks, such as the Bank of England, may nevertheless worry that the energy shock worsens the risk that inflation expectations become unmoored from their targets. But the dilemma is that, if they overreact, they depress consumption further and induce deflationary pressure, just as energy prices return to earth.

The longer prices stay high, the more their effects evolve. Households and firms will become better able to reduce their exposure to energy. Indeed, work by John Hassler, Per Krusell and Conny Olovsson of the Institute for International Economic Studies in Stockholm suggests that costly energy affects the nature of innovation. Firms direct inventive efforts so as to economise on scarce inputs. When energy is abundant, they focus on capital- or labour-saving innovation. When energy is scarce, by contrast, firms do more to improve the energy-efficiency of production, and innovation suffers—as it did in the 1970s.

The extent to which history repeats, however, also depends on what governments do. They could shield customers from higher energy prices,

which would be politically popular but delay the moment of transition from dirty fuels. Or they could encourage more investment in renewable-power capacity, so that energy constraints bind less. Such bold action could end the threat posed by expensive coal, gas and oil, once and for all. ■



自由交流

能源成本飙升会如何阻碍疫情后复苏

过去的能源危机曾推高通胀，诱发经济衰退

过去一个月里，燃料价格扶摇直上，走势堪比一轮凶猛疫情中飙升的感染数字。煤炭和天然气价格触及历史新高。亚洲的天然气现货价格在过去一年跃升近1000%。由于其他燃料短缺，原油需求大增，油价暴涨。

从许多方面来看，能源成本飙升与世界各地的供应链阻塞是同一现象的不同表征。需求出乎意料地强劲反弹，却迎头撞上了供给停滞。干旱导致水力发电不足，这类突发干扰因素加剧了能源短缺。面对能源危机，大家争相提升处于低位的库存，同样导致短缺加剧。但燃料价格飙升比供应链困境更加凶险。以往的能源危机不但和通胀相关联，还牵涉到严重的经济衰退，就如上世纪70年代的经济困境。眼前这次能源短缺又会带来什么？

能源价格高企带来的通胀效应已经相当明显。在欧元区，由于能源成本大涨17.4%，9月的年化整体通胀升至3.4%。基础“核心”通胀（不包括食品和能源价格）上升1.9%，幅度较小。在美国，9月的基础通胀走高，达到4%。但能源成本24.8%的升幅让整体通胀更上一级，达到5.4%。由于10月飙升的燃料价格尚未体现在统计中，未来几个月这些数字应该会进一步上升。

等到能源价格趋向平稳（可能在未来几个月实现，如果今年冬天不是特别寒冷的话可能还会更快），能源对通胀的影响就会开始减弱。高盛的经济学家最近的分析表明，9月能源成本对美国同比通胀率的影响为2.15个百分点，到今年年底可能上升至2.5个百分点——在其他因素不变的情况下，这会让整体通胀升至5.8%，到2022年底影响会最终跌至略微为负。

这对经济增长的损害如何？至少在短期内，最主要的因素是对消费和投资的影响。能源价格飙升时，家庭和企业在短期内无法轻易减少能耗，他们能花在其他商品和服务上的钱就相应减少。美国道富银行（State Street）

的保罗·埃德尔斯坦（Paul Edelstein）和达拉斯联储的卢茨·吉利安（Lutz Kilian）的研究显示，这种影响集中体现在耐用品消费上：能源价格上涨10%，耐用品支出相应下降4.7%（汽车购买量的降幅尤其大）。

而研究人员也注意到，相比根据能源支出在预算中的占比所做的预测，燃料价格上涨导致的消费降幅往往要更大。这似乎是因为能源危机会压抑消费者情绪。加州大学圣地亚哥分校的詹姆斯·汉密尔顿（James Hamilton）研究以往的石油危机发现，能源实际价格上涨20%会引发消费者信心指数下降15点。（自2021年4月以来，密歇根大学收集的一项美国消费者情绪指标已经下降了近17点。）

如果消费者能动用积蓄支付高额账单，能源引发经济衰退的危机也许可以缓解。到2020年底，大型富裕经济体的家庭已积累了相当于GDP6%以上的“超额”（即高于正常水平）储蓄。尽管如此，高盛的分析师估计，能源价格高企将让美国消费增长率在今年下降0.4个百分点，在2022年下降0.5个百分点。那些认为油箱还是半满的人可能会指出，由于耐用品需求特别强劲，供应链一直处于紧张状态，所以消费增长放缓可能有助缓解供应链压力。而抱怨油箱半空的人可能担心中国等地的限电措施会加重短缺问题。

关键是，这轮能源危机的影响将取决于央行的应对手段。燃料价格往往会影响家庭对通胀的预期。这对已经在担心高通胀的央行官员来说是个坏消息。吉利安与同在达拉斯联储的经济学家周小庆的研究表明，能源价格主要影响短期预期，而非更长远的预期。当能源价格下跌时，这些预期也可能迅速调整。然而，英国央行等一些央行可能还是担心能源危机会加剧通胀预期与它们的目标脱节的风险。但令人进退两难的是，如果央行反应过度，到能源价格回落低位，就会进一步压制消费并诱发通缩压力。

能源价格保持高位的时间越长，其影响会发生越多演变。家庭和企业将变得更能减少对能源的依赖。事实上，斯德哥尔摩大学国际经济研究所（Institute for International Economic Studies）的约翰·哈斯勒（John Hassler）、皮尔·克鲁赛尔（Per Krusell）和康尼·奥洛夫森（Conny

Olovsson) 的研究表明，高价能源会改变创新的性质。企业的创造性活动以节约稀缺投入为导向。能源充足时，它们专注于能节省资本或劳动力的创新。相反，能源稀缺时，它们会更着力提高生产的能源效率，创新因而受到影响，就像70年代发生的那样。

但历史会在多大程度上重演也取决于政府的做法。它们可以保护消费者不受能源价格上涨的影响，这在政治上会很受欢迎，但会延误从高污染燃料向清洁燃料的转型。它们也可以鼓励加大投资可再生能源发电，减轻能源短缺的风险。这种果敢行动可以一劳永逸地终结高价煤炭、天然气和石油带来的威胁。 ■



Bartleby

How to run better meetings

The jury system offers clues to managers everywhere

MEETINGS ABSORB more time and drain morale more consistently than any other corporate activity. Before the pandemic managers were spending an average of 23 hours a week in meetings. Since then the barriers to calling people together have come down. Now that calendars are routinely shared, an empty diary slot attracts invitations like picnics do wasps.

Ideas abound for how to make meetings better. Make people stand up, so they cannot settle in for the long haul. Write a memo on the topic at hand that everyone silently reads together at the outset. Toss a ball to each other to make it clear who has the floor and to stop the loudmouths from dominating. Most desperately of all, set aside time at the start for “fun”.

Yet there is a form of meeting that reliably results in good decisions and that commands general respect, even reverence. That meeting is the jury. Any system in which people still believe after more than 800 years is worth a closer look. In its broad principles, if not in its details, it has five lessons for meeting-throwers and meeting-goers.

First, its purpose is clear. “Why are we here?” is a question that humans grapple with not just in the depth of their souls but also during most Zoom calls. No jury doubts the point of its existence, the nature of its task or the need for multiple people to be involved. That level of shared understanding is something to aspire to in other settings.

Second, its size is right. The 12-person formula dates back to 12th-century England and the reign of Henry II. Temporary courts known as assizes summoned this number of men to hear land disputes. It has largely stuck

ever since. For good reason. More people would add voices, but not value. Fewer people would mean less diversity of views. The advantages of keeping meeting numbers tight are not lost on Jeff Bezos, who operated a two-pizza rule at Amazon to limit how many people were in a meeting. The one-jury rule works just as well.

The third lesson concerns the agenda. Jurors have one, very important, question to consider, and a limited number of choices to make. Clarity keeps people focused. No juror is likely to suggest backing up a bit in order to brainstorm what the criminal-justice system should look like. And whereas many pundits advise keeping meetings short, time is not a constraint: jury members do not leave until a decision is made. “Putting a pin in it” is just not an option.

The fourth lesson is about membership. Jurors are less prone to groupthink than the attendees of the average meeting. Prospective members are deliberately drawn from a wide pool, and anyone whose mind is already made up is supposed to be weeded out. Companies cannot convene a bunch of strangers to make decisions for them. But they can consciously try to bring in unfamiliar faces and call on different perspectives. And just as a jury foreman is not chosen by rank, a moderator need not always be the most senior person in the room.

The final lesson concerns psychological safety, the willingness of people to speak up. That can be hard when your boss is frowning at you. But structure helps. Trials are expressly designed to weigh lots of evidence and to take in opposing views. Before juries make decisions, they get to weigh competing accounts of what happened. The best firms echo this approach by structuring discussions in order to test arguments properly. Investment decisions at Blackstone, a private-equity titan, are probed at meetings that systematically focus on the risk factors surrounding a potential deal, as well as what makes it attractive.

Things can go wrong in juries. Jury selection can rig outcomes rather than improve them. Domineering personalities can sway meeker ones. Also, people really can be idiots. A murder conviction in a British courtroom in 1994 was quashed after it was found that some members had used a Ouija board to ask the obvious question of one of the deceased. (The defendant was reconvicted at a second trial.)

Evidently, firms are not the same as courtrooms. Many corporate pow-wows are designed to transmit information and build culture, not to deliver verdicts. Unanimity is no way to run an enterprise. And deciding the fate of a fellow citizen is bound to be more engaging than the average business call. But serving on a jury is not an interruption to work. If you get summoned, you can both do your duty and see what makes for a really good meeting. ■



巴托比

如何更好地开会

世界各地的管理者可以从陪审团制度中得到启发

没有什么公司活动比开会更耗费时间也更持续不断地消耗士气。疫情发生前，管理者平均每周要花23个小时开会。疫情发生后，把人们召集在一起的障碍已被破除。现在员工们经常性地共享日历，如果日程表上还有哪一格是空的，便会吸引来一堆邀请，就像野餐招来一窝黄蜂一样。

关于如何让会议开得更好的点子比比皆是。让大家都站着，这样他们就无法安坐着打持久战。就手头的话题写一份备忘录，会议开始时大家先一起默读。让与会者彼此传球，以明确该谁发言了，防止会议成为大嗓门的天下。最不济的还可以一开始就留出用来“放松娱乐”的时间。

然而，有一种会议形式能够可靠地产生良好的决策，并赢得普遍的尊重，甚至崇敬。这就是陪审团。任何诞生800多年后仍为人们所信任的制度都值得仔细探究一番。如果不揪细节而只看它的总体原则，会议组织者和参与者可以从陪审团制度中学到五点经验。

首先，它目的明确。“我们为什么会在这里？”的问题不仅盘亘在人类灵魂深处，也会在他们参加大多数Zoom会议时不断冒头。没有陪审团怀疑自身存在的意义、自己任务的性质或多人参与的必要性。这种程度的共识值得其他场合去争取。

第二，它规模合适。**12**人的阵容可以追溯到12世纪的英国和亨利二世统治时期。当时，被称为巡回法庭的临时法庭会召集12人来审理土地纠纷。从那以后这个人数规模基本保留了下来。这有充分的理由。人再多些，声音也会更多，但价值却不会提升；人再少些，观点的多样性就会减弱。杰夫·贝索斯深谙保持会议人数精简的好处，他在亚马逊用“两个披萨”的原则来限制与会人数。“一个陪审团”的原则同样有效。

第三个经验与议程有关。陪审员们要考虑的是一个非常重要的问题，能做出的抉择也有限。清晰明确能让人保持专注。不大会有哪个陪审员建议大家做一番回顾，以便集思广益，探讨刑事司法系统应该是什么样子。而尽管许多专家都建议会议时长要短，但时间并不是一个限制：陪审团成员在做出决定之前是不会离开的。根本没有“择日再议”这个选项。

第四点经验关于参会资格。陪审员不像一般会议的参与者那样容易陷入群体思维。可能入选的陪审员是特意从一个很大的池子中抽取的，任何已经拿定主意的人理应被剔除掉。企业不能召集一群陌生人来为自己做决定，但它们可以有意识地尝试引入不熟悉的面孔，呼唤不同的视角。陪审团主席不是按级别选择的，同样，会议的主持人也不一定总得是房间里最资深的人。

最后一个经验涉及心理安全，也就是让人们愿意畅所欲言。当老板在一边冲着你皱眉头时，这很难做到。但是周密的组织安排能帮上忙。庭审的目的就是为了考量大量证据，并考虑对立的观点。在陪审团做出决定之前，他们要权衡关于所发生事件的不同说法。最好的公司会效仿这种方式，组织讨论以恰当检验各种观点。私募股权巨头黑石集团在会议上研究投资决策，这些会议除了系统地关注某项潜在交易的吸引力外，还关注它的风险因素。

陪审团也可能出状况。对陪审员的甄选有可能扭曲而不是改善结果。盛气凌人的人可能会左右更温顺的人的想法。而有些人真的是白痴。1994年，一间英国法庭撤销了一项谋杀定罪，因为几个陪审员被发现用占卜板向死者之一问了个问题——问的什么不言而喻。(被告在二审中再次被定罪。)

显然，公司和法庭不一样。大量公司会议的目的是传递信息和建立文化，而不是做出裁决。意见一致绝非企业经营之道。决定一个同胞的命运肯定要比一般的商业电话会议更叫人投入。但担任陪审员并不妨碍正常工作。如果你被传唤去做陪审员，那你既可以履行自己的职责，又能见识一番真正好的会议是什么样子。 ■



Cell-side markets

Meat no longer requires animal slaughter

You can grow it in a laboratory

A GENERAL PRINCIPLE of restaurant dining is this: if you look into the kitchen and see at least one chef wielding tweezers, prepare for a markedly lighter wallet. This is not because the tweezers will place anything particularly expensive on your plate (the occasional flakes of gold leaf notwithstanding) but because they signify that you are eating at a restaurant so devoted to every detail of your dining experience that it pays people to hover over your plate carefully distributing tasteless little flower petals or sprigs of greenery. They signify luxury, and luxury costs.

In the well-equipped test kitchen of Upside Foods, in an unremarkable office park in Berkeley, California, Morgan Reese uses long tweezers to place two frazzled mushroom slivers and a single caper next to an almond-sized piece of sautéed chicken. Plain chicken may not seem like a gold-flake-calibre luxury. But as Uma Valeti, Upside's CEO, noted while Mr Reese worked, there are only "maybe a thousand-plus people that have tasted [this type of chicken] so far in the world".

That is because this particular chicken was grown entirely in a lab. Some time ago, Upside took a tissue sample from a living chicken that survived the procedure unharmed; the cells gathered in that biopsy were used to form a cell line from which the company is able to produce meat like that on the plate. It looks, smells and tastes exactly like a boneless piece of white-meat chicken—which is precisely what it is, just created using novel means.

It is not a new idea. In "The Space Merchants", a dystopian satire by Frederik Pohl and Cyril M. Kornbluth published in 1952, the hero spends some time

gathering algae to be fed to a thing called “Chicken Little”: “a grey-brown, rubbery hemisphere some fifteen yards in diameter. Dozens of pipes ran into her pulsating flesh. You could see that she was alive.” Chicken Little has been grown from cultured cells to feed a resource-poor world in thrall to hucksterism. A small chamber hollowed out of its flesh provides access to meetings of a revolutionary groupuscule.

Today Upside Foods and its backers hope that lab-grown meat will not shield the revolution, but be the revolution—and in a much more appealing way. The company has broken ground on a new production facility in California’s East Bay. It is not alone. Nearly 100 firms are vying to be the first to bring cultured meat to market. Select locations—including a private club in Singapore and a test kitchen in Tel Aviv—serve it from time to time. But as yet it remains unavailable to the average diner.

It is not hard to see why investors are excited. Demand for meat and fish is soaring, particularly among the rapidly growing middle classes in parts of the developing world. Making that meat the old-fashioned way uses a lot of land and produces gigatonnes of greenhouse gas. Much of the fish people want is not caught sustainably, and some comes from endangered or threatened species. Plant-based substitutes can meet some of the increased demand, but currently they only really compete with processed products such as those based on mince. Growing meat directly from animal cells offers a way of squaring the circle, while also satisfying the moral demands of consumers uneasy about factory farming and animal slaughter. But it is a hugely ambitious undertaking.

Cells, tissues and muscle fibres have been grown in vitro, as scientists say, for decades; Alexis Carrel and his associates first grew the cells of a chick’s heart in a lab in 1912, and kept the culture going for more than 30 years. Such cultures are fundamental to much biological research. One of the things that now makes the process appealing to food producers is that it has

become practical to extract stem cells that can give rise to different types of cells, such as those that make up fat and muscle, and have them do it to order. A cardiologist by training, Mr Valeti says he was inspired to start Upside by “the idea of injecting stem cells into the human heart” to help it regenerate muscle after a heart attack.

Unlike Chicken Little, which was immortal, the cells these firms use are harvested after just a few weeks of culture. What happens then varies by company; each has a proprietary method for turning muscle cells into meat. Animals naturally grow fat, muscle and connective tissue together, in coherent and familiar forms around a skeleton. Cultured-meat producers must figure out how to replicate the mouthfeel engendered by such forms.

Some put the cells on scaffolds, to give them shape: cultured muscle cells, unlike the natural type, do not have bone and sinew to grow around. Others use extrusion, in a process similar to making pasta. Such techniques allow firms to customise the final shape of their product. BlueNalu, a San Diego-based firm growing bluefin tuna and mahi-mahi in a lab, boasts of being able to give chefs “a sheet-pan” of sashimi-quality fish if that is what they want. An Israeli firm, Aleph Farms, uses 3D printers to turn cow cells into steaks—a process borrowed from techniques being used to grow human tissue and organs outside the body for transplant.

Most of the companies emphasise that their process is “species-agnostic,” meaning they can replicate any type of protein for which they can find cells, but most also have placed bets on specific end products. New entrants boasting of a unique approach to some specific tissue or other turn up with remarkable regularity. Some are working on high-value fish, as BlueNalu is. The cultured product will compete against an incumbent product made increasingly rare and expensive by overfishing.

There are echoes here of the strategy successfully used by Tesla to build its electric-car business. Rather than starting with small cars that looked like toys at worst and just a bit weird at best, it kicked off with a sexy sports car and followed up with an expensive luxury sedan, flourishing in that niche as it built up the technology and manufacturing capacity for the mass market.

BlueNalu is not the only firm looking to enter the market at the top end. Gourmey, a French startup, is using cells cultured from duck eggs in an effort to replicate foie gras, a product which combines a high price with high cruelty. Researchers at Osaka University recently announced the stem-cell-and-3D-printer creation of a steak in which muscle, blood vessels and fat were arranged to mimic the structure of Wagyu beef. But it is worth remembering that Tesla's success depended not just on making a high-end product, but on making one that could outperform the competition in almost every way, not just in its lack of exhaust-pipe emissions. No cultured-meat company can yet make that claim.

Even so, the technology has inherent charms. When it comes to the quartet of healthy not harmful, natural not artificial, pure not processed, environmentally friendly not pernicious, cultured meat might seem irredeemably artificial. It may be cytologically indistinguishable from meat, but it has never been part of an animal's life. What makes it less cruel also makes it less natural, at least to most. (It also seems to mean that it can be neither kosher nor halal; both sets of restrictions require meat to be slaughtered according to particular rules.) But to its advocates, such meat does offer a particular type of purity.

Fish meat grown in sealed, sanitised bioreactors will never be exposed to the microplastics, mercury and other pollutants often found in wild seafood. Chicken built up from its constituent cells never comes into contact with faeces, thus eliminating the risk of salmonella. No livestock means no

chance of animal pathogens crossing over into humans, whether in the farm, the market, the slaughterhouse, the kitchen or the dining room.

Companies willing to venture beyond tissue culture into genetic modification or gene editing could go further—improving the nutritional value or even, perhaps, the flavour. The Osaka beef-engineers imagine dialling the fat content of pseudo-Wagyu up or down according to taste or health requirements. Chicken could be loaded with the omega-3 fatty acids that fish get from eating algae, or beef with beneficial plant proteins. And fresh fish can be fresher if it comes straight from the lab than if it must be caught at sea.

But several challenges remain before these products come to a supermarket near you. First is regulation. Here Singapore leads the world. It introduced a regulatory framework in 2019 which allows “alternative protein products that do not have a history of being consumed as food” to be sold if they pass an expert panel’s safety review and are properly labelled. Meat grown in labs must be sold as “cultured”, that made from plants must be labelled as “plant-based” or “mock”. Eat Just, a San Francisco-based firm, got approval for its cultured chicken there late last year. The process is typically expected to take just three to six months.

This compares well, for producers, with America’s, which requires the attentions of two different agencies: the Food and Drug Administration, which monitors cell growth and issues premarket safety assessments; and the Department of Agriculture, which will conduct ongoing inspections, as it does for live-animal facilities, when licensed production gets under way. The European Food Safety Authority’s process may be all under one procedural roof, but it is nevertheless expected to take at least three times longer than Singapore’s.

Singapore had good reason to create a streamlined process. Cultured meat

fits with the tiny country's goal of producing 30% of its food by 2030 to avoid disruptions in supply. And the reason why that goal requires it to get into cultured meat—its lack of an incumbent meat industry—meant a lot less lobbying against cultured meat than can be expected elsewhere.

Another challenge is the range of cuts. In principle cultured meat can be grown as tissues, not just cells. In practice compressible nubs similar to ground animal meat are much easier and what most of the companies do best. Eat Just serves chicken nuggets in Singapore, and SuperMeat offers “crispy cultured chicken fillet” in Tel Aviv (it’s a burger, but made from fried chicken). Whole chicken breasts—to say nothing of a rack of ribs, or any other meat on the bone—remain far off. But given the improvements in plant-based meat alternatives, it is to that level of ambition that the new industry needs to aspire if it is to show decent margins.

At the same time it also needs to make a fundamental part of its process much cheaper. Just like animals in fields, cell cultures in bioreactors need feeding, and they are fussy about nutrients. You cannot just feed them processed algae, as Pohl and Kornbluth imagined. Fetal bovine serum (FBS), a nutrient-rich liquid long used by scientists in the lab, has become the nourishment of choice for many cultured-meat companies. But unfortunately for an industry which wants to sell meat untainted by death, FBS is derived from blood collected from pregnant cows at slaughter. And unfortunately for an industry trying to make its wares a lot cheaper, it is also expensive and subject to wild price fluctuations. On top of that, it is also nutritionally variable from batch to batch.

Cultured-meat companies would like to use synthetic alternatives (as would many laboratory scientists). Creating something truly comparable, though, would almost certainly involve genetically engineering yeast in order to make it produce at least some of the necessary nutrients. That yeast would itself need to be fed in order to produce what is required. To make a cell-

based alternative to meat, you need to make a food chain for those cells as surely as you need to provide grass, silage or feedstock to cattle. And the meat will never be cheaper than the medium it grows in.

This drawback has not stopped investors from piling in to the sector. If they are doing so on the basis that biotechnologists are both cunning and armed with ever more subtle tools, fair enough. But no cultured-meat company is as yet either producing at scale or making money. Upside and BlueNalu are in the process of opening production facilities a lot larger than their original laboratories—not big enough to serve a national or even a significant regional market, but enough to provide a proof-of-concept that could justify the capital investment needed for the big time.

If they can scale up at reasonable cost, though, there will still be doubts as to the eventual size of the market. The benefits of plant-based meat alternatives may not be as clear as some consumers think, but the idea of eating plants is neither novel nor disturbing. The idea of eating something grown from a tissue culture is definitely novel and may prove to be disturbing. How much of a problem that will prove is a question that will only be answered when the choice is presented to more than just a self-selected group of already curious diners in a few cosmopolitan cities. Polls asking people's views of cultured meat show varying responses.

Proponents argue that people frequently eat meats that seem familiar but are not made from the breed, or through the processes, that they used to be. The rich world's pork has been bred to be leaner and its chickens to be more breast-heavy; its production has moved from fields, farmyards and sties to squalid, hurtful factories. But this is a sadly double-edged argument. If people are sufficiently adaptable about the way food is raised as to be happy with today's cruelty, they may also be adaptable enough to embrace meat from the lab. But having learned to accept the cruelty, will they be motivated to make the change?

Upside hopes they will, and to that end it is set on educating consumers and gaining their trust. It is designing its East Bay facility with immense windows into the production rooms, to let consumers see as much as possible. For maximum effect it might consider offering an abattoir the lease on a similarly open building next door free of charge. The lack of takers would be telling. ■



细胞侧市场

吃肉不再需要屠宰动物

你可以在实验室里培养肉【专题《人类世新膳食》系列之二】

餐厅用餐有这样一个一般原则：如果你瞄到厨房里至少有一位厨师挥舞着镊子，那就准备好钱包大出血吧。这不是因为镊子会在你的盘子里放任何特别贵的东西（尽管偶尔会有金箔片），而是因为它们表明你所在的餐厅如此专注于你用餐体验的每一个细节，以至于要雇人在你的盘子上小心翼翼地装点无味的小花瓣或绿色植物的小枝。它们象征着奢侈，而奢侈可不便宜。

Upside Foods设备齐全的测试厨房设在加州伯克利一个不起眼的办公园区里。摩根·里斯（Morgan Reese）用长镊子将两片烤焦的蘑菇片和一个刺山柑放在一块杏仁大小的炒鸡肉旁边。普通鸡肉可能看起来不像金片级别的奢侈品。但正如Upside的首席执行官乌玛·瓦莱蒂（Uma Valeti）在一旁指出的，“到目前为止，世界上可能只有一千多人尝过〔这种鸡肉〕”。

那是因为这块鸡完全是在实验室里培育出来的。前段时间，Upside从一只活鸡身上采集了一个组织样本，那只鸡在手术后安然无恙。活检中收集的细胞被用来培育一个细胞系，让该公司能够从中生产出盘子里那样的肉。它看起来、闻起来和吃起来都像一块去骨的白肉鸡——它确实就是，只不过是用新颖的方法创造出来的。

这并不是个新点子。在弗里德里克·波尔（Frederik Pohl）和西里尔·M·科恩布卢斯（Cyril M. Kornbluth）于1952年出版的废托邦讽刺作品《太空商人》（The Space Merchants）中，主人公花了一些时间收集藻类，然后喂给一个叫做“鸡小小”（Chicken Little）的东西：“一个灰褐色的、橡胶状的半球，直径差不多有15码。几十根管子插进她跳动的肉体。你可以看到她还活着。”“鸡小小”是从培养的细胞成长起来的，以养活一个资源匮乏、到处是强行推销的世界。通过在她肉上凿出来的一个小房间可以参加一个

革命小团体的会议。

如今，Upside Foods及其支持者希望实验室培育的肉类不会成为这场革命的掩护，而是成为革命本身——而且是以吸引力大增的方式。该公司在加州东湾的新生产设施已经破土动工。它并非孤军作战。近100家公司在争取抢先把人造肉推向市场。几处特定的地点——包括新加坡的一个私人俱乐部和特拉维夫的一间测试厨房——不时会供应这种肉。但到目前为止，普通食客仍然吃不到它。

不难看出为什么投资者会感到兴奋。对肉类和鱼类的需求正在飙升，尤其是在发展中国家部分地区快速增长的中产阶级人群当中。以老式方法生产这些肉类会占用大量土地并产生数十亿吨计的温室气体。人们想要的大部分鱼都不是可持续捕获的，有些是濒危或受威胁的物种。以植物为基础的替代品可以满足部分增加的需求，但目前它们其实还只是在和加工产品（例如那些肉末制成的产品）竞争。直接从动物细胞中培育肉类提供了变不可能为可能的方式，同时也满足了对工厂化养殖和屠宰动物感到不安的消费者的道德要求。但这是一个极具挑战性的工程。

科学家们说，细胞、组织和肌肉纤维已经在体外生长了几十年。亚历克西斯·卡雷尔（Alexis Carrel）和他的同事于1912年首次在实验室中培养了小鸡的心脏细胞，并不断培养了30多年。这种培养是许多生物学研究的基础。这个过程如今开始吸引食品生产商，一个因素是已经可以提取干细胞来产生不同类型的细胞——例如构成脂肪和肌肉的细胞——并按需开展这个细胞生产过程。瓦莱蒂毕业于心脏科，他说他创立Upside的灵感来自于“将干细胞注入人类心脏的概念”，这种方法可帮助心脏病发作后的心肌再生。

与永生的“鸡小小”不同，这些公司使用的细胞在培养仅几周后就被“采摘”。接下来发生什么因公司而异，各家都有将肌肉细胞变成肉的专有方法。动物天生以连贯而熟悉的形式围绕骨骼一并生长脂肪、肌肉和结缔组织。培育肉生产商必须弄清楚如何复制这种生长结构产生的口感。

有些公司把细胞放到支架上来赋予它们形状，这是因为培养出来的肌肉细胞与天然的不同，没有骨骼和肌腱可供它们围绕生长。其他公司采用挤出的方式，过程类似于制作意大利面。此类技术让公司可以定制其产品的最终形状。总部位于圣地亚哥的BlueNalu在实验室里养殖蓝鳍金枪鱼和鲭鱼，它号称，如果厨师们想要的话，它可以提供“一烤盘”生鱼片品质的鱼。以色列公司“阿列夫农场”（Aleph Farms）用3D打印机把牛细胞变成牛排——这一过程借鉴了在体外培养人体组织和器官以便移植的技术。

大多数公司强调它们的过程“无所谓物种”，这意味着可以复制能够找到细胞的任何类型的蛋白质，但大多数公司也已将赌注押在特定的最终产品上。号称拥有独家方法来培育某些特定组织的新进入者层出不穷。有些和BlueNalu一样研究高价值鱼类。这些培育产品将与因过度捕捞而日趋稀有昂贵的现有产品竞争。

这里用到的战略和特斯拉成功建立其电动汽车业务的那一套差不多。若从小轿车入手，搞不好看起来就像个玩具，最好的情况也会让人觉得怪怪的。所以它选择先打造性感的跑车，然后是昂贵的豪华轿车，在这个利基市场大展身手，与此同时逐渐建立技术和制造能力来打入大众市场。

BlueNalu并不是唯一一家希望打入高端市场的公司。法国创业公司Gourmey正在用从鸭蛋中培养的细胞复制鹅肝——一种兼具高价格和高残酷性的产品。大阪大学的研究人员最近宣布用干细胞和3D打印机制作牛排，其中肌肉、血管和脂肪被排列成模仿和牛牛肉的结构。但值得记住的是，特斯拉的成功不仅取决于制造高端产品，还取决于制造出几乎在方方面面都能超越竞争对手的产品——而不仅仅是在去掉了排气管这一点上。目前还没有哪家培育肉公司能宣称自己做到了这一点。

即便如此，这项技术也具有与生俱来的魅力。当谈到健康无害、天然无人造、纯无加工、环保无毒这四重奏时，培育肉可能看起来人工得无可救药。它可能在细胞学上与肉无法区分，但它从未曾是一头动物生命的一部分。让它不那么残酷的东西也让它不那么自然，至少对大多数人来说是这

样。（这似乎也意味着它既不合乎犹太教的“可食”也不算清真，这两种限制都要求按特定规则屠宰肉。）但对于其倡导者来说，这种肉确实提供了某种特定意义上的纯净。

在密封、消毒的生物反应器中生长的鱼肉永远不会暴露在野生海产品中常见的微塑料、汞和其他污染物中。由构成鸡的细胞培育出来的鸡肉永远不会接触到粪便，从而消除了沙门氏菌的风险。无论是在农场、市场、屠宰场、厨房还是餐厅，没有牲畜意味着动物病原体没有机会传染给人类。

那些愿意从组织培养再往前探一步而尝试基因改造或基因编辑的公司可以走得更远——提高营养价值，甚至可能是风味。大阪的牛肉工程师想象着根据口味或健康要求调高或调低牛和牛的脂肪含量。可以把鱼类从食用藻类中获得的 ω -3脂肪酸注入鸡肉中，或是让牛肉富含有益的植物蛋白。与必须在海上捕获相比，如果直接来自实验室，鲜鱼会更鲜。

但是，在这些产品进入您附近的超市之前，仍然存在一些挑战。首先是监管。新加坡在这方面领先世界。它在2019年引入了一项监管框架，允许“不曾被当作食品消费的替代蛋白质产品”在通过专家小组的安全审查并贴有适当标签的情况下出售。在实验室培育的肉类必须标明“培育”后出售，由植物制成的肉类必须标记为“植物性”或“模拟”。总部位于旧金山的Eat Just生产的培育鸡肉去年底在新加坡获准出售。整个审查过程通常预计只需要三到六个月。

对于生产商来说，这可与美国的情况媲美。美国要求两个不同的机构介入：食品药品管理局（FDA）负责监测细胞生长并发布上市前安全评估；当被许可的生产开始后，农业部将像监督活体动物设施那样开展持续检查。欧洲食品安全局的流程可能都落在同一个程序范围内，所需时间却预计至少要比新加坡长三倍。

新加坡有充分的理由建立一个简化的流程。培育肉符合这个小国的目标，即到2030年自行生产该国消耗食物的30%以避免供应中断。要达到这个目标需要它进入培育肉的领域，因为它没有现成的肉类产业。这使得在该国

反对培育肉的游说要比在其他地方可预期的少得多。

另一个挑战是肉类的部位。原则上，培育肉可以作为组织生长，而不仅仅是细胞。但实际上，类似于动物碎肉的可压缩小块要容易做得多，也是大多数公司做得最好的一项。Eat Just在新加坡供应鸡块，SuperMeat在特拉维夫供应“培育脆皮鸡柳”（这是一种汉堡，但由炸鸡制成）。整块的鸡胸肉——更不用说排骨或是其他任何带骨的肉——仍然遥不可及。但鉴于植物性肉类替代品的改进，如果这个新行业要显示出可观的利润率，就需要有这样的雄心壮志。

同时，它还需要使其流程中的一个基本部分变得便宜许多。就像田野里的动物一样，生物反应器中的细胞培养物需要喂养，而且它们对营养很挑剔。你不能像波尔和科恩布卢斯想象的那样，只喂它们加工过的藻类。胎牛血清（FBS）是实验室科学家长期使用的一种富含营养的液体，已成为许多人造肉公司的首选食材。但不幸的是，对于一个想要出售未受死亡玷污的肉类的行业来说，FBS来自屠宰怀孕奶牛时收集的血液。而且不幸的是，对于一个试图使其商品成本大幅降低的行业而言，这东西还很贵，价格波动也很剧烈。最重要的是，它的营养成分也因批次而异。

培育肉公司希望使用合成替代品（许多实验室科学家也愿意）。然而，创造真正具有可比性的东西几乎肯定会涉及转基因酵母，以使其至少产生一些必要的营养。这种酵母本身需要喂食才能生产出所需的东西。要制作基于细胞的肉类替代品，你需要为这些细胞制作食物链，就像需要为牛提供草、青贮饲料或存料一样。而且这种肉永远不会比它生长的介质更便宜。

这个缺点并没有阻止投资者涌入该行业。如果他们投资的理由是生物技术专家们足智多谋又拥有日益精妙的工具，那也算有道理。但是，目前还没有一家培育肉公司能够大规模生产或赚钱。Upside和BlueNalu正在设立比它们最初的实验室大得多的生产设施。这些设施不足以服务全国甚至重要的区域市场，但足以提供一种概念验证，能够解释要大红大紫所需的资本投资。

不过，如果它们能够以合理的成本扩大规模，这个市场的最终规模能有多大仍然存疑。植物性肉类替代品的好处可能不像一些消费者想象的那么明显，但吃植物的想法既不新颖也不会令人不安。把从组织培养中生长出来的东西吃下肚的想法绝对是新颖的，可能会令人不安。这会成为多大的问题，答案须等到这种选择被放到广大人群的面前时——而不仅限于少数国际化都市中一批自我选择的好奇食客。询问人们对培育肉的看法的民意调查显示出不同的反应。

支持者说，人们经常吃看起来很熟悉但不是由过去的品种或流程制成的肉类。富裕国家的猪被培育得更精瘦，鸡胸部的肉更重；生产已经从田地、农场和猪圈转移到肮脏而残酷的工厂。但很不幸，这个论点是一把双刃剑。如果人们对食物的饲养方式有足够的适应能力，以至于对当下的残酷现状感到满意，那么他们也可能有足够的适应能力去接受来自实验室的肉类。但在学会接受残酷之后，他们还有动力做出改变吗？

Upside希望他们会，为此它已经准备好教育消费者并赢得他们的信任。它给它位于加州东湾的工厂的生产车间设计了巨大的窗户，让消费者尽可能多地看到内部。为获得最大效果，它可能会考虑把隔壁一栋类似的开放式建筑物免费出租给屠宰场。没人接手的话就足以说明问题了。 ■



Culture club

Microbes are being used more and more to make delicious food

A new realm of “precision fermentation” beckons

THE FETID salinity of prosciutto, bresaola’s jaw-wearying toughness and the pallid greasiness of lardo, which is cured solid fat, all have their fans—if not, normally, among those in the business of keeping arteries clean. But the single best cured meat in the world comes from north-eastern Thailand. Rice, pork, garlic, salt and herbs are stuffed into a casing and left at room temperature for a few days. When cooked, this naem has a robust pigginess. But it is best eaten raw, with chilies and garlic cloves.

Its sinus-clearing sourness, a perfect balance to the other strong flavours, comes courtesy of bacteria that produce lactic acid. It is a strategy the bacteria evolved to prevent the growth of other, less acid-tolerant microbes; by nobbling the competition they get more food for themselves—and leave the rest safe for human consumption. Such bacteria are also at work in Nigerian ogi, Korean kimchi, and a host of other foods including that lockdown mainstay, sourdough bread.

Humans have been harnessing microbe-based biochemistry for food preservation since before history began. Without lactic-acid fermentation a bumper crop of cabbage would rot uneaten. With the right microbes, salt and time it can be turned into sauerkraut. Ethanol fermentation raises bread and fizzes champagne. Acetic-acid fermentation provides vinegar and thus pickling, not to mention the peerless lambic beers of the Zenne Valley in Belgium.

In many cases, such as that of a sourdough starter or a yoghurt culture, the microbes put to work come not as individual species but as long-standing

collectives. The processes by which these collectives are controlled—or at least cajoled—have for millennia been governed by the algorithms of traditional knowledge and the data inputs of sight, smell, taste and, for dough, touch.

Many have now been simplified, industrialised and scaled up. An array of vitamins, flavourings and colours have long been made using microbial fermentation. Not all these products of fermentation are preservatives or additives; some are foods in themselves. When yeast produce alcohol for beer they also produce more yeast—which sometimes turns into Marmite, a savoury spread about which British people delight in having divergent views. Quorn, a plant-based meat alternative that has been on the market for decades, is made from a quickly-growing microfungus discovered by a chemical company in the 1960s.

Now that food technologists have genome sequencing and gene editing at their disposal they are exploring a realm of “precision fermentation” in which microbes can be chosen, or engineered, for very specific purposes. The breakthrough took place in 1990, when Pfizer used the genetic-engineering techniques previously used to make medicines such as insulin to create a microbe that produced the clotting agent found in rennet, which is used to curdle milk proteins into cheese. Rennet was previously sourced from the fourth stomachs of unweaned calves, which is inconvenient. The engineered version is now used in most mass-market cheeses.

Genetically altered microbes now make a variety of proteins important in foodstuffs, such as the leghaemoglobin which provides Impossible Foods with the haem for its burgers. Other companies are editing microbes to produce whey and casein for animal-free cheeses, collagen to use in synthetic leather and spiders’ silk for clothes.

Scientists think the right microbes in the right fermenters could eventually

produce abundant saturated fats, such as those in avocado or coconut oil, to give a rich texture to plant-based meat-substitutes. Palm oil could, in principle, be created without the need for deforestation. That said, something will always have to be grown somewhere to provide the bugs doing the work with energy and raw materials. Fermentation can change things, but it cannot create them out of nothing: it is metabolism, not magic

But the right plate of naem might have you challenging that assertion. ■



培养俱乐部

微生物被日益用于制作美食

“精准发酵”的新领域在招手【专题《人类世新膳食》系列之三】

带着强烈陈腐咸味的意大利火腿、嚼得人下巴酸的坚硬的风干牛肉、白花花的油腻的猪油膏“拉多”（一种腌制的固态脂肪）都有各自的拥趸，虽然通常都不是那些会注意保持血管不阻塞的人群。但世上最好的腌肉来自泰国东北部。把大米、猪肉、大蒜、盐和辛香料灌入肠衣中，在室温下放置几天。得到的酸肉煮熟后“猪味”强烈。但最好是直接生吃，配上辣椒和蒜瓣。

它冲鼻子的酸味与其他强烈味道形成了完美的平衡。这种酸味源自细菌生成的乳酸。这是细菌进化而来的一种策略，用以阻止其他耐酸性较差的微生物生长。通过在竞争中胜出，它们为自己争取到了更多食物——并使得剩下那部分可供人类安全食用。这类细菌也在尼日利亚玉米粉布丁“ogi”、韩国泡菜和许多其他食物中发挥作用，包括在疫情封锁期成为中流砥柱的酸种面包。

自史前时代开始，人类就一直在利用基于微生物的生物化学保存食物。如果没有乳酸发酵，会有大量卷心菜来不及吃就烂掉。有了恰当的微生物、盐和时间的结合，它们可以变成酸泡菜。乙醇发酵能发面团，并让香槟产生气泡。醋酸发酵能酿醋，继而用醋做腌渍，更不用提比利时谐纳河谷出产的无与伦比的兰比克酸啤酒了。

在许多情况下，例如酸酵头或酸奶发酵剂，发挥作用的微生物并非单个物种，而是经久不衰的组合。几千年来，操控（或至少是诱导）这些组合的各种工艺受传统知识这一算法和色、香、味及（做面团时的）触感等数据输入的管辖。

很多工序现在已被简化、工业化和规模化。长期以来，各种各样的维生素、调味剂和色素通过微生物发酵制成。这些发酵的产物并不都是防腐剂

或添加剂，有些本身就是食物。当酵母生成啤酒酒精时，它们也生成了更多酵母——有时会被制成马麦酱，英国人对这种咸酱汁爱恨分明，津津乐道。已经上市数十年的植物性肉类替代品阔恩素肉（Quorn由一种快速生长的微真菌制成，一家化工公司在1960年代发现了这种微生物。

如今食品技术人员已经对基因组测序和基因编辑运用自如，他们开始探索一个名为“精准发酵”的领域，其中微生物可被选择或设计用于非常特定的目的。这项突破发生在1990年，当时辉瑞公司使用过去用于制造胰岛素等药物的基因工程技术创造出了一种微生物，它可以生成凝乳酶中的凝结剂。凝乳酶用于将牛奶蛋白质凝结成奶酪，过去只能从未断奶犊牛的第四个胃中提取，很不方便。由基因工程创造的凝乳酶现在被用于生产大多数面向大众的奶酪。

经基因改造的微生物现在被用于生产食品中所含的各种重要蛋白质，例如为Impossible Foods公司的汉堡包提供血红素的豆血红蛋白。其他公司正在编辑微生物以生产用于无动物奶酪的乳清和酪蛋白、用于人造皮革的胶原蛋白和用于服饰的蜘蛛丝。

科学家认为，合适的发酵槽中合适的微生物最终可以生成丰富的饱和脂肪，例如牛油果或椰子油中的饱和脂肪，给植物性肉类替代品增添了一种丰厚的质感。原则上，无需砍伐森林就可以生产出棕榈油。话虽如此，终归需要在某个地方种植某种东西来为担当重任的细菌们提供能源和原材料。发酵可以改变事物，但不可能无中生有：它是代谢，不是魔法。

但是，一盘正确发酵的泰国酸肉可能会让你质疑这种说法。 ■



Features and bugs

Feeding 9bn people will mean reimagining the edible world

More insects are likely to be on the menu

OVER LATE afternoon Cutty Sark and fried haddock at a bar overlooking the working waterfront in Portland, Maine, Steve Train is doing what so many lobstermen do on shore: telling stories. Mr Train has been a lobsterman for 45 years; he first went out when he was 11 years old.

One story is about sea urchins. For years when he and other lobstersmen found sea urchins in their lobster traps they would crush them underfoot: the urchins were nuisances. That was before Japanese buyers realised that urchin from the cold waters off Maine produced some of the finest uni on earth. There was value, it turned out, in something long overlooked.

Mr Train now hopes the same thing could be true again—this time for weeds. At the end of October, when winter weather and the departure of the lobsters for deeper waters will soon be keeping him off the water, Mr Train lays ropes seeded with kelp across 1.6 hectares (four acres) of water close to where he lives on an island in Casco Bay. He uses the same equipment to tend his kelp farm as he does to catch lobsters: boats and ropes, pullers and winches. Atlantic Sea Farms, the company that supplies the seed, promises to buy every usable blade. It ferments some into “sea-chi”—deliciously briny and funky. Some is frozen for smoothies.

The fight to feed a world of perhaps 10bn by mid-century is being fought on many fronts. It demands massive reductions in the amount of food wasted and farming that ensures long-term soil fertility at the same time as increases in yield. It will also be helped by filling in some of the gaps in the current food system: things overlooked until an entrepreneurial eye

coupled to an appropriate technology sees what could be made of them. Fishing and agriculture tend to be seasonal, leaving workers with time and unused machinery for part of each year that, with imagination, can find alternative employment. There are foods routinely ignored in some places which other palates and cultures prize—such as sea urchins. Kelp farming happens to tick both boxes.

Seaweeds of various sorts are routinely eaten across East Asia, but the global industry is worth only around \$6bn per year according to the UN Food and Agriculture Organisation (FAO)—about as much as Americans spend on tortilla chips. Kelp is loaded with minerals and fibre and a lot more sustainable than many crops it might replace. But as anyone who has ever raised or been a child knows, just because a thing should be eaten does not mean it will be. Filling in the gaps in the world's food web requires unlearning some tastes and preferences.

Consider the insect. Around 1,900 species are eaten around the world, according to the FAO. The cuisine of Oaxaca, arguably Mexico's most complex and delicious, features fried chapulines (grasshoppers) seasoned with lime, chilies and salt and rolled into a fresh corn tortilla. Drinkers in rural Thailand snack on deep-fried, thumb-sized beetles; those working the fields of southern Africa prefer chubby mopane worms. Around 2bn people choose to eat insects on a regular basis. The rest of the world does so unknowingly, and to a lesser degree, while eating other things, as FDA rules make fascinatingly clear: American asparagus, for example, is not allowed to contain more than 40 thrips [tiny winged insects] per 100 grams.

Insects convert nutrients and water into protein far more efficiently than more commonly consumed animals. Raising them does not require land-clearing, releases very little greenhouse gas and can be done alongside other crops—another bit of gap-filling. They can be fed on organic waste, reducing

the flow of waste into landfills. Most species contain more protein by weight than legumes; some contain more than meat and eggs. Their exoskeletons can be uncomfortable in the mouth; but exoskeletons, as eaters of prawn and lobster know, can be removed.

It would undoubtedly be better for the world if people ate more bugs. And yet many in the Western world (including your correspondent, who is otherwise a reasonably adventurous eater) find the notion of such entomophagy revolting. This is illogical, particularly for diners who happily consume shrimp and other crustaceans, but then eating is only rarely logical.

Fifty years ago, most Western diners looked askance at eating raw fish; today you can get sushi at supermarkets. A number of insect-food startups have been garnering a modest amount of investment hoping for a similar change in taste.

Pat Crowley runs one of the older ones, Chapul, founded through a kickstarter funding campaign in 2012. He's an ento-evangelist—black soldier-fly larvae, he enthuses, are "one of the best-tasting insects I've ever had"—who was drawn into the business by his concerns about water resources in the American west. He says that younger consumers are far more open to entomophagy than older ones, which is a source of hope.

But most of Chapul's business is not in whole insects, but in insect flour. The growth of keto, Palaeo and other protein-heavy diets—as well as those that eschew wheat—has made cricket flour an appealing bet for bug farmers. It abounds in protein and minerals, and its neutral, nutty flavour mixes well with other foods.

Processed-insect products from Chapul and others are also eagerly swallowed up by animals that have neither scruples nor choice in what

they eat—that is to say, other farmed animals. This makes insect farming controversial to some, who see it as propping up the cruelties and slaughter of the intensive poultry and livestock business. But from an ecosystem point of view it may be helpful. A rich protein source that does not require large-scale arable farming or lots of water—as soybeans do—may have a lower overall burden, especially if it is largely fed on waste. Replacing fishmeal is particularly appealing. Farmed salmon is often fed with fishmeal made from other species, disrupting the open-ocean food chain. Highly productive insect farms could be a way to turn food waste into fresh fish, which seems greatly preferable.

In time insects may become the sought-after delicacies Mr Crowley would like. It is not just sushi that once turned up noses—potatoes and tomatoes did too. Tastes change over time; the menu from a celebratory dinner in 1921 (*consommé viveur*, boned squab, friandises) seems as archaic to contemporary eyes as the diners' starched collars and flapper hats.

What will a slap-up menu from 2021 look like to people in 100 years? They may marvel at the idea of rack of lamb when the meat they eat has never seen a bone, skeleton or even a blood vessel. They may pity dining choices limited to a small number of living creatures—no fried, giant crickets, or cultured, cured panda ham. They may be astounded at fruits and vegetables sourced from far away, rather than coming—as all the finest produce does—from a farm just a few floors below the restaurant. They may shudder at the risks of eating line-caught fish, or grow envious at the idea of a world where the climate allowed coffee to come from beans grown on hillsides, rather than from yeast which still doesn't quite get the flavonoids right despite a century of genetic tinkering.

Some will deem the cruelty and environmental damage done by their ancestors' diets unimaginable and unforgivable. If they do so from the moral high ground of a better record in such matters, there is every reason

to hope that it will be because some of the technologies described in this report have become mainstream—as unremarkable as slaughterhouses and greenhouses are today. That will help build a diet that reveals its eaters to be part of an Anthropocene that humankind is managing tolerably well, both delighting the palate and lying lightly on the conscience. ■



功能和虫子

养活90亿人将需要重塑食物世界

很可能会有更多昆虫出现在菜单上【专题《人类世新膳食》系列之五】

一个傍晚，在缅因州波特兰市一间俯瞰码头作业区的酒吧里，史蒂夫·特雷恩（Steve Train）叫了顺风（Cutty Sark）威士忌和炸黑线鳕，做一件许多捕龙虾的渔民在岸上会做的事：讲故事。特雷恩捕捞龙虾45年了，第一次出海作业时他11岁。

其中一个故事和海胆有关。曾经很多年里，当他和其他渔民在捕虾笼中发现海胆时，会直接把它们踩个稀巴烂——那会儿海胆是海上公害。日本买家还没有意识到，来自缅因附近寒冷水域的海胆将带来地球上最美味的“uni”。一个长期不被放在眼里的东西原来很有价值。

特雷恩现在希望这样的事再发生一回——这次是海草。时值10月底，冬天来临，龙虾游向更深的水域，他很快就得停止海上作业了。他往紧挨着他位于卡斯科湾（Casco Bay）一个岛上的住处的一片1.6公顷（4英亩）的水域铺投了夹带着海带幼苗的麻绳。他拿来照料这个海带养殖场的设备和捕龙虾的是同一套：船和绳子、牵引器和绞车。提供幼苗的公司大西洋海农场（Atlantic Sea Farms）承诺会买下所有可用的叶子。它把其中一些发酵成海带泡菜（sea-chi）——一种腥咸的美味。另一些则冷冻起来制成冰沙。

为在本世纪中叶养活一个可能有100亿人口的世界，战斗正在许多条战线上同时展开。它要求大量减少食物浪费，耕种方式要在提高产量的同时保证长期的土壤肥力。它还会填补当前食品系统中的一些空白：那些被人们忽略的东西，直到某个企业家的眼光结合以恰当的技术，发现了从中可以创造出什么来。渔业和农业往往是季节性的，所以每年都有一部分时间工人们没活干，机器闲置着。而如果能发挥想象力，他们可以找到交替性的工作。在一些地方常被忽略的食物却被另一些口味和文化推崇，好比海

胆。海带养殖恰好这两项都满足。

东亚地区经常性食用各种海草，但据联合国粮农组织统计，这个产业全球全年仅价值60亿美元左右，和美国人在玉米片上的花费差不多。海带富含矿物质和纤维，且比它可能替代的许多作物都更具可持续性得多。但是，养过孩子的人——或自己曾是个孩子的人——都知道，该吃什么并不等于会吃什么。要填补世界食物网络中的缺口，需要忘记一些已经习得的口味和偏好。

来看看昆虫。据粮农组织称，在世界各地约有1900种昆虫被食用。瓦哈卡（Oaxaca）的美食可说是墨西哥最复杂、最美味的菜肴，其特色是用酸橙、辣椒和盐调味的炸蚱蜢，卷在一个新鲜的玉米饼里。泰国村民把拇指大小的甲虫油炸了下酒。在南部非洲农田里劳作的人喜欢吃一条条肥肥的莫帕尼蠕虫。全球约有20亿人选择经常性食用昆虫。剩下的人在吃别的东西时不知不觉把少量昆虫吃下了肚，看看美国食品药品监督管理局（FDA）的规定就再清楚不过了：比如，美国芦笋每100克含有的蓟马（微小的有翅昆虫）数量不可超过40头。

昆虫将营养物质和水转化为蛋白质的效率远高于人们更常食用的动物。养殖昆虫不需要伐林辟地，释放的温室气体极少，还可以和种植其他作物一道进行——这又填上了一点点空白。它们能以有机废物为食，减少流入垃圾填埋场的废弃物。按重量计算，大多数昆虫的蛋白质含量都超过豆类，有些还超过肉和蛋。把它们塞进嘴里时，它们的外骨骼可能会让人口感不适，但吃虾和龙虾的人都知道，外壳是可以去掉的。

如果人们吃更多虫子，无疑会更有益于世界。但西方世界的许多人都对这种食虫理念感到反胃（包括笔者在内，他除此之外也算是一个相当爱冒险的食客了）。这不合逻辑，对那些快乐地吃着虾和其他甲壳类动物的人来说更是如此。但话说回来，吃东西这件事又很少讲道理。

50年前，吃生鱼这件事令大多数西方食客侧目。今天你可以在超市买到寿司。一批昆虫食品创业公司已经获得了少量投资，寄希望于人们在口味上

发生类似的变化。

帕特·克劳利（Pat Crowley）经营着其中一家稍有些年头的公司Chapul，它在2012年通过一个公众融资活动创立。克劳利是一名昆虫布道者——他兴奋地说着黑色水虻幼虫是“我吃过的最好吃的昆虫之一”。他出于对美国西部水资源的关切而被吸引到这项事业中。他说，与年长的消费者相比，年轻人对食虫的态度要开放得多，这是一个希望之源。

但Chapul大部分的业务都不是整只的昆虫，而是昆虫粉。生酮饮食（keto）、原始饮食（Palaeo）和其他高蛋白饮食法的涌现——以及那些避开小麦的饮食方式——已经使蟋蟀粉成为了对虫农颇具吸引力的赌注。它富含蛋白质和矿物质，中性的类似坚果的风味很容易搭配其他食物。

Chapul等公司生产的加工昆虫产品也在被一些动物大口吞食。这些动物对吃什么既无顾忌也没选择——它们就是其他的养殖动物。这使得昆虫养殖在一些人眼里有了争议，他们认为这助长了密集型家禽和牲畜养殖业的残酷和屠杀。但从生态系统的角度看，这可能是有助益的。一个不需要大规模可耕种田地或大量水（种大豆就需要）的丰富蛋白质来源造成的总体环境负担可能更低，尤其如果它主要是用废弃物喂养的话。替换掉鱼粉的做法特别让人感兴趣。养殖三文鱼通常用由其他鱼类制成的鱼粉喂养，这破坏了公海食物链。高产的昆虫养殖场可能成为把食物垃圾转化为鲜鱼的一种方式，这似乎非常可取。

随着时间推移，昆虫可能会成为克劳利乐见的抢手美味。曾经遭受冷遇的不只寿司——土豆和西红柿也一样。人们的口味会随时间改变：1921年的一份庆典晚宴菜单（清汤、去骨乳鸽、法式点心）在今天的人看来就和用餐者的硬衣领和钟型帽一样古老。

一份2021年的高档菜单在100年后的人看来是什么样子？他们可能会对吃羊排感到惊讶，因为他们自己吃的肉里头从来不见骨头、骨架甚至一丝血管。他们可能会同情前人能选择的活物种类这么少——没有油炸的大蟋蟀或人工培育的腌熊猫火腿。他们可能非常吃惊蔬果要从遥远的外地采购，

而不是像所有最好的农产品那样从餐厅往下几层的农场送上来。想到吃钓来的鱼面临的风险可能让他们发抖。又或者他们对这样一个世界心生艳羡：那时的气候还可以在山坡上种咖啡豆，而不需要用酵母来做咖啡——在反复捣鼓基因一个世纪后，类黄酮这个成分还是不太对劲。

一些人会认为自己祖先的饮食造成的残酷行径和环境破坏不可想象也不可原谅。如果他们是因为自己在这些方面做得更好而站上了道德高地，那么我们完全有理由希望这是基于在本专题中描述的一些技术已经成为了他们社会的主流——就像今天的屠宰场和温室那样稀松平常。这将有助于建立一种饮食，揭示其消费者身处于一个人类管理得还算不错的人类世时期：它既满足味蕾，又不太折磨良心。 ■



Green castles in the sky

Vertical farms are growing more and more vegetables in urban areas

They don't need soil or sunlight

THE BEST basil in the world is grown in a small village on the Ligurian coast just west of Genoa. Picked at the height of ripeness, after just the right number of sunny days and temperate nights, the delicate basil is perfect in the pesto for which Liguria is justly famed.

Unfortunately, many more people use fresh basil than live within driving distance of Genoa. And even on the Ligurian coast, nature does not always provide perfect weather. But a close approximation—crisp and recognisably peppery with the right anise undernotes, perhaps not quite vibrant enough to make a Genoese chef do cartwheels, but better than the limp stuff in plastic sachets sold in supermarkets—can be found in a few shipping containers at the back of a car park in north Brooklyn, just down the block from a synagogue and around the corner from a petrol station.

Those containers house a vertical farm—a farm in which crops grow on top of each other, rather than just next to each other, as they do in a field, allowing growth at far higher density. Square Roots, the farm's owner, grows fresh herbs here, delivering them to 100 retailers in New York within 24 hours of harvest using emission-free electric tricycles. The company has a larger facility in Grand Rapids, Michigan, and ambitions for further expansion.

Not all vertical farms are small. Across the country in South San Francisco, a firm called Plenty runs an 8,100-square-metre (two-acre) vertical farm that, it claims, grows as much produce as a normal farm over 300 times its size. Plans are under way for massive vertical farms in the UAE and Switzerland.

China plans to build an entire neighbourhood in Shanghai around vertical farming.

Most vertical farms share a few attributes. One is a lack of soil. Their stacked rows of crops are grown aeroponically, meaning the roots are fed with a nutrient-rich mist, or hydroponically, meaning the roots either sit in an aqueous, nutrient-rich solution or in a container in which the solution constantly flows over them.

This lets a lot less water than is usually used do a lot more work. No soil means precise control over what level of nutrients all the roots receive. It also eliminates weeds and helps keep down microbes, insects and other crop-devouring pests, many of which need soil for some of their life cycles. No soil also means no fertiliser runoff into waterways; vertical farms tend to recycle things, not dispose of them. Some contain aquaponic ecosystems in which aquaculture and horticulture combine: the plants feed the fish, the fish fertilise the plants.

Sunshine is absent, too. Light comes from strips of LEDs arranged so that all the dense-packed leaves are optimally illuminated. The problem with this is that LEDs and the electricity which powers them cost money. Proponents of vertical farms note that the cost of LEDs is dropping and the amount of light they generate per kilowatt hour is climbing; what is known as Haitz's law says that the efficiency of LED lighting systems improves by a factor of 20 every decade. Even so, energy costs for lighting and temperature control remain high.

In time, things will improve, and not just thanks to Haitz's law. The energy used in vertical farms is almost all electricity, which is becoming both greener, as grids take on more renewable capacity, and cheaper, as that renewable capacity relieves electricity suppliers of fuel costs. Vertical farms can also time their "days" and "nights" to match times when power is

cheaper, and drop demand a bit if the grid needs it—a service grids will increasingly pay for.

That is one example of their greatest gift: control. With light, temperature and nutrients all delivered directly, the conditions for growth can be optimised. And the crops raised are carefully chosen, with fast-growing, light, high-margin produce comprising most of them today. High-quality herbs and leafy greens can be guaranteed at all seasons and from a local source.

Berries may be next. Farming berries uses a lot of pesticides and depends on varieties that can tolerate being shipped long distances. As a result the sweet, floral, fire-engine-red berry picked from a wild July vine is nothing like the insipid pinkish golf-balls stacked on November shelves. Through their control of light, temperature and nutrients vertical farms can have fresh-picked summer-succulent punnets on sale throughout a city all year round. Think of it as the Teslaberry: a superior product with environmental benefits (no pesticide use) that establishes a technology and a brand.

Control needs data. Vertical farms can keep track of what is going on in a way field farming, however high its precision, cannot. The bigger a farm gets, the more information it has, and at least theoretically, the better and more efficient it becomes. Anya Rosen, who manages Square Roots's Brooklyn farm, explains that vertical farming "is not really nature. It's the opposite of that. It's basically a big robot that grows plants inside."

That may not, in itself, sound appetising. But when it comes to the authenticity quartet of health, naturalness, purity and the environment, vertical farms stack up pretty well. Technology around a plant seems less off-putting than technology within a plant. The clinical brightness of a farm in which plants are stacked like servers is not natural; but it has a certain purity. A sealed environment is one not harming the greater environment

outside (unless its voracious appetite for energy is fed with fossil fuels).

Seeing these advantages, mission-driven investors are pouring money into vertical-farming companies despite their energy costs—Plenty has raised \$541m over six funding rounds, while a SPAC may soon take AeroFarms, a New Jersey-based firm with an immense vertical farm in an old industrial building in Newark, public. Again, though, they are doing so in advance of profitability.

To many environmentalists, this is a sideshow. Making real farming less of a stress on the environment is far more important. And vertical farming could be successful as a business without doing much for the planet. It could remain a niche for the urban rich. But vertical farms could have impacts environmentalists and others would value. Unlike plant-based meat alternatives they encourage people to think about how food is produced, rather than just what it tastes like. The experimentation they allow could lead to greater efficiency and higher quality, or both.

Vertical farming will not immediately transform the world's agricultural practices. Plenty of investors will misjudge when to jump in and which firms to back. And even if some investors make it big, their companies will, in the near and medium term, mostly cater to city dwellers who can afford to eat well.

For a world getting richer and more urbanised, that is a good business to be in, and it may be good for the environment, too, if only at the margins. But things could go further. Farming has a long history of, in effect, trading land for energy. Throughout the 20th century tractors and other machinery, artificial fertilisers and pesticides all turned fossil fuels into agricultural productivity, using the energy stored in oil to grow more food on the same amount of land and sometimes less.

In the mid-to-late 21st century artificial lighting and indoor climate control, all powered by cheap, clean electricity, could continue the trend. That possibility does not mean vertical farming investment will pay off in the short term. But just as 20th-century farming would have been unrecognisable to the 19th century farmer, so 21st-century farms may, eventually, outgrow today's in productivity, in environmental friendliness—and in height. ■



空中绿色城堡

垂直农场正在城区种植越来越多的蔬菜

它们不需要土壤和阳光【专题《人类世新膳食》系列之四】

世界上最好的罗勒生长在热那亚以西利古里亚海岸的一个小村庄。度过了数量刚刚好的晴朗的白天和温和的夜晚后，它们在最成熟之时被采摘。散发着清香的罗勒被拌入利古里亚名不虚传的香蒜酱中，堪称完美。

可惜，使用新鲜罗勒的人要远多过开一会儿车就能来到热那亚的人。而且即使在利古里亚海岸，大自然也不总能提供完美的天气。但是，在别处能找到质量还算接近的鲜罗勒：口感脆嫩，清晰可辨的胡椒味中略带一丝茴香味，可能还没有鲜美到会让热那亚的大厨来个侧手翻，但比超市里卖的塑料小包里那些蔫不拉几的东西要好。它们出现在布鲁克林北部一个停车场后方的几个集装箱中，这里旁边是个加油站，街区尽头是座犹太教堂。

这些集装箱里头装着一个垂直农场——作物一层层叠起来，而不是像在田里那样并排挨着，这让它们的种植密度大幅提升。农场的主人“平方根”公司（Square Roots）在这里种植新鲜香料，在采摘后的24小时内用无排放的电动三轮车把它们送到纽约各地的100家零售商手中。这家公司在密歇根州的大急流城还有一个更大些的垂直农场，它还预备扩张到更多地区。

不是所有的垂直农场都很小。在南旧金山市的乡村地区，Plenty公司经营着一个占地8100平方米（2英亩）的垂直农场。它声称其产量堪比一个面积是它300多倍的普通农场。在阿联酋和瑞士都有大型垂直农场计划在推进中。中国计划在上海围绕垂直农业打造一整个街区。

大多数垂直农场都有几个共同点。其一是不用土壤。它们成排堆叠的作物有时是气耕栽培，用富含营养的薄气雾给根部施肥；有时是水耕栽培，把根部浸在富含营养的水溶液中，或是放在容器中，让营养液不断流经它们。

这就可以用比通常少得多的水来做多得多的事。没有土壤意味着全部根部获得的养分水平可以精确控制。也不再有杂草，而微生物、昆虫和其他啃噬作物的害虫数量也受到抑制，因为许多虫子的某些生命阶段需要土壤。没有土壤也意味着没有肥料因径流排入水道：垂直农场通常都把东西循环利用而不是排走。有些垂直农场包含了将水产养殖和园艺合为一体的“鱼菜共生”生态系统：植物可以喂鱼，鱼的排泄物又给植物施肥。

也没有阳光。光来自LED灯条，其排列方式要让所有密集的叶子都得到最佳光照。问题在于使用LED以及为它们供电需要花钱。垂直农场的支持者指出，LED的成本在下降，而它们消耗每度电产生的光量在攀升：根据海兹定律（Haitz's law），LED照明系统的效率每十年提高20倍。但即便如此，光照和温控的能源成本仍然很高。

随着时间推移，情况会有所改善，且不仅仅是因为海兹定律。垂直农场使用的能源几乎全是电力，而随着电网纳入更多可再生能源，电力正变得更加清洁，也更便宜——因为可再生能源减轻了电力供应商的燃料成本。垂直农场也可以根据峰谷电价来安排自己的“白天”和“夜晚”，并且在电网有需要时稍微降低需求——电网会越来越多地为这样的服务付费。

这正体现了它们最大的天赋：控制。光、温度和养分都直接提供，这就可以优化生长条件。种植的作物是经过精心挑选的，如今生长快、轻巧、利润高的农产品占了大多数。高质量的香料和绿叶菜可以保证一年四季的本地供应。

接下来可能还会有莓果。种植莓果要用到大量杀虫剂，还要看哪些品种经得起长途运输。因此，从7月的野生蔓藤上采摘的甘甜、带着花香、火红的浆果和11月份货架上堆放着的干巴巴的淡粉色高尔夫球毫无相似之处。通过对光照、温度和养分的控制，垂直农场可以全年在整个城市出售一篮篮新鲜采摘的充满了夏日风情的多汁的莓果。可以视之为“特斯拉莓果”（Teslaberry）：一种具有环境效益（不使用杀虫剂）的优质产品，通过它确立了一项技术，树立了一个品牌。

控制需要数据。垂直农场所能够以无论多精准的田间耕作都做不到的方式追踪进度。农场越大，它拥有的信息越多，而且至少在理论上会变得越好越高效。管理平方根公司的布鲁克林农场的安雅·罗森（Anya Rosen）解释说，垂直农业“不是什么自然的东西。正相反，它基本上是一台肚皮里种着植物的大型机器人。”

这本身听起来可能有点倒胃口。但是，要说从健康、自然、纯度和环境这四方面做真伪认证，垂直农场的总体可靠度相当好。与改变植物内部的技术相比，用在植物周遭的技术似乎没那么令人不适。在像堆放服务器那样堆放植物的农场里，医院般的光照并不自然；但它在某种意义上是纯净的。一个密封的环境不会损害外部更大的环境（除非它的高能耗是用化石燃料来满足）。

看到这些优势后，那些使命导向的投资者正在向垂直农业公司大笔注资，即便它们有能源成本高的问题。Plenty已在六轮融资中筹到5.41亿美元。总部位于新泽西的AeroFarms在纽瓦克一座旧工业建筑中耕种一个巨大的垂直农场，它可能很快就会通过特殊目的收购公司（SPAC）上市。不过，它们都还没有开始盈利。

在许多环保主义者看来，这只能算是次要的活动。他们认为减少真正的农业对环境的压力要重要得多。而垂直农业有可能取得商业上的成功却不能为地球做多少好事。它的消费者可能永远都只会是城里的富人。但是，垂直农场可能产生环保主义者等人群看重的那种影响。与植物性肉类替代品不同，它们鼓励人们思考食物是如何生产的，而不仅仅是它味道如何。它们推进的实验有可能带来更高的效率和更高的质量，或者两者兼得。

垂直农业不会立即改变世界的农业实践。许多投资者会误判进场的时机和押错公司。而即使一些投资者把它做大了，他们的公司在中短期内也将主要迎合吃得起好东西的城市居民。

在一个越来越富裕、日益城镇化的世界里，这门生意是个不错的机遇，而且也可能对环境有益——即便只是略微地。但事情可能走得更远。农业有

事实上拿土地换能量的悠久历史。在整个20世纪，拖拉机和其他机械、人造肥料和杀虫剂都把化石燃料转化为农业生产率，利用储存在石油中的能量在等量或更少的土地上种植出更多食物。

在21世纪中后期，完全由廉价、清洁的电力驱动的人工照明和室内气候控制可能会延续这种趋势。这种可能性并不意味着垂直农业投资会在短期内获得回报。但正如20世纪的农业会让19世纪的农民认不出来那样，21世纪的农场最终也可能会在生产率、环境友好——以及高度上——超越今天的农场。 ■



From the sublime to the subpar

A triple shock slows China's growth

Coal shortages, covid-19 and a construction slowdown all take their toll

IN A SCENE from “Manufactured Landscapes”, a documentary released in 2006, Edward Burtynsky, a landscape photographer, seeks permission to take pictures of the black mountains of Chinese coal awaiting shipment in Tianjin, an industrial city near Beijing. “Through his camera lens, through his eyes, it will appear beautiful,” Mr Burtynsky’s assistant assures his sceptical host. That turns out to be not quite true. Through the photographer’s lens, the piles of coal have a dark, satanic geometry—not beautiful exactly, but awe-inspiring in their immensity.

Looking at those pictures (one of which is shown above), it is hard to imagine China could ever run short of this fuel. But in recent months, the black pyramids have been not quite immense enough. A scarcity of coal, which accounts for almost two-thirds of China’s electricity generation, has contributed to the worst power cuts in a decade. And the blackouts have, in turn, hurt growth. “Our economy is developing very fast,” Mr Burtynsky’s host tells him, so as to excuse the gloom and dirt in the air. But that is not quite true any more either.

The Chinese economy has been hit by a triple shock, stemming not only from the power cuts but also the pandemic and a property slowdown exacerbated by the financial woes of Evergrande, a developer. Figures published on October 18th showed that economic growth slowed to 4.9% in the third quarter, compared with a year earlier (see chart). Industrial production expanded by only 3.1% year-on-year in September, slower than in any month during the global financial crisis. More than a year and a half after covid-19 first struck, China is reporting growth rates that were unheard

of before the pandemic.

Consider the energy crunch first. The causes of the coal shortage fall into two categories: structural and incidental. The unlucky contingencies include floods in Henan province in July and in Shanxi last month, which forced some mines to close. In addition, in Inner Mongolia, which accounts for about a quarter of China's coal output, an investigation into corruption has implicated and hamstrung some of the officials who might previously have approved expansions in coal mining. Shaanxi province, China's third-largest producer of coal, slowed production to keep the skies clear for a national athletics event in September, which President Xi Jinping attended. And coal expansion has also been inhibited by safety inspectors, who have scrutinised 976 mines, after more than 100 industrial accidents nationwide last year.

The deeper reason for the coal crunch is China's efforts to reduce its dependence on the fuel, which is responsible for a big share of the country's carbon emissions. The authorities have been reluctant to approve new mines or the expansion of existing ones in recent years, because "it's clearly driving the bus in the wrong direction", says David Fishman of The Lantau Group, an energy consultancy.

When supply is tight, prices are supposed to rise, obliging customers to economise on their consumption. But as the price of coal shot up, power stations were unable to pass their higher costs on. The amount they could charge the grid company that buys the bulk of their power could rise only up to 10% above a regulated price, which was changed infrequently. And the tariff paid by end-users was based on a catalogue of prices that was similarly inflexible. Some power stations simply stopped operating, refusing to generate at a loss.

Another shock to the economy came from the pandemic. Outbreaks of

covid-19, such as a cluster that began in Nanjing in July, prompted strict, localised lockdowns, depressing retail spending, especially catering, and travel. According to Flight Master, a travel site, airlines were operating at less than half their full capacity in August and at only two-thirds of it in September.

The final shock was to the country's property sector, a perennial engine of growth, employment, leverage and anxiety. Regulators are trying to curb speculative demand for flats and limit the excessive borrowing of homebuilders. That effort to limit financial risk has brought some existing dangers to a head. Evergrande, huge firm with \$300bn in liabilities, missed a payment on a dollar bond on September 24th, and has been followed by others. Some homebuyers are now understandably nervous about handing over their cash to any developer who may not be in business long enough to finish the projects they are selling.

Against this backdrop, China's developers started 13.5% fewer homes this September than they had a year earlier and their sales, measured by floorspace, fell by a similar percentage. China also reported sharp falls in the production of cement (down by 13% in September compared with last year) and steel (which fell by 14.8%).

On October 15th China's central bank described Evergrande as an idiosyncratic case in a generally healthy industry. That should have been reassuring, except that policymakers will not come to the property sector's rescue until they are sufficiently worried about its plight. Anxiety among regulators may be a necessary condition for alleviating the anxiety of homebuilders and their creditors.

Most economists think China's year-on-year growth will slow even further in the last three months of the year. Bank of America has forecast growth of 2.5% in a base case. China will maintain its vigilance against covid-19, and

the property downturn has further to run. But one of the three whammies should at least pack less of a punch in the remainder of the year. Power stations, unlike property developers, have won belated relief from higher authorities. Mines have been ordered to expand production. And China's principal planning body threatened on October 19th to step in if coal prices remain punishingly high, prompting a sharp sell-off of coal futures.

That threat of intervention in upstream pricing followed a big step towards liberalisation further downstream. The government will give power stations more freedom to pass on higher costs to the grid company. It will also force industrial and commercial customers (but not households or farmers) to pay power prices negotiated in the market, not those set down in a catalogue. These reforms have been in the works for a long time. But it took an acute crisis to force the issue. Policymakers might once have preferred a "measured roll-out of market reforms", notes Mr Fishman. But things changed "when the lights started to go out in factories across the country". China likes to cross rivers by feeling for the stones. But when a stone gives way, it is time to take a leap. ■



从高峰到低谷

三重冲击拖累中国经济增长

煤炭短缺、新冠疫情和房地产建设放缓的影响层层叠加

在2006年上映的纪录片《人造风景》（Manufactured Landscapes）中有这样一幕，风景摄影师爱德华·伯汀斯基（Edward Burtynsky）希望得到许可，去北京附近的工业城市天津拍摄那里等待装运、堆积如黑色山峦的煤炭。中方接待人员对此犹豫不决，伯汀斯基的助手保证说：“透过他的镜头，透过他的眼睛，看起来会很美。”最终结果不全然如此。透过这位摄影师的镜头，这些煤山呈现出一种暗黑的、撒旦式的形态——那并不是美，而是庞大到令人生畏。

看看那些照片（上图是其中一张），很难想象哪天这种燃料在中国还会不够用。但最近几个月，这些黑色金字塔变得有点不够巨大了。中国发电量的近三分之二来自煤炭，煤炭短缺导致了十年来最严重的一轮停电限电。停电又损害了经济增长。“我们经济发展得非常快。”纪录片中，中方人员这样对伯汀斯基说，以此来为空气中漂浮尘霾开脱。但现在这一点也不再确凿了。

中国经济遭受了三重冲击，不仅有停电，还有疫情和房地产业放缓——开发商恒大集团的财务困境加剧了这一局面。10月18日公布的数据显示，与去年同期相比，第三季度经济增速放缓至4.9%（见图表）。9月工业生产同比仅增长3.1%，增幅低于在全球金融危机期间的任何一个月份。在距疫情最初爆发超过一年半后，中国公布了在疫情前闻所未闻的低增速。

先来看能源紧张。造成煤炭短缺的原因有两种：结构性的和偶发的。7月在河南以及10月在山西发生的洪灾迫使一些煤矿关闭就属于不幸的意外事件。此外，在占中国煤炭产量约四分之一的内蒙古，反腐败调查牵涉和束缚了一些此前可能批准过煤矿扩产的官员。中国产煤第三大省陕西9月举办了全运会，国家主席习近平出席，期间为确保天空明净减少了煤炭生

产。去年全国发生100多起工业事故后，安监部门对976处煤矿进行审核，也抑制了煤炭扩产。

煤炭紧缺的深层原因是为中国正努力减少对煤炭的依赖，这种燃料造成了中国碳排放的大头。能源咨询公司The Lantau Group的余德伟（David Fishman）表示，近年来，当局一直不大愿意批准建设新煤矿或扩建现有矿山，因为“这显然与大方向背道而驰”。

供应紧张时，价格理应上涨，迫使顾客节约消费。但在煤价飙升时，发电厂却没法将上涨的成本转嫁出去。它们生产的电力大部分卖给电网公司，但销售电价受到监管而且很少调整，它们收取的电价最多只能比基准价格上涨10%。终端用户支付的费用同样基于一套不能灵活调整的目录销售电价。一些发电厂不愿亏本发电，索性停机。

对经济的另一个冲击来自疫情。局部暴发的疫情，比如7月从南京开始的新一波感染，促使地方上实施严格的封锁，抑制了零售消费，尤其是餐饮和旅游。根据旅游网站Flight Master的数据，航空公司8月只用了全部运力的一半不到，9月也只有三分之二。

最后一道冲击来自中国的房地产业，这个行业一直都是推动经济增长和就业的引擎，也始终是推高杠杆和引发焦虑的源头。监管机构正试图抑制对住房的投机性需求，并限制开发商过度借贷。这种限制金融风险的举措导致一些既有风险趋于激化。背负3000亿美元债务的地产巨头恒大在9月24日未能偿还一笔美元债券，随后其他地产公司也相继违约。如今一些购房者自然会担心把钱交给开发商的风险，因为对方可能不等把在售的项目建成就倒闭了。

在这一背景下，中国开发商今年9月的住宅新开工数量比去年同期减少了13.5%，按建筑面积计算的房屋销量录得近似的降幅。中国的水泥和钢铁产量也大幅下降，9月同比分别下降13%和14.8%。

10月15日，人民银行表示恒大的问题是个别现象，房地产行业总体是健康的。这本该让人安心，只可惜大家也知道，如果政策制定者还没有为房地

产业的困境特别担忧，是不会出手相救的。要缓解开发商和它们的债权人的焦虑，可能必须要等到监管人员变得非常焦虑。

大部分经济学家都认为，今年最后三个月中国经济的同比增速还会进一步下降。美国银行的基本情境预测是增长2.5%。中国将继续严格防控疫情，房地产业还会继续低迷。但在今年余下的时间里，三重冲击中至少有一项应该会减弱。与房地产开发商不同，发电厂已经从上级政府那里获得了姗姗来迟的解困措施。煤矿已接到扩大生产的命令。中国主要的规划机构发改委在10月19日表示，如果煤炭价格继续居高不下，就会出手干预。这引发了煤炭期货遭大举抛售。

在对上游定价发出干预的威胁之前，中国已经向放松下游管制迈出了一大步。政府将给予发电厂更大的自由度将上涨的成本转嫁给电网公司。它还将强制工商业用户（但不包括居民或农户）支付市场协商电价，取消目录销售电价。这些改革已经酝酿了相当长的时间，但直至经历一场严重危机才不得不痛下决心。余德伟指出，政策制定者原来可能更倾向于“谨慎缓慢地推行市场改革”。但是“当全国各地的工厂纷纷停电时”，事情就不一样了。中国喜欢摸着石头过河。但当脚下的石头塌陷，就该纵身一跃了。





Inside the garage of the future

Servicing and repairing electric cars requires new skills

Many workshops will be out of a job

AS A STRING of high-performance cars thunder round the twists and turns of Hockenheimring F1 circuit, in south-west Germany, a stripped-down vehicle at an adjacent Porsche customer centre offers a peek inside a speedy but far quieter way of getting round the track. Christian Brügger, a product engineer with Porsche, a sports-car maker that is part of the Volkswagen group, points to the edge of a large black box in the centre of the vehicle's chassis. "This", he says, "is where the knife goes in."

The box is a 93kWh battery. The chassis belongs to a 260kph Taycan, Porsche's first fully electric vehicle (EV). Cables, bright orange in warning, snake across it to a pair of motors and other electronic gubbins. As many a mechanic, professional and amateur, knows, fiddling with the 12V system of a typical internal-combustion engine (ICE) can give you a nasty electrical jolt. But this battery delivers 800V. Though it is fitted with safety systems, that is enough for a knockout punch that could kill you.

The knife Mr Brügger talks of is special. It has a blunt vibrating blade, like those used by doctors to remove plaster casts without damaging the patient. After some 160 bolts have been removed it can be slid under the edge of the battery's cover to cut away the glue used to seal it tight. This reveals 33 modules containing the lithium-ion cells that constitute most EV batteries. With the cover off, a faulty module can be swapped for a new one.

The battery is the most costly component in an EV. It typically represents about 30% of the value of the car when new. At present, if something goes wrong with a battery it is usually replaced with a new one because dealers'

service centres do not have the ability to undertake internal repairs. As a replacement battery can cost \$20,000 or so for some EVs, that is an expensive proposition. If the car is fairly new and the battery still under its warranty (which usually lasts around eight years), the manufacturer picks up the tab. But as EVs get older and fall in value, many owners may decide to scrap their cars prematurely, rather than fork out such sums.

Some 45% of CO₂ emissions involved in making an EV arise from producing the battery, so it makes sense to repair them and keep the vehicle on the road. Porsche reckons this can be done for about 20% of the cost of fitting a new battery. Most faults are caused by the failure of an individual module or cell. If fixed properly, the company reckons, they can provide many more years of service. Eventually, batteries will give up the ghost. When that happens carmakers aim to recycle them, in order to recover the valuable materials they contain and then use those to make new batteries.

Reparable batteries are good news for EV owners, but for garages they mean investing in specialist equipment, and also training technicians to do the work. Some of this investment is necessary to carry out even routine work on EVs. But as the skills required have more to do with electrical engineering, computing and software than wielding a spanner, there are other industries competing for this talent.

A looming shortage of EV technicians is causing concern in many countries. On October 18th, for example, the Institute of the Motor Industry, which represents Britain's motor trade, said some 90,000 new automotive technicians will be required to service and repair EVs by 2030. As of last year, just 6.5% of Britain's mechanics were qualified to do such work. Steve Nash, the institute's boss, says that with the pace at which EVs are being adopted accelerating, government support is needed to boost training programmes and avoid a big skills gap.

The specialist equipment required, including high-voltage tools, computer diagnostics and safety gear, is expensive. Reportedly, Cadillac, part of General Motors, has told its American dealerships they will need to spend an average of \$200,000 on tools and training if they want to stay with the marque as it becomes all-electric. Industry reports say some have thrown in the towel, but others see a chance to expand.

Many garages, especially small operators who look after older cars, may be reluctant to invest such sums. EVs are unlikely to make them as much money as cars with ICEs. Having fewer moving parts to wear out, EVs are more reliable and require less maintenance than ICE vehicles. A typical ICE drive-train (engine, gearbox and transmission) might contain 2,000 moving parts. An EV's equivalent has 20.

All this could have a big impact on garages' revenues. McKinsey, a consultancy, thinks EVs may reduce spending on spare parts at American dealerships by as much as 40%. With no oil to change or spark plugs to replace, income from routine servicing will also be lower. Porsche's Taycan, for one, is reckoned to need 30% less maintenance than if it was an ICE vehicle. And fewer items on the service sheet will require a trip to the dealership at all, as an increasing number of fixes are carried out with over-the-air software updates.

Repairing batteries should go some way to compensating for lower service revenues, says Peter Reck, an after-sales manager at Porsche. He says the company is introducing three qualification levels for technicians who work on EVs. Those on the first level can carry out routine maintenance and those on the second can remove batteries, but only technicians trained at the highest level will be able to open them up for repair. In this way, the company thinks, some dealerships, staffed by members of this elite, can serve as regional battery-repair hubs for garages who have only level-one and -two technicians. Porsche also plans to provide a "flying doctor" service

of mobile high-voltage technicians who can visit garages if needed.

As vehicle technologies advance, garages will face more changes. As is happening on some aircraft, the increasing number of sensors in vehicles will more closely monitor performance and automatically book them in for preventive maintenance before faults occur. Although fully autonomous vehicles are still some way off, the day may come when EVs drive themselves to a service centre.

Technological disruption like this does, though, provide an opportunity for new entrants. Elon Musk, after all, was an industry outsider when he set up Tesla, his (for now) Californian carmaker, which launched its first EV, the Roadster, in 2008. Already there are signs that companies from other areas are looking to enter the EV-servicing business.

After buying a Roadster, Pete Gruber started repairing them in 2013. His company, Gruber Motor, based in Phoenix, Arizona, has grown into an independent Tesla service centre. The firm has developed its own tools and test equipment to repair the individual components in the electronics and batteries of Tesla cars. This is possible, says Mr Gruber, because he has also had more than 30 years experience running a company that repairs high-voltage power systems in data centres, meaning the technology was familiar. But Mr Gruber, whose garage has its own R&D lab, has a warning: "This is not the sort of work the average mechanic can transition to." Grease monkeys, beware. Your days are numbered. ■



在未来的修车厂里

电动汽车维保需要新技能

很多修车铺子将关门大吉

一辆辆高性能赛车在德国西南部曲折的霍根海姆赛道

(Hockenheimring) 上轰鸣疾驰，旁边一个保时捷客户中心里，一个卸下了装饰件的车架让人一窥另一场快速但安静得多的竞赛。大众集团旗下跑车生产商保时捷的产品工程师克里斯蒂安·布鲁格 (Christian Brügger) 指着车子底盘中央一个大黑盒子的边缘。“这儿，”他说，“就是下刀的地方。”

这个盒子是一个容量为93千瓦时的电池。底盘来自Taycan——保时捷的首款纯电动汽车，时速可达260公里。亮橙警告色的电缆蜿蜒穿过底盘，连接到一对电机和其他电子器件上。许多维修人员，无论专业还是业余，都知道捣弄一台普通内燃机的12伏系统可能会猛地触电。而这个电池的输出电压是800伏。虽然它装有安全系统，但还是足以产生可能致命的电击。

布鲁格说的那把刀很特别。它的刀刃并不锋利，可以振动，类似于医生用来移除石膏而不会伤到患者的锯刀。在拆下160多个螺钉后，这把刀就可以在电池盖板边缘的下方滑动，切开密封胶。然后就能看到33个包含锂离子电池单元的模块，大多数电动汽车都使用这种锂电池。打开盖板后，可以用新的模块换下故障模块。

电池是电动汽车里最昂贵的部件，通常占新车总价的30%左右。目前，如果电池出了问题，通常会换个新的，因为经销商的服务中心没有能力打开电池来修理内部。有些电动汽车更换电池大概要花2万美元，非常昂贵。如果车还比较新，电池仍在保修期内（通常为八年左右），制造商会承担这笔费用。但随着车子老化和贬值，许多车主可能会决定提前报废它们，而不是花这么一大笔钱更换电池。

制造一辆电动汽车的二氧化碳排放约有45%来自生产电池，所以维修电

池、让车能继续跑是合理的。保时捷估计，维修电池的花费可低至换装新电池成本的20%左右。大多数故障是由单个模块或电池单元出问题引起的。该公司估计，如果修理得当，它们可以继续服役许多年。电池最终会报废，汽车制造商打算届时回收它们，重新利用其中有价值的材料来制造新电池。

电池可以修对电动车车主来说是个好消息，但对汽车修理厂来说就意味着要投资添置专业设备，还要培训技术人员。其中一些投资即便对电动汽车的日常保养也是必要的。但这里头需要的技能不是会扭扳手就够了，而更多涉及到电气工程、计算机和软件，这类人才也在被其他行业争抢。

预期将要发生的电动汽车维修技师短缺在许多国家引发了担忧。例如，10月18日，英国汽车业组织汽车工业协会（Institute of the Motor Industry）表示，到2030年，预计需要新增大约九万名汽车技师为电动汽车提供服务和维修。截至去年，只有6.5%的英国修理工有这类资质。协会会长史蒂夫·纳什（Steve Nash）表示，随着电动汽车加速普及，需要政府支持来推进培训项目，避免出现巨大的技能缺口。

所需的专业设备，包括高电压工具、计算机诊断和安全设备等，都很昂贵。据报道，通用汽车旗下的凯迪拉克已告知其美国经销商，待它全面转产电动汽车之后，如果它们还想继续经销该品牌，将需要在工具和培训上平均支出20万美元。行业报告称，一些公司已经打起了退堂鼓，但另一些公司看到了扩张的机会。

许多汽车修理厂，尤其是修老旧汽车的小铺子，可能不愿意投资这么多。维修电动汽车不太可能像维修内燃机汽车那样赚钱。与内燃机汽车相比，电动汽车会磨损的运动部件更少，因此更可靠，需要的维护也更少。一套常见的内燃机传动系统（发动机、变速箱和传动装置）可能包含2000个活动部件，而电动汽车的系统仅有20个。

所有这些都可能对汽车修理厂的收入产生重大影响。咨询公司麦肯锡认为，电动汽车可能会让美国经销商在零配件上的收入减少40%。而因为无

需更换机油或火花塞，来自日常保养的收入也会降低。例如，保时捷 Taycan 的保养费用估计要比同款内燃机车型（假如有的话）低 30%。而且越来越多的修复都是通过 OTA 升级软件完成，因此保养维修单上需要去经销商那里完成的项目就更少了。

保时捷的售后经理彼得·雷克（Peter Reck）说，修理电池应该能在一定程度上弥补保养收入的减少。他说，公司给电动汽车的维修技师设定了三个资格等级。第一级可以做日常保养，第二级可以拆卸电池，只有经过最高等级培训的技师才能打开电池进行维修。保时捷认为，这样一来，配备顶尖维修人员的经销商可以成为区域电池维修中心，支持仅有一、二级技师的汽修厂。保时捷还计划提供“飞行医生”服务，在有需要时派出能做高电压维修的技术人员去汽修厂。

随着汽车技术不断进步，汽修厂将迎来更多变化。就像在某些飞机上正在发生的那样，车上越来越多的传感器将更密切地监测运行，并在出现故障前自动为车辆预约预防性保养。尽管距离实现汽车完全自动驾驶还有些遥远，但电动汽车自己前往服务中心的那一天可能就要来了。

不过这样的技术颠覆的确为新进入者提供了机会。毕竟马斯克在创办特斯拉时就是个外行，他手里的（目前还是）这家加州车厂在 2008 年推出了自家第一款电动汽车 Roadster。已经有迹象表明，其他领域的公司在伺机进入电动汽车维保行业。

在买下一辆 Roadster 后，皮特·格鲁伯（Pete Gruber）从 2013 年开始修理这款车。他的公司格鲁伯汽车（Gruber Motor）位于亚利桑那州凤凰城，已经发展成一家独立的特斯拉服务中心。公司已经开发出自己的工具和检测设备来修理特斯拉汽车的电子器件和电池中的单个部件。格鲁伯表示，之所以能做这件事，是因为他还经营一家给数据中心维修高压电力系统的公司 30 多年，所以对这类技术比较熟悉。但他提醒道，“这不是一般修理工能转型上岗的那种活。”格鲁伯的汽修厂有自己的研发实验室。满手机油的修理工们要小心了，你们在车铺里的日子不多了。■



Technology, business and society

Two new books explore the impact of accelerating technology

A third explains how to profit from it

The Exponential Age. By Azeem Azhar. Diversion Books; 352 pages; \$28.99. Published in Britain as “Exponential”; Random House Business; £20

Human Frontiers. By Michael Bhaskar. MIT Press; 432 pages; \$29.95. Bridge Street Press; £20

Masters of Scale. By Reid Hoffman with June Cohen and Deron Triff. Currency; 304 pages; \$28. Bantam Press; £20

HISTORIANS OF SCIENCE distinguish between useful discoveries, such as dental floss, and “general-purpose technologies” that can be applied to numerous purposes—such as electricity, which powers everything from factories to streetlights to televisions. These transformative inventions, and the gadgets they spawned, were developed at a swift, industrial pace in the 19th and 20th centuries. Now, though, a new phase of progress is under way: many technologies are not following linear growth rates but exponential ones. This does more than speed up innovation. It poses drastic challenges for businesses, governments and society.

Many Western institutions are unprepared for this shift because they are stuck in an industrial-age mindset, say three new books. There is good reason for that: people are generally far more familiar with linear growth, in which things change or add up bit by bit, than with the exponential kind, whereby they double or triple (or more) at each increment. For example, if a step is a metre long and you take 25 of them, you have travelled 25 metres. But if each step grew exponentially, doubling from one to two to four metres and so on, your seventh pace would cover a football pitch—and your 25th

would span 33m metres, or almost the circumference of Earth.

It may initially seem slow and boring, but exponential change suddenly becomes unfathomably dramatic. The world is in the midst of just such a transformation, argues Azeem Azhar. Computer technology, he notes, long observed Moore's law, according to which the power of a computer chip (as measured by the number of transistors) doubles every two years, basically with no rise in cost. But, says Mr Azhar, today such exponential growth is also characteristic of other technologies that have been supercharged by digitisation or advances in artificial intelligence (AI). These include solar cells, batteries, genome-editing, augmented reality, 3D manufacturing, online business, even electric cars and urban farming—as well as, alas, online misinformation, cybercrime and warfare.

A slew of superstar firms are emerging on the back of these technologies. They are dominating their sectors because of network effects, whereby using the same platform is widely beneficial. For example, Alibaba, a Chinese e-commerce giant, created an online-payments system in 2004. Nine years later that had become the world's largest mobile-payment platform, called Ant Financial. By having a plethora of data it could improve its service, which made it more popular, which in turn let it collect more data—a cycle known, in a term popularised by Jim Collins, a management scholar, as a “data flywheel” effect.

Ant Financial's data scientists saw that women who bought skinny jeans were also more likely to pay for phone-screen repairs. They speculated that the handsets were slipping out of the trousers' pockets. So the firm began directing offers of screen insurance at skinny-jeans-wearing women. Because of such insights and targeting, 80% of its customers use at least three of its five financial products. Traditional banks that lack such data are at a huge disadvantage—which Mr Azhar calls “the exponential gap”.

With his experience as a startup entrepreneur, tech investor, innovation executive at big companies and journalist (including, 25 years ago, at *The Economist*), Mr Azhar is well-placed to decrypt these digital trends. He has a knack for interrogating and inverting conventional thinking, for example in making the case that the adoption of exponential technology leads to job increases, not cuts—witness the rising headcounts of expanding businesses such as Amazon or Ocado, a British online grocer. The unemployment that results, he says, is down to the firms that fail to adapt, not those that do.

The importance of harnessing technology for business is the theme of “Masters of Scale” by Reid Hoffman, a co-founder of LinkedIn, and his two co-writers. Readers of his book (based on a popular podcast of the same name) will need to look past the stomach-churning clichés with which he implores would-be tech moguls to “Shoot for the Moon” or “Get in the trenches”. When he delves into the stories of his fellow entrepreneurs, by contrast, Mr Hoffman adeptly draws out the essence of their strategies.

Kevin Systrom, for instance, launched a photo-sharing app that grew exponentially by reducing its features rather than, as you might expect, expanding them: within ten weeks it had 1m users. The company, later named Instagram, was sold to Facebook for more than \$1bn when it had just 13 employees. (Mr Hoffman duly advocates “blitzscaling”, or doing whatever is necessary to get big quickly.) Often a founder’s narrative is a mix of myth and pabulum, but beneath those are usually bold decisions that swayed the company’s fate. The book illuminates the critical, often eccentric insights that have in some cases led to warp-speed success.

The implications of these technology and business trends for economic growth and the advancement of knowledge are Michael Bhaskar’s theme in “Human Frontiers”. He enters the debate over the “great stagnation”: the idea that innovation is becoming harder because the most graspable advances have been made. According to this provocative thesis—a much

gloomier one than Mr Azhar's—research is growing costlier and its findings less dramatic. Much of today's innovation aims to deepen understanding of existing science rather than exploring fresh terrain.

Mr Bhaskar used to be a writer for Google DeepMind, a top corporate AI laboratory, and he fluently explains the stakes of the debate, and the way the limits of knowledge have expanded in episodes ranging from the scientific revolution to the upheavals of AI. Yet, maddeningly, he declines to answer the question he poses. "Our ideas", he writes bathetically, "will either rapidly shrink from the frontier or continue charging towards it." Exponential or bust, in other words.

Cynics may snigger at the hype around tech firms. But exponential-age companies often enjoy the last laugh, whether in Amazon's routing of Sears, Netflix's besting of Blockbuster, Apple's defeat of Tower Records or Instagram's kibosh of Kodak. In each case, the upstarts were better at co-opting digital tools and applying them creatively. These books make a convincing case that something extraordinary is taking place in business and society. But they are far from the end of the conversation. ■



技术、商业和社会

两本新书探讨了科技加速发展带来的影响

第三本阐述了如何从中获利【《指数时代》、《人类前沿》、《规模大师》书评】

《指数时代》，阿奇姆·阿扎尔著。Diversion Books出版社；352页；28.99美元。英国版书名《指教级》；兰登书屋；20英镑。

《人类前沿》，迈克尔·巴斯卡尔著。麻省理工学院出版社；432页；29.95美元。Bridge Street出版社；20英镑。

《规模大师》，雷德·霍夫曼、琼·科恩及德隆·特里夫著。Currency出版社；304页；28美元。班塔姆出版社；20英镑。

研究科学史的人将实用的发现与用途广泛的“通用技术”区别开来，前者如牙线，后者如为工厂、路灯、电视机等各种东西供能的电力。后一类变革性的发明以及由此衍生的小设备在19和20世纪快速实现了工业化生产。而如今，技术进步进入了一个新阶段：许多技术并不是呈线性增长，而是指数增长。这不仅仅加快了创新，也给企业、政府和社会带来了巨大挑战。

按照三本新书的说法，许多西方机构都没有对这种转变做好准备，因为它们还陷在工业时代的思维模式中。这很好解释：相比于每次增长一倍或两倍（亦或更多）的指数增长，人们通常对事物一点一点变化或累积的线性增长要熟悉得多。例如，如果一步的长度是一米，那么你走了25步，就是25米。但是，如果每一步都呈指数增长，从一米翻倍到两米再翻倍到四米，以此类推，走完七步，就相当于绕了足球场一周——而到第25步，就会有3300万米，几乎可以绕地球一周。

指数级变化可能一开始看上去缓慢又枯燥，但会突然暴增到不可估量的程度。阿奇姆·阿扎尔（Azeem Azhar）认为，世界正处在这样一种转变之中。他指出，计算机技术长期以来一直遵循摩尔定律，也就是计算机芯片的性能（以晶体管数量来衡量）每两年就会增加一倍，而成本基本上不会

增加。但是，阿扎尔表示，如今在数字化或人工智能（AI）进步的强力推动下，其他技术也呈现出这种指数增长。这些技术包括太阳能电池、蓄电池、基因组编辑、增强现实、3D制造、在线商务，甚至电动汽车和城市农业。可惜，也包括网络虚假信息、网络犯罪和战争。

得益于这些技术，一大批超级明星公司正在崛起。使用同一个平台可以带来广泛的好处，这样的网络效应让它们得以在各自的领域称雄称霸。例如，中国电商巨头阿里巴巴在2004年创建了一个在线支付系统。九年后的今天，这个系统成为了全球最大的移动支付平台，名为蚂蚁金服。它拥有的海量数据能够帮助它改善服务，令它变得更受欢迎，继而又让它收集到更多数据——这个循环过程即“数据飞轮”效应，管理学者吉姆·柯林斯（Jim Collins）普及了这个名称。

蚂蚁金服的数据科学家发现，购买紧身牛仔裤的女性更有可能去花钱维修手机屏幕。他们推测这是因为手机总是从裤兜里滑出来。于是，蚂蚁金服开始瞄准买紧身牛仔裤的女性，向她们提供手机屏幕保险。正因为这样的洞察力和目标定位，它的用户中有八成人选择了使用它推出的五款金融产品中的至少三款。而缺乏这类数据的传统银行则处于巨大的劣势——阿扎尔称之为“指数级差距”。

阿扎尔曾经创办过公司，做过技术投资者、几家大公司的创新主管和记者（包括25年前曾供职于本刊），这样的经历让他解读数字化趋势时得心应手。他在质疑和颠覆传统思维方面很有一套，比如他论证道，采用指数级技术会带来工作岗位的增加而不是减少——看看亚马逊和英国在线杂货商Ocado等扩张型企业不断增长的员工人数就知道了。它引发的失业是因为有些公司没能适应变化，他说，能适应的公司不会有这个问题。

领英的联合创始人雷德·霍夫曼（Reid Hoffman）和另外二人合著的《规模大师》（Masters of Scale）则主要讲述了利用科技为企业服务的重要性。本书从他的同名热门播客发展而来，读者在阅读时需要忽略其中一些令人倒胃口的陈词滥调，比如，他恳求那些想要成为科技大佬的人“志当存高远”或者“卷起袖子干”。不过，当霍夫曼深入讲述他同辈企业家的故

事时就又是另一副样子了——他娴熟地提炼出了他们战略的精髓。

例如，凯文·斯特罗姆（Kevin Systrom）推出的一款照片分享应用通过对功能做减法——而不是像人们可能预期的那样做加法——实现了指数级增长，在十周之内便拥有了100万用户。这家后来叫作Instagram的公司以超过10亿美元的价格出售给了Facebook，当时它只有13名员工。（霍夫曼在讲到这里时适时倡导起“闪电扩张”，即采取一切必要措施迅速扩大规模。）创始人讲述的故事往往是虚构和鸡汤的混合，而这些故事的背后通常是影响公司命运的大胆决策。这本书阐明了一些至关重要的、很多时候看似古怪的见解，它们在某些案例中带来了飞速成功。

而这些技术和商业趋势对经济增长和知识进步的影响正是迈克尔·巴斯卡尔（Michael Bhaskar）所著《人类前沿》（Human Frontiers）的主题。他加入了关于“大停滞”的争论。“大停滞”一派认为，由于那些最有希望争取到的进步都已被人类取得，创新开始变得越来越困难。根据这一极富争议的论点——比阿扎尔的观点悲观得多——研究成本越来越高，所获得的发现却没有那么激动人心。如今的创新目标大多是深化对现有科学的理解，而不是探索新的领域。

巴斯卡尔曾是谷歌DeepMind这个顶级的企业下设AI实验室的特聘撰稿人。他洋洋洒洒地阐述了这场辩论的利害关系，以及在从科学革命到AI剧变的一系列事件中，知识的边界是如何拓展的。然而，令人抓狂的是，他拒绝回答自己提出的问题。“我们的创意，”他虎头蛇尾地写道，“要么会迅速从前沿撤退，要么继续向它发起冲锋。”换句话说，要么指数增长，要么破产。

愤世嫉俗者可能会暗暗嘲笑科技公司的热度和喧嚣。但指数时代的公司往往笑到了最后，无论是亚马逊击败西尔斯（Sears）、奈飞战胜百视达（Blockbuster）、苹果干掉Tower Records，还是Instagram打垮柯达。在以上每个案例中，新贵们都更善于利用数字工具，并创造性地运用它们。这三本书令人信服地指出，商界和社会正在发生一些不同寻常的事情。但它们还远远没有把这个话题讲透。 ■



Schumpeter

Huawei should dissolve, disperse and seed China's high-tech future

It is too prominent to be able to reinvent itself

HUAWEI, A CHINESE firm emblematic of the breakdown in Sino-American relations, makes for a perfect business-school case study. Less than two years ago the company, based in the southern boom town of Shenzhen, had not only surpassed Nokia and Ericsson, its Nordic rivals, to become the world's leading supplier of telecoms infrastructure. It had also overtaken Samsung to become the biggest seller of mobile phones. Like all good case studies, it has vivid characters, from its founder, Ren Zhengfei, a former army officer and engineer, to his daughter, Meng Wanzhou, just freed from a starring role in the first prisoner-exchange drama of the tech cold war. It is a groundbreaking firm. Like Japan's Sony in the 1980s, it helped change the perception of its home country from one of cheap knock-offs to eye-catching innovation. And its very future may be in peril. With the long arm of American law enforcement around its neck, it is being throttled by a lack access to cutting-edge technology, such as 5G smartphone chips.

The question is what Huawei ought to do next. Should it tough out American sanctions and hope, as Victor Zhang, its global vice-president, puts it, that its research and development (R&D) budget, a whopping \$21.8bn last year, can "fertilise" a new array of business activities that will redefine its future? Or should it instead quietly break itself up, dispersing a 105,000-strong army of engineers to seed a flurry of new ventures? In short, should it remain a tall poppy or let a hundred smaller flowers bloom?

It is a fairly safe bet that Huawei will take the first option. After all, it is an employee-owned company with a fierce self-belief. It has a never-say-die business culture; its salespeople are renowned for drinking anyone under

the table in pursuit of a deal. It could become a national champion for President Xi Jinping's mission to make the country more self-reliant in technology. And the government in Beijing would hate the idea of it wilting under pressure from Uncle Sam.

The tough-it-out approach is strewn with difficulties, though. Since America's government branded Huawei's 5G gear a national-security threat in 2019, and a year later curtailed the firm's access to chips made with American equipment, its smartphone business, which in 2020 generated more than half of revenues, has cratered. Sales have tumbled from more than 60m units in the last three months of 2019 to about 15m units in the third quarter of 2021, according to Dan Wang of Gavekal Dragenomics, a research firm. In China its latest phones lack 5G connectivity.

Although Huawei remains the world's number-one supplier of telecoms gear, its sales and market share are shrinking as America's allies bar it from their 5G networks and other customers fret about its long-term viability. Huawei is putting on a brave face, nonetheless. It is in its "second startup phase", in Mr Zhang's words. Each year it pours at least a tenth of its revenues into R&D (in 2020 the share reached almost 16%). This, Mr Zhang adds, will help build up new core ventures. It is expanding in areas from making cars smarter and helping coal mines become semi-autonomous to infrastructure for cloud-computing and regulating power supply in energy markets. None of these opportunities depends on cutting-edge semiconductors.

Promoting that startup culture in-house may work. But the new endeavours do not generate anything like the revenues of Huawei's smartphone and networks businesses. One analyst describes the coal venture as "a dying company meets a dying industry". A better, bolder way forward would be to embrace the Schumpetarian creed of "creative destruction": let the old firm die so that new ones could emerge, dispersing capital, ideas and talent.

Silicon Valley provides a striking precedent. In 1957 the so-called “traitorous eight” walked out of Shockley Semiconductor Laboratory to found Fairchild Semiconductor. The “Fairchildren” became the backbone of the area’s high-tech, risk-taking culture, establishing Intel, a chip giant, and scores of other firms, including venture-capital veterans like Kleiner Perkins. Huawei’s engineers at HiSilicon, its chip-design unit, could do something similar. That could advance China’s growing ambitions in the chip industry, illustrated by the unveiling on October 19th by Alibaba, a tech giant, of a new, custom-built, state-of-the-art server chip.

Huawei has no plans for a HiSilicon spin-off, Mr Zhang says. The firm’s tactical retreat in the smartphone business illustrates what it may and may not be able to do. Last year it sold Honor, a niche smartphone brand, to give it the freedom to evade American export controls. Honor’s new phones now have access to American chips and the software and services of Google, an American tech giant, that Huawei still does not. Despite the backing of Shenzhen’s government, which invites questions about just how entrepreneurial Honor will be, the industry’s reaction to the divestiture has been “really positive” both inside and outside China, reports Ben Stanton of Canalys, a telecoms-research firm. Moreover, he reckons, Huawei’s best smartphone engineers have moved to Honor, keeping alive the older firm’s engineering and sales culture.

Unsurprisingly, Honor has also attracted the attention of America’s foreign-policy hawks, including Marco Rubio, a Republican senator who on October 14th called it an “arm of the Chinese Communist Party” and a foreign-policy threat, and urged President Joe Biden’s administration to blacklist it. This is a reminder of how hard it will be for any firm in Huawei’s shadow to shake off such accusations, whether true or not. Better for its engineers to roam free instead. They are likely to be more creative within small groups than inside a corporation—all the more so if what Mr Wang calls “China’s Sputnik moment” engenders a burst of domestic innovation. Huawei’s liberated

brain-boxes may then also teach America a lesson in how counterproductive knee-jerk technonationalism can be. ■



熊彼特

华为应解体、分散，播撒中国高科技未来的种子

它太过显眼而无法自我重塑

成为中美关系破裂的象征的中国公司华为是个完美的商学院研究案例。不到两年前，这家总部位于南方繁荣城市深圳的公司不仅超越了其北欧竞争对手诺基亚和爱立信，成为全球领先的电信基础设施供应商，还取代三星成为第一大手机销售商。像所有优秀的研究案例一样，它也有形形色色的生动人物，像是曾担任过军官和工程师的创始人任正非，以及他的女儿孟晚舟——她近期刚刚卸下科技冷战第一出人质交换大戏的主演一角。它是一家开创性的公司。就像20世纪80年代的日本索尼公司一样，它帮助改变了自己国家在世人眼中的形象——从一个山寨大国变成了引人注目的创新之国。而它的未来可能处于危险之中。美国执法部门的长臂钳住了它的脖子，无法获取5G智能手机芯片等先进技术令它难以喘息。

问题是华为下一步该怎么做。它是否应该咬牙顶住美国的制裁，寄希望于自己的研发预算（去年高达218亿美元）能够像其全球副总裁张国威所说的那样，“孕育”一系列新的商业活动，从而重新定义自己的未来？还是说它应该悄悄地自行分拆，解散它10.5万人的工程师大军，播撒种子催生一大批新企业？简而言之，它应该保持一枝独秀傲立，还是促成百朵小花齐放？

认为华为会选前一种是个很稳妥的猜测。毕竟它是一家员工持股的公司，有着强烈的自我信念。它有着永不言败的企业文化；它的销售人员名声在外——他们为了做成交易，可以把任何人都喝趴下。它或许能成为国家龙头企业，投身国家主席习近平提出的让中国在技术上更加独立自主的使命。而且北京当局应该也极不愿意看到它在山姆大叔的施压下变得萎靡不振。

然而，咬牙坚持这条路困难重重。2019年，美国政府将华为的5G设备列为

国家安全威胁，并在一年后限制它获取用美国设备制造的芯片。自那之后，华为的智能手机业务（2020年贡献了超过一半的营收）跌入谷底。销量已从2019年最后三个月的逾6000万部暴跌至2021年第三季度的约1500万部，研究公司龙洲经讯（Gavekal Dragenomics）的王丹（音译）表示。在中国，其最新款的手机没有5G连接。

尽管华为仍旧是全球头号电信设备供应商，但由于美国盟友把华为挡在自己的5G网络之外，加上其他客户也担心华为的长期生存能力，它的销售额和市占率正在萎缩。尽管如此，华为还是一副若无其事的样子。用张国威的话说，它正处于“二次创业阶段”。它每年将至少十分之一的收入投入研发（2020年这一比重达到近16%）。这将有助于打造新的核心项目，张国威补充说。它正在向各个领域扩张：从提升汽车的智能化程度和帮助煤矿实现半自主化操作，到云计算基础设施和调节能源市场电力供应。这些机会全都不依赖尖端半导体。

在内部提倡这种创业文化也许会奏效。但新项目产生的收入根本比不上华为的智能手机和网络业务。一名分析师对它的煤矿业务的描述是“一家濒死的公司遇上一个濒死的行业”。一个更好、更大胆的前进方式应该是拥抱熊彼特的“创造性破坏”信条：让旧公司死去，换来一批新公司生长，从而让资本、创意和人才散播开来。

硅谷提供了一个令人瞩目的先例。1957年，所谓的“八叛徒”出走肖克利半导体实验室（Shockley Semiconductor Laboratory），成立了飞兆半导体（Fairchild Semiconductor）。这些“仙童”成为硅谷高科技冒险文化的中流砥柱，创立了芯片巨头英特尔和其他许多公司，包括像凯鹏华盈（Kleiner Perkins）这样的老牌风险投资公司。华为的芯片设计部门海思的工程师们或许也可以做类似的事情。这可能会推进中国对芯片行业不断增长的雄心。科技巨头阿里巴巴于10月19日发布了新款的高端定制服务器芯片，便是这种雄心的体现。

张国威表示，华为没有剥离海思的计划。华为在智能手机业务上的战术性撤退显示了它可能做得到什么、做不到什么。去年，它出售了智能手机利

基品牌荣耀，让它可以自由地绕开美国的出口管制。荣耀的新款手机现在可以使用美国的芯片以及美国科技巨头谷歌的软件和服务，而华为目前仍不能用这些。尽管背靠深圳政府这一点令人质疑荣耀能有多少创业精神，但海内外业界对此次剥离的反应都“十分正面”，电信研究公司科纳仕（Canalys）的本·斯坦顿（Ben Stanton）报告称。此外，他认为，华为最好的智能手机工程师已经转移到了荣耀，华为的工程和销售文化也就得以保留。

不出所料，荣耀也引起了美国外交政策鹰派人士的注意，其中包括共和党参议员马可·卢比奥（Marco Rubio）。他在10月14日称荣耀是“中国共产党的一只手臂”，对外交政策构成威胁，并敦促拜登政府将其列入黑名单。这提醒人们，任何处在华为阴影下的公司都会很难摆脱这类指控，不管它们所言真实与否。更好的办法还是让它的工程师们想去哪里去哪里。他们在小团队之中应该会比在一家大公司里更有创造力——如果王丹所说的“中国的斯普特尼克时刻”引发了一轮国内创新爆发，那就更是如此了。到时候，这些从华为解放出来的聪明绝顶之人或许也能给美国上一课，让它看到不经大脑的技术民族主义反应会如何适得其反。 ■



Cloudy with a dearth of chips

How the pandemic has changed the weather in the technology industry

The cloud, hardware and competition are gaining in importance

THE TECH industry recently appeared to be sitting on cloud nine. One record after another fell when quarterly results were reported three months ago. Revenues had grown by 40% on average compared with the same period a year ago and profits by 90% for the five Western technology titans—Alphabet (Google's parent company), Amazon, Facebook, Apple and Microsoft, collectively known as GAFAM. Indices of tech shares, such as the S&P 500 Information Technology benchmark, climbed to stratospheric heights.

If the latest round of quarterly earnings are any guide—three of the digital giants have already reported and results from Amazon and Apple are due to after The Economist goes to press—the tech industry is coming back down to earth. Assuming that the pair meet analysts' expectations, GAFAM's revenues and profits will both have increased but by a more modest 30%. Share prices are languishing. The slowdown—or breather, if you will—provides additional evidence of the degree to which the pandemic has changed the tech industry. The question now is whether the sector is on a new trajectory or will revert to type over the next few years.

For starters, one of the first predictions when covid-19 hit in early 2020 was that it would make big tech even bigger. Those firms, ran the theory, would be best placed to benefit from an increased demand for digital offerings, whereas smaller firms, having fewer resources to get through the pandemic, would suffer most from its downsides. The first half of this prediction has come true: as the growth of the five firms' market capitalisation shows. In January 2020 their combined value accounted for 17.5% of the S&P 500.

Today their share hovers around 22%.

That said, many smaller companies have also grown in size and value. The pandemic has given rise to a group which could be called “tier-two tech”, the weight of which, measured by market capitalisation, has grown notably relative to the titans. In May we defined this group to include 42 firms with a market value then of no less than \$20bn that were incorporated in 2000 or later. In February 2020 these had a joint market capitalisation of 22% of GAFAM’s. Today the figure stands at 31%

The reasons for this new strength are multiple. One is the large number of listings of late, particularly of tech startups: more than 100 since the start of the year, says Renaissance Capital, a data provider. Despite some high-value deals, a backlash against big tech’s acquisitiveness has slowed the pace of mergers and takeovers this year. Most importantly, the pandemic has shown that there are big digital markets that are not dominated by GAFAM. The group of tier-two firms, for instance, is led by PayPal, a payments provider, that boasts a market capitalisation of \$276bn.

Yet the most intriguing shifts are qualitative. The first is that the tech industry has become far cloudier than previously. “We saw two years of digital transformation in two months,” said Satya Nadella, the boss of Microsoft, early in the pandemic, referring mostly to the growth of its cloud. Taken together, revenues of the three biggest clouds—Microsoft’s cloud business, Amazon’s AWS and Google Cloud Platform, which between them provide more than 60% of online-infrastructure services—have surged by more than a third from \$27bn in the fourth quarter of 2019 to nearly \$37bn in the second quarter of this year.

The gathering cloud’s bigger beneficiaries seem to be smaller firms, however. Taking a panel of 50-odd second-tier tech firms today, about four-

fifths are providers of cloud services. Some are now forces to be reckoned with: Snowflake, a cloud-based data platform, is worth \$104bn; Twilio, which provides corporate-communication services, some \$61bn; and Okta, which manages employees' digital identities, some \$39bn.

Older tech firms are now also more firmly anchored in the cloud. Salesforce, a software giant, was one of its pioneers. Adobe, another software titan, has successfully reinvented itself for this new form of computing. Even the cloud's laggards, Oracle and SAP, the world's largest vendors of conventional corporate software, are at last making use of it. The biggest hardware-makers—Cisco, Dell and IBM—are also increasingly selling their wares “as-a-service”, accessed remotely through the cloud on a pay-per-use basis rather than installed on office computers.

The industry's second shift is that lowly hardware has also made a comeback of sorts during the pandemic, despite the migration up into the computing skies. Most surprisingly, personal computers staged a revival as remote workers required better gear. In 2020 PCs saw their biggest growth in a decade, with more than 300m devices shipped, 13% more than in 2019, according to IDC, a market-research firm. Growth has since slowed, but mainly because shortages of chips and other components are holding back production. Dell, the world's third-largest maker of PCs after Lenovo and HP, has done best, increasing shipments in the third quarter by nearly 27% compared with last year, according to IDC—almost guaranteeing good results when Dell reports on November 23rd.

Chipmakers give an even stronger signal of the return of hardware to the industry's core. Although Intel disappointed investors when it released its quarterly results on October 21st, sending its share price down, sales were up by 5% to \$19.2bn and profits by 60% to \$6.8bn. Samsung Electronics, the world's largest memory-chipmaker, which will also report results on October 27th, saw its profits jump to the highest level in three years. And

TSMC, the top contract manufacturer of semiconductors, for its part said on October 14th that sales had continued to grow at a rapid clip, reaching \$14.9bn with net income coming in at \$5.6bn, an increase of 16.3% and 13.8% respectively.

The big question is whether the three companies can profitably follow through on their record-breaking investment plans. These are meant to satisfy growing demand for chips not just from cloud providers, but from firms making gear for what is called the “edge”: devices connecting to the cloud or extending it, from smartphones to intelligent sensors. Intel, for instance, has said that it will invest up to \$28bn in 2022. TSMC plans to spend \$100bn over the next three years to expand its chip-fabrication capacity.

The third big change to the tech industry during the pandemic may be the most consequential: increased competition. Although members of GAFAM have yet to attack each other’s main franchises, such as online search in the case of Google and ecommerce for Amazon, rivalries have heated up. So far, vigorously competing clouds and changes in Apple’s privacy policies on the iPhone—which hurt Facebook’s ad revenues according to results released on October 25th—are the main examples. But on October 21st Google announced that it would lower the fee it charges providers of subscriptions in its app store to 15%, putting pressure on Apple to do the same. And with so many people now working remotely and probably continuing to do so, a platform battle has broken out between Google, Microsoft, Salesforce and Zoom, a popular videoconferencing service, over which will dominate the virtual office.

Other firms are also picking more fights with GAFAM. Facebook’s social-media fortress looks a lot less safe now that it has at least two serious rivals: America’s Snapchat, a social network owned by Snap, and TikTok, the short-

video app operated by ByteDance, a Chinese internet giant. According to data divulged in a recent wave of leaks, Facebook's teenage users in America now spend two to three times longer on TikTok than on Instagram, which belongs to the American social-media conglomerate. Amazon also faces more competition, both in the form of incumbents that have at last embraced the digital world, including Walmart, and newcomers, such as Shopify, which helps merchants sell online and fulfil orders. PayPal's attempt to buy Pinterest, another social network, now seems to have been abandoned, but it would have helped PayPal to move deeper into ecommerce.

After nearly two years of covid-19 the tech industry is cloudier, more tied to hardware and more turbulent. Of these trends, the first two are unlikely to last for ever, at least in their current form. Digital meteorologists argue that the cloud has already reached "peak centralisation", meaning that it will henceforth grow not so much through football-pitch-sized data centres, but at the "edge", where its digital services touch the physical world. And given the economics of the semiconductor industry—fabrication plants often cost over \$10bn and take years to build—the chip shortage could eventually turn into a glut.

A more open question is how long the new phase of competition will last. Optimists argue that, after a long period of ossification, the pandemic has helped push the industry into a more dynamic period, in which the giants compete with each other as well as with smaller firms. Pessimists say that this phase will not last long—and that the industry's leaders will sooner or later shore up their fortresses and buy out competitors. And that is why, more than ever before, trustbusters should not let down their guard. ■



多云，少芯片

疫情如何让科技业风云变幻

云、硬件与行业竞争日趋重要

科技业近来似乎有青云直上之势。三个月前的季度业绩报告接连录得破纪录的数字。统称GAFAM的西方科技五巨头——Alphabet（谷歌母公司）、亚马逊、Facebook、苹果和微软的收入较去年同期平均增长40%，利润增长90%。标普500信息技术指数等科技股指数直冲云霄。

假如新一季财报可以看作风向标（三家数字巨头已公布财报，亚马逊和苹果将在本刊新一期付印后公布），它显示的却是科技业正从云端跌回地面。假设亚马逊和苹果的业绩与分析师的估计相符，那么GAFAM的收入和利润都有所上升，但增幅减至30%。股价萎靡不振。这样的放缓（或者你会说是“休整期”）是疫情大力改变科技业的又一佐证。当前的问题是，科技业是走在了新轨道上，还是会在未来几年内回归旧格局。

首先，2020年初疫情爆发后，最早出现的预测之一就是在科技界将“大者愈大”。持这种看法的人认为，科技巨头最有可能因数字产品需求大增而获益，而资源较少、在疫情中处...



Our NFT auction

The fun in non-fungible

Our auction reveals the promise of decentralised finance—and some big problems

IF NOTHING ELSE, our auction of an NFT was entertaining—and lucrative. Starting on Monday October 25th The Economist invited bids for a non-fungible token of an image of our recent cover on decentralised finance. NFTs are a digital property deed that lives on a blockchain and can be bought on financial platforms using digital currencies. At one point, a club of would-be bidders formed a decentralised autonomous organisation, called “RabbitHoleDAO”, to try to crowd-source enough funds to buy our token. A scramble of bids forced the winner, who went by the alias @9x9x9, to make an offer of 99.9 ether—around \$420,000. The proceeds, net of fees, taxes and transaction costs, will be donated to The Economist Educational Foundation, an independent charity we support.

Plenty of others are having fun, too. Pokémon-style NFTs are being bred by a quarter of a million users of Axie Infinity, a video game. Armies of art fans trade digital collectables. NFTs on the Ethereum blockchain are today worth \$14bn, up from \$340m in 2020. Jefferies, an investment bank, thinks the total will reach \$80bn by 2025.

At this point you may well have a nagging doubt: what exactly do the owners of NFTs get? The best way of thinking about this is that NFTs are a way to unbundle property rights. Having legal title to a conventional asset typically confers a standard set of benefits. With a house, car or company stock, your title brings proof of ownership, the right to exclusive use, the ability to charge for its use by others and the right to receive the proceeds of a sale.

In high finance it is common, with the help of pricey lawyers, to slice and

dice elements of these rights, as with a derivatives contract. But this kind of flexibility is not cheaply available to consumers and small firms. NFTs have the potential to change that. In our auction we defined the property rights using the default conditions on the platform. So the new owner of our NFT has rights akin to a licence: they can display the image in certain ways, but cannot commercialise it (by, for instance, selling T-shirts with the image on them). On behalf of the charity we support, we also have the ability to take a 10% cut of any future sale of the token. In theory an NFT sale can embody any combination of property rights designed by the seller. There are other advantages. A public, irrevocable record of the transaction exists on a blockchain and works with other digital applications.

Yet for all their conceptual promise, NFTs have three big practical flaws, as our experiment showed. Despite the slick interface of NFT platforms, the process is a nightmare. It includes setting up a digital wallet, funding it to pay any fees associated with creating an NFT, creating the token and finding a way to convert the proceeds into conventional money in a bank account. For most legal and tax advisers this is all virgin territory. The process is expensive: we paid “gas”, a fancy word for fees, and other levies. In order to become mainstream, applications in decentralised finance will have to be as easy to use as an iPhone and cheaper than dealing with conventional financial intermediaries.

The second problem is energy. Our modest experiment created as many emissions as a seat on a long-haul flight. Most platforms are exploring how to lower their energy use. If NFTs are to be the Next Big Thing, they must innovate their way towards a carbon-neutral footprint.

A third concern is contract enforcement. We hope that this will not be an issue for our token, because the asset—a unique digital representation of a cover image already in wide circulation—will be used within decentralised finance, and there is no obvious incentive to misuse it. But for NFTs that

refer to assets outside this self-contained world, such as a patent or a building, the property rights conferred by the NFT may conflict with other contracts, and courts may not recognise the digital agreement.

This is starting to change. A flat in Kyiv changed hands this year, when an NFT representing it was sold in a deal recognised by Ukraine's authorities. But decentralised finance has a long way to go before it is integrated with the legal system. The to-do list is daunting, but if these problems are resolved, NFTs could yet become more than a token gesture. ■



【首文】本刊的NFT拍卖

不可替代的乐趣

此次拍卖揭示了去中心化金融的前景——以及一些重大问题

别的不说，本刊此次NFT拍卖很有趣——也很有赚头。10月25日星期一，本刊推出一枚非同质化代币（NFT）邀请人们投标，内容是本刊近期一张关于去中心化金融的封面图片。NFT是一种存储在区块链上的数字财产证书，可以用数字货币在金融平台上购买。一群有意竞标的人一度还成立了一个名为“兔子洞DAO”（RabbitHoleDAO）的分布式自治组织，试图众筹足够的资金来购买我们这枚代币。竞标热火朝天，最终网名@9x9x9的用户花了99.9枚以太币（约合42万美元）才将它收归名下。扣除费用、税收和交易成本后，所得收入将捐赠给我们支持的独立慈善机构经济学人教育基金会。

还有其他许多人也正玩得开心。电子游戏Axie Infinity的25万用户在培育宝可梦风格的NFT。大批艺术爱好者交易数字收藏品。如今，以太坊区块链上的NFT价值总计140亿美元，而在2020年还只有3.4亿美元。投资银行杰弗瑞（Jefferies）认为，到2025年NFT价值总计将达到800亿美元。

说到这里，你心头的疑问可能还是挥之不去：NFT的所有者究竟能得到什么？对此最好的思考角度是把NFT视作分解产权的一种方式。拥有某项传统资产的合法业权通常会得到一系列标准利益。就房屋、汽车或公司股票而言，合法业权会赋予你所有权证明、独家使用权、对他人收取使用费用的能力以及收取销售收入的权利。

在高级金融领域，对这些权利要素做分割很常见（在收费高昂的律师的帮助下），就像在衍生品合约中那样。但消费者和小企业却不能以较低的成本获得这样的灵活性。NFT有可能改变这种状况。在此次拍卖中，我们用平台的默认条款来定义产权。因此，我们NFT的新主人拥有类似于许可证的权利：他们可以用某些方式展示这幅图，但不能将其商业化（例如出售

印有这幅图的t恤）。我们还能够代表所支持的慈善机构从该代币未来的销售中获得10%的分成。理论上，一次NFT出售可以按照卖方的设计包含任何产权组合。NFT还有其他优势。交易记录公开、不可更改，存储于区块链之上，并可与其他数字应用协同工作。

然而，尽管从概念上看NFT颇有前景，但正如我们此次实验所显示的，它有三大实际缺陷。尽管NFT平台的界面很精美，使用过程却是一场噩梦。先要设置一个数字钱包并充值，以支付与创建NFT相关的费用，接着创建代币，还要想办法将收益转化为银行账户中的常规货币。对于大多数法律和税务顾问来说，这都还是一块处女地。整个过程成本不菲：我们支付了“燃油费”（系统给费用起的花哨名称），以及其他税费。若要成为主流，去中心化金融的应用就必须像iPhone那样简单易用，并且要比跟传统金融中介打交道更便宜才行。

第二个问题是能源。我们的小规模实验产生的排放相当于一次单人长途飞行。大多数平台都在探索如何降低能耗。如果NFT要成为“下一个大事件”，就必须为实现碳中和足迹而创新。

第三个问题是合同执行。我们希望自己的代币不会有这个问题，因为它承载的资产——一张已经广泛流传的封面图片独一无二的数字形式——将局限在去中心化金融内使用，而且人们也没有滥用它的明显动机。但如果NFT代表的资产存在于这个遗世独立的世界之外（比如一项专利或一栋建筑），那NFT赋予的产权可能就会与其他合同相冲突，法庭可能不承认这种数字协议。

这种情况已经开始改变。今年，基辅的一套公寓以NFT的形式易手，此次交易得到了乌克兰政府认可。但在与法律体系融合之前，去中心化金融还有很长的路要走。待完成的各项工作十分艰巨，但如果这些问题得到解决，NFT可能会变得不再是区区代币而已。 ■



The real-time revolution

Enter third-wave economics

How the pandemic reshaped the dismal science

AS PART OF his plan for socialism in the early 1970s, Salvador Allende created Project Cybersyn. The Chilean president's idea was to offer bureaucrats unprecedented insight into the country's economy. Managers would feed information from factories and fields into a central database. In an operations room bureaucrats could see if production was rising in the metals sector but falling on farms, or what was happening to wages in mining. They would quickly be able to analyse the impact of a tweak to regulations or production quotas.

Cybersyn never got off the ground. But something curiously similar has emerged in Salina, a small city in Kansas. *Salina311*, a local paper, has started publishing a “community dashboard” for the area, with rapid-fire data on local retail prices, the number of job vacancies and more—in effect, an electrocardiogram of the economy.

What is true in Salina is true for a growing number of national governments. When the pandemic started last year bureaucrats began studying dashboards of “high-frequency” data, such as daily airport passengers and hour-by-hour credit-card-spending. In recent weeks they have turned to new high-frequency sources, to get a better sense of where labour shortages are worst or to estimate which commodity price is next in line to soar. Economists have seized on these new data sets, producing a research boom (see chart 1). In the process, they are influencing policy as never before.

This fast-paced economics involves three big changes. First, it draws on data that are not only abundant but also directly relevant to real-world problems.

When policymakers are trying to understand what lockdowns do to leisure spending they look at live restaurant reservations; when they want to get a handle on supply-chain bottlenecks they look at day-by-day movements of ships. Troves of timely, granular data are to economics what the microscope was to biology, opening a new way of looking at the world.

Second, the economists using the data are keener on influencing public policy. More of them do quick-and-dirty research in response to new policies. Academics have flocked to Twitter to engage in debate.

And, third, this new type of economics involves little theory. Practitioners claim to let the information speak for itself. Raj Chetty, a Harvard professor and one of the pioneers, has suggested that controversies between economists should be little different from disagreements among doctors about whether coffee is bad for you: a matter purely of evidence. All this is causing controversy among dismal scientists, not least because some, such as Mr Chetty, have done better from the shift than others: a few superstars dominate the field.

Their emerging discipline might be called “third wave” economics. The first wave emerged with Adam Smith and the “Wealth of Nations”, published in 1776. Economics mainly involved books or papers written by one person, focusing on some big theoretical question. Smith sought to tear down the monopolistic habits of 18th-century Europe. In the 20th century John Maynard Keynes wanted people to think differently about the government’s role in managing the economic cycle. Milton Friedman aimed to eliminate many of the responsibilities that politicians, following Keynes’s ideas, had arrogated to themselves.

All three men had a big impact on policies—as late as 1850 Smith was quoted 30 times in Parliament—but in a diffuse way. Data were scarce. Even by the 1970s more than half of economics papers focused on theory alone, suggests

a study published in 2012 by Daniel Hamermesh, an economist.

That changed with the second wave of economics. By 2011 purely theoretical papers accounted for only 19% of publications. The growth of official statistics gave wonks more data to work with. More powerful computers made it easier to spot patterns and ascribe causality (this year's Nobel prize was awarded for the practice of identifying cause and effect). The average number of authors per paper rose, as the complexity of the analysis increased (see chart 2). Economists had greater involvement in policy: rich-world governments began using cost-benefit analysis for infrastructure decisions from the 1950s.

Second-wave economics nonetheless remained constrained by data. Most national statistics are published with lags of months or years. "The traditional government statistics weren't really all that helpful—by the time they came out, the data were stale," says Michael Faulkender, an assistant treasury secretary in Washington at the start of the pandemic. The quality of official local economic data is mixed, at best; they do a poor job of covering the housing market and consumer spending. National statistics came into being at a time when the average economy looked more industrial, and less service-based, than it does now. The Standard Industrial Classification, introduced in 1937-38 and still in use with updates, divides manufacturing into 24 subsections, but the entire financial industry into just three.

Especially in times of rapid change, policymakers have operated in a fog. "If you look at the data right now...we are not in what would normally be characterised as a recession," argued Edward Lazear, then chairman of the White House Council of Economic Advisers, in May 2008. Five months later, after Lehman Brothers had collapsed, the IMF noted that America was "not necessarily" heading for a deep recession. In fact America had entered a recession in December 2007. In 2007-09 there was no surge in economics

publications. Economists' recommendations for policy were mostly based on judgment, theory and a cursory reading of national statistics.

The gap between official data and what is happening in the real economy can still be glaring. Walk around a Walmart in Kansas and many items, from pet food to bottled water, are in short supply. Yet some national statistics fail to show such problems. Dean Baker of the Centre for Economic and Policy Research, using official data, points out that American real inventories, excluding cars and farm products, are barely lower than before the pandemic.

There were hints of an economics third wave before the pandemic. Some economists were finding new, extremely detailed streams of data, such as anonymised tax records and location information from mobile phones. The analysis of these giant data sets requires the creation of what are in effect industrial labs, teams of economists who clean and probe the numbers. Susan Athey, a trailblazer in applying modern computational methods in economics, has 20 or so non-faculty researchers at her Stanford lab (Mr Chetty's team boasts similar numbers). Of the 20 economists with the most cited new work during the pandemic, three run industrial labs.

More data sprouted from firms. Visa and Square record spending patterns, Apple and Google track movements, and security companies know when people go in and out of buildings. "Computers are in the middle of every economic arrangement, so naturally things are recorded," says Jon Levin of Stanford's Graduate School of Business. Jamie Dimon, the boss of JPMorgan Chase, a bank, is an unlikely hero of the emergence of third-wave economics. In 2015 he helped set up an institute at his bank which tapped into data from its network to analyse questions about consumer finances and small businesses.

The Brexit referendum of June 2016 was the first big event when real-time

data were put to the test. The British government and investors needed to get a sense of this unusual shock long before Britain's official GDP numbers came out. They scraped web pages for telltale signs such as restaurant reservations and the number of supermarkets offering discounts—and concluded, correctly, that though the economy was slowing, it was far from the catastrophe that many forecasters had predicted.

Real-time data might have remained a niche pursuit for longer were it not for the pandemic. Chinese firms have long produced granular high-frequency data on everything from cinema visits to the number of glasses of beer that people are drinking daily. Beer-and-movie statistics are a useful cross-check against sometimes dodgy official figures. China-watchers turned to them in January 2020, when lockdowns began in Hubei province. The numbers showed that the world's second-largest economy was heading for a slump. And they made it clear to economists elsewhere how useful such data could be.

In the early days of the pandemic Google started releasing anonymised data on people's physical movements; this has helped researchers produce a day-by-day measure of the severity of lockdowns (see chart 3). OpenTable, a booking platform, started publishing daily information on restaurant reservations. America's Census Bureau quickly introduced a weekly survey of households, asking them questions ranging from their employment status to whether they could afford to pay the rent.

In May 2020 Jose Maria Barrero, Nick Bloom and Steven Davis, three economists, began a monthly survey of American business practices and work habits. Working-age Americans are paid to answer questions on how often they plan to visit the office, say, or how they would prefer to greet a work colleague. "People often complete a survey during their lunch break," says Mr Bloom, of Stanford University. "They sit there with a sandwich,

answer some questions, and that pays for their lunch.”

Demand for research to understand a confusing economic situation jumped. The first analysis of America’s \$600 weekly boost to unemployment insurance, implemented in March 2020, was published in weeks. The British government knew by October 2020 that a scheme to subsidise restaurant attendance in August 2020 had probably boosted covid infections. Many apparently self-evident things about the pandemic—that the economy collapsed in March 2020, that the poor have suffered more than the rich, or that the shift to working from home is turning out better than expected—only seem obvious because of rapid-fire economic research.

It is harder to quantify the policy impact. Some economists scoff at the notion that their research has influenced politicians’ pandemic response. Many studies using real-time data suggested that the Paycheck Protection Programme, an effort to channel money to American small firms, was doing less good than hoped. Yet small-business lobbyists ensured that politicians did not get rid of it for months. Tyler Cowen, of George Mason University, points out that the most significant contribution of economists during the pandemic involved recommending early pledges to buy vaccines—based on older research, not real-time data.

Still, Mr Faulkender says that the special support for restaurants that was included in America’s stimulus was influenced by a weak recovery in the industry seen in the OpenTable data. Research by Mr Chetty in early 2021 found that stimulus cheques sent in December boosted spending by lower-income households, but not much for richer households. He claims this informed the decision to place stronger income limits on the stimulus cheques sent in March.

As for the Federal Reserve, in May 2020 the Dallas and New York regional Feds and James Stock, a Harvard economist, created an activity index using

data from SafeGraph, a data provider that tracks mobility using mobile-phone pings. The St Louis Fed used data from Homebase to track employment numbers daily. Both showed shortfalls of economic activity in advance of official data. This led the Fed to communicate its doveish policy stance faster.

Speedy data also helped frame debate. Everyone realised the world was in a deep recession much sooner than they had in 2007-09. In the IMF's overviews of the global economy in 2009, 40% of the papers cited had been published in 2008-09. In the overview published in October 2020, by contrast, over half the citations were for papers published that year.

The third wave of economics has been better for some practitioners than others. As lockdowns began, many male economists found themselves at home with no teaching responsibilities and more time to do research. Female ones often picked up the slack of child care. A paper in Covid Economics, a rapid-fire journal, finds that female authors accounted for 12% of economics working-paper submissions during the pandemic, compared with 20% before. Economists lucky enough to have researched topics before the pandemic which became hot, from home-working to welfare policy, were suddenly in demand.

There are also deeper shifts in the value placed on different sorts of research. The Economist has examined rankings of economists from IDEAS RePEC, a database of research, and citation data from Google Scholar. We divided economists into three groups: "lone wolves" (who publish with less than one unique co-author per paper on average); "collaborators" (those who tend to work with more than one unique co-author per paper, usually two to four people); and "lab leaders" (researchers who run a large team of dedicated assistants). We then looked at the top ten economists for each as measured by RePEC author rankings for the past ten years.

Collaborators performed far ahead of the other two groups during the pandemic (see chart 4). Lone wolves did worst: working with large data sets benefits from a division of labour. Why collaborators did better than lab leaders is less clear. They may have been more nimble in working with those best suited for the problems at hand; lab leaders are stuck with a fixed group of co-authors and assistants.

The most popular types of research highlight another aspect of the third wave: its usefulness for business. Scott Baker, another economist, and Messrs Bloom and Davis—three of the top four authors during the pandemic compared with the year before—are all “collaborators” and use daily newspaper data to study markets. Their uncertainty index has been used by hedge funds to understand the drivers of asset prices. The research by Messrs Bloom and Davis on working from home has also gained attention from businesses seeking insight on the transition to remote work.

Not everyone likes where the discipline is going. When economists say that their fellows are turning into data scientists, it is not meant as a compliment. A kinder interpretation is that the shift to data-heavy work is correcting a historical imbalance. “The most important problem with macro over the past few decades has been that it has been too theoretical,” says Jón Steinsson of the University of California, Berkeley, in an essay published in July. A better balance with data improves theory. Half of the recent Nobel prize went for the application of new empirical methods to labour economics; the other half was for the statistical theory around such methods.

Some critics question the quality of many real-time sources. High-frequency data are less accurate at estimating levels (for example, the total value of GDP) than they are at estimating changes, and in particular turning-points (such as when growth turns into recession). In a recent review of real-time indicators Samuel Tombs of Pantheon Macroeconomics, a

consultancy, pointed out that OpenTable data tended to exaggerate the rebound in restaurant attendance last year.

Others have worries about the new incentives facing economists. Researchers now race to post a working paper with America's National Bureau of Economic Research in order to stake their claim to an area of study or to influence policymakers. The downside is that consumers of fast-food academic research often treat it as if it is as rigorous as the slow-cooked sort—papers which comply with the old-fashioned publication process involving endless seminars and peer review. A number of papers using high-frequency data which generated lots of clicks, including one which claimed that a motorcycle rally in South Dakota had caused a spike in covid cases, have since been called into question.

Whatever the concerns, the pandemic has given economists a new lease of life. During the Chilean coup of 1973 members of the armed forces broke into Cybersyn's operations room and smashed up the slides of graphs—not only because it was Allende's creation, but because the idea of an electrocardiogram of the economy just seemed a bit weird. Third-wave economics is still unusual, but ever less odd. ■

Dig deeper

All our stories relating to the pandemic can be found on our coronavirus hub. You can also find trackers showing the global roll-out of vaccines, excess deaths by country and the virus's spread across Europe. ■



实时革命

经济学第三次浪潮来袭

新冠疫情如何重塑了这一沉闷的科学【深度】

上世纪70年代初，作为向社会主义转型计划的一部分，萨尔瓦多·阿连德（Salvador Allende）创建了“赛博协同控制工程”（Project Cybersyn）。这位智利总统希望它能让官员们对本国经济产生前所未有的深入了解。管理人员会把来自工厂和田野的信息输入中央数据库。在控制室里，官员们将能看到金属产量是否在上升而农场产量却在下降，或者采矿业的薪资有什么变化。他们将能很快分析出对法规或生产指标的些微调整带来了什么影响。

这个赛博工程从未真正启动。但在堪萨斯州的小城萨利纳（Salina），某种与之离奇相似的东西却已浮现。当地报纸《萨利纳311》（Salina311）开始刊登针对本地区的“社区信息栏”，包含本地零售价格、工作岗位空缺数量等各种即时数据——可以说就是给经济做的一张心电图。

在萨利纳真实发生的事也在越来越多国家的政府里上演。去年新冠疫情爆发时，官员们开始研究可视化“高频”数据，比如每天的机场客流和每小时的信用卡消费。近来，他们转向了新的高频信息来源以求更好地了解哪个部门最缺劳动力，或者估计下一样价格飙升的大宗商品会是什么。经济学家“猛扑”向这些新的数据集，掀起了一股研究热潮（见图表1）。在这个过程中，他们正在对政策产生前所未有的影响。

这种快节奏经济学涉及三大变化。首先，它利用的数据不仅数量庞大，还与现实问题直接相关。当政策制定者试图了解封锁措施给休闲消费带来的影响时，他们会查看餐厅的现场预订情况；当他们想要弄清楚供应链的瓶颈时，会研究货轮的每日行踪。及时又精细的数据宝库之于经济学，就像当初的显微镜之于生物学，开启了一种观察世界的新方式。

其次，使用这些数据的经济学家更热衷于影响公共政策。他们中的更多人做求快不求精的研究来了解新政策的效用。学者们纷纷涌向推特参与辩论。

第三，这种新型经济学几乎不涉及理论。其践行者声称让信息本身说话。先驱者之一哈佛大学教授拉杰·切蒂（Raj Chetty）提出，经济学家之间的争论应该和医生之间关于咖啡是否有害健康的分歧没什么两样：纯粹要看证据。所有这些都在经济学家中引发了争议，一个重要原因是有些学者（比如切蒂）在这场转型中比其他人做得更好，使得这一领域被几个超级明星主宰。

以他们为代表的这门新兴学科或许可被称为经济学的“第三次浪潮”。第一次浪潮是伴随着亚当·斯密以及1776年出版的《国富论》出现的。当时的经济学多与个人的著作或论文有关，专注于某个重大的理论问题。斯密试图打破18世纪欧洲的垄断惯例。20世纪，约翰·梅纳德·凯恩斯希望改变人们对政府在管理经济周期中的作用的看法。米尔顿·弗里德曼的目标则是消除政客们借由凯恩斯思想攫取的许多职权。

这三人都对政策产生了重大影响——直到1850年英国议会还引用斯密多达30次。但这种影响是弥散式的。数据在当时很稀缺。经济学家丹尼尔·汉默梅什（Daniel Hamermesh）在2012年发表的一项研究指出，即使到了上世纪70年代，还有超过一半的经济学论文只关注理论。

经济学的第二次浪潮改变了这种情况。到2011年，纯理论的论文占比降至仅19%。官方统计数据的增多为学究们提供了更多的研究数据。更强大的计算机让模式识别和因果推断变得更容易（今年的诺贝尔经济学奖就授予了因果识别的实证研究）。随着分析变得愈加复杂，每篇论文的平均作者数量也在增加（见图表2）。经济学家更多地参与到政策制定中：从上世纪50年代起，发达国家政府开始在基础设施决策中使用成本效益分析。

然而，经济学的第二次浪潮仍然受制于数据不足。大多数国家统计数据会滞后数月或数年。“传统的政府统计并没有多有用——等到它们出炉的时

候，数据就已经过时了。”美国财政部助理部长迈克尔·福肯德（Michael Faulkender）在疫情开始时表示。地方上的官方经济数据的质量充其量只能算好坏参半：它们在统计房地产市场和消费者支出方面不尽人意。刚开始有全国性统计的时候，一般经济体相比现在工业比重更大而服务业比重更小。在1937至1938年间出台、如今仍在更新使用的美国标准行业分类（Standard Industrial Classification）将制造业分为24个子部门，而整个金融业只分为三个。

在快速变化的时期，政策制定者尤其是在云里雾里工作。2008年5月，时任白宫经济顾问委员会（White House Council of Economic Advisers）主席爱德华·拉泽尔（Edward Lazear）说，“如果你看看当前的数据……我们并没有处在通常界定的经济衰退期。”五个月后，也就是雷曼兄弟破产后，国际货币基金组织（IMF）指出美国经济“不一定”会走向严重衰退。而事实上，美国在2007年12月就已经进入了经济衰退期。2007至2009年间，经济学论文发表数量并没有激增。经济学家对政策的建议大多基于自己的判断、经济学理论以及走马观花地查阅国家统计数据。

官方数据与实体经济现状之间的差距有时仍很显著。在堪萨斯州的沃尔玛逛一逛，就会发现从宠物食品到瓶装水的许多商品都供应不足。但一些国家统计数据并没能反映出这些问题。经济政策研究中心（Centre for Economic and Policy Research）的迪恩·贝克（Dean Baker）援引官方数据称，美国的实际库存（不包括汽车和农产品）并不比疫情前低多少。

在疫情发生前就有迹象显示经济学将迎来第三次浪潮。一些经济学家发现了新的极其详尽的数据流，比如匿名的税务记录和手机定位信息。要分析这些庞大的数据集，就需要建立实际上相当于工业实验室的机构，由经济学家团队清理和探究这些数字。苏珊·埃塞（Susan Athey）是将现代计算方法应用于经济学的先驱，她在斯坦福的实验室就有大约20名非校内的研究员（切蒂的团队自称也有差不多这么多人）。在疫情期间新研究被引用次数最多的20位经济学家，有三位运行着自己的工业实验室。

更多的数据来自企业。Visa和移动支付公司Square记录消费模式，苹果和

谷歌追踪活动轨迹，保安公司知道人们进出大楼的时间。“所有的经济活动都要用到计算机，因此事情自然都会被记录下来。”斯坦福大学商学院的乔恩·莱文（Jon Levin）表示。摩根大通银行的老板杰米·戴蒙（Jamie Dimon）意外地成为了掀起经济学第三浪的英雄人物。2015年，他在摩根大通内部协助建立了一个机构，利用来自该银行网络的数据分析有关消费金融和小企业的问题。

2016年6月举行的英国脱欧全民公投是实时数据接受检验的第一件大事。英国政府和投资者需要早于英国官方公布GDP数据很久就了解这次非同寻常的冲击的程度。他们在网页上搜寻诸如餐馆预订和提供折扣的超市数量等能说明问题的信息，并准确地得出结论：尽管经济正在放缓，但远够不上许多机构和人士此前预测的那种灾难。

如果没有新冠疫情，实时数据可能在更长时间内仍只会是小范围的专门需求。中国企业从很久前就开始生成各类高频精细数据，从观影人次到人们每天喝下多少瓶啤酒。官方数据有时很可疑，用啤酒和电影等统计数据做交叉核对是个好办法。去年1月湖北省开始实施封锁时，中国事务观察人士便求助于这些数据。当时的数据显示这个世界第二大经济体正滑向不景气。它们清楚地向其他国家的经济学家表明了这类数据的用处。

疫情初期，谷歌开始发布有关人们行踪的匿名数据，这帮助研究人员建立了一个显示封锁严苛程度的每日指标（见图表3）。网上订餐平台OpenTable开始每天发布餐馆预订信息。美国人口普查局很快启动了每周一次的家庭调查，了解家庭成员的就业状况、能否付得起房租等等。

去年5月，约瑟·玛丽亚·巴雷罗（Jose Maria Barrero）、尼克·布卢姆（Nick Bloom）和史蒂文·戴维斯（Steven Davis）三位经济学家开始对美国的商业活动和工作习惯展开月度调查。他们让处于劳动年龄段的美国人有偿回答一些问题，比如打算多久去一次办公室，或者更喜欢以哪种方式问候同事等。“人们通常会在午休时间完成调查，”来自斯坦福大学的布卢姆说，“他们坐在那儿，吃着三明治，回答一些问题，午饭钱就有着落了。”

为了弄懂令人困惑的经济形势，对研究的需求猛增。去年3月，美国开始给民众的失业保险金增加每周600美元的额外补助，第一份针对这一举措的分析报告在几周后发布。去年8月，英国政府对去餐馆用餐提供了补贴，两个月后它已经意识到这么做可能增加了新冠感染人数。关于疫情的许多事情似乎不证自明，比如经济在去年3月暴跌，比如穷人遭受的打击比富人大，又或者向居家办公转变的影响要好于预期等等。但实际上是因为有了迅速跟上的经济研究，它们才变得显而易见。

要量化实时研究对政策的影响则比较难。说到有人认为经济学家的研究影响了政客对疫情的应对，一些经济学家嗤之以鼻。许多使用实时数据的研究表明，为美国小企业提供资金援助的薪资保障计划（Paycheck Protection Programme）起到的效果不如预期。但小企业游说组织确保了政客在几个月里都没有废除这项计划。乔治梅森大学（George Mason University）的泰勒·考恩（Tyler Cowen）指出，经济学家在疫情期间最重要的贡献是建议及早承诺采购疫苗，而这根据的是过去的研究而非实时数据。

不过，福肯德表示，美国经济刺激措施中之所以会包含对餐饮业的特别支持，是受到了OpenTable数据的影响，这些数据显示餐饮业复苏乏力。切蒂在今年年初的研究发现，去年12月发放的经济刺激支票提振了低收入家庭的消费，但对相对富裕的家庭影响不大。他声称，正是因为参考了这项研究，政府才决定在今年3月发放经济刺激支票时设定更严格的收入限制。

至于美联储，去年5月，达拉斯和纽约联储以及哈佛大学的经济学家詹姆斯·斯托克（James Stock）利用SafeGraph的数据创建了一个活动指数，这家数据供应商用手机ping测试追踪人们的活动情况。圣路易斯联储则使用Homebase的数据追踪每日就业数字。两者都在官方数据公布之前就揭示了经济活动不足。这让美联储更快传达了其鸽派的政策立场。

即时的数据也有助于形成辩论。相比于2007至2009年，这一次所有人都更早地意识到世界经济陷入了严重衰退。IMF在展望2009年全球经济时引

用的论文有40%发表于2008至2009年。相比之下，它在去年10月发表的展望中有超过一半的引文来自当年发表的论文。

有些经济学家从这第三次浪潮中得到的好处比其他人更多。封锁开始后，许多在家办公的男性经济学家没了教学任务，有了更多时间做研究。而女性经济学家常常要挑起照顾孩子的重担。高频出版的期刊《新冠经济学》（Covid Economics）上的一篇论文发现，在疫情期间提交的经济学工作论文中，作者为女性的占12%，而疫情前这一比例为20%。那些在疫情爆发前就已经开始研究诸如居家办公、福利政策等课题的经济学家比较走运，随着这些议题变得热门起来，他们瞬间成了香饽饽。

在对不同类型的研究的重视程度上也发生着更深层的变化。本刊调查了研究数据库IDEAS RePEC的经济学家排名和Google Scholar的引用数据。我们把经济学家分为三类：“独行侠”（发表的每篇论文的平均合著者不到一人）；“合作者”（每篇论文往往有一个以上的合著者，通常是二到四人）；以及“实验室领导”（那些管理着一个由专职助手组成的大型团队的研究者）。然后，我们基于RePEC过去十年的论文作者排名，查看每个类别前十名经济学家的表现。

疫情期间，合作者的表现遥遥领先于另两类（见图表4）。独行侠的表现最差，这是因为分工有利于使用大数据集的研究。至于合作者的表现为什么会好于实验室领导，原因就没那么清楚了。或许是因为合作者能更灵活地与最适合解决手头问题的人共事，而实验室领导则被一批固定的合著者和助手困住了。

最受欢迎的研究类型突显了第三次浪潮的另一个特点：它对商业的用处。在疫情期间相比前一年出现最大飞跃的四位经济学家中有三位都是“合作者”，包括布卢姆、戴维斯和另一位经济学家斯科特·贝克（Scott Baker），他们利用日报上的数据来研究市场。对冲基金公司已经在使用他们编制的不确定性指数了解资产价格的驱动因素。布卢姆和戴维斯所做的有关居家办公的研究也引起了那些希望了解向远程工作转型的企业的关

注。

不是所有人都乐见经济学的这一走向。当经济学家说自己的同行正在变成数据科学家时，这可不是在夸人。对此客气一些的解读是，在研究中更密集地使用数据是在纠正一种久已有之的不平衡。“在过去几十年里，宏观经济学最大的问题是过于理论化。”加州大学伯克利分校的约恩·斯泰因森（Jón Steinsson）在7月发表的一篇文章中指出。加强对数据的使用可以促进理论研究。今年的诺贝尔奖一半授予了在劳动力经济学中应用新实证方法，另一半授予了围绕这些方法的统计理论。

一些批评者质疑许多实时信息来源的质量。高频数据在估计“水平”（例如GDP总值）时要比在估计“变化”时准确性更低，特别是和估计“拐点”（例如经济从增长转为衰退）相比。咨询公司Pantheon Macroeconomics的塞缪尔·图姆斯（Samuel Tombs）在最近对实时指标的研究中指出，OpenTable的数据偏向于夸大去年餐厅就餐人数的反弹幅度。

其他人则对经济学家面临的新激励因素感到担忧。如今，研究人员竞相角逐为国家经济研究局（National Bureau of Economic Research）撰写研究报告的机会，以在某个研究领域立桩划界或寻求影响政策制定者。糟糕的是，快餐式学术研究的用户往往把它当成慢工出细活的缜密研究来对待——后者的论文遵循着老式的出版流程，包括无休止的研讨会和同行评审。已经有一些使用高频数据、获得大量点击的论文受到质疑，其中之一声称南达科他州的一场摩托车赛导致了新冠病例激增。

不管有些什么担忧，新冠疫情给经济学家们带来了新的活力。在1973年的智利政变中，武装人员闯进了赛博协同控制工程的控制室，砸烂了图表幻灯片——不仅因为它是阿连德的创造，还因为用心电图来描述经济的想法看起来实在有点怪异。经济学的第三次浪潮仍旧不同寻常，但渐渐也不那么稀罕了。





Progress and procrastination

China's long wait for a tax everyone loves to hate

The government will at last roll out a property tax

IF SUN YAT-SEN had got his way, China would have been a bold pioneer in the taxation of real estate. During his exile in Europe from 1896 to 1898, the republican revolutionary fell under the spell of Henry George, an influential American journalist who believed a single tax on land should replace all others. Sun hoped pre-industrial China could adopt such innovations more easily than the West, because it was “unimpeded by the opposition of entrenched capital”, as one scholar put it.

Instead China has become a timid procrastinator in the taxation of real estate, particularly of the property built on top of land, as opposed to the land itself. It first proposed a recurring tax on the value of property in 2003. And it introduced a half-baked pilot scheme in the cities of Shanghai and Chongqing in 2011. The tax was included in the five-year legislative plan of the National People’s Congress (NPC), China’s rubber-stamp parliament, in 2015. But things went no further. Reform, it seems, was impeded by the opposition of entrenched interests, including no doubt many officials who would prefer not to declare their properties, let alone pay taxes on them.

But in August Xi Jinping, China’s president, expressed support for a property tax as part of his campaign to curb excessive wealth and promote “common prosperity”. And on October 23rd the NPC said pilot schemes would be expanded to new cities (although it did not say when or which).

Such a tax is sorely needed. China raises little money from its personal-income taxes, which are too easily avoided. Indirect levies, such as the value-added tax, are more lucrative but regressive. Local governments in

particular lack a stable source of revenue, which leaves them heavily reliant on land sales and transfers from the central government. Although China does impose a variety of property-related taxes (including one on the purchase of land), these levies fall more heavily on the construction and trading of real estate than on the possession of it. As China's property market matures, and its economy moves beyond breakneck urban expansion, housebuilding and selling will provide fewer feathers to pluck.

The tax could also ameliorate some of the perversities of China's economic model. About a fifth of its urban housing stood vacant in 2017, according to the China Household Finance Survey, led by Li Gan of Texas A&M University. A property tax would make it more costly to buy second or third homes and keep them empty, in the hope of selling them on for a higher price. It could therefore discourage speculation and invigorate China's underdeveloped rental market.

But a property tax will also be unpopular. It is the tax "everyone loves to hate", as Jay Rosengard of Harvard University has put it. Such taxes are not discreetly withheld from a paycheque or embedded in a product's price. Payments can be lumpy, conspicuous and irksome, especially if the taxpayer doubts that bureaucrats will spend the money well. As property prices have raced ahead of incomes, many homeowners may also be "asset-rich" but relatively "cash-poor". In 2019, for example, a property tax of 1.2% would have eaten up over 10% of the average urban resident's disposable income.

Some people also fear that the tax will crash the market. That seems unlikely. It will be some time before any revenue is actually collected. And the tax is not the only lever that policymakers can pull. China's cities impose a variety of other impediments and deterrents to property purchases, including hefty downpayment requirements, limits on the purchase of additional flats, and rules that oblige buyers to show a history of local social-security contributions. If a property tax were to weigh too heavily on

the market, these prudential limits could be eased.

The bigger danger is that the tax will do too little, not too much, to cool speculation. The Chongqing tax, which is levied chiefly on detached and high-end properties and exempts the first 100 square metres of space, depressed prices by 2.5% a year, relative to where they would have been, according to a study in 2015 by Zaichao Du and Lin Zhang of Southwestern University of Finance and Economics in Chengdu. But prices still rose on average. Shanghai's tax had no effect on prices at all.

To make them more palatable, the Chongqing and Shanghai pilot taxes were both patchy and complicated. The new pilot cities should try cleaner designs. Any flaws, kinks or ill-judged exemptions can be difficult to fix later. Indonesia, Mr Rosengard has pointed out, decided to keep its effective property tax at a meagre 0.1% while it collected better data on property ownership and values. Yet even after the data improved, it found it difficult to raise the rate. Britain's property tax in the 1980s was based on increasingly anachronistic rental values. But the government was so reluctant to update them that it introduced a disastrous "poll" tax instead. Ontario in Canada spent 30 years talking about reforming its property tax, before eventually taking the plunge in 1998, as detailed by Richard Bird and Enid Slack of the University of Toronto.

Sun Yat-sen hoped that China's late start in economic modernisation would help it avoid some of the mistakes of the countries that went before it. China's later start in property taxation gives it plenty more examples to avoid. ■



进步与拖延

一项人人嫌弃的税收在中国姗姗来迟

政府终于要推出房产税了

如果孙中山得偿所愿，中国本可以成为房地产税的勇敢先驱。在1896至1898年流亡欧洲期间，这位共和革命者受到了亨利·乔治（Henry George）的影响，后者是一位颇有力的美国记者，主张用单一的土地税取代其他所有税收。孙中山希望尚未工业化的中国可以比西方更容易采用这些创新，因为正如一位学者所说，中国当时“还不受根深蒂固的资本的阻碍”。

事情的走向正相反，中国在征收房地产税上成了畏首畏尾的拖延者，尤其是对建在土地上的房产而不是对土地本身。2003年，政府首次提出一种按房产价值征收的经常性税种。2011年，上海和重庆启动了半成品试点计划。2015年，中国“橡皮图章”式的立法机关全国人大将房地产税列入了五年立法规划。但是事情到这里停下了。改革似乎受到了既得利益者的阻挠，无疑包括了许多官员，他们都不想申报房产，更别说为此纳税了。

但今年8月，在抑制财富过度集中、促进“共同富裕”的运动中，中国国家主席习近平表示支持开征房地产税。10月23日，全国人大表示，将把试点计划扩大到更多城市（但没有说明具体时间表和城市）。

这样的税收已成为一种迫切需要。中国通过个人所得税征收的税金太少，这些个税往往可以被轻易规避。像增值税这样的间接税带来的税收更多，但属于累退税。地方政府尤其缺乏稳定的税收来源，只能严重依赖土地出让和中央政府的转移支付。尽管中国确实征收各种与房地产相关的税（包括土地购置税），但更多是针对房地产的建设和交易环节，而不是持有环节。随着中国房地产市场的成熟，以及经济发展迈过城市高速扩张的阶段，住宅建设和销售的税基将逐渐缩小。

房地产税还可以改善中国经济模式的一些反常之处。由德州农工大学（Texas A&M University）的甘犁牵头的《中国家庭金融调查》显示，

2017年中国约有五分之一的城市住房处于空置状态。如果开征房产税，那么人们购买第二套或第三套住房并空置，以期房价上涨后出售获利的成本就会更高。因此这可能会抑制投机行为，并激活中国发展不足的租赁市场。

但征收房地产税也会相当不受欢迎。用哈佛大学的杰伊·罗森加德（Jay Rosengard）的话说，这是一种“人人都爱嫌弃它”的税。它既不会从工资里悄悄扣缴，也不会掩埋在产品价格之中。税额可能很大、很显眼，令人不快，如果纳税人怀疑官僚们不会善用这笔钱就更是如此。由于房价增速超过了收入，许多房主还可能是“资产富有”但相对“现金贫乏”。例如，在2019年，若征收1.2%的房地产税就将吞掉城市居民平均可支配收入的10%以上。

有人还担心这项税收会令房地产市场崩溃。这似乎不太可能。到真正开始征税还需要一段时间。而房地产税也并非政策制定者的唯一调控手段。中国许多城市对购房者设置了各种各样的其他门槛和障碍，包括高比例的首付、对购买多套住房的限制，以及要求购房者出示在本地缴纳社保的记录。如果房产税对市场的影响太大，可以放宽这些审慎限制手段。

更大的危险是房地产税对抑制投机的作用太小，而不是太大。在重庆，房地产税的主要征收对象是独栋住宅和高档住房，免税面积为100平方米。成都西南财经大学的杜在超和张林在2015年的一项研究显示，这对房价的抑制效果为每年2.5%。但房价总体仍在上涨。上海的房地产税则对房价完全没有影响。

在重庆和上海试点时，为让人们更易接受，房地产税被设计得零散而复杂。新的试点城市应该尝试更简明的设计。任何错误、缺陷或欠思考的免税项目在日后都会难以修正。罗森加德指出，印尼当初决定将房产税的有效税率保持在微不足道的0.1%，从而更好地收集有关房产所有权和价值的数据。然而，当数据质量改善之后，却发现很难提高税率了。上世纪80年代，英国的房产税建立在越来越不合时宜的租赁价格基础之上。但政府极不情愿更新租赁价格，转而引入了一项灾难性的“人头”税。多伦多大学的

理查德·伯德（Richard Bird）和伊妮德·斯莱克（Enid Slack）详述了加拿大安大略省如何花了30年时间讨论房产税改革，直到1998年才最终放手一试。

孙中山曾希望，中国后起步的经济现代化能有助于避免重蹈其他国家的覆辙。中国的房产税起步更晚，前车之鉴就更多了。■



The third star

Samsung Electronics wants to dominate cutting-edge chipmaking

The South Korean dynasty's third generation is taking on TSMC and Intel. Can it succeed?

SAMSUNG ELECTRONICS (SE) is a behemoth. The South Korean tech company is the crown jewel of the mighty Samsung *chaebol*, as the country's conglomerates are known. It makes more smartphones than any other company in the world, as well as home-entertainment systems and appliances. It dominates the manufacturing of memory chips, which are used to store data on electronic devices and whose price has been pushed up by the global semiconductor shortage. SE's annual revenues of \$200bn are not much lower than those of Apple, the most valuable firm in history, and it is sitting on a cash pile of \$100bn.

Now both SE and its parent group, whose name means "three stars", are entering a critical new chapter. In August Lee Jae-yong, the scion of the family which founded Samsung in 1938, was released from prison, where he spent two stints after a conviction for his involvement in a bribery scandal. He is finally taking full control of the empire from his late father, Lee Kun-hee, who died last year. Succession was complicated first by the elder Lee's six-year coma, then by his son's bribery conviction, linked to SE's efforts to win the government's backing for a merger of two Samsung subsidiaries that would cement his control.

Free at last, Mr Lee has grand plans for the company, which he wants to become as dominant in cutting-edge logic chips, used for processing information, as it already is in memory and smartphones. That will pit SE head-to-head with chipmaking powerhouses such as TSMC of Taiwan and America's Intel, and thrust it into a fierce global contest over one of the

world's most strategic industries.

On October 7th SE confirmed it will manufacture some of the world's most advanced logic microprocessors, based on its novel "gate-all-around" architecture with transistors measuring three nanometres (billions of a metre), in 2022. It also surprised analysts by announcing a plan to mass-produce two-nanometre chips from 2025. It is forecast to invest an eye-watering \$37bn or so in capital expenditure across its businesses this year. And it is winning new customers, such as Nvidia, an American chip designer, and Tesla, an electric-car maker.

The outcome of Mr Lee's gamble will have profound consequences—and not just for Samsung. It matters to South Korea, whose president justified Mr Lee's parole as being in the national interest, given the *chaebol*'s importance to the economy. And it will influence the global semiconductor industry, the critical nature of which has been underscored by the worldwide chip shortage. To ensure success, the man whom acquaintances describe as shy, decent and astute must also summon a degree of ruthlessness.

SE is a complex corporate creature with a strategic challenge and underwhelming stockmarket performance. It is best understood as divided into two main businesses. The first makes "sets": smartphones, televisions and household appliances. The second produces "components", which go into Samsung's own sets, as well as being sold to external customers like Apple. Samsung splits its sets business further into two divisions: TVs and appliances such as washing machines, and digital devices (chiefly smartphones). The component business, meanwhile, comprises semiconductors and displays.

The sets business is not a growth engine. In Mr Lee's hierarchy of SE operations, say people close to the company, home appliances sit at the bottom, below the TV unit with similarly low margins but a bigger role in

reinforcing SE's valuable brand. Next comes the handset business, which in the early 2010s contributed over half of profits. Although its obituary has been written several times before, it continues to generate lots of cash and, thanks to a new fast-selling range of phones with foldable screens, some fresh optimism.

Atop the hierarchy sit semiconductors. Historically, SE has focused on memory chips, where it has 44% of the global market for DRAM chips (used for temporary storage in desktops) and 36% in NAND devices (used for permanent storage in mobiles). The memory business brings in just over 20% of revenues but nearly half of operating profits (see chart 1). Everything else is potentially expendable in the service of its juicy margins. If a "set" business has a disagreement with a components unit over pricing or other terms, insiders say, the component business takes precedence. According to the company, its unique ecosystem benefits from having diverse businesses which allow internal innovation while providing stability through the ups and downs of industry cycles.

Analysts reckon that SE's memory-making has plenty of life left in it. Because such chips are critical for storing data across industries, it is "only going in one direction: up", says Nicolas Gaudois of UBS, a bank. Omdia, a research firm, predicts that the global memory-chip market will expand at double-digit rates each year between 2020 and 2025. It is now less cyclical thanks to surging demand from data centres and, on the supply side, consolidation in the industry where ever more extreme miniaturisation means that rivals can no longer step up production as easily as before. SE says that it has proven an ability to innovate and extract value in established businesses. Internally, though, certain SE executives worry that memory is a mature operation. And some investors fret that demand for memory chips may soften towards the end of the year.

One option would be to follow Apple and develop a services business, which has grown from 8% of the iPhone-maker's revenues in 2012 to a fifth. However, despite a few successes, notably in payments and health apps, SE's efforts to add software and services to its world-beating hardware have been sporadic.

This is partly because SE's hardware-first approach is deeply rooted in its culture. It will probably be reinforced by Mr Lee's character and experience. "His disposition is very cautious and conservative, more so than his father," says a former SE executive. This innate conservatism may have been strengthened by his first big endeavour after attending Harvard Business School. In the late 1990s, at the height of the dotcom bubble, he invested in eSamsung, a venture-capital firm. Watching the subsequent bust left Mr Lee sceptical of Korean software engineers, says the former executive; eSamsung was shut down.

Going big on services could also jeopardise SE's long-standing and successful partnerships with software giants such as Google and Microsoft. In 2014 SE launched a music-streaming service called Milk Music, which despite its success was scrapped two years later. "Google viewed Samsung's software efforts as fragmenting the Android ecosystem and felt threatened," recalls a former executive. "I feel pretty sure that Samsung has given up on software and services," he sighs. He worries about a big missed opportunity. Even if the firm talks about making another run at it, he adds, this would probably be merely to keep Google and other partners honest.

Another problem is China. The country is an important source of demand for both memory and logic chips. To help satisfy it, SE is finishing its second memory-chip plant in the western city of Xi'an this year. Despite rising tensions between China and the West, in particular America, neither SE nor any other South Korean chipmaker is likely to give up on their giant neighbour, which is likely to remain a big buyer for many years (especially

for the technically more complex DRAM chips). This means that SE must walk a fine line to keep Chinese clients while not relinquishing American customers.

This array of complications and risks helps explain SE's underperformance relative to other giants, both in consumer technology (Apple and Xiaomi of China) and chipmaking (TSMC and Intel). Because it combines several relatively distinct businesses, the company suffers from a conglomerate discount. It is listed only in Seoul, where limits on exposure to individual stocks have in the past pushed local investors to sell SE, which accounts for nearly a fifth of the KOSPI stockmarket index, whenever its share price spiked. And SE's enormous cash pile depresses returns.

As a result, despite solid operating performance SE's shares have traded between one and one-and-a-half times forward book value, far below its peers. Increasing its dividend from 22% of net profit in 2018 to 78% in 2020 helped more than double SE's market value in the two years to January. But Apple's nearly trebled in the same period. A strong outlook for semiconductors and lower cyclicalities in memory chips have yet to translate into a richer valuation. Having surged by nearly half in late 2020, SE's market capitalisation has declined by 13% since the start of the year, while New York's tech-heavy NASDAQ index and a basket of global chipmakers have made gains (see chart 2).

Mr Lee's bet on cutting-edge logic chips is designed to reverse the underperformance. The idea is to win a big slice of a fast-growing and lucrative market for non-memory chips, which account for 70% of the \$550bn global semiconductor market. Mr Lee has set out a goal to match SE's roughly 40% market share in memory in the "foundry" business of manufacturing processors for customers.

The Samsung scion has his work cut out. SE's foundry division took a hit in 2016 when Apple moved all its business for the A-series processor for the iPhone to TSMC. That shock offered a stark example of how SE's complex structure throws up possible conflicts of interest with key customers. Half of SE's foundry output goes to its sets divisions, with the rest supplying outside customers. Apple preferred TSMC, a pure foundry firm, to SE, with which it competes in smartphones.

So far progress towards Mr Lee's ambitious target, first signalled a few years ago, has been slow. The firm has around 15% of the foundry market, compared with more than 50% for TSMC, which plans to spend \$100bn over the next three years on new capacity. SE's non-memory chip revenues make up only 7% of total sales (though that is up from nothing in 2005 and the company also makes some other specialised processors for sensors and the like). The share of profits is lanlanti

Perceived conflicts of interest are not its only challenge. Although the memory and logic businesses share some commonalities and overheads, they differ in important ways. Producing memory chips is chiefly about speed, volume and economies of scale. Making high-end logic processors is much more complex technologically, with engineering done at nanoscopic scales and customers increasingly desiring silicon customised for their purposes.

On technology SE (and, to be fair, just about everyone else) has fallen behind TSMC in at least the last two generations of cutting-edge processors. Part of that may be down to sensible caution. But reticence can further complicate relations with customers, many of which are reluctant to place orders unless they can get capacity guarantees, says a semiconductor executive at another firm. Rather than anticipating their needs, SE has been reactive, says the executive.

Cognisant of these problems, Mr Lee clearly wants to accelerate SE's transformation. The company is using its research-and-development (R&D) prowess to take some risks on next-generation logic chips, for example with its new advanced chip architecture. The company does not break out how much of its capital spending is going to memory chips and how much to logic. According to CLSA, a broker, there is an emphasis on logic chips, which are also more R&D intensive.

SE is also mulling a \$17bn factory to manufacture cutting-edge logic chips in Texas, to appease America's desire to bring more chipmaking back home from Asia (and, possibly, to partake in a delayed \$52bn subsidy splurge on the semiconductor industry that Congress is considering). And the new customers it is courting, such as Nvidia and Tesla, have no overlap with its other businesses, notes Sanjeev Rana of CLSA.

Help could come from the fraught geopolitics of semiconductors. Although rising technonationalism over chip design and manufacture makes governments favour domestic production and local champions, it may nevertheless end up benefiting SE. As China ratchets up military pressure on Taiwan, which it considers part of its territory, fears are growing over TSMC's future. According to another semiconductor executive, many firms that use TSMC are scrambling to reduce exposure to the Taiwanese company, just in case. As TSMC's closest rival, Samsung could be a big beneficiary. SE has the biggest industrial complex of semiconductor fabs and engineers in the world, and some of the best chip technology, says Mark Newman, a former Samsung group executive who is the chief commercial officer of Nyobolt, a battery startup.

One way to turbocharge the transition would be to split SE into its constituent businesses, as investment bankers have long recommended. This would also eliminate the potential conflicts of interest that have hampered SE's foundry division. A dual listing in America, meanwhile,

could help with the KOSPI-related drag.

Neither a break-up nor another listing looks likely, however. Mr Lee seems reluctant to countenance the radical first option. One attempt at persuading SE into the second around 2016, as part of an activist campaign by Elliott Management, an American hedge fund which had taken a stake, failed. Aware of this, shareholders are therefore putting pressure on SE to at least do something about its unused cash. One idea would be to pay out 100% of free cashflow to them. Alternatively, SE could do a big acquisition. The company states that “the founding family is clearly aligned with all other shareholders in its objectives to create maximum value and see that value properly reflected in the market.”

To make a material difference to SE’s financial performance any deal would have to be big. Mr Lee’s predisposition and preferences make such a gamble improbable in software and services. That leaves chipmaking as the place where the firm’s cash could be spent. One potential takeover target is NXP Semiconductors, a Dutch firm that specialises in the fast-growing market for automotive chips. With a market value of \$50bn it would be a heavy lift, but not an impossible one.

If Samsung Electronics is to become a logic-chip star to rival TSMC, Mr Lee had better get lifting. Last year he vowed not to hand management of SE to his children (though the Lees are likely to retain the biggest stake in the company through various family-controlled vehicles). The promise to be the last Lee to run the firm, combined with what insiders say are other improvements to corporate governance, clears the path to the top for its multitude of talented executives. They must be hoping that Mr Lee leaves them a legacy that is less complicated than his father’s. ■



第三颗星

三星电子希望主导尖端芯片制造

这个韩国企业王朝的第三代对台积电和英特尔发起挑战。它能成功吗？【深度】

三星电子是一个庞然大物。这家韩国科技公司是三星集团这个财阀（chaebol，韩国对大型企业集团的称呼）皇冠上璀璨的明珠。它生产的智能手机比世界上任何其他公司都多，此外也生产家庭娱乐系统和家用电器。它主导着存储芯片的制造，这些芯片用于在电子设备上存储数据，其价格因全球半导体短缺而被推高。三星电子年收入2000亿美元，并不比有史以来市值最高的苹果公司低多少，而且还坐拥1000亿美元的现金储备。

现在，三星电子及其母公司都正在迈入一个关键的新篇章。创始人家族（于1938年创立三星）后代李在镕今年8月获假释出狱，此前他因卷入贿赂丑闻被定罪，两度入狱。如今他终于从去年去世的父亲李健熙手中完全接过了三星帝国的指挥棒。继任问题曾经一团迷雾，因为老李去世前昏迷了六年，而小李又因行贿入狱。李在镕的行贿罪与三星电子为获取政府对三星集团两家子公司合并的支持有关，这两家子公司的合并将巩固他的控制权。

现在李在镕终于重获自由身，他为三星电子勾画了宏伟蓝图，希望它能复制在存储芯片和智能手机领域取得的成功，在用于处理信息的尖端逻辑芯片领域也取得主导地位。这将让三星电子与台积电和美国的英特尔等芯片制造巨头正面交锋，并将其推入一场激烈的全球竞争，逐鹿全球最具战略意义的产业之一。

10月7日，三星电子证实将于2022年投产全球最先进的逻辑微处理器，这是基于其新型“环栅”晶体管架构的三纳米（一纳米等于十亿分之一米）芯片。它还宣布计划从2025年开始量产两纳米芯片，令分析师感到惊讶。预计今年三星电子在各类业务中的资本支出上将总计投入370亿美元左右，

令人瞠目。而且它还在赢得新客户，例如美国芯片设计公司英伟达和电动汽车制造商特斯拉。

李在镕这轮押注的结果将产生深远的影响，不仅仅是对三星集团。这对韩国很重要，考虑到三星对该国经济的重要性，韩国总统认为李在镕获假释符合国家利益。全球半导体行业也会受到影响，全球芯片短缺凸显了这个行业的重要性。认识李在镕的人说他腼腆、正派、精明。但为了确保成功，他还必须使出一些狠劲儿来。

三星电子是一个复杂的企业，面临战略挑战，股市表现欠佳。要弄懂它的最好办法是把它分为两个主要业务来看。第一个制造“设备”：智能手机、电视和家用电器。第二个生产“组件”，既用于三星自己的设备，也出售给苹果等外部客户。三星将其设备业务进一步分为两个部门：电视机和洗衣机等电器，以及数字设备（主要是智能手机）。而组件业务由半导体和显示屏两大部分组成。

设备业务不是增长引擎。与三星电子关系密切的人士表示，按照李在镕的业务分级，家用电器处于最底层，在电视部门之下，电视的利润率一样很低，但在巩固三星电子这个宝贵的品牌方面作用更大。再上一层是手机业务，在2010年代初为三星电子贡献了过半的利润。尽管这项业务已经被写过几次讣告了，但它仍在继续产生大量现金，并且由于新的折叠屏系列手机十分畅销，也催生了一些新的乐观情绪。

最顶层的业务是半导体。三星电子历来专注于存储芯片，它在DRAM芯片（用于台式电脑的临时存储）和NAND设备（用于移动设备的永久存储）领域分别拥有44%和36%的全球市场份额。存储业务仅带来了略高于20%的收入，却贡献了营业利润的近一半（见图表 1）。其他一切都可以为这一高利润业务让路。内部人士表示，如果设备部门与组件部门在定价或其他问题上存在冲突，则组件部门的需求优先。据三星电子称，其独特的生态系统得益于业务的多元化，这在行业周期波动中起到稳定作用的同时，也为内部创新提供了空间。

分析人士认为，三星电子的存储业务还有很大的发展空间。由于这种芯片对各行各业存储数据至关重要，因此它“只有一个发展方向——向上”，瑞银的尼古拉斯·高多瓦（Nicolas Gaudois）表示。研究公司Omdia预测，2020年到2025年间，全球存储芯片市场将以每年两位数的速度增长。现在行业的周期性减弱了，这是因为数据中心对芯片的需求激增，而在供应这一侧，产业整合把芯片微型化不断推向极致，意味着竞争对手无法再像以前那样轻松升级产能。三星电子表示，它已证明了自己在成熟业务中创新和提取价值的能力。不过，在公司内部，有些高管担心存储业务已经太过成熟。而一些投资者担忧对存储芯片的需求可能会在临近年尾时减弱。

另一种选择是效仿苹果，发展服务业务，这部分业务在苹果收入中的占比已从2012年的8%增长到五分之一。然而，尽管三星电子主要在支付和健康应用等方面也有所斩获，但在往它世界一流的硬件上增添软件和服务这方面，它花的功夫还只是零零星星。

这在一定程度上是因为硬件为王的发展理念深植于三星电子的企业文化中。而李在镕的性格和经历可能还会进一步强化这一点。“他为人非常谨慎保守，比他父亲更甚。”一位公司前高管说。这种与生俱来的保守可能又因他在哈佛商学院进修后的第一个重大商业决策而加深。上世纪90年代末互联网泡沫最严重时，他向风投公司eSamsung注资。这位前高管表示，后来互联网泡沫破灭，eSamsung倒闭，见证了全过程的李在镕对韩国的软件工程师信任不起来了。

大力发展战略业务也可能危及三星电子与谷歌和微软等软件巨头长期以来成功的合作关系。2014年，三星电子推出了音乐流媒体服务Milk Music，尽管很成功，但两年后还是关停了它。“谷歌认为三星涉足软件分割了安卓生态系统，感觉受到了威胁。”一位前高管回忆道。“我很确定三星已经放弃了软件和服务。”他叹息道。他担心这会错失一个大机遇。即使三星吹风要再尝试一次，他补充说，可能也只是为了提醒谷歌和其他合作伙伴客气一点。

另一个问题是中国。无论是内存芯片还是逻辑芯片，中国都是需求大国。

为了满足中国的需求，三星电子在西安的第二家存储芯片厂将在今年建成。尽管中国与西方国家的关系日益紧张，尤其是与美国，但三星电子和任何其他韩国芯片制造商都不太可能放弃他们的庞大邻国，因为中国在未来很多年里应该仍会是大买家（特别是对技术上更复杂的DRAM芯片）。这意味着三星电子必须小心走好折衷路线，既要保住中国客户，又不能丢了美国客户。

这一系列复杂情形和风险有助于解释为什么相较于其他巨头，无论是在消费电子技术（对比苹果和中国的小米）还是在芯片制造领域（对比台积电和英特尔），三星电子的股价都表现欠佳。因为它旗下有几种相对独立的业务，所以会遭受“多元化折让”。三星电子仅在首尔上市，那里对个股设有投资限制，过去每当它股价飙升就会被本地投资者抛售，毕竟它占了韩国综合股价指数KOSPI的近五分之一。它庞大的现金储备也压低了投资回报。

因此，尽管经营业绩稳健，三星电子的股价一直在远期账面价值的1到1.5倍之间徘徊，远低于同行。它将股息从2018年占净利润的22%增加到了2020年的78%，这让它的市值在截至2021年1月的两年间翻了一番不止。但苹果的市值在同期几乎增加了两倍。半导体的强劲前景和存储芯片的周期性弱化尚未转化为更高的估值。在2020年末飙升近50%以后，三星电子的市值自年初以来已下降了13%，而纽约以科技股为主的纳斯达克指数和一篮子全球顶尖芯片制造商的市值均有上涨（图表2）。

李在镕押注尖端逻辑芯片就是为了扭转在股市的疲软走势。他想要在快速增长且利润丰厚的非存储芯片市场中争得一块大蛋糕，这一市场占全球5500亿美元半导体市场的70%。李在镕制定了一个目标：为客户生产处理器的芯片代工业务要达到和公司在存储领域约40%的市占率相当的水平。

这位三星接班人的任务非常艰巨。2016年，苹果将iPhone的A系列处理器的所有业务都转给了台积电，打击了三星电子的代工业务。这个例子充分说明了三星电子的复杂结构可能与关键客户产生利益冲突。三星电子的代

工产品一半用于自己的设备部门，一半供应给外部客户。因为与三星电子在智能手机领域存在竞争，苹果更喜欢台积电这家纯代工企业。

李在镕的宏伟蓝图从几年前就开始显现轮廓，但至今进展缓慢。三星电子在代工市场占有约15%的份额，而台积电超过50%。台积电计划在未来三年投入1000亿美元扩大产能。三星电子的非存储芯片收入只占总收入的7%（尽管在2005年还是零，而且公司还制造一些用于传感器等领域的专用处理器），这部分的利润占比还要更低。

利益冲突认知并非唯一的挑战。尽管存储和逻辑业务有一些共同点，可以分摊一些费用，但它们在一些重要方面有所不同。生产存储芯片的关键在于速度、数量和规模经济。制造尖端逻辑处理器在技术上要复杂得多，需要纳米级工艺，而且客户对定制的需求也越来越大。

在尖端处理器的技术方面，三星电子（公平地说还有几乎所有其他公司）比台积电至少落后了两代。它合理的谨慎可能是原因之一。但含蓄的作风会使得与客户的关系进一步复杂化，许多客户不愿下订单，除非他们能获得产能保证，另一家公司的另一位半导体高管指出。三星电子没有主动预见他们的需求，而是一直在被动应对，他说。

李在镕清楚知道存在这些问题，他显然希望加快公司转型。三星电子正在利用它强大的研发能力在下一代逻辑芯片上做一些冒险之举，比如使用它的新型尖端芯片架构。它没有列明其资本支出中有多少用于存储芯片，多少用于逻辑芯片。据经纪公司里昂证券称，重头放在逻辑芯片业务上，这一块的研发投入也更密集。

三星电子还在考虑投资170亿美元在得克萨斯州建厂生产尖端逻辑芯片，以安抚美国将更多芯片生产从亚洲迁回国内的愿望（同时也可能是想从美国国会正在审议的对半导体行业的520亿美元巨额补贴中分一杯羹，该计划已延搁许久）。此外，三星电子正在争取的英伟达和特斯拉等新客户与它的其他业务并无重叠，里昂证券的桑吉夫·拉纳（Sanjeev Rana）指出。

半导体行业令人头痛的地缘政治纷争有可能帮三星一把。尽管在芯片设计

和制造方面不断升温的技术民族主义让政府更为青睐国内生产和本地龙头企业，却可能最终令三星电子得利。随着台海局势紧张，人们越来越担心台积电的未来。另一位半导体高管表示，许多让台积电代工的公司都在拼命降低依赖这家公司所带来的风险，以防万一。三星作为与台积电差距最小的竞争对手，可能成为一大受益者。三星电子拥有世界上最大的半导体工厂和工程师的产业配套，以及一些最好的芯片技术，前三星集团高管、电池创业公司Nyobolt的首席商务官马克·纽曼（Mark Newman）说。

加速转型的一个方法是按主要业务拆分三星电子，投行人士长期以来都这样建议。这也将消除那些阻碍了三星电子代工业务的潜在利益冲突。与此同时，在美国双重上市可能有助于减少KOSPI对其股价的拖累。

然而，无论是拆分还是双重上市，看来都不太可能。李在镕似乎不大愿意接受拆分这个激进的选项。而在2016年前后，持有三星电子股权的美国对冲基金埃利奥特管理公司（Elliott Management）曾在一次维权行动中试图说服三星电子双重上市未果。了解这些情况的股东因此在向三星电子施加压力，要求它至少要把尚未使用的现金利用起来。一个想法是把全部自由现金流派发给股东，或者还可以寻求大型收购。三星电子表示，“创始家族与所有股东的目标毫无疑问是一致的，那就是创造最大价值，并确保这样的价值恰当反映在市场中。”

要给三星电子的财务表现带来实质性改变，交易必须得是大手笔的。李在镕的秉性和偏好让公司不太可能在软件和服务领域冒这样的险。可以花钱的地方就只剩芯片制造了。一个潜在的收购目标是荷兰公司恩智浦半导体（NXP Semiconductors），它专注于快速增长的汽车芯片市场。这家市值500亿美元的公司会是块硬骨头，但也不是啃不下来。

如果三星电子要在逻辑芯片领域成为能与台积电抗衡的明星，李在镕最好开始大动作了。去年，他誓言不会让子女接手掌管三星电子（尽管李氏后代很可能会通过各种家族控制的投资工具继续持有最多的公司股份）。李在镕承诺自己将是李氏家族最后一位公司掌门人，加之据内部人士称还有其他改进公司治理的举措，都为公司众多才华横溢的高管扫清了登顶道路

上的障碍。他们一定希望，比起他的父亲所留下的，李在镕留给他们的遗产不会那么复杂。 ■



Hard pass

Why vaccine passports are causing chaos

The problem is with humans, not technology

MANY COUNTRIES did not require passports before the first world war. But as the conflict spread, states scrambled to introduce travel documents to help secure their borders. The result, after the armistice, was a bewildering smorgasbord of different information for different nationalities that could create chaos rather than clarity at border crossings. But returning to a world where people could travel freely across borders was by then unimaginable.

In 1920 the League of Nations stepped in. It designed a 32-page booklet with the country's name on the cover and such basic personal information as place and date of birth. Some governments grumbled—France thought the booklet too expensive to print compared with its single sheet—and it took a few years for them to adapt. But today all passports follow the same format. Whether at Heathrow in Britain or Moshoeshoe I International in Lesotho, officials can glance at a passport and be fairly certain of its bearer's travel privileges.

During the covid-19 pandemic, a similar process is under way. States have rushed to create vaccine passports to stop the virus at the border—or at the doors to the restaurant or gym. Often people must prove that they have been vaccinated, recently tested negative or had covid and recovered.

This time governments are not alone. Tech has thrown open the doors to firms like IBM and Microsoft, industry associations like the International Air Transport Association and non-governmental organisations like the World Economic Forum. Three undergraduates at the University of Applied Sciences Upper Austria spent last summer pulling all-nighters to build a

pass that works across the European Union. They can't afford much marketing, but the app, the GreenPass, has been downloaded 100,000 times.

As during the Great War, urgency has trumped co-ordination. India, which has administered over a billion jabs, has a "CoWIN" certificate with a QR code, identifying information and, confusingly, a photograph not of the bearer but of the prime minister, Narendra Modi. People in England can choose between a QR code on the National Health Service (NHS) app or website or a letter of certification from their doctor. In America, where President Joe Biden has vowed not to create a national vaccination database, many different state and private health passes are in use.

The trouble is that these passes are not interoperable. Most look the same: a QR code on a smartphone or piece of paper. Yet even scanning the codes can be a problem. Different verifier apps read different passes. Once scanned, the codes serve up widely varying information, depending on the national or local health systems or attitudes about privacy. Some vaccine passports, like the CommonPass used in parts of America, share raw data on vaccination status. Others, like the one issued by the NHS, yield only a symbol, a tick or a cross. And the rules of the game are not fixed. During a surge of infections last month, Israel yanked its "green pass" from 2m people who had not yet received booster jabs.

The administrative, commercial and even psychological burdens are obvious at airports. Traveller numbers have dropped between 85% and 90%, yet reaching the gate has become a more demanding obstacle course than ever. Queues lengthen as anxious travellers fumble for slips of paper and QR codes. Officials struggle to keep track of which vaccines state regulators have approved and how long which test results are valid for which destinations. As Corneel Koster, chief customer and operating officer at Virgin Atlantic, an airline, puts it: "It's kind of a jungle out there."

It is past time for standardisation. Yet designing a digital health pass is trickier than designing a travel document. Passports may reveal age, but vaccine passes are gateways to personal health information, potentially a great deal of it. That scares people. Even among countries with relatively high vaccination rates, support for vaccine passports varies, from 52% in Hungary to 84% in Britain (see chart). In India people are used to sharing their fingerprints and iris scans as part of the Aadhaar biometric ID system. Yet many, like Debjani Mazumder, a publishing executive in Delhi, worry about pharmaceutical companies and insurers getting hold of their health records. “I feel like a guinea pig,” Ms Mazumder says.

In theory, digital technology should make it easy to verify vaccination status. Yet because verifying apps cannot recognise all QR codes, many verifiers take what Edgar Whitley at the London School of Economics calls a “flash-and-go” approach, simply eyeballing them. A black market is thriving. Oded Vanunu at Check Point Software Technologies, a cyber-security company, has posed as a buyer and sourced fake French vaccine certificates for €75 (\$87), Russian ones for 9,500 roubles (\$134) and Singaporean alternatives for €250 on the dark web and Telegram, a messaging app. These sham passes look the part but would fall short if properly scanned.

When airline agents, employers and bar staff scan QR codes, they check for two things: confirmation that the bearer has been vaccinated or tested for covid and a digital signature proving the information comes from a trusted issuer. Uniformity across digital health passes would require broad agreement on exactly what health information to include, and how to label and package it. That ought to be relatively easy. In August, the World Health Organisation (WHO) published guidance recommending the minimum data for a certificate. The name and date of birth of the bearer plus the brand and batch number of a jab are considered necessary. Identifying who administered a jab—information some passes include—is not.

What is trickier is creating a unified system for checking the digital signatures of health authorities. Creating a repository of all trusted signatures is an expensive and politically fraught task. Countries with a national health service, like Britain, have just one issuer. But in America, there are around 300, including state governments, hospitals and pharmacies.

Without a trusted way to verify certificates across borders, even the most advanced technology falters. George Connolly is chief executive of OneLedger, a firm that designed OnePass, a blockchain-based vaccine passport. He says it has access to data from only around 20 jurisdictions. So he gets contractors to check passes from elsewhere by phoning and e-mailing health authorities. Dakota Gruener, head of ID2020, a public-private partnership focused on digital IDs, rolls her eyes. “Do you need blockchain? No,” she says. “Is blockchain a distraction? Yes.”

Luddites have reason to feel smug. As Albert Fox Cahn of the Surveillance Technology Oversight Project, an advocacy group, puts it: “There is so much money being spent on building this really shiny new metal fence around our society when the wooden gate was working just fine.” Bits of paper signed by clinicians, like the WHO’s “yellow card”, have sufficed as immunisation records for decades. These are more globally inclusive, given that many people in poor countries do not have smartphones. Judging by black-market prices, paper passes are not much easier to forge. Fake versions of paper vaccine certificates issued by America’s Centres for Disease Control and Prevention go for \$150 apiece on Telegram, more than some digital alternatives.

The biggest impediment to sensible vaccine passports is not technology but geopolitics. It would take a universally trusted organisation with sophistication in health, technology and diplomacy to get countries to agree on global standards. This might seem an obvious role for the WHO. But,

embroiled in the rivalry between America and China, the organisation has been blasted from all sides for its handling of the pandemic. On digital passes, the WHO has got itself in a muddle. Even as it has published lengthy documents describing what vaccine passports should look like, it has insisted that proof of vaccination should not be required for international travel when vaccine distribution is so skewed to rich nations.

Crucially, the WHO has declined to involve itself in validation and verification. Maintaining a register of trusted signatories would require a large staff. It would also require politically charged choices, like whether to recognise signatures from Palestine or Afghanistan, and which vaccines are good enough. The WHO would also have to take some kind of action when a state broke the rules. Carmen Dolea, head of the International Health Regulations Secretariat at the WHO, says this task goes beyond its mandate. “There are liability issues,” she adds.

Still, clumsily, the world does seem to be converging on a few standards and technologies. The European Union’s standards for digital covid certificates, for example, are also being used by Turkey and Switzerland. India’s have been picked up by Sri Lanka and the Philippines.

The next step, the WHO says, is for countries to negotiate bilateral or regional arrangements. Recent negotiations between Britain and India illustrate how messy this can be. Britain had refused to accept India’s CoWIN vaccine certificates, in part because they did not state the bearer’s precise date of birth. The government in New Delhi included only the year of birth because many poor Indians do not know their exact birthdays. A tit-for-tat escalation in travel restrictions kept families apart and business trips on hold for weeks, before an agreement was reached last month. India added the precise date, reasoning that most people who can afford international travel know their birthdays.

Some wonks still think they can fix the problems of poor governance with more technology. Nandan Nilekani, co-founder of Infosys, a tech giant, and the driving force behind India's Aadhaar system, is pinning his hopes on "adaptors" that convert one type of pass into another. Creating the right adaptors would be like finding a way to save shoppers from having to walk around with American Express cards, MasterCards and Visa cards in case shops require different kinds of payment. But technology that builds bridges between passes would not solve the problem that issuers would have to trust one another—and users would have to trust the adaptors fiddling with their health data.

Perhaps, from the ashes of the pandemic, the world will devise a seamless digital vaccine passport that will replace the yellow card. But when covid is still killing thousands of people a week, the bickering over QR codes and digital signatures among multilateral organisations, tech groups and states is a sideshow, if not a distraction. Vaccine passports will never contain the virus. Only vaccines will. More than three-quarters of people in Denmark, Singapore and Qatar are fully vaccinated, according to Johns Hopkins University. Yet less than 1% of those in Ethiopia and Uganda are. Someday, vaccine passports might help keep the peace. But right now the world must focus on winning the war. ■



难关

疫苗护照为什么是在添乱

问题在人，不在技术【深度】

在第一次世界大战之前，入境许多国家都不需要护照。但随着这场战争蔓延，各国开始争相推行旅行证件来保护边境安全。结果就是到了停战之后不同国籍的人在过境时提供的信息五花八门，让人眼花缭乱，有时会制造混乱而不是提升秩序。不过，要回到一个可以自由跨境旅行的世界，在那儿是不可想象的。

到1920年，国际联盟（League of Nations）介入了。它设计了一本32页的小册子，包含个人出生地、出生日期等基本信息，封面上印有国家名称。一些国家的政府对此颇有怨言，比如法国认为，与自己的单页文件相比，这本小册子的印制费用太高了。它们花了好几年才适应。但现在，所有的护照都遵循这种统一格式。无论是在英国的希思罗机场，还是非洲莱索托（Lesotho）的莫舒舒一世国际机场（Moshoeshoe I International），边检人员只要看一眼护照，就基本能确定持有人的旅行权利。

在新冠疫情期间，一个类似的过程正在发生。为了把病毒挡在国门外——或者餐馆、健身房门外，各国争相推出疫苗护照。一般来说，人们必须证明自己已经接种了疫苗，以及最近的病毒检测呈阴性，或者感染过病毒并已康复。

这一次，政府不是单打独斗。科技发展使得社会各界迅速参与其中，包括IBM和微软等公司、国际航空运输协会（International Air Transport Association）等行业组织，以及世界经济论坛等非政府组织。去年夏天，奥地利应用科技大学（University of Applied Sciences Upper Austria）的三名本科生夜以继日地开发了一个能在整个欧盟使用的通行证。虽然他们没钱开展大规模营销，但这款名为GreenPass的应用已经被下载了10万次。

和一战期间一样，由于事情紧急，就顾不上相互协调了。已完成超过10亿

剂疫苗接种的印度推出了“CoWIN”证明，上面有二维码和识别认证信息，不过令人困惑的是，上面的照片不是持有者本人而是总理莫迪。在英国，人们可以选择使用英国国家医疗服务体系（NHS）的应用或网站上的二维码，或出示医生的证明信。在美国，总统拜登已经宣称不会建立国家疫苗接种数据库，人们正在使用许多州和私营机构出具的各式各样的健康通行证。

麻烦在于这些通行证之间不具有互通性。它们大多数看上去一个样：要么是智能手机上的二维码，要么是印在纸上的二维码。然而，即便是扫描这些二维码也可能是个问题。不同的通行证要由不同的验证应用来读取。扫描二维码之后，给出的信息五花八门，这取决于各国或各地卫生系统提供的数据以及对隐私的不同态度。一些疫苗护照，如美国部分地区使用的CommonPass，会提供疫苗接种情况的原始数据。其他一些疫苗护照则只生成一个符号，比如NHS的就只会显示一个“√”或“×”。游戏规则也不是固定不变的，以色列在上月感染激增期间收回了200万名未接种疫苗加强针的民众的“绿色通行证”。

在各地机场，管理、营利、甚至心理上的压力都显而易见。旅客数量减少了85%到90%，但要到达登机口却变成了一个前所未有的艰难征程。焦急的旅客翻找着纸质材料和二维码，队伍越排越长。边检人员很难弄清楚哪些疫苗获得了国家监管机构的批准，以及哪些检测结果在多长时间里对哪些目的地有效。维珍航空（Virgin Atlantic）的首席客户兼运营官科尼尔·科斯特（Corneel Koster）说，“那地方就是一团乱。”

早就该统一标准了。然而，相比旅行证件，设计数字健康通行证更加复杂。护照可能会泄露年龄，而疫苗通行证会显示个人健康信息——而且可能是大量的。这让人们感到害怕。即使在疫苗接种率相对较高的国家，对疫苗护照的支持率也各不相同，比如匈牙利是52%，而英国是84%（见图表）。在印度，人们已经习惯了交出自己的指纹和虹膜扫描，这是Aadhaar生物识别身份认证系统的一部分。但也还是有许多人担心自己的医疗记录落入制药公司和保险商手中，德里的出版业高管德布贾尼·马祖姆德（Debjani Mazumder）就是其中之一。“我觉得自己就像只小白鼠。”

她说。

从理论上说，数字技术应该会让验证疫苗接种情况变得容易。但因为验证应用无法识别所有的二维码，许多验证员在检查时就像伦敦政治经济学院（London School of Economics）的埃德加·惠特利（Edgar Whitley）所说的那样“一晃而过”，就只是扫一眼而已。黑市生意兴隆。网络安全公司“检查点软件技术”（Check Point Software Technologies）的奥代德·瓦努努（Oded Vanunu）假扮买家，在暗网和即时通讯应用Telegram上分别以75欧元（87美元）、9500卢布（134美元）和250欧元购得假冒的法国、俄罗斯和新加坡的疫苗证书。这些伪造的通行证看上去很逼真，但如果被认真扫描就会露馅。

当机票代理商、雇主和酒吧员工扫描二维码时，他们会检查两件事：一是确认持有人已经接种过疫苗或接受过新冠病毒检测，二是确认该通行证的数字签名来自可信的签发机构。要实现数字健康通行证的统一，就需要在具体包括哪些健康信息以及如何对它定名和设计上达成广泛共识。这应该相对容易。今年8月，世卫组织（WHO）就通行证所需提供的最基本数据发布了指导意见。持有人的姓名、出生日期，以及接种疫苗的品牌和批号被认为是必要数据；疫苗由谁施打（有些通行证就包含了这项信息）则不是必要的。

更棘手的部分是建立单一系统以供查核各种卫生管理机构的数字签名。创建一个包括所有可信签名的数据库是一项既费钱又绕不开政治的工作。像英国这样拥有全民公费医疗服务的国家只有一家签发机构。而美国有大约300家，包括各州政府、医院和药房。

如果没有一种可信的跨境认证方式，即使是最先进的技术也无能为力。OneLedger公司设计了基于区块链的疫苗护照OnePass，CEO乔治·康诺利（George Connolly）表示自己只能获得大约20个司法辖区的数据，所以他让承包商通过给卫生管理机构打电话和发电子邮件来检验其他地方的通行证。专注于数字ID的公私合营企业ID2020的负责人达科塔·格鲁纳（Dakota Gruener）翻了个白眼。“用得着区块链吗？用不着，”她说，“区

块链是不是个干扰？是的。”

卢德派有理由洋洋得意了。正如倡导组织“监控技术监督项目”（Surveillance Technology Oversight Project）的阿尔伯特·福克斯·卡恩（Albert Fox Cahn）所说，“花了这么多钱，在我们的社会周围修起这道崭新的金属栅栏，而原来的木栅栏门明明还用得好好的。”几十年来，一些临床医生签署的纸质证明——就像世卫组织的“黄皮书”（《国际预防接种证书》）——足以用作免疫记录。考虑到贫穷国家很多人没有智能手机，这些证明在全球的适用范围更广。从黑市价格来看，伪造纸质通行证的难度并没低多少。在Telegram上，伪造的美国疾病控制与预防中心（CDC）的纸质疫苗证书每张售价150美元，比一些假的数字证书还贵。

要创建合理明智的疫苗护照，最大的障碍不是技术，而是地缘政治。要让各国达成一致的全球标准，需要一个在医疗卫生、技术和外交方面都足够成熟且广受信任的机构。这似乎是世卫组织当仁不让的角色。然而，由于卷入了中美对抗，该组织对疫情的应对受到了来自四面八方的猛烈抨击。在数字通行证上，该组织自己也陷入了混乱。它一边发布了冗长的文件，描述疫苗护照看上去应该是什么样子，一边又坚持认为，在疫苗分配如此偏向富裕国家的情况下，国际旅行不应该要求提供接种证明。

关键问题是，世卫组织已经拒绝参与疫苗护照的批准和认证。要维护一个可信签署方名册需要大量人手。它还需要做出各种带政治色彩的选择，比如是否承认来自巴勒斯坦或阿富汗的签名，以及哪些疫苗的质量足够好。当一个国家违反规定时，它也必须采取某种行动。世卫组织《国际卫生条例》秘书处（International Health Regulations Secretariat）的负责人卡门·多莱亚（Carmen Dolea）表示，这项工作超出了它的职权范围。“这牵涉到责任问题。”她补充道。

尽管如此，世界各国似乎也还是笨拙地在向某些标准和技术靠拢。比如，土耳其和瑞士也在使用欧盟的新冠数字证书标准。斯里兰卡和菲律宾借鉴了印度的证书标准。

世卫组织表示，下一步是各国协商双边或区域协定。近期英国和印度之间的谈判显示了这件事有多棘手。英国拒绝承认印度的CoWIN疫苗证书，部分原因是证书上没有注明持有人的确切出生日期。印度政府过去只收录民众的出生年份，因为许多印度穷人不知道自己确切是哪天出生的。两国之间以牙还牙的旅行限制不断升级，让很多家庭的成员天各一方，商务出行也暂停了数周，直到上个月达成协议。印度在证书上加上了确切的出生日期，理由是大多数能负担得起跨国旅行的人都知道自己的生日。

一些学究仍然觉得自己能用更多的技术来解决管理不善的问题。科技巨头印孚瑟斯（Infosys）的联合创始人南丹·尼勒卡尼（Nandan Nilekani）推动了印度Aadhaar系统的建立，他把希望寄托在能把一种通行证转换成另一种的“适配器”上。创建对路的适配器就好比是要找到一种方法让购物者不必把美国运通卡、万事达卡和Visa卡都带在身上，以满足不同商店对支付方式的不同要求。但是，技术虽然能在不同的通行证之间搭建桥梁，却不能解决不同签发机构之间相互信任的问题，也不能解决用户对处理自己健康数据的适配器的信任问题。

或许，在经历疫情的战火洗礼后，世界将设计出一种能无缝对接的数字疫苗护照，取代世卫组织的黄皮书。但在每周仍有数千人因新冠肺炎丧生的情况下，多边组织、科技集团和各地政府围绕二维码和数字签名的争吵即便没有分散精力，也是在纠缠旁枝。疫苗护照永远不会遏制新冠病毒的蔓延。只有疫苗才会。根据约翰斯·霍普金斯大学的数据，丹麦、新加坡和卡塔尔已经有超过四分之三的人完成了疫苗全程接种。而在埃塞俄比亚和乌干达，这一比例还不到1%。未来有一天，疫苗护照或许会帮助维持和平。但眼下，世界必须集中精力打赢抗疫战争。 ■



Bartleby

The limits to the lessons of army leadership

Life in uniform is very different from life in suits

ONE OF THE all-time-great corporate emails was sent several years ago, by a manager at Shell to pep up a team of oil engineers on a project in the far east of Russia. "Personally, I, like most others, love winning," he raved. "I despise cowards and play to win all of the time."

The language was bizarre in other ways, too. "When everyone of you were kids, I am sure that you all admired the champion marble player" struck a chord with precisely no one in 2007. The anachronism was because the writer borrowed liberally from a stirring speech by General George Patton to American troops in 1944. Patton's "all real Americans love the sting and clash of battle" became "all real engineers love the sting and clash of challenge." And so on.

Copying from the army is seldom so cack-handed, but the idea that managers have lessons to learn from uniformed types persists. A cottage industry rests on the conceit that soldiers have insights into leadership that can be of use in the boardroom. Two new books based on the premise have come out last month—"Risk: A User's Guide" co-written by Stanley McChrystal, a retired four-star general in the US Army, and "The Habit of Excellence" by Lieutenant-Colonel Langley Sharp, a British officer.

General McChrystal's book is a pot-pourri of anecdotes and case studies on how to manage risk. The general's idea of creating "fusion cells" to bring together a network of intelligence teams in the fight against al-Qaeda has spread to other areas: the state of Missouri did something similar to connect different agencies to combat covid-19.

Lieutenant-Colonel Sharp has written the more distinctive book, a detailed account of how the British army goes about developing its leaders. Much of the thinking will be surprisingly familiar to managers. The army's concept of "mission command", in which the overall intent of a mission is set at the centre and the decision-making that brings it to fruition is delegated to people on the ground, is akin to the ethos of agile software development. "Serve to Lead", the motto of the army's academy at Sandhurst, came decades before the now-modish management theory of "servant-leadership".

Yet these echoes are only that. The differences between leading in the armed forces and leading a business come through more strongly from both books than the similarities. Most obviously, the use of lethal force tends not to be a big feature of corporate life. The stakes are much lower, and the calculus of risk is therefore just different.

Leaders in the armed forces can draw on deeper motivations among soldiers than bosses can with their employees. History offers a shared narrative to those in service. Patriotism provides a ready-made sense of purpose. And nationality operates like a permanent non-compete clause: soldiers do not change their allegiances to countries in the same way that workers can switch companies. "England expects that every man will do his duty," was the message that Admiral Nelson sent his sailors before the battle of Trafalgar in 1805. Swap in the name of your employer and see how it sounds.

The contrasts do not end there. Leaders in the armed forces play a much more familial role than the average boss. They will have been in the forces themselves for years. The people below them are often very young. Many live and work in close proximity.

The armed forces also emphasise intensive training in preparation for moments of extreme stress, when there is no time for senior figures to be consulted. When pivotal decisions need to be made at companies, the

bigwigs schedule a meeting weeks in advance. The closest analogues of army leadership lie in elite sports rather than in firms.

It is interesting for civilians to read about army life, but largely because it is so alien. It may make sense to hire veterans, but as part of the mix rather than as a template. A research paper from 2014 found that bosses who had been in the armed forces were more conservative than those who had not donned uniform. They invested less; they were less likely to commit fraud; and their firms performed better in times of crisis.

Patton's speech in 1944 ended by imagining what his soldiers would say to their grandchildren after the war was long over: "Son, your Granddaddy rode with the Great Third Army and a Son-of-a-Goddamned-Bitch named Georgie Patton!" The Shell executive's missive finished thus: "Details of the team are summarised in the enclosed email." War and work are not the same. ■



巴托比

军队领导经验的局限

军队职场大不同

几年前，壳牌的一名经理为了激励一个俄罗斯远东项目的石油工程师团队，发送了史上“最伟大”的企业邮件之一。他激情澎湃地说，“就个人而言，我和大多数人一样，热爱胜利，鄙视懦夫，总是想赢。”

这封邮件的措辞还有些其他怪异之处。比如“诸位在孩提时代想必都很崇拜弹珠游戏的冠军”这句话在2007年没有引起任何共鸣。这话听着不合时宜，是因为作者大量照搬了乔治·巴顿（George Patton）将军在1944年向美军发表的那番激动人心的演讲。巴顿那句“真正的美国人都喜欢战争的刀光剑影”被改成了“真正的工程师都喜欢挑战的刀光剑影。”诸如此类，不胜枚举。

仿效军队很少有如此拙劣的。不过认为管理者可以从戎装者那里学两手的观点很常见。有一门小生意便构筑在“把军人对领导力的洞见用在企业管理上”这一异想天开的想法之上。两本基于这种观点的新书于10月上架。一本是由美国退役四星上将斯坦利·麦克里斯特尔（Stanley McChrystal）参与合著的《风险：用户指南》（Risk: A User's Guide），另一本是由英国军官兰利·夏普（Langley Sharp）中校撰写的《卓越的习惯》（The Habit of Excellence）。

麦克里斯特尔将军的书是关于风险管理的奇闻轶事和案例研究的杂烩。他提倡打造“融合小组”，把不同的情报团队集结成工作网络来打击基地组织。这一思路已经传播到其他领域：密苏里州做了类似的事情，将不同机构联合起来抗击疫情。

夏普中校的书更具特色，详细记述了英军培养领袖的历程。其中很多见解都会意外地为经理人熟知。军队中有“任务指挥”的概念，即一项军事任务的总体目标由中央部门制定，但实现这一目标的决策权授予前线人员，这

与敏捷软件开发的理念类似。桑德赫斯特皇家军事学院的校训是“领导是为了服务”，比当今流行的“仆人式领导”管理理论的出现早了几十年。

不过，共同之处仅限于此。比起相似之处，这两本书实则都更强烈地显示了领导军队与领导企业的区别。最显而易见的是，使用致命武器一般不会是企业的一大特征。企业远没有那么利害攸关，对风险的计算也因此全然不同。

和老板激励员工相比，军队将领能够利用士兵更深层的动力。军人能从历史中找到共同的记述。爱国精神提供了现成的使命感。而国籍相当于永久的竞业条款：军人不会像员工跳槽那样改变对国家的忠诚。在1805年特拉法尔加战役爆发前，纳尔逊上将在动员他的水手时说：“英格兰希望人人都能尽忠职守。”换成你的老板这么说，你会作何感想？

反差还不止这些。比起一般的老板，军队将领的角色非常像家人。他们本人一般会服役多年，下级通常都很年轻。许多人都非常紧密地生活、工作在一起。

军队也注重高强度训练，为来不及请示上级的极端压力情形做好准备。而当企业需要做出关键决策时，高层会提前数周安排会议日程。比起企业，竞技体育的领导风格和军队更相仿。

普通人会觉得阅读讲述军旅生活的作品很有意思，但这主要是因为这种生活对他们来说很陌生。雇用退伍军人或许会是明智的决定，但让他们成为多元队伍的一部分就好，而不是当模板。2014年的一篇研究论文发现，当过兵的老板比没穿过军装的领导更加谨慎。他们投资更少；弄虚作假的可能性更低；公司在危机关头的表现更好。

在1944年演讲的结尾，巴顿畅想在战争结束很久后他的士兵们会对孙儿们说什么：“孩子，你爷爷我当年曾和伟大的第三集团军还有那个牛逼的乔治·巴顿并肩作战！”而那位壳牌高管的邮件的结尾是：“团队详情总结见所附电邮。”看来，战争与工作总归不是一回事。■



The Economist film

The race to zero - trailer

This race to zero is a vital step towards managing climate change. But what does net zero really mean?



经济学人视频

“净零”竞赛 - 预告片

“净零排放”竞赛是应对气候变化的关键一步，但这个词到底是什么意思？



Inner strength

Even after a weak patch, America's economy is still in high gear

High inflation, supply snarls—and strong growth momentum

MANAGERS AT HUB GROUP, a transport company, used to be able to click a few buttons at their headquarters in Illinois and, eight weeks later, receive a new shipping container from China, ready for use in America. Recently, though, Phillip Yeager, the firm's president, faced a headache. After a long wait at the congested port of Long Beach, its container was at last next in line to go ashore. But the ship in front did not have a chassis for moving its freight and was blocking the landing berth. Mr Yeager's team scrambled to find a chassis for it. Only then could Hub get its container, a full month late.

Multiply by thousands of containers, and the tale helps explain how supply chains have become so snarled, particularly in America, the world's biggest consumer market. And this is just one of the cross-cutting forces buffeting the economy. Demand for goods is incredibly strong, but companies are struggling to find workers and supplies, which in turn is pushing up wages and prices, all against a backdrop in which the pandemic—the original cause of the distortions—is fading but not gone. And officials, poised to withdraw the extraordinary fiscal and monetary stimulus of the past 18 months, are throwing another element into the fray. At the end of its policy meeting on November 3rd, the Federal Reserve said that it would start paring back its \$120bn monthly bond-buying programme, putting it on track to halt all purchases by June next year.

All this makes for a volatile mix, as was illustrated by third-quarter GDP, published on October 28th. The economy grew at an annual rate of 2% compared with the previous three months. That, depending on your frame of reference, was either most impressive or very disappointing. Compared

with forecasts made in late 2020, growth during the first three quarters of this year has been more than a third faster than projected. But forecasts had zoomed higher since: at one point economists expected third-quarter growth to be more than three times as fast as it actually was.

The fourth quarter may bring a bounce-back. Consumer confidence fell precipitously as the summer wore on and the Delta variant took hold. Now Delta is receding and confidence rebounding, which bodes well for shopping and travelling during the holiday season. Supply chains, though still far from normal, may be improving a bit. Mr Yeager talks of better “network fluidity”, with more trains arriving on time and warehouses running more efficiently. Analysts at Bank of America reckon that growth could pick up to an annual rate of 6% over the final three months of the year.

Any near-term rebound aside, however, how much longer before the recovery runs out of air? Three big factors suggest that it may be nearing its end: a tight labour market, stubbornly high inflation and a rapid unwinding of stimulus. Yet there is also cause to think that each will not undercut the recovery, and that growth momentum may remain strong.

Easily the most positive economic development of the past year has been the remarkable decline in unemployment. After a recession the labour market usually takes years to heal. Things looked grim at the height of the pandemic, when unemployment soared to 14.7%, the highest rate since the Depression. Yet the return to work, albeit not to offices, has been astonishingly strong. The unemployment rate, 4.8% in September, is low for this point in a recovery (see chart 1).

Indeed, the focus now is on how hard it is for companies to hire workers, especially for blue-collar jobs. That might suggest that the recovery is nearing an end, with the economy straining at its limits. Yet some slack

remains. About 3m people, 2% of the pre-pandemic labour force, have still to return to work. Some may have retired early, but many are on the sidelines, concerned about child care and catching covid-19. As those concerns diminish—the return to school has gone well so far and vaccines are proving effective against severe illness—such people are, little by little, resuming work.

The surge in inflation presents another big worry about the recovery (see chart 3). The personal consumption expenditures price index, the Fed's preferred gauge, increased by 4.4% in September from a year earlier, the most in more than three decades. For much of the past year officials at the Fed and many other economists, too, have argued that inflation is transitory, an outgrowth of gummed-up supply chains.

The tight job market, however, complicates the picture. Wages rose by 1.5% in the third quarter compared with the second, the biggest gain in at least two decades. Welcome as it is to see nurses and waiters get pay bumps, the fear is that rising wages will lead to yet more upward pressure on prices and ultimately to a dreaded wage-price spiral, as experienced in the 1970s. But conditions are very different. Far fewer workers are represented by unions today, and far fewer contracts have cost-of-living adjustments baked into them. That should weaken the link between inflation and pay. The Fed may have been unduly optimistic in thinking that price pressures would quickly subside, but its logic remains persuasive. As supply chains slowly return to normal and as people re-enter the labour force, inflation should ebb without the need for forceful interest-rate rises.

Related to that is the final big concern: the withdrawal of stimulus. With the fiscal deficit hitting 15% of GDP in 2020, the highest level since the second world war, the comedown was bound to be painful. The shift to smaller

deficits will deduct about 2.5 percentage points from growth over the next year, easily the biggest fiscal drag of the past two decades, according to the Hutchins Centre on Fiscal and Monetary Policy in Washington (see chart 2).

The monetary cliff will not be as steep, but it now looms over the economy. The next question after tapering is when the Fed will raise interest rates. On October 29th Goldman Sachs, a bank, said that the first rate rise could come as soon as July, a full year earlier than it had previously forecast, because of its expectation that inflation will remain elevated.

An end to stimulus would usually augur poorly for growth. Yet other factors could insulate the economy. The consumption of goods is about 15% higher than its trend level, partly because people have spent much less money than usual on holidays and restaurants and much more on furniture, exercise bikes and stay-at-home essentials. But with the pandemic now apparently petering out, people are buying experiences again—a fillip for growth, given that services account for nearly 80% of output.

Even without any more stimulus cheques, momentum for spending is strong. Jay Bryson of Wells Fargo, another bank, says that the strength of household balance-sheets should be the starting point in any analysis of America's growth prospects. Personal debt obligations as a share of disposable income are near their lowest on record. Business inventories are also near all-time lows, implying substantial need for restocking, if only companies can get the goods they need on time. "Knowing what I know today, I would say that we are still in the early stages of this recovery," says Mr Bryson.

Mr Yeager has reached a similar conclusion. As retailers rush to restock their shelves, Hub's order books are filling up fast. It has even had to turn some prospective clients away. "We think the strength really does carry through to

the end of next year and potentially beyond," he says. ■

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内在力量

经历一段疲软之后，美国经济仍然高歌猛进

通胀高企，供应紧张——而增长势头强劲

过去，运输公司枢纽集团（Hub Group）的经理只需在伊利诺伊州的总部点几下按钮，八周后就能收到来自中国的新集装箱，可以在美国使用了。但最近，公司总裁菲利普·耶格尔（Phillip Yeager）很头疼。在拥堵的长滩港外等待了很多天后，眼看自家的集装箱终于要上岸了，排在前面那艘货轮却没有卸货的底盘车，堵住了泊位。耶格尔的人马忙不迭地给这艘船找来一辆底盘车。他们的集装箱这才上得岸来，但已经晚了足足一个月。

这是成千上万只集装箱的旅程的缩影，从中可以窥见供应链缘何变得一团糟，特别是在美国这个全球最大的消费市场。而这只是交叉冲击美国经济的力量之一。目前商品需求异常强劲，企业却苦于人手和补给不足，这推高了工资和价格，而此时，在最初引发了供需错位的疫情将散未散。官员们准备撤回过去18个月里非同寻常的财政和货币刺激，令纷乱的局面又添变数。美联储在11月3日的政策会议临近尾声时表示，将开始缩减每月1200亿美元的购债规模，预计到明年6月将完全结束。

上述种种混合成了不断震荡的局势，从10月28日公布的第三季度GDP数字可见一斑。美国经济相比第二季度的年化增速为2%，这个数字可以说十分亮眼，也可以说非常令人失望，待看你使用哪个参照系。相比2020年底的预测，今年前三个季度的经济增速要高出预计三分之一。但在那之后预测数字已经提高：经济学家对第三季度增速的预测一度达到实际水平的三倍多。

第四季度的增速可能回升。今年夏天将尽之时，德尔塔病毒变种遍地开花，消费者信心急剧下降。而现在，德尔塔的威力逐步减退，市场信心回升，假日季的零售和旅游市场看好。供应链虽远未回归常态，但渐趋改善。耶格尔说“网络流动性”有所提升，更多火车准点到达，仓库运作也更

高效了。美国银行（Bank of America）的分析师估计，今年最后一季的年化增速可能回升至6%。

先撇开任何短期反弹不谈，这轮整体经济复苏还能持续多久？三大因素表明复苏可能已接近尾声：劳动力市场吃紧、通胀居高不下、刺激措施迅速撤回。然而，也有理由认为它们无一会削弱复苏，增长势头可能依旧强劲。

过去一年经济发展中最积极的一面当属失业率显著下降。在经济衰退过后，劳动力市场一般需要几年时间才能恢复。在疫情高峰期，失业率飙升至14.7%，是自大萧条以来的最高点，形势一度显得非常严峻。然而，复工（尽管不是回到办公室）势头惊人地强劲。9月的失业率为4.8%，就所处的复苏期时间点而言属低水平（见图表1）。

事实上，当前的焦点问题是企业招不到人，特别是蓝领工作。这可能表明复苏接近尾声，因为经济已拉伸至极限。不过，还是有一些闲置部分的。约有300万人（占疫情前劳动人口的2%）仍未重新投入工作。有些可能已提前退休，但许多人仍在犹豫观望，担心返岗后没人照顾孩子，也怕感染病毒。但目前学生返校进展顺利，疫苗也被证明能有效避免重症，这些忧虑减轻，他们正逐步返回职场。

通胀激增是复苏的另一大忧虑（见图表3）。9月，个人消费支出物价指数（美联储衡量通胀的主要指标）同比上升4.4%，是30多年来的最高升幅。在过去一年的大部分时间里，美联储官员和其他许多经济学家都说通胀是供应链堵塞造成的暂时现象。

但就业市场紧张让局面变得更复杂。第三季度工资水平比上一季上升1.5%，是至少20年来的最大升幅。虽然人们对护士和服务员工资上涨喜闻乐见，但还是担心工资上涨会进一步带来价格上行压力，最终导致上世纪70年代那种可怕的工资-价格螺旋上升再现。但现在的情况与当年大不相同。如今加入工会的工人数量要少得多，包含生活成本调整条款的劳动力

合同也少得多。这应该会削弱通胀与工资之间的关联。美联储认为价格压力会迅速消退，这可能有点过分乐观了，但背后的逻辑还是有说服力的。随着供应链慢慢恢复正常，以及人们重新进入劳动力市场，估计无需强力加息，通胀也会降下来。

与此相关的是最后一大问题：刺激措施撤回。美国财政赤字在2020年达到GDP的15%，为二战以来最高，压低赤字必然是个痛苦的过程。华盛顿哈钦斯财政与货币政策中心（Hutchins Centre on Fiscal and Monetary Policy）的数据显示，减少赤字将导致明年经济增速降低约2.5个百分点，很可能造成20年来最大的财政拖累（见图表2）。

货币刺激的撤回不会如此剧烈，但现在它的阴影笼罩着整个经济。减少资产购买后，下一个问题是美联储将在何时加息。10月29日，高盛表示，首轮加息最快可能在明年7月到来，比它之前的预测提前足足一年，因为高盛预计通胀将保持在高位。

退出刺激措施通常都预示着经济增长放缓。不过其他因素可能使经济免受影响。商品消费比原有走势高出约15%，原因之一是人们在度假和餐馆用餐上的消费比往常少了很多，而在家具、健身单车和居家必需品上开销大增。但随着疫情明显减退，人们又开始把钱花在体验上，这会推动经济增长，毕竟服务业占到美国总产出的近80%。

即使没有更多经济刺激支票，消费势头也相当强劲。富国银行的杰伊·布赖森（Jay Bryson）表示，家庭资产负债表的实力应该是任何对美国增长前景分析的起点。个人偿债义务占可支配收入的比例接近历史新高。商业库存也接近史上最低位，也就是说存在大量补货需求，只要企业能及时得到所需货物。“就目前我所了解的情况来看，我觉得我们还处在复苏的早期。”布赖森说。

耶格尔也得出了差不多的结论。零售商都急于补货，大量订单令枢纽集团应接不暇，甚至不得不拒绝了部分潜在客户。“我们认为，这股势头肯定

能延续到明年年底，可能还不止。”他说。





Reinvention as a service

The IT establishment is dressing in new clothes

But taking on the big tech firms will be hard

“WE ARE A different company now. We are no longer focused just on mobile. And we have the numbers to back it up.” Cristiano Amon, the boss of Qualcomm, which makes chips mostly for smartphones, is emphatic when he describes what he will tell Wall Street at the firm’s investor day on November 16th. He is in good company. Some of the other famous members of a previous generation of big-tech firms (Cisco, Dell Technologies, Hewlett Packard Enterprise and IBM) have recently met investors to explain how they intend to stay relevant in the age of cloud computing and artificial intelligence (AI).

There is action as well as words. On November 1st Dell spun off VMware, a big software-maker; later in the week IBM floated much of its professional-services business. The tech old guard hope to reinvent themselves, much as Microsoft has done in recent years in spectacular fashion.

Although dwarfed by the current big-tech generation (see chart 1), this handful of IT veterans still has clout. There is hardly any business that does not use some of their products and services. In the past 12 months they cranked out a huge \$284bn in revenues collectively and \$56bn in gross operating profits. And they employ 690,000 people worldwide. Each firm has its own specialisms. Qualcomm designs its chips, but outsources manufacturing. Both Cisco and IBM, mainly regarded as hardware-makers, have become largely software firms. As for Dell and Hewlett Packard Enterprise (HPE), their reputation is rooted in personal computers (PCs), even though they now sell other hardware, from storage devices to supercomputers (the PC business stayed with HP’s other branch when the

company split in 2015).

Yet all face similar challenges. For a start, they mostly used to sell wares, be they hard or soft. In recent years, however, delivering IT in big distinct chunks has moved to providing it “as-a-service”, or “AAS,” in the parlance—a business that is now dominated by startups and big cloud-computing providers such as Amazon Web Services (AWS) and Google Cloud Platform (GCP). The internet allowed such things as number-crunching and data storage to be served up online. AI is part of this story, too: the more data are collected in the cloud, the more they can be mined and turned into algorithms, which then become the engines of new services, such as detecting hacking attacks.

The quest to escape commoditisation is pushing the industry towards services. IT has always been a lumpy business, with customers paying large sums of money for new wares once every few years. At the same time hardware and even some software have become low-margin businesses. Subscriptions to services, by contrast, bring more predictable revenues and higher profits. Services are good for buyers, too, argues Pierre Ferragu of New Street, an equity-research firm. In the past a customer might have had to buy an oversized network switch for \$10,000. Now it can be had for \$3,000, plus \$2,000 a year for services. “Everybody is happier,” he explains.

That means taking on cloud operators that offer similar subscriptions, such as AWS. The pandemic has accelerated the cloud’s rise but it has become apparent that not all number-crunching can be done in big data centres. Firms have many reasons to keep some computing in-house, including regulations preventing others processing their data and the risk of depending on a big cloud provider. Then there are “edge” devices, from smartphones to intelligent sensors, which connect to the cloud and extend it, generating ever more data. It is often more efficient to bring computing to the data than the other way around.

The tech veterans want to help firms manage this world of many clouds (“hybrid” or “multi” in the lingo). Red Hat Hybrid Cloud Platform, now at the centre of IBM’s software offerings, is an uber-cloud of sorts that runs on top of many systems, including IBM’s own machines, public clouds and edge ones. It is supposed to allow customers to stay independent of any one system. HPE offers something similar called GreenLake. Cisco boasts several more specialised platforms, including one to optimise a firm’s many applications.

Dell and Qualcomm are different. By floating VMware, which sells software similar to IBM’s platform, Dell appears to be moving against the stream. But the spin-off mainly serves to get rid of a conglomerate discount. Dell has negotiated a detailed agreement to continue to benefit from VMware’s products. It has also launched an as-a-service effort of its own, called APEX, which is supposed to offer cloud computing in Dell’s trademark “pragmatic and predictable way”, in the words of Allison Dew, the firm’s chief marketing officer, who is also in charge of APEX.

As for Qualcomm, it sees the cloud not as a threat but an opportunity. As growth slows in its main market, smartphones, it hopes that the cloud will create new demand for its chips from makers of other devices, from connected cars to intelligent sensors. “If you believe in the cloud, you have to believe in the edge,” says Mr Amon. “You can’t have one without the other.”

As well as developing new lines of business, deals large and small have been part of the metamorphosis. IBM’s hybrid cloud platform owes its name and underlying technology to Red Hat, an open-source software maker it acquired for \$34bn in 2019. The creation of Kyndryl, the name given to the business that that IBM has spun off, allows it to hive off its army of IT workers and consultants in favour of selling tools and digital services to automate customers’ businesses. “We are a technology firm again,” says Rob

Thomas, a senior executive at the company.

What are the results so far of the tech incumbents' transformation dreams? Cisco was the first to react, promising in 2017 that more than half of its revenue would come from software and subscriptions within three years. HPE announced an even more ambitious goal in 2019, saying that it will offer its entire portfolio of products as a service by 2022. IBM, mainly thanks to its mainframe business, has always had a healthy stream of subscription revenues, but wants to grow these further.

Taken at face value, the numbers are impressive. Cisco announced that it had reached its targets set in 2017: software and services now generate 53% of revenue. HPE boasted services revenues of \$1.2bn and after the Kyndryl spin-off IBM's software sales will leap to 65% of revenues. Mr Amon will hammer home the point that Qualcomm's non-handset businesses, such as cars and the internet of things, already have revenues of \$10bn, about a third of the total, and are growing 1.6 times faster than its handset ones.

But so far, investors do not seem to be convinced that old IT's new clothes are a good fit: the group's collective market capitalisation, now amounting to about \$600bn, has only barely budged from where it was before the charm offensive aimed at Wall Street. Much will depend on whether they will be able to attract top technical talent. Without it, they will have a hard time competing with both the big cloud providers and hot startups. Antonio Neri, HPE's chief executive, says he recently moved the firm's headquarters from Silicon Valley to Houston, Texas, in part because recruitment is easier there.

Do these firms still have what it takes? Most have new ranks of hungry executives but even the veterans still have fire in the belly. Michael Dell has remained at the wheel of the firm he founded in 1984, except for a hiatus in 2004-07. Asked about his future, he replies: "I love what we do: It's fun, it's

interesting, it's exciting. I have no plans to change my involvement." ■



重塑即服务

老牌IT企业换新装

但要与科技巨头较量会很艰难

“我们公司和过去不一样了。我们不再只专注手机。我们有数据可以证明。”在谈到自己将在11月16日的公司投资者大会上向华尔街传递的信息时，主要生产智能手机芯片的高通公司的老板克里斯蒂亚诺·安蒙

(Cristiano Amon) 语气坚定。他有一批志同道合者。上一代科技巨头的一些其他成员，如思科、戴尔、慧与(Hewlett Packard Enterprise)以及IBM，最近都和投资者见了面，解释自己打算如何在云计算和人工智能(AI)的时代保有重要的一席之地。

有表态，也有行动。11月1日，戴尔剥离了大型软件公司VMware；同一周晚些时候，IBM将自己大部分的专业服务业务分拆上市。科技业的老牌公司希望重塑自我，就像微软在近年完成了非凡的转型那样。

尽管与当前一代科技巨头比起来相形见绌(见图表1)，这几家老牌IT公司仍有其影响力。它们的某些产品和服务几乎所有公司都在用。过去12个月，它们总共创造了2840亿美元的巨额营收以及560亿美元的营业利润。它们在全球有69万名雇员。每家公司都有自己的专长。高通设计芯片，但把芯片制造外包出去。被普遍视为硬件制造商的思科和IBM在很大程度上都变成了软件公司。至于戴尔和慧与，它们都靠个人电脑(PC)成名，尽管它们现在也销售从存储设备到超级计算机的各种硬件(2015年惠普拆分时，PC业务留在了另一个部门)。

但这些公司都面临类似的挑战。首先，它们过去都以产品(硬件或软件)销售为主。但是近年来，IT的交付模式已经从过去的提供各种大型组件转变为“即服务”(as-a-service)模式，也就是所谓的“AAS”——这种业务现在由一些创业公司以及亚马逊云科技(AWS)、谷歌云平台(GCP)等大型云计算供应商主导。互联网使得数字运算和数据存储等服务都可以在线上

提供。人工智能也是如此：云平台收集的数据越多，就有更多的数据可供挖掘并转化为算法，然后由这些算法驱动一些新服务，比如检测黑客入侵。

避免产品因同质化而丧失溢价能力推动着该行业向服务模式转型。IT一直是个波动的行业，客户每隔几年就要付一大笔钱购买新产品。而与此同时，硬件、甚至一些软件都已经成为低利润的业务。相比之下，订阅服务能带来更多可预见的收入和更高的利润。股票研究公司New Street的皮埃尔·费拉居（Pierre Ferragu）认为，服务对买家也有好处。过去，客户可能要花一万美元购买一台过大的网络交换机。而现在只要花3000美元，外加每年2000美元的服务费就能拥有它。“这是皆大欢喜的事。”他解释道。

这意味着要与AWS等提供类似的订阅服务的云运营商展开竞争。疫情加快了云平台的兴起，但人们也已了解到，不是所有的数据处理都能在大型数据中心完成。企业会把某些计算留在内部完成，原因有很多种，比如有些法规不准许把数据交由外部公司处理，依赖某家大型云服务供应商会带来风险等。此外还有智能手机、智能传感器等各种“边缘”设备，它们与云平台连接，并拓展了云平台，不断产生更多的数据。把计算带入数据往往要比把数据带入计算更高效。

老牌科技公司希望帮助企业管理这个有如此多云平台（行话叫“混合云”或“多云”）的世界。红帽混合云平台（Red Hat Hybrid Cloud Platform）目前是IBM的核心软件产品，这是一种超级云，运行在许多系统之上——包括IBM自己的机器、公共云和边缘云。它应该能让客户不依赖任何一个系统。慧与也有类似的叫作GreenLake的云平台。思科自称拥有几个更专门化的平台，其中一个可以优化一家公司的许多应用。

戴尔和高通则跟它们不同。戴尔让VMware（以类似IBM的方式销售软件）上市，似乎是逆势而为。但这次分拆主要是为了避免多元化折扣。戴尔已经谈定了一项详细协议，让它能继续从VMware产品中受益。它还推出了自己的“即服务”项目APEX，用戴尔首席营销官兼APEX负责人

艾利森·迪尤（Allison Dew）的话说，希望APEX能以戴尔标志性的“实用和可预见的方式”提供云计算服务。

对高通来说，云技术不是威胁，而是机遇。随着它主打的智能手机这一块增长放缓，高通希望云技术能让其他设备的生产商对它的芯片产生需求，比如联网汽车和智能传感器的厂商。“如果你相信云，你就得相信边缘云，”安蒙表示，“二者缺一不可。”

除了发展新业务，大大小小的交易也是转型的一部分。IBM的混合云平台的名称和底层技术都来自它在2019年以340亿美元收购的开源软件公司红帽（Red Hat）。IBM分拆出了一家命名为勤达睿（Kyndryl）的新公司，得以将大批IT员工和咨询顾问分离出去，他们专注于销售工具和数字服务来帮助客户实现业务自动化。“我们又成了科技公司。”IBM高管罗伯·托马斯（Rob Thomas）说。

迄今为止，老牌军团的转型梦想实现得如何？思科是第一个做出调整的公司，它在2017年承诺，三年内过半收入将来自软件和订阅业务。慧与在2019年宣布了一个更加宏伟的目标，要在2022年前把所有产品都转为以服务形式提供。IBM一直有着不错的订阅收入，这主要得益于它的大型主机业务，但它希望这类收入还能进一步增长。

若只看表面，目前的相关数字令人赞叹。思科宣布它已经实现了2017年设定的目标：软件和服务如今带来了53%的收入。慧与宣称自己的服务收入达12亿美元；在分拆了勤达睿后，IBM的软件销售将一举占到收入的65%。安蒙将会再三强调，高通的汽车和物联网等非手机业务的收入已达到100亿美元，约占总收入的三分之一，而且它们的增速比手机业务快1.6倍。

但到目前为止，投资者似乎并不确信老牌IT公司的新装很合身：这几家公司目前的总市值约为6000亿美元，和它们向华尔街展开魅力攻势之前相比几乎是原地踏步。成败在很大程度上将取决于它们能否吸引到顶尖的技术人才。如果不能，它们将很难与大型云服务供应商以及如日中天的创业

公司竞争。慧与CEO安东尼奥·内里（Antonio Neri）表示，他最近把公司总部从硅谷搬到了得克萨斯州的休斯顿，原因之一是那里更容易招到人。

这些公司仍然具备成功的必要条件吗？它们大多有一批渴望有所成就的新高管，但即使老将们胸中也仍有一团火。除了2004至2007年这一小段时间外，迈克尔·戴尔（Michael Dell）一直都掌管着他创立的公司。当被问及自己未来的打算时，他回答说：“我热爱我们做的事：它好玩，有趣，激动人心。我不打算从里头抽身。”■



Schumpeter

How Adobe became Silicon Valley's quiet reinventor

From an also-ran to the world's fourth-most-valuable software firm

BY SILICON VALLEY standards, Adobe is a dull company. Nudging 40 it is middle-aged. It does not make headlines with mega-mergers or have a swashbuckling chief executive. “I feel very comfortable not being out there pounding my chest,” confesses its boss, Shantanu Narayen, in a rare interview. All the while, Adobe has quietly managed to adapt to the age of cloud computing. It has done a better job of reinventing itself perhaps even than Microsoft, the technology industry’s best-known comeback kid. Microsoft’s CEO, Satya Nadella, is said to have examined Mr Narayen’s handiwork closely—and not just because he attended the same secondary school in India as Adobe’s leader, albeit a few grades down. Since 2007, when Mr Narayen took the helm, Adobe’s market capitalisation has swelled from \$24bn to \$276bn. In the past ten years it has outperformed both Mr Nadella’s Microsoft and Salesforce, another rival business-software maker.

To most ears, Adobe is synonymous with desktop publishing. Founded in 1982, it set key standards, in particular PostScript, which tells printers where to make the dots, and PDF, the “portable document format” that allows printed documents to be distributed online. It also developed programs for editing digital content. One, Photoshop, became a verb. Adobe’s pricey software was installed on desktop computers, and updated with new versions every year or so. By the late 2000s this model itself looked in need of an update. Smartphones unleashed people’s creativity far from their desks and cloud computing enabled software to be offered as a service over the internet.

Rather than cling to the lucrative legacy business, Mr Narayen embraced a

chance “to reimagine ourselves”. Putting Photoshop and other popular but complex applications, such as Illustrator, fully into the cloud would have been technically too tricky. But Adobe still found a way to use the cloud to improve its products. Today Adobe’s two original software businesses have morphed into two subscription-based “clouds”. The smaller “Document” cloud provides services ranging from the mundane (converting a PDF into a word-processing file) to the mission-critical (managing the digital documents of government agencies). All have seen a boom during the pandemic-induced shift to remote work. The other, much bigger “Creative” cloud lets users edit all sorts of digital content, from websites to videos. Since this content no longer lives on hard drives but in data centres, it can be worked on from different devices and by several people at a time.

Adobe’s transformation would not be half as successful, however, without other innovations. One is what the firm calls its “data-driven operating model” (DDOM), jargon for using data generated by its digital services to improve them and develop new ones in a perpetual feedback loop. Adobe has mastered this both internally and by developing a third cloud, which allows other firms to optimise their digital offerings. This “Experience” cloud lets its subscribers, among other things, track how online buyers behave and how they might best be guided to making a purchase.

Another innovation was its management structure. Some tech firms, such as Apple, espouse top-down micromanagement. Alphabet, Google’s parent company, is almost anarchic in its bottom-upness. Adobe is a healthy mix. Mr Narayen sets out the destination, and the managers of the three clouds chart the exact course. To make DDOM and the Experience cloud work, for instance, he set a goal that was both precise and exacting: Adobe’s data platform must be able to serve up content in less than one-tenth of a second. How that objective was reached was then up to the engineers.

Adobe’s three clouds, operating model and management style help explain

why it offers, in the words of Mark Moerdler of Bernstein, a broker, an “unusual investment combination in software”: high margins and good growth. Its latest quarterly results are emblematic. Revenues rose by 22% year on year, to \$3.9bn, while the operating margin edged up to 46%, according to Bernstein.

Possibilities for more data-driven growth abound. On October 7th Adobe completed the \$1.3bn acquisition of Frame.io, a video-editing service. Artificial intelligence, which extracts patterns from digital information, will underpin many new services (such as Adobe’s recent offering that turns PDFs into web pages, which can then be more easily navigated on smartphones). Similar algorithms could help professional content creators be more productive and also make Photoshop more accessible for newbies. The “creator economy” is only just getting going. And then there is the much-hyped “metaverse” of interconnected virtual worlds, which will be full of digital objects Adobe’s tools help build.

As Mr Narayen would be first to admit, the software business is full of risks. “Software follows a sort of S curve,” he observes: performance eventually moves sideways if “you do not invest in the right opportunities”. The Creative and Document clouds, which together generate 73% of Adobe’s revenues and 80% of its gross profit, are a ripe target for competitors. Startups such as Figma, a website for designers of online services which is fully cloud-based, are betting even more than Adobe on online collaboration. With 14 years under his belt as boss, talk of succession is in the air. It would be as big a transition as the handover from Steve Jobs to Tim Cook at Apple, says Brent Thill of Jefferies, an investment bank. It is anyone’s guess whether it could be as successful.

Investors have indeed cooled a bit on Adobe of late. Its market value is down by \$40bn from a peak in September, a steeper decline than at most other tech giants. Yet the company has proved time and again that it can prosper

by embracing change rather than fighting it. That has made Mr Narayen the darling of investors and analysts, as well as a role model for tech bosses such as Mr Nadella. Nothing dull about that. ■



熊彼特

Adobe如何成为硅谷的低调转型大师

从平庸之辈到全球市值第四高的软件公司

按硅谷的标准来看，Adobe是一家乏味的公司。它年近四十，已步入中年。它不会因为大手笔并购或者言谈大胆的CEO而登上头条。“不用整天站出来拍着胸脯夸口，我感到很自在。”公司老板山塔努·纳拉延

（Shantanu Narayen）在为数不多的一次采访中坦言。但与此同时Adobe已经默默适应了云计算时代。它的自我重塑甚至可能比微软还要成功，后者是科技行业最出名的东山再起的范例。据说微软CEO萨蒂亚·纳德拉

（Satya Nadella）密切关注纳拉延的一举一动，而这不仅仅是因为他曾与这位Adobe掌门人在印度上同一所中学，虽然低了几届。自2007年纳拉延掌舵以来，Adobe的市值已从240亿美元膨胀至2760亿美元。在过去10年里，其表现优于纳德拉的微软和另一家商业软件公司Salesforce。

对于大多数人来说，Adobe就是桌面出版的代名词。这家成立于1982年的公司是一些关键标准的制定者，特别是控制打印机列印点阵的PostScript，以及方便印刷文档在线分发的“便携式文档格式”PDF。它还开发了编辑数字内容的程序，其中之一的Photoshop已经成了一个动词。Adobe昂贵的软件安装在台式电脑上，大约每年更新一次版本。到2000年代后期，这种模式本身似乎也需要更新了。智能手机让人们不在电脑桌旁也能发挥创意，而云计算让软件成为可以通过网络提供的一种服务。

纳拉延没有固守利润丰厚的传统业务，而是抓住了“重新想象我们自身”的机会。要把Photoshop和Illustrator等流行但复杂的应用程序完全放到云上，技术上的难度太大。但Adobe仍然找到了一条路来利用云技术改进自己的产品。如今，Adobe原有的两块软件业务已经演变为两朵基于订阅的“云”。较小的“文档”云提供各种服务，从普通日常操作（将PDF转换为可以做文字处理的文件）到事关重大的任务（管理政府机构的数字文档）。在由疫情引发的向远程办公的大转型中，这些服务都大受欢迎。另一朵大

得的“创意”云让用户编辑从网站到视频的各种数字内容。这些内容现在已经不再放在硬盘上，而是存在数据中心里，因此可以由多人通过不同设备同时处理。

然而，如果没有其他创新，Adobe的转型远不会如此成功。其中一个创新是它所说的“数据驱动运营模式”（DDOM），这个行业术语指的是利用数字服务产生的数据，通过一个永续的反馈循环不断改进既有服务并开发新的服务。Adobe不仅在内部充分运用了这种模式，还将其应用于外部——它开发了第三朵云来让其他公司优化自己的数字产品。这朵“体验”云的订户可以利用各种工具，跟踪线上买家的行为，分析如何最好地引导他们购买产品，等等。

另一项创新是它的管理架构。苹果等一些科技公司崇尚自上而下的微观管理。谷歌的母公司Alphabet奉行自下而上的哲学，甚至近似无政府状态。Adobe则将两者有效地结合起来。纳拉延制定好目标，三朵云的管理者策划具体的路线。例如，要让DDOM和“体验”云达到预期效果，纳拉延定下了一个既精确又严格的目标：Adobe的数据平台必须能够在不到十分之一秒的时间内将内容准备到位。如何实现这一目标则交由工程师解决。

Adobe的三朵云、运营模式和管理风格有助于解释它何以能同时实现高利润和高增长——用经纪公司盛博的马克·莫德勒（Mark Moerdler）的话说是提供了一个“软件行业里不常见的投资组合”。最新的季度财报具有标志意义。盛博的数据显示，公司营收同比增长22%至39亿美元，而经营利润率小幅上升至46%。

能带来更多由数据驱动的增长的机会比比皆是。10月7日，Adobe以13亿美元完成了对视频编辑服务Frame.io的收购。从数字信息中提取模式的人工智能将撑起许多新服务（例如Adobe最近推出了将PDF转换为网页的服务，方便在智能手机上浏览）。类似的算法可以帮助专业内容创作者提高生产力，也可以让Photoshop新手更快上手。“创作者经济”才刚刚起步。此外还有风头正劲的互联虚拟世界“元宇宙”，里面将充斥Adobe的工具帮助构建的数字化物件。

软件业充满风险，这一点纳拉延再清楚不过。“软件遵循着一种S型曲线。”他说。也就是说，“如果你没有抓住合适的投资机会”，业绩数字终将停止向上攀升。创意云和文档云总共为Adobe贡献了73%的营收和80%的毛利，自然会成为竞争对手紧盯的目标。有些创业公司对线上协作的押注比Adobe还多，比如面向线上服务的设计师的Figma，这是一个完全在云上运作的网站。纳拉延担任一把手已经14年了，关于继任人的议论纷纷扬扬。投资银行杰富瑞的布伦特·赛尔（Brent Thill）说，这一交接将堪比苹果的乔布斯交棒给库克。不过谁也不知道它能否取得同样的成功。

投资者最近对Adobe的热情确实略有降温。它的市值较9月份的高点已经缩水了400亿美元，跌幅超过大多数其他科技巨头。然而，这家公司已经一次又一次地证明，它可以通过拥抱而非对抗变化来蓬勃发展。这使得纳拉延成为投资者和分析师的宠儿，也成为纳德拉等科技公司老板们的榜样。这可一点也不乏味。 ■



Set in green concrete

How cement may yet help slow global warming

It is a big source of emissions, but might one day be the reverse

THE ROMANS perfected concrete, and their legacy still stands in the form of the magnificent roof of the Pantheon, the world's largest unreinforced concrete dome. Since it was completed in around 125AD by the Emperor Hadrian, an awful lot more concrete has been poured—some 30bn tonnes every year, at the moment, to put up buildings, roads, bridges, dams and other structures. The grey stuff has become the most widely used construction material on the planet, and demand is growing.

This is bad news for global warming. The problem is that concrete's crucial ingredient, cement, which is mixed with sand, gravel and water to make the stuff, is responsible for a huge amount of greenhouse-gas emissions. Taking in its various stages of production, the 5bn tonnes of cement produced each year account for 8% of the world's anthropogenic CO₂ emissions. If the cement industry were a country it would be the third-largest emitter in the world, after China and America.

So far, concrete has few practical alternatives. The development of cross-laminated, “engineered”, timber—which, being produced from wood, can be a renewable resource—is gaining interest, even for some high-rise buildings. But compared with concrete, engineered timber remains, for now, a novelty. Concrete's biggest users, especially China, which makes more than half of the world's cement, are not about to stop employing it. Hence cleaning up the industry might seem a hopeless task. But it isn't, for technologies are being developed to make concrete greener. Green enough, perhaps, for it to go from adding CO₂ to the atmosphere, to subtracting it.

The place to start is where emissions are greatest. Cement production begins with the quarrying of limestone, the main component of which is calcium carbonate (CaCO_3). This is mixed with clay and passed through a rotating kiln at more than $1,400^\circ\text{C}$ in a process called calcination. The heat drives off the carbon and part of the oxygen, which combine to form CO_2 . The remaining lumps, called clinker, are made of molecular complexes of calcium oxide and silica, known collectively as calcium silicates. The clinker is then cooled and milled into cement. More than half the emissions involved in cement-making are a consequence of calcination, and most of the rest result from burning coal and other fossil fuels to power the process (see chart). All told, nearly one tonne of CO_2 is released for every tonne of fresh cement.

The inevitability of calcination's creation of CO_2 makes capturing the gas before it can enter the atmosphere, and storing it away, the most effective approach to decarbonise the cement industry, according to a study by Paul Fennell of Imperial College, London, and his colleagues, published earlier this year in Joule. The captured CO_2 could be held underground or used by other industries—for instance to make synthetic fuel. But it might also be injected back into concrete at the point when it is being mixed with water to cure it. Water promotes chemical reactions that cause cement to harden. CO_2 has a similar effect and, in the process, gets locked up as calcium carbonate.

In fact, reversing calcination in this way makes concrete stronger than if water alone is used. So, not only is some of the original emission thus dealt with, less cement is needed for a given job, lowering overall emissions still further. McKinsey, a consultancy, reckons reverse calcination could, at present, sequester up to 5% of cement's emissions. As the technology improves it expects that might rise to 30%.

Several companies are starting down this route. CarbonCure, a Canadian

firm, has fitted equipment which injects CO₂ into ready-mixed concrete to more than 400 plants around the world. Its system has been used to construct buildings that include a new campus in Arlington, Virginia, for Amazon, an online retailer (and also a shareholder in CarbonCure), and an assembly plant for electric vehicles, for General Motors, in Spring Hill, Tennessee.

At present the CO₂ used by CarbonCure has been captured by industrial-gas companies. But firms are developing equipment intended to collect the gas directly from cement kilns. And Calix, based in Sydney, Australia, is working on an electrically powered system which heats the limestone indirectly, from the outside of the kiln rather than the inside. That enables pure CO₂ to be captured without having to clean up combustion gases from fuel burnt inside the kiln—so, if the electricity itself came from green sources, the resulting cement would be completely green.

A pilot plant using this technology has run successfully as part of a European Union research project on a site in Belgium operated by Heidelberg Cement, a German firm that is one of world's biggest cement-makers. A larger demonstration plant is due to open in 2023, in Hanover, to help scale up the technology.

Another approach—less green, but still better than using fossil fuels—is to substitute some of the coal burnt in kilns with municipal and industrial waste. Several firms are already doing this. Cemex, a Mexican building-materials giant, for example, makes a kiln fuel called Climafuel out of municipal waste that has been denuded of its recyclable substances. This is rich, in the form of plant material (“biomass”), in carbon that has recently been in the atmosphere, and is simply returning there, rather than having been dug up as fossil fuel. Up to 60% of the coal used by some of Cemex's British cement plants has been replaced with Climafuel.

Companies are also looking at ways to substitute some of the cement in concrete with other materials. Many add fly ash, a by-product of coal-fired power plants, or crushed slag from the blast furnaces used to make iron. But neither of these approaches is sustainable in the long run. As Peter Harrop, boss of IDTechEx, a firm of analysts in Cambridge, England, and the co-author of a new report on the future of concrete and cement, observes, coal use is dwindling and steel production aspires to move to newer, cleaner technologies.

For Dr Harrop, an important part of the answer is to “tech-up” concrete in ways which mean that less of it will be needed to do particular jobs. This means adding things like synthetic and natural fibres—or even graphene, a substance stronger than steel that consists of single-layer sheets of carbon atoms. Only small amounts are needed to produce beneficial results.

Graphene and other reinforcement will lead to new, ultra-high-performance concretes, which Dr Harrop thinks will be particularly suitable for 3D printing. This builds up precise layers of material under robotic control, and greatly reduces waste. “Using much less cement is a very important part of the answer,” he adds, especially as cement production looks otherwise set to double over the next 20 years.

Additives can also make concrete last longer and reduce the need for maintenance. At the University of Michigan, Victor Li and his colleagues use synthetic and natural fibres, along with CO₂ injection, to produce a bendable concrete they call Engineered Cementitious Composite (ECC). The internal structure of this material was inspired by nacre, a flexible material commonly called “mother of pearl” that coats the insides of the shells of molluscs such as abalone and oysters.

Adding such flexibility to concrete lets bridges and roads cope more easily with heavy traffic, and improves the earthquake resistance of tall buildings.

ECC develops only tiny surface cracks when it ages. Dr Li says it is thus better at keeping water out and preventing corrosion of reinforcing steel bars inside. Such corrosion can cause reinforced-concrete structures to crumble within a few years of their construction—sometimes resulting in their collapse.

Substitution of materials could go still further. Solidia, a firm in New Jersey, makes cement containing calcium silicates with a higher ratio of silica to calcium oxide than the standard “Portland” variety. This has two consequences. One is that Solidia’s process requires less heat (and therefore less fossil fuel) than conventional calcination, and so releases less CO₂ in the first place. The other is that, when mixed into concrete, Solidia’s silica-rich silicates can be cured more rapidly than regular cement by using captured CO₂ instead of water. Solidia is working on applications for its cement with one of its investors, LafargeHolcim, a Swiss building-supplies giant.

Taking all these developments into account, how green could concrete get? Dr Fennell says it would be reasonably easy to reduce the industry’s CO₂ emissions to around 80% of present levels per tonne of concrete produced by better energy use and the modification of materials. But companies could really pull the stops out if they moved to kilns largely or entirely powered by biomass, such as wood. The carbon in this would, until recently, have been CO₂ in the air. If, after being turned back into that gas by being burned in the kiln, it was stored away and not released, the consequence, as new trees grew to replace those consumed, would be a net flow of carbon out of the atmosphere.

This sort of system, called bioenergy with carbon capture and storage (BECCS), is one way climate modellers imagine providing the “negative emissions” needed for net-zero or net-negative emissions targets. BECCS-based electricity generation is often talked of, but BECCS might actually

be better suited to cement-making—because in a carbon-conscious world the CO₂ capturing equipment will already be there, dealing with results of calcination. And if that happened, one of the pariahs of global warming might thus redeem itself by helping alleviate the damage being done to the planet, and so leave behind a legacy as impressive in its way as that of the Romans. ■



浇筑绿色混凝土

水泥如何可能帮助减缓全球变暖

它是一大排放源，但有朝一日角色可能反转

罗马人完善了混凝土技术，他们流传世间的技艺就凝结在万神殿的宏伟屋项中，这是世界上最大的无钢筋混凝土圆顶。自它在公元125年左右由哈德良皇帝下令建成以来，全球已浇筑了海量的混凝土，目前每年约浇筑300亿吨，用于建造建筑物、道路、桥梁、水坝和其他结构。这种灰色材料已成为地球上使用最广泛的建筑材料，而且需求还在不断增长。

这对全球变暖来说不是好事。混凝土由水泥、沙子、砾石和水混合而成，问题在于其主要成分水泥在生产过程会释放大量温室气体。把各个生产环节都计算在内，每年生产的50亿吨水泥在全球人为二氧化碳排放中占8%。如果把水泥工业看作一个国家，它将是仅次于中国和美国的世界第三大排放国。

到目前为止，混凝土几乎没有可行的替代品。交叉层压的“复合”木材（由木头制成，可作为再生资源）的开发正在引发关注，甚至是在高层建筑方面。但与混凝土相比，复合木材目前仍然是新鲜事物。混凝土消耗大国不会停止使用这种材料，尤其是生产了全球一半以上水泥的中国。看起来要清理这个污染行业似乎毫无希望。但事实并非如此，因为研究人员正在开发让混凝土变得更环保的技术。未来的绿色混凝土也许不但不会增加大气中的二氧化碳，还会减少它。

可以从排放量最大的环节入手。水泥生产始于石灰石的开采，石灰石的主要成分是碳酸钙。石灰石与粘土混合后在超过1400°C的回转窑中加热，这一过程称作煅烧。高温会分解出碳和部分氧气，二者结合就形成了二氧化碳。剩下的块状物被称为熟料，由氧化钙和二氧化硅的分子复合物构成，统称为硅酸钙。熟料冷却后磨成水泥。水泥生产中的碳排放有一多半都是煅烧的结果，其余大部分来自燃烧煤炭和其他化石燃料为煅烧提供热能

（见图表）。合计下来，每生产一吨新鲜水泥，就会释放近一吨二氧化碳。

伦敦帝国理工学院的保罗·芬奈儿（Paul Fennell）及其同事今年早些时候在期刊《焦耳》（Joule）上发布了一项研究。他们认为，由于煅烧过程必然会产生二氧化碳，所以在它进入大气之前将其捕获并储存起来是水泥行业脱碳最有效的方法。捕获的二氧化碳可以封存在地下，或者用于其他行业，比如生产合成燃料。但或许也可以在混凝土与水混合进行固化的环节把二氧化碳回注到混凝土中。水会促进化学反应，令水泥硬化。二氧化碳也有类似的作用，在这个过程中，它会以碳酸钙的形式被锁在水泥里。

事实上，比起只用水，用这种方式逆转煅烧会让混凝土更加坚固。因此这不仅处理掉了部分原始排放，建筑工程中所需的水泥用量也会减少，这就进一步降低了排放总量。咨询公司麦肯锡估计，目前逆转煅烧最多可以封存5%的水泥碳排放，而随着技术进一步改进，可能会增加到30%。

有几家公司正在沿着这个方向发展。加拿大公司CarbonCure为全球400多家工厂安装了将二氧化碳注入预拌混凝土的设备。它的系统也已用在建筑项目中，包括在线零售公司亚马逊位于弗吉尼亚州阿灵顿（Arlington）的第二总部大楼（亚马逊也是CarbonCure的股东）和通用汽车位于田纳西州斯普林希尔（Spring Hill）的电动汽车装配厂。

目前CarbonCure使用的是由工业气体公司捕获的二氧化碳。但一些公司正在开发直接从水泥窑收集二氧化碳的设备。位于澳大利亚悉尼的Calix公司正在开发一种电力驱动的系统，在窑外间接加热石灰石，而不是在窑内加热。这样可以直接捕获纯二氧化碳，而无需处理窑内燃料燃烧产生的混合气体。因此，如果它用的电力本身来自绿色能源，那这样生产出来的水泥就完全是绿色的。

使用这项技术的一个试点项目已经在顺利推进。作为欧盟一个研究项目的组成部分，它由全球最大水泥制造商之一的德国海德堡水泥公司（Heidelberg Cement）在它位于比利时的水泥厂运行。一个更大的示范

工厂定于2023年在汉诺威（Hanover）投用，帮助扩大应用这种技术。

还有一种方案不那么环保，但仍好过使用化石燃料，那就是用城市生活和工业垃圾代替部分在水泥窑中燃烧的煤。有几家公司已经这样做过了。例如，墨西哥建筑材料巨头西麦斯（Cemex）用已提取过可回收物的生活垃圾生产出一种名为Climafuel的窑炉燃料。这种燃料以植物材料（“生物质”）的形式富含了不久前还在大气中的碳，只是在燃烧中又把它排放了回去，而不像化石燃料那样从地下挖出来。Cemex在英国的部分水泥厂已有多达60%的煤炭被Climafuel替代。

企业也在想办法用其他材料替代混凝土中的部分水泥。许多公司添加了燃煤发电厂的副产品粉煤灰或经粉碎的炼铁高炉熔渣。但从长远来看，这两种方法都不可持续。煤炭使用量正在减少，钢铁生产也要转向更新、更清洁的技术，彼得·哈罗普（Peter Harrop）说。他是英国剑桥的分析公司IDTechEx的老板，与人合著了一份关于混凝土和水泥的未来的新报告。

在哈罗普看来，解决问题的一大重点是让混凝土“技术升级”，从而减少建设项目的混凝土用量。这就意味着要添加诸如合成纤维和天然纤维之类的东西，甚至是石墨烯，这种由单层碳原子组成的物质比钢更强固。少量使用即可产生良好效果。

石墨烯和其他增强材料的加入将带来新的超高性能混凝土，哈罗普认为它将特别适合用3D打印制造出来。这将在机器人的控制下精确地逐层铺设材料，会极大减少浪费。“大幅减少水泥用量是解决方案中非常重要的一环。”他补充道，尤其是在未来20年水泥产量原本看来势必要翻番的情况下。

添加剂也可以延长混凝土的使用寿命并减少维护需要。在密歇根大学，李志辉和他的同事用合成纤维和天然纤维再加上注入二氧化碳，生产出一种可弯曲混凝土，他们称之为高延性纤维增强水泥基复合材料（ECC）。这种材料的内部结构的灵感来自珍珠层，这是一种通常被称为“珍珠母”的柔性材料，是鲍鱼和牡蛎等软体动物外壳的内层物质。

增加混凝土的柔性可以让桥梁和道路更轻松地承受繁忙交通的压力，并提升高层建筑的抗震能力。ECC在老化时只会产生微小的表面裂纹。李志辉说，因此它更能够阻止水分渗入和防止内部钢筋腐蚀。这种腐蚀可能导致钢筋混凝土结构在建成后的几年内崩裂，有时导致它们坍塌。

在运用替代材料方面或许还可以更进一步。新泽西州的Solidia公司生产的硅酸盐水泥的二氧化硅与氧化钙之比高于标准的“波特兰”水泥。这有两个结果。一是Solidia的工艺所需的热能少于传统煅烧（因此也需要更少的化石燃料），所以它释放的二氧化碳本身就更少。另外，在混合形成混凝土时，Solidia这种富含二氧化硅的硅酸盐水泥可以比普通水泥更快地固化，因为它使用的是捕获的二氧化碳，而不是水。Solidia正在与其投资者之一瑞士建筑材料巨头拉法基豪瑞（LafargeHolcim）合作研究这款水泥的应用。

考虑到所有这些发展，混凝土能变得多环保？芬奈儿说，通过提升能源效率和改进材料，将混凝土行业的二氧化碳排放量减少到目前每吨排放水平的80%左右应该还算容易实现。但如果混凝土企业转用主要或完全由木材等生物质提供热能的窑炉，它们有可能最大限度地实现减排。生物质燃料中的碳原本就是不久前还在空气中的二氧化碳。在窑中燃烧变回二氧化碳后，如果将这部分碳储存起来而不释放到空气中，那么随着新长成的树木不断取代消耗掉的树木，大气中的碳将出现净减少。

这类系统被称为生物能源与碳捕获和储存（BECCS），是气候建模者所设想的实现净零或净负排放目标所需“负排放”的方式之一。人们经常会谈到BECCS发电，但BECCS实际上可能更适合水泥生产，因为在一个注重减碳的世界里，将已经可以部署二氧化碳捕获设备来处理煅烧排放。果真如此，全球变暖的罪人之一或许可以通过帮助减轻对地球已造成的损害来自我救赎，并因此和罗马人一样留下令人印象深刻的遗产。■



Unimals

A novel way to optimise robots

It harks back to a 19th-century idea about evolution

IT MIGHT SOUND obvious that if you want to improve a robot's software, you should improve its software. Agrim Gupta of Stanford University, however, begs to differ. He thinks you can also improve a robot's software by improving its hardware—that is, by letting the hardware adapt itself to the software's capabilities.

As they describe in *Nature Communications*, he and his colleagues have devised a way of testing this idea. In doing so, they have brought to robotics the principles of evolution by natural selection. They have also cast the spotlight on an evolutionary idea that dates from the 1890s, but which has hitherto proved hard to demonstrate.

There is a wrinkle. The team's robots, which they dub “unimals”, are not things of metal and plastic. Rather, they are software entities that interact with a virtual environment in the way that metal-and-plastic devices might interact with a real one. Unimals are pretty simple, having spheres for heads and cylinders for limbs (see picture). The environments through which they roamed were also simple, and came in three varieties: flat arenas, arenas filled with hills, steps and rubble, and ones that had the complexities of the second sort, but with added props like cubes that needed to be moved around.

To begin with, the unimals were given a variety of randomly assigned shapes, but with identical software running each of them. That software was a piece of artificial intelligence called a deep evolutionary reinforcement learning algorithm, or DERL.

Newly created unimals started in a virtual boot camp, in which the DERL learned enough about the world to face the challenges to come. They were then entered into tournaments. In groups of four, Dr Gupta put them through tests of agility, stability and ability to manipulate objects. Each group's winner was allowed to "breed" by spawning a daughter with one mutation (an extra limb for stability, perhaps, or extra rotation in a joint, for flexibility). This daughter was substituted for the oldest unimal in the pool, assigned to a new group of four, and the process repeated.

Unimals were withdrawn from the fray after ten generations of evolution, and Dr Gupta reckons about 4,000 varieties of them underwent training. The team were surprised by the diversity of shapes that evolved. Some had arms as well as legs. Others had only legs. There were bipeds, tripeds and quadrupeds. Some moved like lizards. Others resembled an octopus walking on land. Crucially, though, the researchers found that the most successful unimals learned tasks in half the time that their oldest ancestors had taken, and that those which evolved in the toughest arenas were the most successful of all.

In this evolution of unimals' morphology to promote the ability to learn, Dr Gupta sees a version of something called the Baldwin effect. In 1896 James Baldwin, an American psychologist, argued that minds evolve to make optimal use of the morphologies of the bodies they find themselves in. What Dr Gupta has shown, though in software rather than in the real, biological world, is that the obverse can also be true—changes in body morphology can optimise the way minds (or, at least, DERLs) work. Even though he held the software constant from generation to generation, it became more efficient at learning as the unimals' bodies evolved.

Whether that discovery can be turned to account in the way robots are developed remains to be seen. But it is certainly, in the jargon beloved of some businessfolk, an out-of-the-box idea. ■



通用动物

一种优化机器人的新奇方法

它让人联想到19世纪一个关于进化的观点

如果想改进机器人的软件，那就应该改进它的软件。这听起来好像是明摆着的事，但斯坦福大学的阿格里姆·古普塔（Agrim Gupta）却有不同意见。他认为还可以通过改进硬件来改进机器人的软件。这种对硬件的改进是让硬件去自适应软件的功能。

据他和同事在《自然-通讯》（Nature Communications）中的描述，他们设计出了一种方法来测试这一想法。在此过程中，他们把通过自然选择来实现进化的原理引入了机器人科学领域。一个有关进化的观点也因他们而受到关注，这个观点可以追溯到19世纪90年代，但直到今天都还很难被证明。

他们用了一个新招。这支团队的机器人——取名“unimal”（通用动物）——不是用金属和塑料制成的，而是软件实体，可以与虚拟环境交互，就像用金属和塑料制成的设备可以与真实环境交互一样。unimal的模样非常简单，头是球体，胳膊或腿是圆柱体（见图）。它们漫游其中的环境也很简单，分为三种竞技场：第一种很平坦，第二种布满小山丘、台阶和瓦砾；第三种和第二种一样复杂，但还增加了像立方体这样需要被移动的道具。

首先，这些unimal被随机分配了各种形状，但都由完全相同的软件运行。这种软件是人工智能的一种，名叫深度进化强化学习算法，或称DERL。

新造的unimal从一个虚拟训练营起步，在那里，DERL对所处世界有了足够的了解，准备好面对接下来的挑战。随后这些unimal被安排参加锦标赛。古普塔让它们四个一组，测试它们的敏捷性、稳定性和操纵物体的能力。每组的获胜者可以“繁殖”，产生一个带有一个突变的后代（这个突变也许是多长出一条肢体来保持稳定，或者是增加关节的旋转度来提升灵活

性）。这个后代会替换掉池子里最老的unimal，被分配到一个新的四人组，重复上述过程。

经过十代进化后，团队让unimal们结束了竞赛，古普塔估计大约有4000多种形态接受了训练。它们进化出的形状之多令团队惊讶。有些有胳膊也有腿，其他的就只有腿。有的是两条腿，有的三条，有的四条。有的像蜥蜴一样移动。还有一些仿佛是在陆地上行走的章鱼。但最重要的是，研究人员发现，那些最成功的unimal学习掌握任务所花的时间是它们最老的先辈的一半，而在难度最大的竞技场中进化的个体是最成功的。

在unimal改变形态以提高学习能力的进化过程中，古普塔观察到了某种“鲍德温效应”。1896年，美国心理学家詹姆斯·鲍德温（James Baldwin）提出，心智会进化，以最好地利用所寓居身体的形态。古普塔的实验表明（尽管是在软件世界而非真实的生物世界），这话反过来说也可能是成立的——身体形态的变化可以优化大脑（或者至少是DERL）的工作方式。尽管他给一代又一代的unimal用的都是相同的软件，但随着它们身体的进化，这套软件在学习方面变得愈发高效。

这一发现能否被善加利用到机器人研发中还有待观察。但是，用一些商界人士经常挂在嘴边的行话来说，这无疑是一个“跳出框架”的创意。■



Placing perches in the sky

Private space stations will soon be in orbit

And with them, industry

ON OCTOBER 21ST a consortium led by Lockheed Martin, one of America's biggest aerospace companies, announced plans to build a permanently crewed commercial space station called Starlab, and launch it into orbit around Earth by 2027. Not to be outdone, on the 25th, Blue Origin, a firm that is Jeff Bezos's ticket into space, unveiled plans for a yet more ambitious effort. Orbital Reef, pictured above as an artist's impression, is a joint venture with (among others) Lockheed's competitor Boeing. It will host up to ten people and will serve, as Blue Origin put it, as a "mixed-use business park". The hope is that this orbiting industrial estate will open by the end of the decade.

Private-enterprise missions to orbit are not new. Mr Bezos's rival Elon Musk, for example, has been offering them, via his rocketry firm SpaceX, for several years. But these two projects, if they succeed, will be on a far grander scale. Eye-catching though they are, however, they are not alone. Several other firms, egged on in some cases by NASA, that country's space agency, have similar ideas. The firms' owners hope to make money. NASA hopes to save America's amour propre. And, acting together, these motives seem likely, some time this decade, to result in the first real settlement of outer space by private enterprise.

The underlying reason for all this activity is the imminent death of the International Space Station (ISS). This intergovernmental but American-dominated effort, the first elements of which were launched in 1998, was designed to last about 15 years, so is already past its sell-by date. Cracks and air leaks have multiplied. And, on September 9th, the smell of smouldering

plastic wafted through it, though no open flames broke out.

NASA believes that, with upgrades, the ISS can limp on until 2028, or perhaps a bit longer. But either way, it will not be long until thrusters on the most expensive object ever made push the whole caboodle to fiery doom over the Pacific Ocean. No other intergovernmental habitat will supersede it. But NASA is encouraging commercial replacements instead.

The agency's plan is to pay the firms behind these replacements for services rendered, such as hosting astronauts or conducting research in the microgravity that the perpetual freefall of orbit offers. That, says Phil McAlister, a senior space-flight official at the agency, may save NASA as much as \$1.5bn a year. But Mr McAlister also claims that commercial opportunities in orbit are now so abundant that industry should be able to support much of the cost of private space stations, even without government contracts.

NASA calls its side of this enterprise the Commercial Low-Earth-Orbit Destinations (CLD) project. Last year it awarded \$140m to Axiom Space, a firm in Houston that is already manufacturing such a station. It will soon hand out a further \$400m to two, three or possibly four of a dozen other firms which hope to enter the market. Officials at the agency are privately thrilled with the unexpectedly high number of bids they have received for a share of this money. But they are not commenting publicly about the competition until the winners are announced later this year.

Of Axiom's project, the first module will, if all goes to plan, be launched in September 2024 and will dock at one of the ISS's two ports. It will be joined, six and 12 months later, by a second and a third module. After a fourth and final module, equipped to generate extra solar power, arrives in 2027, Axiom Station, as the whole assembly will be known, will detach and become a "free flyer" with nearly double the usable volume of the ISS.

The cost of doing all this will be about \$3bn, says Matt Ondler, Axiom's top technologist. Though no trifle, that is but a small fraction of what the ISS has cost. Every year, NASA spends roughly \$3.5bn merely to maintain and operate the station. And that covers only about three-quarters of the cost of doing so. The rest is provided by Canada, Japan, Russia and participating European countries.

Axiom's lower budget is partly explained by elimination of the waste common in government spending. But the firm is also harnessing lessons from the ISS to cut costs for things that range from blocking radiation, via recycling urine to recovering water from rubbish. Beyond that, much kit is cheaper and better now than when the ISS was designed in the 1990s. Today's solar panels generate, kilo for kilo, six times more power. And lots of the components developed for smartphones and cars will be used in Axiom Station. Mr Ondler reckons it will cost, per unit of capability, about a hundredth of the bill for the ISS.

Axiom's competitors, for their part, have kept quiet about their stations' expected costs, but all the firms envisage a range of ways to make money. Hosting astronauts, tourists and even marketing campaigns will be one source of revenue. Servicing and refuelling satellites could be another. Many people also believe there will be demand for pharmaceutical and biotechnological work in microgravity, including the 3D-printing of human organs for transplantation and the development of stem-cell therapies.

On Earth, gravity means that cells printed onto scaffolds intended to create structures that are the same shape as natural organs have to be suspended in a viscous gel, to stop them dripping off the scaffold. This means high pressure is required to force them through the nozzle of the printer that sprays them onto the scaffold, a process that damages a fair number of those cells. In orbit, though, nothing drips, so the gel is no longer needed. Cell cultures, meanwhile, benefit from microgravity because their components

remain in suspension in their nutrient fluids, rather than tending to settle out, as happens in Earthbound fermentation tanks.

The firms also plan to host microgravity manufacturing. Axiom, for example, says one of its potential customers thinks it can produce better eyesight-restoring retinal implants in space than on Earth. Other firms with which it is in talks hope to harness freefall to make purer fibre optics for lasers and, more challengingly, to forge stronger alloys for things like jet turbines.

At first blush, all this sounds a bit like sci-fi. But the technology to achieve it exists. For one thing, robots operating in freefall can achieve extraordinary precision. As Christian Maender, head of “in-space” manufacturing at Axiom, puts it, “they need not fight the weight of their own systems”. Launch costs have fallen sharply too, especially since NASA gave privatisation a shot in the arm by ending its staggeringly expensive Space Shuttle programme in 2011. Mr Maender reckons the next decade will see them halved again. Investors, for their part, are enthused. Axiom says it has had to turn some away.

Part of Blue Origin’s Orbital Reef is to be provided by Sierra Space, a division of an aerospace firm called Sierra Nevada Corporation which already had a separate project to make a space station out of big, inflatable bladders. Once ejected into space from a rocket’s fairing, such a bladder will expand into a habitat 11 metres long and with a diameter of eight metres, somewhat resembling a cylindrical paper lantern.

To stop its modules being punctured by bits of high-velocity orbiting debris and cosmic dust, Sierra has designed shielding that incorporates layers of Kevlar and Vectran—fabrics used in things like bulletproof jackets and the airbags that cushion the fall of spacecraft dropped onto Mars. The outer layers will break up these incoming objects. The smaller, and therefore less

energetic, fragments that result will then be stopped by the underlying layers.

Sierra's modules will be fitted out, by astronaut handymen and women, with a rigid internal structure that incorporates avionics and control interfaces. Crew quarters, galley, toilet and facilities for research, manufacturing and satellite-servicing can be installed as required (see picture below, of a ground-based mock-up). Connected together, three of these modules will provide nearly as much pressurised volume as does the ISS.

The ISS, however, took about 40 launches to assemble. Sierra reckons it can loft and equip three modules with just eight or nine launches. The firm plans to shuttle goods and crew between Earth and its orbital facilities using a spaceplane called Dream Chaser that it is developing. (Orbital Reef is to be supplied by Boeing's Starliner capsule, but Dream Chaser might pitch in for that job, too.) Dream Chaser will be able to land on any long airport runway. That, Sierra hopes, will provide a competitive edge for the manufacture of fragile, urgently needed goods, not to mention providing a comfortable and convenient ride for rich space tourists.

Sierra's plan is for Dream Chaser to make its much-delayed maiden flight next year, and to have its station operating in 2027, so that its "anchor" tenant, NASA, can move in before the ISS's demise. Others, it hopes, will follow. Earlier this year, for example, the firm said it was working with Redwire Space, a company that is also part of the Orbital Reef project, and which has been using the ISS to test processes intended to manufacture speciality ceramics, crystals and fibre optics.

The second phase of NASA's CLD plan is to award, in about 2025, big contracts for specific orbital services. The agency hopes that by the middle

of the decade at least two companies will be far enough along to secure such contracts, and to begin offering services in orbit shortly thereafter. When the time comes to abandon the ISS, the agency is keen not to be left in the lurch with no human-suitable habitat in orbit around Earth. Experts caution, though, that the ageing space station might not make it to 2028. Some Russian officials, noting spreading cracks and other signs of senescence, have proposed that their country jump ship by 2025.

It could, therefore, get dicey. If no American firm is operating a space station by the time the ISS is abandoned, America's leadership in space may suffer. To make matters worse from an American point of view, China's new and expanding space station, Tiangong, could become fully operational next year. Todd Harrison, a space and defence expert at CSIS, an American think-tank, says China's goal of signing up international partners for Tiangong involves "actively courting" America's European allies. Were America to find itself bereft of a space station, Britain, France or Germany might, he reckons, join Tiangong.

That seems a stretch, diplomatically speaking, especially given other collaborations between NASA and Europe's spacefaring powers. But even the raising of such ideas shows that times are changing. Prognosticators would, however, be wise to factor in the ambition and ingenuity of America's aerospace industry. For an inkling of what might be achieved consider Nanoracks, a company based near Houston that is one of Lockheed Martin's Starlab partners. In addition to Starlab, Nanoracks is at work on a completely different type of space station that is both more basic and more technologically challenging. This involves converting, in orbit, discarded rocket stages into stations it calls outposts.

The idea of converting rocket stages harks back to Skylab, America's first space station, which was built, on the ground, out of the third stage of a surplus Saturn V rocket. In this case, though, the conversion will be of the

upper stage of one of SpaceX's Falcon 9s, or a similar rocket, and will be done in space by a small robot affixed to the stage in question.

After the stage achieves orbit, the robot will cut metal and assemble parts to create a docking port, windows and other fixtures. When Jeffrey Manber, Nanoracks' boss, pitched the idea a half decade ago, he says, "my company laughed at me". NASA, however, was intrigued. The agency paid for a study on the feasibility of using a robot to convert the upper stage of an Atlas V. The results were promising.

NASA has therefore coughed up more than \$12m for a test aloft, planned for January. If all goes well, a robot will soften a sample of metal in orbit by generating frictional heat with a spinning tool, and will then cut that metal without, it is hoped, creating scraps that could become projectiles dangerous to other satellites. This has never yet been done in space. A camera will capture the action, which, for extra safety, will take place inside a containment vessel. A welding test will be launched later, says Robbie Harris, Nanoracks' head of technology for outposts.

If Mr Manber's proposal works, building private space stations could become (at least by the standards of space flight) cheap indeed. And the cheaper those stations get, the more uses they may be put to. Orbiting greenhouses intended to develop hardy crops are one idea. Biopharmaceutical laboratories are another. A third, for the truly adventurous, is honeymoon hotels in space. How that will work out in practice remains to be seen. The accommodation will be cramped, for sure, and the champagne may have an unnerving tendency to float out of its glasses. But there is no question that, viewed from out of the porthole at least, the Earth will be moving. ■



高空栖息地

私营空间站将很快进入轨道

跟着上去的是产业【深度】

十月二十一日，由美国最大的航空航天公司之一洛克希德·马丁（Lockheed Martin）牵头的财团宣布计划建造永久性载人商业空间站Starlab，并将在2027年之前将其发射至地球轨道。25日，承载贝索斯太空探索雄心的蓝色起源（Blue Origin）不甘示弱，公布了一项更宏伟的计划。Orbital Reef（见上方效果图）是它与洛克希德的竞争对手波音等公司的合资项目。它最多可容纳10人，按蓝色起源的说法，将充当“多功能商业园区”。该公司希望这个在轨道上运行的产业园区能在这个十年结束前开张。

私营企业执行太空任务并不新鲜。比如贝索斯的对手马斯克的SpaceX火箭公司提供太空运输服务已经有几年了。但这两个项目如果成功，规模可要大得多。尽管十分引人注目，但它们并非绝无仅有。其他几家公司也有类似的项目，有些是受到了美国国家航空航天局（NASA）的推动。这些公司的所有者想要赚钱，NASA则希望保住美国的面子。各方出于不同目的而共同行动，看起来很有可能在2030年前让私营企业首次真正进驻外太空。

这些行动背后的根本原因是国际空间站即将退役。这一美国主导的、政府间合作的空间站的第一个舱段于1998年发射升空，设计寿命约15年，早就已经在超期服役。出现裂缝和漏气的情况越来越多。9月9日，虽然不见明火，空间站里飘荡着一股塑料烧焦的气味。

NASA认为，通过升级，国际空间站还能撑到2028年或者更久一些。但不管怎样，用不了多久，这个有史以来造价最高的设施终将在推进器的推动下脱离轨道，在太平洋上空燃烧解体。没有其他政府间空间站来取代它。但NASA正在鼓励商业性替代方案。

NASA的计划是向提供替代空间站的公司付费购买服务，例如接待宇航员入驻，或者在轨道持续的自由落体状态所提供的微重力环境下开展科研。NASA的高级太空飞行官员菲尔·麦卡利斯特（Phil McAlister）称，这每年也许能为NASA节省多达15亿美元。但他说，轨道上现在商机无限，即使没有政府合同，产业界也应该能够负担得起私营空间站的大部分成本。

NASA方面把这项事业称作商业近地轨道目的地（CLD）项目。去年，它向休斯顿的Axiom Space提供了1.4亿美元资金，这家公司已经在制造这样一个空间站。此外还有十多家公司也想进入这个市场，NASA将很快再向其中两三家甚至四家总共提供4亿美元。竞标分这笔钱的公司数目超出了NASA的预期，官员私下里非常兴奋。但在年底宣布中标公司之前，他们不会对这场竞赛做公开评论。

如果一切按计划进行，Axiom项目的第一模块舱将于2024年9月发射，并将与国际空间站的两个端口之一对接。第二和第三个模块舱将分别于6个月和12个月后发射，与第一个模块舱对接。在配备有太阳能发电装置的第四个也是最后一个模块舱于2027年抵达并对接后，将构成“*Axiom空间站*”并与国际空间站分离，在太空中“自由飞翔”，其有效容积是国际空间站的近两倍。

*Axiom*的首席技术专家马特·奥恩德勒（Matt Ondler）表示，完成所有这些步骤的成本约为30亿美元。虽然数目不小，但也只是国际空间站已经花掉的钱的零头。每年，NASA仅在维护和运营国际空间站上就要花掉约35亿美元。而这还只是全部维护和运营费用的四分之三左右，其余部分由加拿大、日本、俄罗斯和使用空间站的欧洲国家提供。

没有了政府支出中常见的浪费，这是*Axiom*的预算较低的原因之一。但该公司也在利用国际空间站的经验教训来降低各种环节上的成本，比如在屏蔽辐射、循环利用尿液、从垃圾中回收再利用水分等方面。此外，现在很多配套元件都比上世纪九十年代设计国际空间站时更便宜也更好。今天，同等重量的太阳能电池板产生的电力是当年的六倍。*Axiom*空间站还会用到许多为智能手机和汽车开发的部件。奥恩德勒估计，新空间站每单位承

载力的成本约为国际空间站的百分之一。

Axiom的竞争对手对自己空间站的预期成本闭口不谈，但所有公司都设想了各种生财之道。接待宇航员、游客甚至营销活动都将成为收入来源。为卫星提供维护和燃料补给可能是另一个财源。许多人还认为将会有在微重力下开展制药和生物技术研究的需求，包括人体移植器官3D打印和干细胞疗法的研发。

在打印人体器官时，为创造出与自然器官相同的结构需要用到支架。在地球上，因为重力的作用，打印到支架上的细胞会滴落下来。为了避免这个问题，就要让它们悬浮在凝胶中。这就意味着必须用高压把细胞从打印机的喷嘴喷射到支架上，这一过程会损坏相当数量的细胞。而在轨道上不存在滴落的问题，也就不再需要凝胶。与此同时，微重力环境也有利于细胞培养，因为细胞会在营养液中保持悬浮状态，而不会像在地球上那样容易沉淀在发酵罐中。

这些公司还计划提供微重力制造场所。例如，Axiom表示，它的一位潜在客户认为自己可以在太空中生产恢复视力的视网膜植入体，要比在地球上生产的更好。与Axiom洽谈的其他公司希望利用自由落体状态为激光器制造更纯净的光纤，还有更具挑战性的为喷气式涡轮机等设备制造更坚固的合金。

乍看起来，这一切好像有点科幻的色彩。但实现这种科幻景象的技术是存在的。一方面，在自由落体状态中工作的机器人可以达到非凡的精度。正如Axiom的太空制造负责人克里斯蒂安·曼德（Christian Maender）所说，“它们不需要对抗自身系统的重量”。发射成本也已大幅下降，尤其在2011年以后，NASA在那一年结束了它代价惊人的航天飞机计划，为私营航天注入了一剂强心针。曼德估计，未来十年发射成本还会再减半。投资者对此充满热情。Axiom说它不得不婉拒了一些投资意向。

蓝色起源的Orbital Reef有一部分将由航天公司Sierra Nevada Corporation的Sierra Space部门提供，该公司另有一个用大型充气式气囊做空间站的项

目。一旦从火箭的整流罩中射入太空，这样的气囊将膨胀成11米长、截面直径8米的太空舱，状如一个圆柱形纸灯笼。

为了防止这样的太空舱被轨道上高速飞行的碎片和宇宙尘埃刺破，Sierra设计了防护罩，内含凯夫拉（Kevlar）和Vectran纤维层，这些材料也被用于制作防弹衣和航天器着陆火星时使用的缓冲气囊。物体撞上防护罩外层会破碎，防护罩内层可阻止由此产生的体积较小、因而动能也较小的碎片进入太空舱。

宇航员会在Sierra的太空舱装配一个十分坚固的内部结构，配有航空电子设备和控制接口。他们可以根据需要安装休息区、厨房、厕所，以及用于科研、制造和维护卫星的设施（见下图的地面模型）。三个太空舱连接在一起，将提供几乎与国际空间站一样多的加压空间。

不过，建造整个国际空间站共进行了约40次发射。Sierra认为只要八九次发射就可以让它的三个太空舱升空并组装完毕。该公司计划用自己正在研发的“追梦者”（Dream Chaser）航天飞机在地球与轨道设施之间运送货物和人员。（Orbital Reef将由波音公司的飞船Starliner负责运输补给，但追梦者可能也会参与其中。）它将能够降落在任何长距离的机场跑道上。Sierra希望这会让自己在生产易碎又急用的产品方面带来竞争优势，更不用说还能为富有的太空游客提供舒适便捷的乘坐体验了。

Sierra的计划是让“追梦者”于明年启动拖延已久的处女航，让它的空间站在2027年投入运营，这样它的“驻场”租户NASA就可以在国际空间站报废前入驻。它希望其他租户也会随之而来。例如，今年早些时候，Sierra表示正在与同样参与了Orbital Reef项目的Redwire Space合作，该公司一直在使用国际空间站来测试用于制造特种陶瓷、晶体和光纤的工艺。

NASA的CLD计划的第二阶段是在2025年左右就某些轨道服务给出大合同。NASA希望在那之前，至少有两家公司的项目能已经进展到可以获得这种大合同的程度，并在此后不久开始在轨道上提供服务。等到必须弃用国际空间站时，NASA希望不会因为在近地轨道上没有人类的落脚点而陷

入被动。不过，专家警告说，老化的国际空间站可能无法撑到2028年。一些俄罗斯官员注意到了裂缝蔓延和其他老化迹象，建议自己国家在2025年之前退出国际空间站项目。

因此，这其中是有风险的。如果到国际空间站废弃之时没有美国公司在运营空间站，美国在太空的领导地位可能会受到影响。从美国人的角度来看，更糟糕的是中国新建的、不断扩大的空间站天宫可能将在明年全面建成。美国智库战略与国际研究中心（CSIS）的太空和国防专家陶德·哈里森（Todd Harrison）表示，中国天宫空间站签约国际合作伙伴的目标包括“积极拉拢”美国的欧洲盟友。他认为，如果美国没了空间站，英国、法国或德国有可能加入天宫。

从外交上来说这似乎不太可能，尤其是考虑到NASA与欧洲航天大国之间还有其他合作。但有人会提出这样的看法，就表明时代在变化。然而，明智的预言者应该考虑到美国航空航天业的雄心和创造力。对于可能实现的成就，看看休斯顿附近的Nanoracks公司就能窥见一斑，它是洛克希德·马丁Starlab项目的合作伙伴之一。除了Starlab之外，Nanoracks还在开发一种完全不同的空间站，它更基础，在技术上也更具挑战性。这个项目要在轨道上把被丢弃的火箭级改造成它称之为“前哨”的空间站。

改造火箭级的想法可以追溯到美国第一个空间站天空实验室（Skylab），这个在地面上建成的空间站就是由一枚空余的土星5号火箭的第三级改造而成。不过，Nanoracks项目要改造的将是SpaceX的猎鹰九号（Falcon 9）或类似火箭的上面级，并且将由安装在这一级上的小型机器人在太空中完成。

火箭的上面级入轨后，机器人将切割金属并组装部件来制作对接端口、舷窗和其他固定装置。Nanoracks的老板杰弗里·曼伯（Jeffrey Manber）说，五年前他提出这个想法时，“我公司的人都笑话我”。然而，NASA却很感兴趣，资助了一笔钱来研究用机器人改造一架阿特拉斯5型火箭（Atlas V）上面级的可行性。结果令人鼓舞。

因此，NASA已经为计划在明年1月在太空进行的一项测试挤出了1200多万美元。如果一切顺利，一台机器人将在轨道上使用旋压刀具产生摩擦热来软化金属样品，之后再切割，希望这样不会产生可能威胁其他卫星的碎片。这样的实验从未在太空中做过。摄像机将捕捉实验过程，实验将在安全壳内进行，以提高安全性。之后将启动焊接测试，Nanoracks的前哨技术负责人罗比·哈里斯（Robbie Harris）表示。

如果曼伯的主意最终行得通，建造私营空间站可能会变得（至少按太空飞行的标准看）很便宜。空间站越便宜，能派上的用场可能就越多。比如开发耐寒作物的轨道温室。又比如生物制药实验室。对于真正喜欢冒险的人来说，第三种用途就是太空中的蜜月酒店。它具体要怎么实现还需拭目以待。这种酒店肯定会很局促，而且香槟可能随时从杯子里飘出来，让人紧张兮兮。但毫无疑问，至少向舷窗外望去，将能看到地球在动。■



Passing the buck

Pricing power is highly prized on Wall Street

At the moment there is a glut

MCDONALD'S HAS employed a "barbell" pricing strategy for decades, luring customers with low-cost items in the hope that they will then splurge on pricier fare. This balancing act is now at risk. On October 27th the fast-food giant said that, due to rising costs, prices at its American restaurants will increase by 6% this year compared with 2020. The burger chain says labour expenses have risen by 10% at its franchised restaurants and 15% at its company-owned locations. Add the rising cost of ingredients and the result is higher prices for burgers and fries. For now, it seems, customers can stomach it. Chris Kempczinski, McDonald's boss, said the increase "has been pretty well received". After digesting the news, investors have sent shares in the fast-food firm up by 6%.

A growing number of companies are raising prices as costs for labour and raw materials rise, often with no ill effects. This summer PepsiCo, an American food giant, lifted prices for its fizzy drinks and snacks to offset higher commodity and transport costs; it plans further increases early next year. Ramon Laguarta, the firm's boss, suggested in an earnings call in October that customers do not seem bothered. "Across the world consumers seem to be looking at pricing a little bit differently than before," he said. In September Procter & Gamble, a multinational consumer-goods giant, raised prices for many of its products. The effect on demand was minimal. "We have not seen any material reaction from consumers," Andre Schulten, the firm's chief financial officer (CFO), told analysts last month.

"Pricing power", the ability to pass costs to customers without harming sales, has long been prized by investors. Warren Buffett has described it

as “the single most important decision in evaluating a business”. It is easy to see why. When hit with an unexpected expense, firms without pricing power are forced to cut costs, boost productivity or simply absorb the costs through lower profit margins. Those with pricing power can push costs onto customers, keeping margins steady.

Today, firms are eager to flaunt their price-setting clout. “We can reprice our product every second of every day,” Christopher Nassetta, boss of Hilton Worldwide, a hotel operator, told investors last month. “We believe we’ve got pricing power really better than almost anybody if not everybody in the industry,” boasted John Hartung, CFO of Chipotle, a restaurant chain, in October. Companies such as Starbucks, Levi Strauss and GlaxoSmithKline make similar claims. “We are a luxury company, so we do have pricing power,” bragged Tracey Travis, CFO of Estée Lauder, a cosmetics firm, on November 2nd.

They are not alone. Of the S&P 500 companies that have reported third-quarter results, over three-quarters beat projections, according to Bank of America Merrill Lynch. “This earnings season there was a lot of angst on the part of investors that higher input costs would erode margins,” says Patrick Palfrey of Credit Suisse, a bank. “In fact, what we have seen is another spectacular quarter on behalf of corporations so far in spite of input cost pressures.” According to Savita Subramanian and Ohsung Kwon of Bank of America mentions of “price” or “pricing” in American earnings calls—a proxy measure for pricing power—increased by 79% in the third quarter from a year earlier. In the second quarter, such mentions were up by 52% year on year.

If costs spiral out of control, the power to raise prices will become ever more important. On November 2nd JPMorgan Chase’s global purchasing-managers index, a measure of manufacturing activity, showed that input prices in the sector increased in October at the highest rate in more than

13 years. But the prices of manufactured goods and services also rose at the fastest pace since records began in 2009. A gap between input and output price inflation is typically interpreted as a sign that firms are struggling to raise prices and that margins are being squeezed. That isn't happening yet.

Identifying firms with pricing power is crucial for investors. Analysts tend to look for three things. The first is a big mark-up—the difference between the price of a good and its marginal cost—which only firms with market power can get away with. Big and steady profit margins are another sign of pricing power. “If you are a firm that is dominant in your market, you are much more resilient to shocks,” explains Jan Eeckhout, an economist and the author of “The Profit Paradox”, a book published earlier this year.

Size is another factor. All else equal, bigger companies with greater market share have more pricing power than smaller ones. A recent survey of American CFOs conducted by Duke University and the Federal Reserve Banks of Richmond and Atlanta found that 85% of large firms reported passing on cost increases to customers, compared with 72% of small firms.

A “pricing-power score” for companies in the S&P 1500 compiled by UBS is based on four indicators: mark-up, market share, and the volatility and skew of profit margins. The bank found that firms providing consumer staples, communication services and IT have the most pricing power and that energy, financial and materials companies have the least (see chart 1). When UBS compared the financial performance of companies with strong and weak pricing power, they found that the former have delivered more profit growth since 2010 and generated better stock returns, particularly during periods of high inflation (see chart 2).

Firms that score well on this index have lagged in the past year, notes UBS. This may be explained by cyclical factors. When profit margins are

expanding, the argument goes, firms with pricing power tend to generate relatively low returns; when margins are shrinking, they produce high returns. At the moment, profits are still healthy.

For now, demand is robust and consumers seem relatively insensitive to price changes. But companies are planning more price increases. A survey by America's National Federation of Independent Business, a trade group, found that the margin of small-business owners planning to raise prices in the next three months over those planning to lower them grew to 46%, the biggest gap since October 1979. This is a concern for some central bankers such as James Bullard, president of the Federal Reserve Bank of St Louis. In October he noted that for years companies have worried that if they raised prices, they would lose market share. "That may be breaking down," he says.





传导价格

定价权在华尔街备受追捧

有定价权的公司现在真不少

几十年来，麦当劳一直采用“杠铃式”定价策略，先以低价单品吸引顾客，希望他们最终会点一堆更贵的。这种平衡术现在有点行不通了。10月27日，这家快餐巨头表示，由于成本上升，今年它在美国的餐厅将比2020年涨价6%。这家汉堡连锁店说，它加盟店的人工成本已经上升了10%，直营店上升了15%。再加上食材成本上涨，汉堡和薯条的价格也就水涨船高。到目前为止，消费者似乎还消化得了。麦当劳老板克里斯·坎普钦斯基（Chris Kempczinski）表示，涨价的“接受度相当不错”。听闻这一消息后，投资者纷纷追捧麦当劳，让它的股价上涨了6%。

随着人工和原材料成本上升，越来越多的公司都在提价，而且往往并没有产生不良后果。今年夏天，美国食品巨头百事提高了其碳酸饮料和零食的价格，以抵消大宗商品和运输成本的上涨；该公司计划明年初进一步提价。公司老板拉蒙·拉瓜尔塔（Ramon Laguarta）在10月的一次财报电话会议上表示，客户似乎并不介意。“全球各地的消费者对定价的看法似乎和以前有一点点不同。”他说。9月，跨国消费品巨头宝洁提高了旗下许多产品的价格。这给需求带来的影响微不足道。“我们并没看到消费者有实质性反应。”该公司首席财务官安德烈·舒尔滕（Andre Schulten）上月对分析师表示。

“定价权”——在不影响销售的情况下将成本转嫁给消费者的能力——长期受到投资者推崇。巴菲特曾将它形容为“评估一家企业时唯一最重要的判断”。其中的道理很简单。当支出意外上涨时，没有定价权的公司只能削减成本、提高生产率，或者干脆牺牲利润率来消化成本。而掌握定价权的公司可以将成本传导给客户，维持利润率稳定。

这阵子，企业都急着吹嘘自己的定价能力。“我们每分每秒都能改价格。”

酒店运营商希尔顿酒店集团（Hilton Worldwide）的老板克里斯托弗·纳塞塔（Christopher Nassetta）上个月对投资者表示。“我们相信自己的定价权在业内数一数二。”连锁餐厅Chipotle的首席财务官约翰·哈同（John Hartung）在10月夸口道。星巴克、李维斯和葛兰素史克等公司也都有类似的表达。11月2日，化妆品公司雅诗兰黛的首席财务官特雷西·特拉维斯（Tracey Travis）吹嘘道：“我们是奢侈品公司，所以我们的的确拥有定价权。”

它们并非特例。美银美林的数据显示，在已经公布第三季财报的标普500成分股公司中，超过四分之三业绩超过预期。“这个财报季，投资者普遍担心成本上升会侵蚀利润率，”瑞信银行的帕特里克·帕尔弗雷（Patrick Palfrey）说，“但事实上，尽管存在原材料成本压力，从公司层面看本季度依旧辉煌。”据美国银行的萨维塔·苏布兰马尼安（Savita Subramanian）和权五成（Ohsung Kwon，音译）称，美国公司在三季度财报电话中提到“价格”或“定价”的次数（可作为衡量定价权的指标）比去年同期增加了79%。在第二季度，提及次数同比增加了52%。

如果成本上涨失控，提价的能力就变得更重要了。11月2日，摩根大通的全球采购经理指数（衡量制造业活动的指标）显示，10月制造业投入品价格大幅上涨，增幅创13年来新高。但制成品和服务的价格也在上涨，达到2009年有记录以来的最快增速。制成品价格涨幅落后于投入品涨幅的现象通常被解读为企业难以提价、利润率遭挤压的信号。但这种情况目前尚未发生。

识别掌握定价权的公司对投资者来说至关重要。分析师一般关注三个方面。首先是大幅的成本加成——即商品价格与其边际成本之间的差额，只有拥有市场支配力的公司才能做到这一点。不俗而稳定的利润率是定价权的另一个标志。“如果一家公司在市场上占据主导地位，它抵御冲击的能力就会强很多。”今年早些时候出版的《利润悖论》（The Profit Paradox）一书的作者、经济学家简·埃克霍特（Jan Eeckhout）解释道。

规模是另一个因素。在其他条件相同的情况下，市场份额更高的大公司比

小公司拥有更大的定价权。杜克大学、里士满联储和亚特兰大联储最近对美国首席财务官的一项调查发现，85%的大公司表示将增加的成本转嫁给了客户，相比之下小公司的这一比例为72%。

瑞银给标普1500成分股公司编制了一个“定价权得分”，它基于四个指标：成本加成、市场份额、利润率波动性和利润率偏度。瑞银发现，提供必需消费品、通信服务和信息技术的公司定价能力最强，能源、金融和基础材料公司的定价能力最弱（见图表1）。通过比较，瑞银发现自2010年以来，定价能力更强的公司实现了更高的利润增长，股票回报也更高，在高通胀时期尤其明显（见图表2）。

瑞银指出，在过去一年里，该指数的高得分公司股价表现落后。这或许可以用周期性因素来解释。其逻辑是，在企业利润扩张时期，拥有定价权的公司往往回报相对较低；但当利润缩水，它们产生高回报。目前，企业利润仍然丰厚。

当前市场需求强劲，消费者似乎对调价相对不太敏感。但企业正在计划进一步提价。行业组织美国独立企业联合会（National Federation of Independent Business）的一项调查显示，计划在未来三个月提价的小企业主比计划降价的多46%，这是1979年10月以来的最大差距。这让一些美联储官员不安，比如圣路易斯联储主席詹姆斯·布拉德（James Bullard）。他在10月指出，多年来企业一直担心涨价会导致自己失去市场份额。“这种担忧可能正在消散。”他说。 ■



Free exchange

Do “greedy jobs” cause the gender pay gap?

Mothers' careers suffer when parents maximise their combined income, says a new book

RADICAL AND liberal feminists, as defined by philosophers, differ on the extent to which women's freely made choices matter. A liberal feminist desires maximum autonomy for women, demanding equal rights and an end to sex discrimination. A radical feminist sees in society patriarchal forces that are bigger than any one person, and which oppress women in part by influencing their choices. Economic differences between the sexes—such as the gender pay gap—are always a sign of injustice.

A new book by Claudia Goldin of Harvard University, an expert on women and work, is a study both of American women's choices and of the context in which they are made. “Career and Family: Women's Century-Long Journey Toward Equity” traces the history of work and family for college-educated women, and diagnoses what still troubles their careers today.

A caricature of history might involve a journey from home to the workplace. In fact, the first generation Ms Goldin studies, born in 1878-97, contained plenty of working women. But a successful career typically required forgoing children and sometimes marriage. Among those listed in “Notable American Women”, a collection of biographies, no more than three in ten had a child, she writes. The choice women faced was “family or career”.

By the third generation, those born between 1924 and 1943, college-educated women had a more uniform life experience: “family then job”. The typical woman worked after graduation, but soon married, had children and dropped out of the workforce. She returned once her children were in school, and the gradual removal of formal discriminatory barriers opened

up opportunities for her. But her prolonged absence from work meant she did not have the skills and experience necessary to thrive in the workplace.

It is only by the fifth group, born after 1958, that many women aspired to achieve “career and family”. The shift was aided by the contraceptive pill, which helped women delay marriage; improved fertility treatments, which helped them delay child-bearing; and more liberal social norms. Yet, despite the staggering extent of the change Ms Goldin documents, a clear gender gap still exists for these women, most notably with respect to pay. American women earn on average 20% less per hour worked. For college graduates, the gap is larger, at 26%.

It is at this point that the book becomes provocative. Drawing on reams of research Ms Goldin argues that most women no longer suffer much labour-market discrimination in the sense of unequal pay for equal performance, as is often claimed by the left. Nor is the gender pay gap driven primarily by women’s choice of occupation, an explanation sometimes favoured by the right. Even if the distribution of women’s occupations matched that of men—“if women were the doctors and men were the nurses”—she calculates that at most a third of the pay gap would disappear.

The most important cause is that women curtail their careers as a part of a rational household response to labour markets, which generously reward anyone, male or female, who is willing to hold down what Ms Goldin calls a “greedy job”. These are roles, such as those in law, accountancy and finance, that demand long and unpredictable hours. Parents need somebody to be on-call at home in case a child falls ill and needs picking up from school, or needs cheering on at a concert or football match. That is incompatible with a greedy job, which requires being available for last-minute demands from a client or boss. No one person can do both. The rational response is for one parent to specialise in lucrative greedy work, and for the other—typically the mother—to prioritise the children. Ms Goldin writes that “couple equity

has been, and will continue to be, jettisoned for increased family income.”

A gender pay gap resulting primarily from the choices of households is a thorny problem for liberals who prize freedom of choice. It is also tricky territory for economists, who often emphasise the “revealed preference” of those they study, and the resulting efficiency of market outcomes. True to her membership of the Chicago school of conservative-leaning economists, Ms Goldin does not offer the confident prescriptions for the expansion of government that could have easily followed her compelling diagnosis of the problem. Some parts of her book suggest she supports more subsidies for child care, like those proposed by President Joe Biden. But speaking to *The Economist* she was more circumspect, pointing out that among Mr Biden’s proposals she would prioritise cash transfers to parents (a policy that makes no attempt to change households’ choices). The book is about “what happened and why”, she says, rather than solutions.

Another theme of the book, however, is just how much progress for women is a result of technological change and innovation. Could similar forces disrupt greediness? For some jobs it is hard to see how; little can stop the self-employed pouring hours into their businesses, say. But firms have an incentive to make jobs less greedy, because hiring and promoting mothers means drawing from a bigger pool of talent. Ms Goldin points to pharmacy as an example of an industry that has made the transition. Many pharmacists used to be self-employed, with customers expecting personal service. But computers and consolidation have led to pharmacists becoming more substitutable for each other, making the job less greedy without a loss of status or pay. Perhaps remote work or artificial intelligence will do the same for other professions.

Like a radical, Ms Goldin has identified a structural feature of the economy: “It isn’t you, it’s the system,” she reassures the reader. But she has the liberal’s hesitancy about disrupting a system that is built on choice. ■



自由交流

“贪婪的工作”导致了性别收入差距吗？

一本新书称，当父母让合并收入最大化时，母亲的事业受损

按照哲学家的定义，激进派和自由派的女权主义者在有关女性自由选择的重要程度上有所差异。自由派女权主义者希望女性拥有最大的自主权，要求权利平等、终结性别歧视。激进派女权主义者认为社会中的父权力量比任何个人都强大，并在某种程度上通过影响女性的选择来压迫她们。性别之间的经济差异——比如性别收入差距——始终都是不公平的一个标志。

哈佛大学研究女性与工作的专家克劳迪娅·戈尔丁（Claudia Goldin）的新书一并观察了美国女性的选择以及做出这些选择的环境条件。《职业与家庭：女性迈向平等的世纪历程》（Career and Family: Women's Century-Long Journey Toward Equity）追溯了受过大学教育的女性的工作史和家庭史，并分析了至今仍困扰她们职业生涯的因素。

对历史的速写可能少不了从家庭走向职场的历程。实际上，戈尔丁研究的第一代女性——出生于1878年至1897年——包含大量职业女性。但成功的事业通常都需要放弃生育，有时还要放弃婚姻。她写道，在传记集《美国知名女性传》（Notable American Women）中，有孩子的女性不超过三成。女性面临的选择是“家庭或事业”。

到了出生于1924年至1943年的第三代，受过大学教育的女性有了更加统一的人生体验：“先家庭，后工作”。通常女性在毕业后工作，但很快就结婚生子，然后退出职场。孩子们一上学，她们又回归工作。那个年代职场上白纸黑字的歧视性障碍逐渐消除，给她们提供了机会。但太久不工作意味着她们不具备在职场上顺利发展所必需的技能和经验。

直到1958年以后出生的第五代女性出现，才有许多人渴望拥有“事业和家庭”。这样的转变得益于避孕药的出现、受孕治疗的改进以及更开明的社会规范。避孕药帮助女性推迟了结婚年龄，受孕治疗帮助她们推迟了生育

年龄。然而，尽管戈尔丁记录的这些变化很惊人，这些女性仍面对明显的性别差距，在薪酬上最显而易见。美国女性的平均时薪比男性低20%。在大学毕业生中这一差距更大，为26%。

正是在这一点上，这本书开始具有争议性。戈尔丁参考了大量的研究，认为大多数女性已经不再像左派经常声称的那样，在劳动市场上受到很多同工不同酬的歧视。性别收入差距也并非像右派有时爱拿来辩解的那样，主要由女性的职业选择造成。即使女性的职业分布与男性相同——“如果女的当医生、男的当护士”——她计算出顶多会减少三分之一的工资差距。

最重要的原因是，女性缩减了自己的职业生涯，这是家庭对劳动力市场做出的一种理性反应的一部分。这个市场慷慨地奖励任何愿意坚守戈尔丁所说的“贪婪的工作”的人，无论男女。这些职位，比如法律、会计和金融行业的工作，需要很长且不可预测的工作时间。父母中需要有一个人在家里随叫随到，准备着孩子生病需要从学校接回，或是需要到音乐会或足球比赛上加油鼓劲。这和贪婪地索取精力的工作无法兼容，因为这种工作要随时待命，满足客户或老板的紧急需求。没有人能同时兼顾这两头。理性的反应是，父母中的一方专事报酬丰厚的贪婪工作，另一方——通常是母亲——主要照顾孩子。戈尔丁写道：“为了能增加家庭收入，夫妻平等被舍弃了，而且以后仍将如此。”

对于崇尚自由选择的自由主义者来说，主要由家庭选择造成的性别收入差距是个棘手的问题。对经济学家来说，这也是一个棘手的领域，他们经常强调研究对象的“显示性偏好”，以及由此带来的市场效率。戈尔丁的态度符合她所属的倾向保守的芝加哥学派，在对这个问题做出令人信服的诊断后，却并没有自信地开出扩大政府干预这一原本已是顺理成章的药方。书中部分内容流露出她支持对儿童保育提供更多补贴，就像美国总统拜登主张的那样。但在接受本刊采访时，她显得更为谨慎，指出在拜登的主张里，她会优先选择向父母提供现金援助（这项政策无意改变家庭的选择）。她说，这本书是关于“发生了什么以及为什么发生”，而不是解决方案。

不过，这本书的另一个主题是，女性的进步在多大程度上是技术变革和创新的结果。类似的力量会颠覆工作的贪婪程度吗？对于某些工作来说这难以想象，比如没有什么能阻止个体经营者在自己的事业上投入大量时间。但是企业有动力让工作变得不那么贪婪，因为雇用母亲、给她们升职意味着从更大的人才库中吸取人才。戈尔丁指出，制药行业就是已经实现转型的一个例子。许多药剂师以前是个体经营户，因为顾客也希望得到个人化的服务。但是计算机和业内整合让药剂师之间的相互替代变得更容易了，令这份工作变得不那么贪婪，同时却没有损失地位和报酬。或许远程工作或人工智能也会对其他职业起到同样的作用。

戈尔丁像一个激进分子那样，指出了经济的一个结构性特征。“不是你的问题，而是体制的问题。”她向读者保证。但作为一名自由派，她对于颠覆一个建立在选择之上的体制犹豫不决。 ■



The Economist film

Net Zero - The Essentials

Embracing, enacting and scaling a negative emission plan to get to net zero is a Herculean task, and it's not just a technological revolution.



经济学人视频

关于净零排放，你需要知道什么？

接受负排放理念、制定计划并规模化从而实现净零排放，是极为艰巨的任务，这也不只是一场技术革命。



Attack on the tycoons

China attempts to clean up its sleaziest regional banks

It's not just Evergrande. The rot in China's banking system goes deeper

IT'S BEEN A bad year to be a big cheese in China. Billionaire entrepreneurs have been hounded. Over-extravagant entertainers have disappeared from the internet. Now a new type of tycoon is feeling the heat. The latest regulatory crackdown on what the government considers private-sector misbehaviour extends to businessmen with excessively cosy ties to banks. The fear is that insider dealing, preferential access to credit and lax corporate governance pose threats to stability, particularly in the regional and local underbelly of China's financial system.

The most prominent red flag is Evergrande, a debt-ridden property firm close to collapse that until recently had a 36% stake in Shengjing Bank, a local lender based in the north-eastern province of Liaoning. The authorities are said to be investigating whether Evergrande, which is run by a billionaire, Hui Ka Yan, took control of Shengjing, with about 1trn yuan (\$156bn) in assets, using illicit means, as well as conducting some 100bn yuan in related-party transactions.

Another notorious case involves HNA Group, an acquisitive conglomerate which took over Yingkou Coastal Bank in Liaoning in 2014 (see chart 1). HNA put new leaders into the bank and transformed it into a mill for shadow-banking products that provided it and related groups with copious amounts of credit. Its assets tripled in 2016, making it the fastest-growing bank in China that year—before it almost collapsed. Since February HNA has been in bankruptcy administration. Chen Feng, its co-founder and chairman, was arrested in September, as was its CEO.

The malaise goes far deeper, posing a potential threat to economic stability in some Chinese provinces, particularly rust-belt ones like Liaoning. The 134 metropolitan and 1,400-odd rural commercial banks in China make up about 32% of its commercial-banking sector, with some 90trn yuan, or \$14trn, in total assets. That is almost the size of Britain's entire banking system. They exist in the shadow of China's six big national-level banks and 12 joint-stock banks, which are predominantly state-owned and have the most visibility. Unlike the bigger banks, during most of the past decade many of those in the lower tiers have sold ownership stakes to large private investors, to the point of being under the influence of them. In recent years some have become cesspools of bad debts, insider dealing and failures of risk management, which are often attributed to misaligned ownership incentives.

This has aroused the concern of regulators. The central government is expediting a reform to push out what it calls "problem shareholders" from banks. On October 15th the China Banking and Insurance Regulatory Commission introduced rules that extended supervision of those that it considered to be banks' controlling shareholders. According to China Daily, a government mouthpiece, that extended to anyone holding a 10% stake or more in a city or local bank, or those holding the largest equity stake in a bank or insurance company, with ownership of no less than 5%. The aim is to weed out over-cosy corporate interests.

If corporate shareholders are indeed the problem, the authorities will have their hands full. The Economist calculates that of 107 city commercial banks that disclosed financial information for 2020, 72 with about 20.2trn yuan in total assets had large corporate shareholders, many of which were property developers and manufacturers. Twenty-two of this group were controlled outright by corporations and tycoons, or had been until they were recently forced to restructure. But even those with more than one large shareholder have attracted the attention of regulators. The authorities are likely to be

scrutinising the way investors compete with each other for preferential treatment.

The level of corporate ownership at rural commercial banks extends even further—to the point that it has shocked some researchers. Wang Chunyang of Peking University surveyed 1,295 rural banks and found that 1,122, or about 87% of them, had private companies as their largest shareholders. By our calculations, that level of private ownership implies that up to 39.4trn yuan in rural-banking assets could be controlled or influenced by private interests. For these banks, identifying problems early is a challenge. Smaller lenders are more likely to hide their bad debts, says Ruan Tianyue of National University of Singapore, creating a regulatory blind spot.

Private ownership of banks, by itself, is not the cause of the problem. Some privately held banks, such as the newly created Zhongbang Bank, have performed well. For their part, many small, government-controlled lenders have demonstrated abysmal risk controls. But in banks lacking in corporate governance, the risk is that the owners use their clout to extract loans on preferential terms, undermining prudent risk management and increasing the level of bad debts.

That could have economic consequences. Some experts liken the state of China's small banks to that of the more than 1,000 savings-and-loan institutions that collapsed in America in the mid-1980s due to deregulation and lax lending controls. They say bad-debt problems among city and rural banks could hurt regional economic growth.

Another problem is more political in nature. As evidence grows of tycoons' murky relationships with banks, the more it plays into the narrative of President Xi Jinping that socialist command-and-control policies do a better job than private capital in allocating economic resources.

Signs of misbehaviour appear to be mushrooming. Besides Evergrande, which has been forced to sell some of its shares in Shengjing, Hong Kong-listed Bank of Gansu required a bail-out last year after it lent to and invested heavily in the debt securities of one of its shareholders, which eventually defaulted. Bank of Jinzhou, a north-eastern lender, required an emergency restructuring after its largest shareholder, to which it had extended many loans, could no longer pay back creditors. Anbang Insurance, the unwieldy conglomerate best known outside China for buying the Waldorf Hotel in 2014, controlled Chengdu Rural Commercial Bank until 2020. Xiao Jianhua, a tycoon who was kidnapped by Chinese agents from a Hong Kong hotel in 2017, controlled two lenders, Baoshang Bank and Bank of Harbin, both of which required expensive state bail-outs.

These problems are unlikely to abate as China's economy decelerates and more companies default. In September shares in Fuxin Bank were put up for sale in an online auction meant to help raise capital for the struggling lender after a property developer with shares in the company could no longer repay its debts. Bank of Langfang faces a potential increase in bad debts after its second-largest shareholder, China Fortune Land, a developer, defaulted on a 5.3bn yuan bond earlier this year.

Regulators take several approaches towards weeding out miscreant owners—of varying severity. One is to push out problematic shareholders. In mid-2020 the banking regulator published a list of 38 “illegal shareholders” that it had forced to divest. Another is detention. Mr Xiao, for instance, is thought to be currently held in Shanghai, where he is assisting in the unwinding of his business operations. A third is the death sentence. Cai Guohua, former chairman of Hengfeng Bank, which required a bail-out in 2020, was handed a suspended death sentence for, among other things, taking illegal loans.

Authorities have no intention of forcing all private shareholders out of the

banks, but they are moving to ensure that the largest shareholders come from the state, says Lian Ping of Bank of Communications, a large Chinese bank. This will mean an upheaval across the industry, given how prevalent large, private shareholders have become in recent years. Such regulatory actions will take time and will need to avoid undermining depositor confidence at banks.

In some regions, such as the north-east, the government has sought to restructure handfuls of banks at a time, possibly worried about a regional concentration of debt woes. S&P Global, a ratings agency, says that nearly 8% of the loan books of the most prominent city and rural lenders in the north-east were non-performing or of questionable status in 2020. The figure was just 3% for the loan books of similar banks in eastern China (see chart 2).

The north-east has one of the highest rates of private ownership in the country. In Liaoning province, for example, eight of its 15 city commercial banks are privately controlled. That produced a drive for consolidation. After the HNA debacle, Yingkou Coastal Bank became the central pillar of an effort to merge banks in Liaoning. At first regulators went so far as to attempt to bring together 12 of Liaoning's banks. But later this ambition was downsized to two, including Yingkou.

For all the regulatory overdrive, the neatest solution continues to evade Chinese regulators: allowing banks to fail and exit the market. Not since the collapse of Hainan Development Bank in 1998 has a lender been allowed to fail. And that was a convoluted bankruptcy that still drags on to this day. Rural banks would be fertile ground for such tests. ■



打击大亨

中国想要清理最藏污纳垢的地方性银行

不只是恒大问题。中国银行系统中的腐坏在更深处

对中国的名流大亨来说，今年是糟心的一年。腰缠亿万的企业家备受打压。浮夸放浪的艺人在互联网上销声匿迹。现在，另一类大亨也感到了压力。新一轮监管行动针对政府认定的私营部门不当行为，把打击对象扩展至与银行关系过于密切的商人。政府担心内幕交易、优先信贷和公司治理松懈的问题会威胁经济稳定，特别是中国金融系统中薄弱的地方性银行。

最显眼的危险信号是恒大，这家债台高筑、濒临倒闭的房地产公司直到最近还持有盛京银行36%的股份，后者是东北辽宁的一家地方性银行。据称，政府正在调查亿万富翁许家印执掌的恒大是否曾利用非法手段控制盛京（拥有约一万亿元的资产），并进行了约一千亿元的关联交易。

另一个臭名昭著的例子是海航集团。这家热衷收购的企业集团曾于2014年接管辽宁的营口沿海银行（见图表1）。海航更换了银行的领导班子，将其转变为影子银行产品的“工厂”，为自己和相关集团提供大量信贷。其资产在2016年增长两倍，成为当年中国增长最快的银行——之后就濒临破产。今年2月起，海航一直处于破产重整状态。其联合创始人兼董事长陈峰于9月被捕，同样被捕的还有它的CEO。

但弊病远不止这些，它潜藏于更深处，在中国部分省份已经构成对经济稳定的潜在威胁，尤其是像辽宁这样的老工业基地。中国的134家城市商业银行和1400多家农村商业银行在国内商业银行的占比为32%，总资产约90万亿元，几乎相当于英国整个银行系统的规模。高居这些地方性银行之上的是六家全国性银行和12家股份制银行，它们主要为国有控股，知名度也最高。与大型银行不同，在过去十年的大部分时间里，许多中小银行都向大型私人投资方出售了相当的股权，使得他们能够影响银行的决策。近年来，一些银行已成为积聚坏账、内幕交易和失败风控的“污水坑”，而这些

现象往往被归咎于所有权激励的错位。

这已引起监管机构的关注。中央政府正在加快改革，清除银行里所谓的“问题股东”。10月15日，中国银保监会出台规则，对它认定的银行“大股东”加强监管。据官媒《中国日报》报道，监管范围扩大到在一家城市银行或地方银行中持股10%或以上的股东，或者是在一家银行或保险公司持股最多且持股比例不低于5%的股东。这是为了清除银行与企业间过于密切的利益关系。

如果企业股东确实是问题所在，那政府可有的忙了。据本刊估算，在已披露2020年财务信息的107家中国城市商业银行中，有72家（总资产约达20.2万亿元）拥有企业大股东，多为房地产开发商和制造企业。其中22家银行完全受控于企业和大亨，或者在近期被迫重组前一直如此。但即使那些拥有不止一个大股东的银行也被监管机构盯上了。政府很可能会审查其不同投资方是如何争夺优先待遇的。

农村商业银行的企业持股更多，多到令一些研究人员震惊。北京大学的王春阳调查了1295家农商行，发现其中1122家（即约87%）的最大股东是私营企业。据本刊计算，这样的私营企业持股规模意味着高达39.4万亿元的农商行资产可能受私人利益控制或影响。对于这些银行，要及早发现问题并不容易。新加坡国立大学的阮天悦表示，小银行更可能隐瞒坏账，形成监管盲点。

私营企业持有银行股权本身并非问题根源所在。一些民营银行运作良好，比如近年成立的众邦银行。而许多由政府控制的小银行的风控一塌糊涂。但是，在公司治理不佳的银行，风险在于大股东会利用自身影响力以优惠条件榨取信贷，破坏审慎的风险管理制度，导致坏账水平上升。

这可能对经济造成影响。一些专家认为中国小型银行的现状很像上世纪80年代中期美国银行业的情形，当时有1000多家储蓄贷款机构因政府放松管制和信贷控制松懈而破产。这些专家表示，城商行和农商行的坏账问题可能损害地方经济增长。

另一个问题在本质上更具政治色彩。既然越来越多证据显示大亨们与银行关系暧昧，这就越发印证了国家主席习近平的说法，即社会主义的命令与控制式政策要比私人资本更能合理分配经济资源。

不当行为的迹象似乎迅速涌现。除了已被迫出售盛京部分股份的恒大外，在香港上市的甘肃银行去年也需要政府救助，之前该银行向自己的一个股东放贷并大量投资其债务证券，而该股东最终违约。地处东北的锦州银行向其最大股东提供了大量贷款，后来该股东无法向债权人偿还款项，锦州银行因此被紧急重组。安邦保险是一家庞大臃肿的企业集团，因2014年收购纽约华尔道夫酒店而在海外声名大噪，直到2020年该集团都是成都农商行的控股股东。2017年在香港一家酒店被中国特工带走的富商肖建华曾是包商银行和哈尔滨银行这两家银行的控股股东，而这两家银行最终都需要政府斥巨资救助。

随着中国经济减速和更多公司违约，这些问题不太可能得到缓解。阜新银行因一家持有其股权的房地产开发商无法偿还贷款而陷入困境，为筹集资金，今年9月，该股东持有的股权被放到网络平台上拍卖。今年早前，廊坊银行的第二大股东、房地产开发商华夏幸福基业对53亿元债券违约，这家银行因而面临坏账上升的风险。

监管机构采取几种方式清理不良股东，严厉程度不一。一种是赶走问题股东。在2020年年中，中国银保监会公布了一份包含38名“违法违规股东”的名单，迫使他们撤资。另一种是关押。例如，肖建华据信目前被关押在上海，在那里配合拆解他的商业版图。第三种方式是死刑。例如2020年需要政府出手救援的恒丰银行的前董事长蔡国华被判处死刑缓期执行，罪名包括违法放贷等。

中国大型银行交通银行的连平认为，当局无意将所有私人股东从银行逼走，但正在确保最大股东来自政府部门。这意味着整个银行业将迎来一番大震荡，毕竟近年来私营大股东已变得非常普遍。这类监管行动将耗费时日，而且需要避免破坏存款人对银行的信心。

在东北等地区，可能是出于对区域聚集性债务困境的担忧，政府试图一次重组多家银行。评级机构标普全球表示，2020年，在东北最主要的城商行和农商行的贷款总额中，不良贷款或问题贷款占了近8%。而在东部地区的同类银行中，该比例仅为3%（见图表2）。

东北是中国私营企业持股银行比例最高的地区之一。举例来说，在辽宁省，15家城商行中有八家是私人控股。这就产生了一股整合推力。海航暴雷后，营口沿海银行成为了辽宁省银行整合行动的核心支柱。起初，监管机构甚至试图把辽宁省的12家银行合并到一起，后来这雄心勃勃的计划被缩减为只合并两家，营口沿海银行是其中之一。

尽管种种监管行动力度超强，中国监管部门对最有效的解决方案还是避而不用：任由银行破产并退出市场。1998年海南发展银行破产之后，再没有一家银行被允许倒闭。而这个错综复杂的银行破产案至今余波未了。农商行会是做这类试验的肥沃土壤。 ■



Unlocked

Joe Biden's infrastructure bill will boost competitiveness for decades

Infrastructure year is finally here

LOCK AND DAM 25 on the upper Mississippi River is testament to how good American infrastructure can be. Stretching nearly 1,300 feet (400 metres) across the water, the concrete-and-steel structure is a crucial link in the system that connects Midwestern fields to Southern ports and thence to Asian markets. Roughly 60% of America's corn and soy exports pass through it every year. But it is almost 100 years old, and engineers wage a constant battle to keep it operational. It has the same capacity as when it was built, while boats have grown bigger. "How many highways built in the 1930s still have the same number of lanes now?" asks Andy Schimpf, a manager at the lock.

Salvation may be at hand. On November 5th the House of Representatives passed a five-year, \$1trn bill to repair and upgrade America's ageing infrastructure. About \$2.5bn has been allocated to inland waterways, and Mr Schimpf is optimistic that some will go towards rebuilding Lock and Dam 25, doubling the size of its chamber. Today, workers sometimes need to break apart barges to get them through, and then reassemble them on the other side, which can take up to three hours. A bigger lock could reduce transit time to 30 minutes.

Hundreds of similarly delayed and neglected public projects around America will get a big boost from the infrastructure bill, which President Joe Biden will soon sign into law (it long ago passed the Senate). It includes \$40bn of new funding for fixing bridges, the largest investment since the construction of the interstate highway system. There will be nearly \$70bn for passenger rail, aimed both at clearing years-old maintenance backlogs

and bringing service to new areas. Another \$65bn should ensure that every American has access to high-speed internet. And the list goes on and on, from highways to airports and the electricity grid to water pipes.

For years American infrastructure has suffered from under-investment. It would take \$2.6trn over the next decade to get it up to scratch, according to the American Society of Civil Engineers (ASCE), a professional body (albeit one with an interest in spending more). The bill will not fix everything. But it could be the beginning of a process that will make a real difference.

How big a difference? Roughly half the headline amount would have been expected as part of regularly budgeted maintenance, meaning that about \$550bn actually constitutes new spending, to be disbursed over five years. That might not sound like much, but it is. From 2022 to 2026 federal infrastructure spending will rise from about 0.8% of annual GDP to 1.3%, well above the trend of the past four decades. Adie Tomer of the Brookings Institution, a think-tank, says that is nearly the same average level as during the New Deal, which helped lift America's fortunes after the Great Depression.

As a rough rule of thumb, an additional \$100bn per year spent on infrastructure could boost growth by about a tenth of a percentage point when the digging actually begins, and potentially more if it catalyses additional private-sector investment, notes Ellen Zentner of Morgan Stanley, a bank. In the longer term, she estimates, a sustained expansion of infrastructure spending could support productivity and raise America's potential growth by as much as a fifth of a percentage point, a big deal for a large, mature economy. "That's why whenever you talk to economists, infrastructure is the stuff that we go to bed at night dreaming of," says Ms Zentner.

Getting a positive return will, of course, require the money to be allocated

well. Considering the shortfalls in investment over the years, it should not be hard to find good projects. On average a water main breaks every two minutes somewhere in America, while nearly half of all roads are in bad shape, according to the ASCE. In some cases the investments will not generate new growth so much as defend America's existing strengths. Take the locks on the upper Mississippi: they help American soybeans compete against Brazilian ones. Labour is much cheaper in Brazil, but transportation is better in America. Keeping the locks in good shape underpins that. "If you were to close any of them down for a few months, it would cost us billions of dollars," says Steve Censky, CEO of the American Soybean Association.

Just about doubling the federal government's expenditure on infrastructure overnight could lead to waste, however. Cost overruns often bedevil American infrastructure projects. It is more expensive to build rail in America than in almost any other country, according to Transit Costs Project, a research group. The price of building highways has also soared. That just about anyone can mount a legal challenge against public works in their vicinity is part of the problem, leading to delays and missed budgets. And the current backdrop is hardly propitious, with supply-chain congestion affecting even the most basic home-building projects.

On the positive side of the ledger, the bill creates space for private investors to join the government's efforts, which could both enlarge total spending and impose more financial discipline. Any city or state seeking federal funding for transport projects costing more than \$750m will be required to evaluate whether partnering with private-sector investors would deliver better results. Some projects, such as the development of the first-ever national network of chargers for electric vehicles, naturally lend themselves to co-operation with the private sector, given that is where the technology resides. The government also wants companies to pitch in to make infrastructure more resilient to climate change. Grant programmes, useful in attracting private investment in water systems, are likely to be expanded.

"This bill can potentially create a framework for ongoing and necessary public and private investment in infrastructure," says Aaron Bielenberg of McKinsey, a consultancy.

But a dose of scepticism is also useful. Ultimately, the amount that America spends on infrastructure is a direct result of the amount that Americans are willing to be taxed. And that, by the standards of other rich countries, is not very much. "Ten years from now, I think we will look back and say that this bill was a historic investment, a great expansion of investments that were neglected," says Austan Goolsbee, an economist at the University of Chicago and a former adviser to President Barack Obama. "But people are still going to be saying, well, why don't we have high-speed rail all over the country?" Even so, better to fix roads, expand ports and lay broadband cables than not. ■



开闸

拜登的基建法案将长期提振美国竞争力

基建年终于来了

密西西比河上游的25号闸坝是美国基础设施现状的写照。这座钢筋混凝土建筑在水面上横跨近1300英尺（400米），是连接美国中西部农田和南部港口，进而通向亚洲市场的运输系统中的关键一环。每年美国大约60%的出口玉米和大豆都要通过这里。但它建成已近百年，工程师持续奋战才让它维持运行。它的容量仍和建成之初一样，但通过的船舶却越来越大。

“30年代修建的公路有多少到现在还是当初那么多车道的？”闸坝的管理人员安迪·辛普夫（Andy Schimpf）反问道。

解救可能已近在咫尺。11月5日，众议院通过了一项为期五年的一万亿美元法案，用于修复和升级美国老化的基础设施。约有25亿美元划拨给了内河航道，辛普夫乐观地认为其中一部分将用于重建25号闸坝，将闸室的容量扩大一倍。现在，工人有时需要先拆分驳船，等通过船闸后再重新接起来，整个过程可能要花上三个小时。船闸扩大之后，通过时间可以缩短到30分钟。

总统拜登很快会签署这项基础设施法案，让它成为法律（法案早已在参议院获得通过），美国各地成百上千个像这样被拖延和忽视的公共项目将获得大力推进。其中包括用于维修桥梁的400亿美元追加拨款，这是美国建成州际公路系统以来最大笔的桥梁投资。将有近700亿美元投向客运铁路，用于清理多年来的维修积压，并将线路覆盖到新地区。另外还有650亿美元用来确保每个美国人都能接入高速互联网。其他项目从高速公路到机场、从电网到供水管网不胜枚举。

多年来，美国的基础设施一直苦于投资不足。据专业团体美国土木工程师协会（American Society of Civil Engineers，以下简称ASCE）估算，在未来10年需要投入2.6万亿美元才能令其恢复正常标准。（不过扩大支出对

ASCE有利。）这个法案无法修复一切。但它有望启动一个进程，推动真正变化。

那是多大的变化？预计其中约一半的支出将进入经常性维护预算，这意味着五年内会有约5500亿美元的新增支出。听起来可能不多，但实际上不少。从2022年到2026年，联邦政府的基础设施支出将从每年占GDP约0.8%提升到1.3%，远高于过去40年的趋势线。智库布鲁金斯学会的艾迪·托默（Adie Tomer）表示，这几乎接近罗斯福新政时期的平均水平，而新政帮助美国走出了大萧条。

摩根士丹利的艾伦·岑特纳（Ellen Zentner）指出，根据粗略的经验法则，每年在基础设施上多投入1000亿美元，实际动工时可以推动经济增长约0.1个百分点；如果能够带动额外的私营部门投资，增幅可能还会更高。她估计，从较长时期来看，持续扩大基础设施支出可以支撑生产率，并将美国经济的潜在增速提高多达0.2个百分点，这对一个大型成熟经济体来说相当可观。“正因为如此，对于每个经济学家来说，基础设施总是我们梦寐以求的东西。”岑特纳表示。

当然，要想获得良好回报，首先必须合理分配资金。考虑到多年来的投资不足，找到好的项目应该不难。根据ASCE的数据，在美国平均每两分钟就有一条给水总管破裂，几乎半数的道路都状况堪忧。在某些情况下，这些投资并不会带来太多新的增长，而更多是维护美国现有的优势。以密西西比河上游的船闸为例：它们有助于美国大豆与巴西大豆竞争。巴西的劳动力便宜得多，但是美国的运输条件更好。保持船闸顺畅运行是这一优势的基础。“任何一个船闸关闭几个月都会给我们造成数十亿美元的损失。”美国大豆协会（American Soybean Association）的CEO史蒂夫·森斯基（Steve Censky）表示。

不过，一夜之间将联邦政府的基础设施支出差不多翻番可能导致浪费。美国的基础设施项目经常为成本超支所困。根据研究机构“运输成本项目”（Transit Costs Project）的数据，美国的铁路建设成本几乎比其他任何国家都高。公路建设成本也已经大幅上涨。另一个问题是，几乎任何人都

可以对他们附近的公共工程提出法律挑战，导致工期延误和预算超支。而当前的形势也不容乐观，供应链拥堵使得即便最基本的住宅建设项目也都受到了影响。

从积极的方面来看，这个法案为私人投资者参与政府项目提供了空间，这既可以扩大总体支出，也可以加强财务约束。任何城市或州如果要为投资7.5亿美元以上的交通项目寻求联邦拨款，都必须评估与私人投资者合作是否能取得更好的效果。一些项目与私营部门合作是自然而然的，例如建设第一个全国性的电动汽车充电网络，因为这些技术掌握在私营部门手里。政府也希望企业投入资金，使基础设施更能适应气候变化。有助于将私人投资吸引到水务系统的拨款计划很可能会扩大。“这项法案可能会为基础设施方面持续和必要的公共和私人投资提供一个框架。”咨询公司麦肯锡的亚伦·比伦伯格（Aaron Bielenberg）说。

但是对此稍有些怀疑也是必要的。说到底，美国在基础设施上能支出多少，直接取决于美国人愿意缴多少税。而以其他富裕国家的标准来看，这个数额并不算多。“10年之后再往回看，我想我们会说这项法案是一项历史性的投资，极大地加强了以前被忽视的投资，”芝加哥大学的经济学家、奥巴马的前顾问奥斯坦·古尔斯比（Austan Goolsbee）说，“但人们仍然会说，为什么我们没有遍布全国的高速铁路？”即便如此，能修补公路、扩建港口和铺设宽带总是好的。 ■



COP26

Are climate goals set in 2015 dead or alive?

The pledges made in Paris seem like being left behind

“AT THE END of the COP we need to be in a position to say ‘We are still on track to be well below 2 degrees, we still have a shot at the 1.5 degrees.’ All our efforts this week should be directed at that.” Thus spoke Frans Timmermans, an EU commissioner, as the COP26 climate summit in Glasgow rolled into its final week. Unfortunately for Mr Timmermans, political resolve and climate plans do not currently add up to the demanding goals set out by the Paris agreement of limiting global warming to “well below 2°C” above preindustrial averages, let alone to keeping it as low as 1.5°C. Instead, the latest number-crunching suggests that the plans of the 193 parties to the agreement collectively carve a path to approximately 2.4°C of warming by the end of the century.

That is only a modest improvement on where things stood when the Paris agreement was being negotiated in 2015. Under the deal that was struck at the time, governments offered up pledges to reduce their national emissions. Toiling away in the background, climate modellers estimated that the cumulative consequence of these pledges would be to bring about roughly 2.7°C of warming by 2100. Aware of the disconnect between this figure and the agreement’s overall goals, negotiators said they would present new, hopefully improved decarbonisation plans every five years, in the hopes that this “ratchet mechanism” would bring the overall 1.5-2°C Paris goals closer.

Hence the flurry of climate pledges that were made over the past year. They focus on what will be done by the end of the decade, by which time global greenhouse gas emissions must be roughly half what they were in 2010 in

order to have a good chance of limiting warming to 1.5°C. So far, no country is on track to do this, says Niklas Höhne of NewClimate Institute, a think-tank. Dr Höhne is part of a consortium of researchers called Climate Action Tracker, which plugs national climate policies and pledges into models in order to give an idea of how they translate into temperatures. The group's latest results (see chart), published on November 9th, say that if all 2030 decarbonisation plans were to be carried out as advertised but no further efforts were made, there would be a 68% chance that global average temperatures in 2100 would be between 1.9°C and 3.0°C warmer than pre-industrial times, with a median estimate of 2.4°C.

At first glance this seems considerably more pessimistic than what the International Energy Agency (IEA), a think-tank that works for governments, said earlier: "COP26 climate pledges could help limit global warming to 1.8°C". "BIG NEWS," tweeted the agency's director, Fatih Birol, "#COP26 climate pledges mean Glasgow is getting closer to Paris!". In fact, the two numbers are entirely consistent with each other. It is just that the IEA's modellers assumed not only that countries would deliver on their 2030 promises but also that those who said they would reach net-zero emissions by mid-century or soon after would actually do so.

Yet for now, talk of net-zero is mostly just that: talk. China, for instance, has said it would ensure its emissions hit a peak before 2030 and reach net-zero by 2060 in spite of the fact that it still generates more than 60% of its electricity from coal. Many other countries have made similar net-zero promises with very little if any detail of how they plan to get there.

COP26 has also seen plenty of multilateral deals and agreements announced on the sidelines of the UN talks. These dealt with some headline issues, like curbing methane emissions, deforestation and phasing out coal use, but none were reached unanimously. More than 100 countries have so far

signed up to cut their collective methane emissions by 30% by 2030. Another group agreed to quit using coal in two decades. Last week, a team of independent climate researchers found that pledges to cut methane could shave 0.12°C off temperature projections for the second half of the century compared with cuts embedded in nationally determined contributions—but only if every country signed up. China, India and Russia, the three largest emitters of methane, have yet to do so. Phasing out coal by 2040 would further reduce temperature projections by 0.28°C, but again only if it were a global effort. Yet China and India, the two most coal-hungry nations, have not joined the “powering past coal alliance”.

COP26 was never meant to deliver the whole package—pledges sufficient to keep global warming to well below 2°C and national strategies to back up those promises—in one fell swoop. It was always going to be one in a series of stepping stones. Nevertheless, the slow pace of global climate ambition has left a huge gap between where the world needs to be in order to keep the hope of a 1.5°C world alive and where it is. If the gap is not rapidly reduced, which would require all large emitters around the globe to drastically accelerate decarbonisation, then all hopes will rest on wholly infeasible options to draw carbon dioxide out of the atmosphere. ■

For the latest from COP26 see our news updates. For more coverage of climate change, register for The Climate Issue, our fortnightly newsletter, or visit our climate-change hub ■



COP26

2015年定下的气候目标名存实亡？

在巴黎做出的承诺似乎被抛诸脑后

“到本次大会结束时，我们得有底气说，‘我们仍走在通往显著低于2度的轨道上，我们仍有机会实现1.5度目标。’我们这一周所有的努力都应以此为方向。”在格拉斯哥举行的COP26气候峰会进入最后一周议程之际，欧盟专员弗兰斯·蒂默曼斯（Frans Timmermans）曾这样说道。可惜事情未如他所愿。目前的政治决心和气候计划全部加起来，并不能达到《巴黎协定》设定的严苛目标，即把气温相比工业化前平均水平的上升幅度控制在“显著低于2°C”，更不用说低至1.5°C了。实际上，最新的数字分析表明，该协定的193个缔约方的所有计划合并起来，将让地球到本世纪末升温约2.4°C。

这和2015年谈判《巴黎协定》时的情况相比只是略有改善。根据当时达成的协议，各政府做出了减少本国排放的承诺。在幕后算个不停的气候建模人员估计，这些承诺的累积结果是到2100年升温约2.7°C。意识到这个数字与协定的总目标脱节，谈判代表们表示他们将每五年提出新的、希望会有所改进的脱碳计划，寄望这种“棘轮机制”将让1.5°C到2°C的巴黎目标越来越近。

于是在过去的一年里，大家纷纷拿出了新的气候承诺。它们都着力于到这个十年结束时要完成什么，届时全球温室气体的排放量须降至2010年时的约一半才有较大的机会将升温限制在1.5°C。智库新气候研究所

（NewClimate Institute）的尼克拉斯·赫内（Niklas Höhne）表示，到目前为止，还没有任何国家有望做到这一点。赫内博士是名为“气候行动追踪者”（Climate Action Tracker）的研究人员联盟成员，该组织将国家气候政策和承诺输入模型，以了解它们会带来怎样的气温变化。该组织于11月9日发布的最新结果（见图表）显示，如果所有2030年脱碳计划都如宣传的那样执行，但没有进一步的努力，那么到2100年，全球平均气温将有

68%的可能性比工业化前时期高 1.9°C 至 3.0°C ，中位数估计为 2.4°C 。

乍一看，这似乎比政府间组织、智库国际能源署（IEA）早先所说的“COP26气候承诺可能有助于将全球变暖限制在 1.8°C ”要悲观得多。“大新闻，”署长法提赫·比罗尔（Fatih Birol）在推特上发文说，“#COP26气候承诺意味着格拉斯哥离巴黎越来越近了！”事实上，这两个数字是完全一致的。只不过国际能源署的建模人员不仅假设各国将兑现它们关于2030年的承诺，而且也假设那些声称将在本世纪中叶或之后不久实现净零排放的国家真会这样做。

然而就目前而言，有关净零的说法基本上就是——说法。例如，中国表示将确保它的排放量在2030年前达到峰值，在2060年前降至净零，尽管目前它超过60%的电力仍然来自煤炭。许多其他国家也做出了类似的净零承诺，但几乎没有给出任何关于如何达到目标的细节。

在联合国会谈间隙也有不少多边交易和协议宣告达成。它们涉及一些重要议题，比如遏制甲烷排放、森林砍伐和逐步脱煤，但无一获全员签署。迄今为止有100多个国家签署了到2030年合并减排甲烷30%的协议。另一组国家商定在20年内停止使用煤炭。大会进行到第二周，一组独立的气候研究人员发现，与各国自主贡献方案中包含的削减计划相比，联合减排甲烷的承诺可让本世纪下半叶的预测气温多下降 0.12°C ——前提是每个国家都签署。中国、印度和俄罗斯这三个最大的甲烷排放国尚未加入。在2040年前逐步脱煤将使预测气温进一步降低 0.28°C ，但前提依然是全球协同努力。但中国和印度这两个煤炭需求量最高的国家还没有加入“脱煤者联盟”（powering past coal alliance）。

COP26的目的从来就不是要一蹴而就——包括足以令全球升温显著低于 2°C 的承诺以及支撑这些承诺的国家战略。它永远都会是一长串通向前方的踏脚石中的一块。尽管如此，全球气候抱负的步伐之缓慢，已经使得要让升温 1.5°C 的希望不致破灭所应抵达的位置与实际情况之间出现一条鸿沟。如果这鸿沟不迅速缩小——它将要求所有排放大国都急剧加速脱碳——那么

所有希望都将寄托在从大气中直接回收二氧化碳这种完全不切实际的选项上了。





Manufacturing a green revolution

South Korea's climate targets will mean remaking its economy

Its industrial centres will have to transform or disappear

"IF WE DO well, the country does well, and if the country does well, that is the way for us to do well," reads the inscription on the walls of the former Hyundai Heavy shipyard in Gunsan on South Korea's west coast. The quote from Chung Ju-yung, the late founder of Hyundai, one of the country's biggest conglomerates, is an apt summary of South Korea's development strategy. Equating manufacturing prowess with the national interest drove the massive state-led investment in heavy industry that made South Korea rich.

Today the fading letters are an ominous sign of things to come. Four years ago the Hyundai shipyard and the GM car factory in Gunsan shut within ten months of each other, resulting in the loss of tens of thousands of jobs. There is a risk of more such devastation in the future. The country's industrial behemoths have no clear plan to eliminate greenhouse-gas emissions by 2050, which the government has promised to do. How they do so will determine the future not just of South Korea's industries but of its industrial cities, too.

South Korea's coastal cities are the most visible markers of the country's rapid industrialisation. Starting in the 1960s, sleepy fishing ports and trading posts turned into sprawling industrial centres, filled with shipyards, car factories, steel mills, oil refineries and container terminals. Industry generates 37% of GDP, compared with the rich-country average of 27%, and more than 80% of exports. GDP per person in Ulsan, the most important industrial city, is 75% higher than the national average. At a museum in the city you can wander around model versions of industrial installations to

take in the story Ulsan wants to tell about itself. “We went from a GDP of \$100 per person to this,” beams Shin Hyeong-seok, the museum’s director.

But as South Korea joins the rest of the world in the effort to curb climate change, its centres of heavy industry are turning from drivers of growth into liabilities. Their reliance on fossil fuels is one reason why South Korea is the world’s seventh-biggest emitter of greenhouse gases. President Moon Jae-in has promised to reduce emissions by 40% below 2018 levels by 2030, and that South Korea will be carbon-neutral by 2050, a target that was written into law in August.

Environmental groups point out that Mr Moon’s targets are still insufficient to meet South Korea’s commitments under the Paris agreement. The government itself freely admits that it is lagging behind other rich countries in reducing emissions. But the announcement has alarmed industry representatives. They warn of production cuts and large-scale job losses unless businesses are given more time and support to reach the targets.

The transition to a low-carbon economy, if pursued seriously, will be the biggest challenge for manufacturers since the transition from light to heavy industry in the 1970s, says Park Sang-in, an economist who focuses on South Korea’s conglomerates at Seoul National University. The fact that South Korea is so late to the game makes the task harder, because bigger reductions will now have to happen over a shorter period of time.

If the government is to achieve its targets, carbon-intensive manufacturing industries will have to reduce their emissions by as much as 80% over the next three decades (what carbon is still emitted will have to be captured and stored in facilities yet to be developed). De-industrialising and shifting towards less energy-intensive services would be one way to achieve that. But given the importance of manufacturing to the economy, the

consequences for workers and the industrial centres where they live would be devastating. The only alternative is for industries to change. “We do not want to lose the role these industries play in the economic growth process, so it is critical that they be transformed,” says Kang Sung-jin, who studies industrial development at Korea University in Seoul.

What will this transformation look like? Factories that make petrol and diesel cars will have to switch to making batteries and electric vehicles. Shipbuilders will have to produce carriers that run on greener fuels, and the petrochemical industry will have to provide those fuels. Steel furnaces will have to run on something other than coke made from coal. Electricity for both industry and households, now produced mostly by coal-fired power stations, will have to come from renewable sources.

Just as during the switch from light to heavy industry, the change will be most visible in industrial cities. In the future the government envisions, places like Ulsan and Gunsan will be connected to huge offshore wind farms and covered in solar panels. Green hydrogen will power next-generation container ships and carbon-neutral steel furnaces.

The government’s most recent plans have spurred companies into action. Yet the lack of preparation means that the road to net zero is likely to be bumpy, with industries vulnerable to shocks. Moreover, there is no guarantee that the pledges will survive the next election. Climate change is not yet a big issue in the presidential-election campaign, and the next government may not feel the need to keep up pressure on the conglomerates.

That means that many of South Korea’s industrial centres could end up looking more like Gunsan, as investment in green tech yields results in other countries and higher emissions render some of South Korea’s industries obsolete. Government efforts to get Gunsan’s laid-off workers

into new employment have progressed only sluggishly. Thousands have left the city.

At the site of the old colonial port, where city officials have launched a series of urban-regeneration projects, visitors to a large ship-shaped museum can relive the experience of trading rice in a 1930s version of the city. Unless South Korea's green economy gets whirring, the museum in Ulsan on the opposite coast may soon acquire a similar old-timey vibe. ■



制造绿色革命

为达到气候目标，韩国需要重塑经济

它的工业中心若不转型就会消失

“我们好，国家就发展得好；国家好，我们就发展得好。”在韩国西海岸的群山市，现代重工造船厂旧址的墙上有这么一句话。它出自韩国最大的企业集团之一现代集团的已故创始人郑周永，非常到位地概括了韩国的发展战略。把制造能力与国家利益划上等号，推动了政府主导的大规模重工业投资，使韩国成为了富裕国家。

今天，墙上这些斑驳褪色的字句却成了不祥之兆。四年前，现代的这家造船厂和同样位于群山的通用汽车工厂在十个月内相继关闭，几万个工作岗位消失不见。未来有可能出现更多这样的强冲击事件。韩国政府承诺在2050年前实现温室气体净零排放，但工业巨头们并无明确的实施计划。它们如何兑现承诺不仅将决定韩国工业的未来，还将决定韩国工业城市的未来。

韩国的沿海城市最能体现这个国家的快速工业化。从上世纪60年代开始，沉寂的渔港和商栈变身成为庞大的工业中心，造船厂、汽车厂、钢厂、炼油厂和集装箱码头遍布其中。工业在韩国GDP中的占比为37%（富裕国家的平均水平为27%），在出口中的占比达80%以上。最重要的工业城市蔚山的人均GDP比全国平均水平高75%。在该市的一个博物馆里，你可以漫步于各种工业设施模型之间，领略这个城市想要对外讲述的故事。“我们从人均GDP只有100美元开始，发展到今天这样。”馆长申亨锡（Shin Hyeong-seok，音译）满面春风地说道。

但随着韩国加入全球遏制气候变化的努力，它的那些重工业中心正从增长推动力变成拖累。它们对化石燃料的依赖是韩国成为世界第七大温室气体排放国的原因之一。韩国总统文在寅承诺，到2030年，排放将比2018年减少40%，而到2050年，韩国将实现碳中和，这一目标已于8月写进法律。

环保组织指出，文在寅的减排目标仍不足以实现韩国在《巴黎协定》中的承诺。韩国政府也坦言自己的减排工作落后于其他富裕国家。但这些目标惊动了工业界代表。他们警告说，除非政府给予企业更多时间和支持来实现目标，否则减产和大规模失业将无可避免。

首尔国立大学专门研究韩国企业集团的经济学家朴相仁（Park Sang-in，音译）表示，假如认真执行向低碳经济转型，那将是制造企业自上世纪70年代韩国从轻工业转向重工业以来面对的最大挑战。韩国在低碳转型中起步太晚，这让任务变得更加艰巨，因为必须在更短的时间内实现更大幅度的减排。

如果韩国政府要实现目标，高碳排放的制造业就必须在未来30年内减排多达80%（仍在排放的碳将必须被捕获封存，不过所需设施还有待开发）。去工业化及转向能源密集度较低的服务业也许是实现目标的途径之一。但鉴于制造业对韩国经济的重要性，去工业化将给工人及他们所在的工业中心带来毁灭性后果。唯一的出路是工业界自己做出改变。“我们不想失去这些行业在经济增长过程中扮演的角色，所以让它们实现转型是至关重要的。”在首尔高丽大学研究工业发展的姜晟振说。

这会是怎样的转型呢？生产汽油和柴油汽车的工厂必须转向生产电池和电动汽车。造船厂要改为生产使用更环保燃料的船舶，石化行业必须能供应这些环保燃料。炼钢炉不能再以煤炭制成的焦炭为燃料。工业和家庭用电现在主要来自燃煤发电，将来必须转为使用可再生能源。

正如从轻工业到重工业的转型一样，这种变化将在工业城市体现得最为明显。韩国政府对未来的设想是，蔚山和群山这样的城市会与巨大的海上风电场连接，而且全面覆盖太阳能电池板。绿色氢气将为下一代集装箱船和碳中和炼钢炉提供动力。

政府最新的计划已经促使企业行动起来。但准备不足意味着实现净零排放的道路很可能坎坷不平，让工业界容易受到冲击。而且并不能保证下届政府会继续信守这些承诺。气候变化目前还不是总统选举中的重要议题，下

届政府可能会觉得没必要继续对企业集团施压。

这意味着，随着其他国家的绿色技术投资获得成果而韩国的一些产业因排放更高而在竞争中惨遭淘汰，韩国的许多工业中心最终的结局可能会和群山一样。政府帮助群山的失业工人再就业，但进展缓慢，成千上万人已离开这座城市。

在群山日本殖民时代的旧港口，市政府官员推出了一系列城市改造项目，包括一座庞大的船形博物馆，馆中再现了在上世纪30年代的群山买卖大米的场景，供访客体验。除非韩国的绿色经济发展起来，否则在东海岸的那座蔚山博物馆可能很快也会呈现出一股类似的怀旧气息。 ■



Covid-19

New antiviral drugs mark a big turning point in the covid-19 pandemic

The highly effective drugs can be taken as pills

THE LATEST news in the fight against covid-19 is encouraging. Two new antiviral drugs have been deemed so effective that clinical trials ended early. Data from these trials have not yet been published. However, regulators are moving swiftly to consider general use of the drugs. They will fill a large gap in the toolkit doctors are using to fight the virus, and could well help end the global pandemic.

The new drugs are molnupiravir (Lagevrio), developed by Merck, a pharmaceutical company, working with Ridgeback Biotherapeutics, a biotech firm, and Paxlovid, which was developed by Pfizer. All three are American companies. Those most at risk from the serious effects of covid are far less likely to be hospitalised, or die, if they take a course of either of these pills in the five days after symptoms first appear.

Merck said in October that molnupiravir reduced the risk of hospitalisation or death by about half, when given to patients with one risk factor for covid, such as obesity or heart disease. Regulators in America, Europe and at the World Health Organisation are assessing the drug. Britain has approved it and will start using the treatment next month. On November 5th Pfizer said its pill reduced the risk of hospitalisation or death by 89% if taken within three days. (In fact, during its trial no patient died at all when taking Paxlovid within five days of symptoms.)

Molnupiravir is what is known as a prodrug, which means that it is converted into its active form when it arrives inside cells. Once there, it is incorporated into the genetic material of the virus whereby it disrupts

its ability to replicate. Errors accumulate in the virus's genetic material, a process known as "error catastrophe". Trials in animals have raised concerns that the drug might pose risks to unborn children, hence the British government has advised against its use during pregnancy, or while breastfeeding. Other regulators may issue similar warnings.

Paxlovid is in fact a combination of two drugs: an existing one called ritonavir, which is given alongside a novel protease inhibitor known as PF-07321332. The protease inhibitor was designed to bind and block the protease enzymes that SARS-COV-2 uses to replicate. Ritonavir prevents the protease inhibitor from being broken down too quickly in the body.

Molnupiravir and Paxlovid are also known as "small molecule" drugs. These are molecules that are easy to make. Both firms say the price of the drugs will vary according to the wealth of the nation buying them. That will likely mean that rich countries will pay \$700 for a five-day course of pills, while poorer ones might pay around \$20, and maybe less as the cost of manufacturing comes down.

Although both firms have said they intend to make these drugs widely accessible around the world, Merck already has an edge. It has signed a number of licences which allow other manufacturers to produce the drug, and it has reserved 3m doses for low- and middle-income countries. This is to ensure that rich countries do not monopolise the supply of the new medicines as they have done for vaccines. Merck expects to make 10m doses this year, and 20m next year. Generic manufacturers will make many more. Pfizer, which has not yet received any regulatory authorisations, expects 180,000 packs of pills to be produced by the end of this year, and 21m in the first half of 2022.

These drugs herald a second big turning point in the pandemic (the first being vaccines). Rising case numbers across Europe suggest there will be

a strong demand for such medicines to keep people out of hospital. While patients wait for them to arrive, it is also possible that doctors might consider the use of fluvoxamine, an antidepressant medicine which also appears to lower the risks from covid.

As the new treatments roll out for use, there will be concern among some scientists and doctors about the virus developing resistance, particularly if patients do not complete their course. Keeping one step ahead of SARS-COV-2 will require planning for such an eventuality. That means deducing which antiviral drugs can be given in combinations to create a therapy that the virus will struggle to defeat. ■



新冠病毒

新的抗病毒药物标志着疫情出现重大转折点

这些特效药可以口服

抗疫之战的最新消息振奋人心。两种新的抗病毒药物被认为非常有效，临床试验都早早结束。这些试验的数据尚未公布。但监管机构已经在快速反应，考虑普及用药。这两种药将填补医生们抗病毒工具箱中的一大空白，而且很可能帮助终结全球疫情。

两种新药分别是制药公司默克与生物技术公司Ridgeback Biotherapeutics 合作研发的莫努匹拉韦（molnupiravir，又名Lagevrio），以及辉瑞公司研发的帕罗韦德（Paxlovid）。三家全部是美国公司。对于有高风险发展为新冠重症的患者，如在症状首次出现后的五天内服用任何一种药物一个疗程，住院率或死亡率都会大幅降低。

默克公司在10月份宣布，给存在一种新冠风险因素（如肥胖症或心脏病）的患者服用莫努匹拉韦后，其住院率或死亡率大致减半。美国、欧洲和世卫组织的监管官员正在评估这种药物。英国已经予以批准，并将于下月开始用于治疗。11月5日，辉瑞公司表示，如果患者在症状出现后三天内服用帕罗韦德，住院率或死亡率能降低89%。（事实上，在试验期间，在症状出现五天内服用帕罗韦德的患者无一死亡）。

莫努匹拉韦是所谓的前体药物，也就是说它会在到达细胞内部后转化为活性形式。一旦进入细胞，它就会被整合进病毒的遗传物质，从而破坏病毒的复制能力。错误在病毒的遗传物质中累积，此过程称为“错误巨变”。动物试验引发了有关给未出生的孩子带来风险的担忧，因此英国政府建议在孕期或哺乳期不要服用。其他监管机构可能也会发出类似的警告。

帕罗韦德实际上是两种药物的组合：一种是现有药物利托那韦（ritonavir），另一种是新型蛋白酶抑制剂PF-07321332，二者一同服用。这种蛋白酶抑制剂的任务是结合并阻断新冠病毒用于自我复制的蛋白酶。

利托那韦则防止蛋白酶抑制剂在体内被过快分解。

莫努匹拉韦和帕罗韦德也被称为“小分子”药物。这些分子很容易合成制造。两家公司都表示，新药将根据购买国家的财富水平做差异化定价。这很可能意味着富国将要为一个为期五天的疗程支付700美元，而穷国可能支付约20美元，随着制药成本的下降，价格还会更低。

虽然两家公司都已表示它们打算在全世界广泛供应这些药物，但默克已经领先一步。默克已经签署了许多授权许可，允许其他制药商生产这款新药，此外还为中低收入国家预留了300万个疗程的药物。此举是为了确保富国不会像垄断疫苗那样垄断新药供应。默克预计今明两年将分别生产1000万和2000万个疗程。学名药厂的产量还会多得多。尚未获得任何监管批准的辉瑞预计到今年年底将生产18万个疗程，2022年上半年将生产2100万个。

这两种药物预示着疫情迎来了第二个重大转折点（第一个是疫苗）。欧洲各地持续攀升的确诊病例数表明，为让患者免于住院，对这类药物的需求会非常大。在患者等待新药到来的同时，医生也可能会考虑使用氟伏沙明（fluvoxamine），这种抗抑郁药物似乎也能降低新冠重症风险。

随着新疗法的推广普及，一些科学家和医生将会担心病毒产生抗药性，特别是如果患者不服用完整疗程的话。要想领先新冠病毒一步，就需要做好规划来应对这种可能性。这意味着要推断出哪些抗病毒药物可以组合使用，从而创造出病毒无力战胜的疗法。 ■



The other metaverse

Companies want to build a virtual realm to copy the real world

Linking the digital and physical worlds could unlock innovation

CALL IT THE multiplication of the metaverses. Ever since Mark Zuckerberg, the boss of Facebook—sorry, Meta—laid out his vision in late October for immersive virtual worlds he thinks people will want to spend lots of time in, new ones are popping up all over. An entertainment metaverse will delight music fans, influencers will flock to a fashion metaverse to flaunt digital clothes, and there is even a shark metaverse (it has something to do with cryptocurrencies). Mostly these are the brainchildren of marketeers slapping a new label on tech's latest craze.

One new virtual world deserves real attention: the “enterprise metaverse”. Forget rock stars and fancy frocks, this is essentially a digital carbon copy of the physical economy. Building living, interactive blueprints that replicate the physical world might, in time, come to shape it. The vision of what this might mean has become clearer in recent days. Microsoft, the world’s largest software firm, earlier this month put it at the centre of its annual customer shindig, as did Nvidia, a big maker of graphics processors, on November 9th.

Corporate virtual worlds are already more of a reality than Meta’s consumer version, where people will get to hang out with their friends at imaginary coastal mansions. Unlike that metaverse, which is populated mostly by human avatars, the corporate version is largely a collection of objects. These are “digital twins”, virtual 3D replicas of all sorts of physical assets, from single screws to entire factories.

Crucially, they are connected to their real selves—a change on the shop floor, for instance, will trigger the equivalent change in its digital twin—and

collect data about them. This set-up enables productivity-enhancing operations that are hard today, for example optimising how groups of machines work together. Simulating changes virtually can then be replicated in the real world. And, its boosters hope, a path would be laid to automate even more of a firm's inner workings.

Whether the enterprise metaverse becomes a reality is not simply of interest to aficionados of corporate information technology (IT). Innovations unlocked through insights gleaned from digital mirror-worlds can help firms become more adaptable and efficient—helping them reduce carbon emissions, for example. Promoters of the concept even argue that it will put to rest the old adage, coined by Robert Solow, a Nobel-prizewinning economist, that you can “see the computer age everywhere but in the productivity statistics”.

The concept of this “twinworld”, as the enterprise metaverse might be called (a spiffy moniker will surely be found), is not new. Some of the necessary technologies have been around for years, including devices with sensors to capture data, known as the “internet of things” (IoT)—another field still waiting for a moniker upgrade. Software to design detailed virtual replicas originated in computer games, the current benchmark for immersive worlds.

But other bits have only recently become good enough, including superfast wireless links to connect sensors, cloud computing, and artificial intelligence, which can predict how a system is likely to behave. “Digital twins aggregate all of these things,” explains Sam George, who runs the enterprise-metaverse effort at Microsoft.

As is its wont as a maker of corporate software, Microsoft has developed an entire platform on top of which other firms can develop applications. This includes tools to build digital twins and analyse the data they collect. But

this “stack”, as such collections of code are known, also provides technology which allows people to collaborate, including Mesh, a service that hosts shared virtual spaces, and HoloLens, a mixed-reality headset, with which users can jointly inspect a digital twin.

Nvidia’s roots in computer graphics mean it focuses more on collaboration and creating demand for its chips. Its Omniverse is also a platform for shared virtual spaces, but one that allows groups of users to bring along elements they have built elsewhere and combine these into a digital twin they can then work on as a team. The common technical format needed for such collaboration will come to underpin digital twins in the same way HTML, a standard formatting language, already underpins web pages, predicts Richard Kerris, who is in charge of Omniverse.

Both platforms have already attracted a slew of startups and other firms that base some of their business on this technology. Cosmo Tech, for instance, takes Microsoft’s tools to do complex simulations of digital twins to predict how they might evolve. And Bentley Systems, which sells engineering software, uses Omniverse to optimise energy infrastructure. Both Microsoft and Nvidia have also teamed up with big firms to show off their wares. AB InBev, a beer giant, collaborates with Microsoft to create digital twins of some of its more than 200 breweries to better control the fermentation process. In the case of Nvidia, the top partner is BMW, which uses Omniverse to make it easier to reconfigure its 30 factories for new cars.

Despite all this activity, it is not a given that the enterprise metaverse will take off as fast as its champions expect, if ever. Similar efforts have failed or disappointed, including many IoT projects. “Smart cities”, essentially attempts to build urban metaverses, turned out to use technology that was just not up to snuff and relied too much on proprietary standards.

If the enterprise metaverse does indeed take shape, though, it will be an

intriguing process. Will it be based on proprietary technology or on open standards (there is already a Digital Twin Consortium)? And, asks George Gilbert, a veteran observer of the IT industry, how will software-makers such as Microsoft be paid for their wares? Since their code will be more embedded than ever in firms' products and services, some may ask for a slice of revenue instead of licensing or subscription fees.

And then there is the question of how the overall metaverse economy will function. Since most business activity will be digitally replicated, economists may have unprecedented insight into what is going on. Digital twins could exchange services between themselves and perhaps replace firms as the main unit of analysis. If digital twins live on a blockchain, the sort of platform that underpins most cryptocurrencies, they could even become independent and own themselves. Expect at least as many possibilities as metaverses to unfold. ■



另一个元宇宙

企业希望创建真实世界的虚拟镜像

把数字世界和物理世界联系起来可以开启创新

元宇宙可谓遍地开花。自从Facebook（抱歉，现在是Meta了）的老板扎克伯格在10月下旬描绘了他对沉浸式虚拟世界（他认为人们会想要在那里花很多时间）的构想以来，各种新的元宇宙就开始层出不穷。娱乐元宇宙会让乐迷们高兴不已；网红们会涌向时尚元宇宙，炫耀数字服装；甚至还有个与加密货币相关的星际鲨鱼元宇宙。这些大多是营销人员的创意，不过是给最新的科技热安上一个新名词。

不过，有一个新的虚拟世界确实值得关注，那就是“企业元宇宙”。企业元宇宙本质上是实体经济的数字翻版，相形之下摇滚明星和花哨衣裙实在不算什么。假以时日，如此构建出的复制了物理世界的逼真的交互式蓝图可能会塑造物理世界。这可能意味着什么？对这一问题的构想最近开始变得清晰起来。本月初，全球最大的软件公司微软将企业元宇宙设定为自己年度客户大会的中心话题，图形处理器巨头英伟达在11月9日也是这么做的。

在Meta的个人版中，人们可以和朋友在虚构的海滨豪宅中玩耍。个人元宇宙里聚集了人们的数字化身，企业元宇宙则不同，它本身就更接近现实，很大程度上是一个个物体的集合。这些“数字孪生体”是从单个螺丝到整个工厂的各种实物资产的虚拟3D复制品。

关键是，它们与实体自我相关联——例如，车间里发生了一个变化，其数字孪生体就会出现相同的变化——并收集关于它们的数据。这种设置能够实现目前难以实现的那类提高生产率的操作，比如优化一组机器的协同工作。在虚拟世界中模拟变化，之后便可以在真实世界中复制这种变化。此外，这种做法的支持者希望能由此探索出一条道路，让企业的内部运作更多地实现自动化。

企业元宇宙能否成为现实，并不只有企业IT迷才感兴趣。从数字镜像世界获得洞见，继而解锁创新，可以帮助企业提升适应能力和效率——比如帮助它们减少碳排放。这一概念的倡导者甚至认为，它将颠覆出自诺贝尔经济学奖得主罗伯特·索洛（Robert Solow）的那句老话：“计算机时代（的影响）随处可见，就是在生产率的统计数据中看不到。”

企业元宇宙或许可以被叫作“孪生世界”（以后肯定还会有更响亮的叫法），这一概念并不新鲜。其中一些必要的技术已经存在多年，比如，被称为“物联网”（IoT）的带有数据采集传感器的设备——物联网这个名称也该升级一下了。设计精细的虚拟复制品所用的软件源自目前充当了沉浸式世界的模板的电脑游戏。

但其他技术直到近来才变得足够强大，包括连接传感器的超高速无线链路、云计算和可以预测系统如何运行的人工智能。“数字孪生体集合了所有这些东西。”微软负责企业元宇宙项目的山姆·乔治（Sam George）解释道。

老本行就是开发企业软件的微软已经开发了一个完整的平台，其他公司可以在此基础上开发应用。这包括创建数字孪生体以及对它们收集的数据进行分析的工具。但这个“堆栈”（即代码集合）也提供方便人们协作的技术，比如提供共享虚拟空间的服务平台Mesh，以及让不同用户可以一起检查一个数字孪生体的混合现实头显HoloLens。

英伟达以计算机图形处理起家，这意味着它会更加关注协作以及为自家芯片创造新需求。它的Omniverse也是一个共享虚拟空间的平台，但它可以让一群用户把各自在其他地方创建的元素带进来，并把这些元素组合进一个数字孪生体，然后组成一个团队共同操作它。这种协作需要有通用技术格式，这种格式将会像HTML（一种标准的格式化语言）支撑网页那样支撑数字孪生体，Omniverse的负责人理查德·克里斯（Richard Kerris）预测。

两个平台都已经吸引到大量创业公司和其他企业，它们基于这种技术创建

起部分业务。例如，Cosmo Tech利用微软的工具来创建复杂的数字孪生体模拟，以预测未来可能的变化。销售工程软件的Bentley Systems利用Omniverse优化能源基础设施。微软和英伟达都通过和大公司合作来展示自己的产品。啤酒巨头百威英博（AB InBev）与微软合作，对它200多家酿酒厂中的一些创建了数字孪生体，以更精准地控制发酵过程。而英伟达最大的合作伙伴是宝马，它利用Omniverse来更方便地改造自己的30家工厂以生产新车型。

尽管如此热闹，企业元宇宙并不一定就会像它的拥护者所期望的那样，很快就大行其道——是否有这一天都不好说。一些类似的尝试已经失败或令人失望，比如许多物联网项目。“智慧城市”实质上就是试图创建城市元宇宙，但使用的技术不够好，而且太过依赖专有标准。

不过，如果企业元宇宙真的形成，过程将会非常有趣。它会基于专有技术还是开放式标准（现在已经有了个“数字孪生体联盟”[Digital Twin Consortium]）？而且，IT业资深观察人士乔治·吉尔伯特（George Gilbert）问道，像微软这样的软件公司将如何对自己的产品收费？由于这些软件公司的代码将比以往任何时候都更多地植入到各家公司的产品和服务中，一些软件公司可能会要求收入分成，而不是收取许可费或订阅费。

然后还有整个元宇宙经济将如何运作的问题。由于大多数商业活动将被数字化复制，经济学家或许将就正在发生的事情获得前所未有的洞察。不同的数字孪生体之间可能会相互交换服务，它们也可能会取代公司成为主要的分析对象。如果数字孪生体依存于区块链，也就是那种支持大多数加密货币的平台，它们甚至可能会独立存在而不隶属于任何人。想来各种可能性至少会和以后出现的元宇宙一样多。■



The movie business

How Hollywood's biggest stars are losing their clout

Streaming has changed the economics of talent

HOLLYWOOD LABOUR disputes have a certain theatrical flair. When Scarlett Johansson sued Disney in July, claiming she had been underpaid for her role in “Black Widow”, the studio launched an Oscar-worthy broadside against the actress’s “callous disregard for the horrific and prolonged global effects of the covid-19 pandemic”. In September film crews marched to demand better conditions, brandishing placards designed by America’s finest propmakers. And when WarnerMedia decided to release “Dune” on its streaming service on the same day it hit cinemas on October 21st, the movie’s director, Denis Villeneuve, huffed magnificently that “to watch ‘Dune’ on a television...is to drive a speedboat in your bathtub.”

The streaming revolution has sent money gushing into Hollywood as studios vie to attract subscribers. Netflix boasts that its content slate in the fourth quarter will be its strongest yet, with new titles such as “Don’t Look Up”, starring Leonardo DiCaprio, and the final season of “Money Heist”, a Spanish bank-robbing saga. On November 12th Disney announced its latest commissioning blitz, with new shows including “Star Wars” and Marvel spin-offs. In total, streaming firms’ content spending could reach \$50bn this year, according to Bloomberg.

Yet despite the largesse it is a turbulent time in Tinseltown, as everyone from A-list stars to the crews who style their hair goes to war with the film studios. Some of the disputes have arisen from the pandemic, which has upended production and release schedules. But the tension has a deeper cause. As streaming disrupts the TV and movie business, the way talent is compensated is changing. Most workers are better off, but megastars’ power

is fading.

Start with the pandemic. As cinemas closed, studios scrambled to find screens for their movies. Some, like MGM's latest James Bond flick, were delayed by more than a year. Others were sent to streaming platforms—sometimes without the agreement of actors or directors. Those whose pay was linked to box-office revenues were compensated, either behind the scenes (as WarnerMedia did in the case of "Dune") or after very public spats (as with Disney and Ms Johansson).

Even before covid, streaming was changing the balance of power between studios and creatives. First, there is more work to be done. "There's an overwhelming demand and need for talent, driven by the streaming platforms and the amount of money that they're spending," says Patrick Whitesell, boss of Endeavour, whose WME talent agency counted Charlie Chaplin among its clients. Three years ago there were six main bidders for new movie projects, as Netflix vied with five major Hollywood studios. Now, with the arrival of Amazon, Apple and others, there are nearer a dozen. Streamers pay 10-50% more than the rest, estimates another agent.

Below-the-line workers, such as cameramen and sound engineers, are also busier. Competition among studios has created a "sellers' market", says Spencer MacDonald of Bectu, a union in Britain, where Netflix makes more shows than anywhere outside North America. In the United States the number of jobs in acting, filming and editing will grow by a third in the ten years to 2030, four times America's total job-growth rate, estimates the Bureau of Labour Statistics.

The streamers' hunger for variety means their seasons have half as many episodes as broadcast shows, and are less frequently renewed. That means "people are having to hustle for work more often," says one script supervisor. A fatal accident on the set of "Rust", a movie starring Alec

Baldwin, has stirred a debate about the frantic pace of production. But the streamers' short, well-paid seasons allow more time for CV-burnishing side-projects, and the work is more creatively rewarding. IATSE, a union which represents 60,000 below-the-line workers in America, has reached an agreement with studios for better pay and conditions; its members began voting on the deal on November 12th.

More controversial is the streamers' payment model, which is creating new winners and losers. Creative stars used to get an upfront fee and a "back-end" deal that promised a share of the project's future earnings. For streamers, a show's value is harder to calculate, lying in its ability to recruit and retain subscribers rather than draw punters to the box office. Studios also want the freedom to send their content straight to streaming without wrangling with a star like Ms Johansson, whose pay is linked to box-office takings. The upshot is that studios are following Netflix's lead in "buying out" talent with big upfront fees, followed by minimal if any bonuses if a project does well.

That suits most creatives just fine. "Buy-outs have been very good for talent," says Mr Whitesell. "You're negotiating what success would be...for that piece of content, and then you're getting it guaranteed to you." Plus, instead of waiting up to ten years for your money, "you're getting it the day the show drops". America's 50,000 actors made an average of just \$22 per hour last year, when they weren't parking cars and pumping gas, so most are happy to take the money up front and let the studio bear the risk. Another agent confides that some famous clients prefer the streamers' secrecy around ratings to the public dissection of box-office flops.

For the top actors and writers, however, the new system is proving costly. "People are being underpaid for success and overpaid for failure," says John Berlinski, a lawyer at Kasowitz Benson Torres who represents A-listers. The old contracts were like a "lottery ticket", he says. Create a hit show that ran

for six or seven seasons and you might earn \$100m on the back end; make a phenomenon like “Seinfeld” and you could clear \$1bn.

A few star showrunners such as Shonda Rhimes, a producer of repeat TV hits currently at Netflix, can still swing nine-figure deals. But creators of successful shows are more likely to end up with bonuses of a couple of million dollars a year. And though actors are receiving what sound like huge payments for streamers’ movies—Dwayne Johnson is reportedly getting \$50m from Amazon for “Red One”, for example—in the past they could make double that from a back-end deal.

Some creative types grouse that the newcomers simply don’t understand showbusiness. With its “phone-company mentality”, AT&T, a cable giant that acquired WarnerMedia in 2018, turned Hollywood’s most storied studio into “one of the last stops you’d make”, complains one agent. Disney’s new boss, Bob Chapek, came up through the company’s theme-park division. The Silicon Valley streamers are more comfortable with spreadsheets than stardust.

But their unwillingness to venerate A-listers also has an economic rationale. The star system, in which actors like Archibald Leach were transformed into idols like Cary Grant, was created by studios to de-risk the financially perilous business of movie-making. A blockbuster, which today might cost \$200m to shoot plus the same in marketing, has one fleeting chance to break even at the box office. The gamble is less risky if a star guarantees an audience.

Today, studios are de-risking their movies not with stars but with intellectual property. Disney, which dominates the box office, relies on franchises such as Marvel, whose success does not turn on which actors are squeezed into the spandex leotards. Amazon’s priciest project so far is a \$465m “Lord of the Rings” spin-off with no megastar attached. Netflix’s

biggest acquisition is the back-catalogue of Roald Dahl, a children's author, which it bought in September for around \$700m.

What's more, streaming's approach to generating hits is different. Whereas winning at the box office required betting big on a few mammoth projects, Netflix's method is "more like a random walk where 'hits' are first discovered by their users, then amplified by...algorithms," notes MoffettNathanson, a firm of analysts. Netflix served up 824 new episodes in the third quarter of this year, more than four times as many as Amazon Prime or Disney+. Its biggest success, "Squid Game", has a cast that is largely unknown outside South Korea. "Competition is not limited to who has the best content; it is also framed around who has the best tech" for discovering it, says MoffettNathanson. In the new Hollywood, stars are neither made nor born: they are algorithmically generated. ■

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影业

好莱坞巨星正在失去影响力

流媒体改变了演艺人员经济学

好莱坞的劳资纠纷带有几分戏剧性。斯嘉丽·约翰逊在7月状告迪士尼没有给足她出演《黑寡妇》的报酬。迪士尼对她发起了奥斯卡颁奖词级别的抨击，说这位女演员“冷酷无视新冠疫情在全球造成可怕的而持久的影响”。9月，电影摄制人员上街游行要求改善工作条件，手中挥舞着美国最好的一批道具制作师设计的标语牌。华纳媒体（WarnerMedia）决定让《沙丘》在10月21日院线首映当天于其流媒体平台同步上架，该片导演丹尼斯·维伦纽夫（Denis Villeneuve）怒发冲冠，语出惊人：“在电视上看《沙丘》……就如同在你家浴缸里开快艇。”

电影公司正在竞相吸引订阅观众，流媒体革命已经让大量资金涌入好莱坞。奈飞称其第四季度的节目将是迄今为止最精彩的，其中包括由莱昂纳多·迪卡普里奥主演的《千万别抬头》（Don't Look Up）等新剧，还有西班牙银行抢劫传奇《纸钞屋》（Money Heist）的最后一季。11月12日，迪士尼宣布了包括《星球大战》和漫威衍生剧在内的最新一批委托制作计划。彭博的数据显示，今年流媒体公司的内容支出总计可能达到500亿美元。

然而，尽管并不缺钱，好莱坞却处于动荡时期，因为从一线明星到发型师等工作人员，所有人都在和电影公司开战。部分争议源自打乱了影视制作和放映计划的疫情。但这种紧张局面还有更深层次的原因。随着流媒体不断颠覆电视和电影产业，演艺人员的报酬方式正在发生变化。大多数从业人员的待遇更好了，但巨星的议价力在减弱。

先从疫情说起。随着院线关闭，电影公司争先恐后地为它们的电影寻找放映渠道。有些电影推迟了上映，比如米高梅最新的007电影就推迟了一年多。其他的则放到了流媒体平台上，而有时这并未经过演员或导演同意。

那些片酬与票房挂钩的人拿到了补偿，要么是私下了结（像华纳传媒的《沙丘》），要么是通过高调的口水仗（如迪士尼和约翰逊）。

甚至在疫情之前，流媒体就已经开始改变电影公司和创作人员之间的力量平衡了。首先，要干的活更多了。“流媒体平台，还有它们撒出的大把资金，推动了对演艺人员的巨大需求。”Endeavour集团的老板帕特里克·怀特塞尔（Patrick Whitesell）说，该集团的艺人经纪公司WME曾服务过查理·卓别林。三年前，一部新电影一般有六个主要竞标方，由奈飞与好莱坞五大电影公司相竞争。现在，随着亚马逊、苹果等公司的加入，竞标的公司有十来个。流媒体公司开出的价格会比其他公司高出10%至50%，另一家经纪公司估计。

摄影师和音响工程师等主创团队以外的工作人员也更忙碌了。电影公司之间的竞争创造了“卖方市场”，广播娱乐电影与剧院工会（Bectu）的斯宾塞·麦克唐纳（Spencer MacDonald）说。Bectu是英国的工会，奈飞在英国制作的内容比除北美外的任何地方都多。美国劳工统计局估计，在到2030年的十年内，美国在表演、电影摄制和剪辑方面的工作岗位将增长三分之一，是美国总就业岗位增长率的四倍。

流媒体平台渴求多样性，这就使得它们的剧集每季集数只有传统电视剧的一半，也更少续拍新季。这意味着“人们不得不更频繁地更换剧组”，一位剧本监制说。亚历克·鲍德温（Alec Baldwin）主演的电影《铁锈》（Rust）片场发生致命事故，引发了一场关于制作节奏太过疯狂的争论。但流媒体集数更少而报酬不俗，让人们有更多时间参与额外的项目来丰富自己的简历，也能带来更多创作上的历练和成就感。代表美国六万名主创外工作人员的工会国际戏剧舞台雇员联盟（IATSE）已与电影公司达成协议，争取到了更好的薪资和工作条件，会员于11月12日开始对该协议投票。

更具争议的是流媒体的薪酬模式，它正在创造新的赢家和输家。以前，演艺明星会获得一笔预付款和一份承诺从作品未来收益中分成的“片酬入股”协议。在流媒体上，节目的价值更难计算，要看能否招揽和留住订阅者，

而不是吸引观众到影院。电影公司也希望能够自由地把内容直接拿到流媒体平台上播放，而不必与像约翰逊这样片酬与票房收入挂钩的明星争执不休。其结果是，电影公司纷纷效仿奈飞的做法，以高昂的前期费用与演艺人员“一次过结清”，日后就算剧集红了，也不用再给他们多少分红，或者完全不给。

对于这种模式，大多数创作人员都能接受。“一次过结清对演艺人员非常有利，”怀特塞尔说，“你是根据某个片子可能会获得的成功来谈判，谈成了也就保证能拿到手。”此外也不用等上十年才能拿到钱，“片子上线那天就能落袋为安”。去年，美国五万名演员的平均时薪只有22美元，还得靠代客停车和在加油站打工维持生计，所以大多数人都乐于先收钱，让电影公司承担风险。另一位经纪人透露，相比票房惨败被公开剖析，一些知名客户更喜欢流媒体对收视率秘而不宣。

然而，对于顶级演员和编剧来说，新的薪酬模式损失很大。“成功时报酬过低，失败时报酬过高。”Kasowitz Benson Torres律师事务所的律师约翰·柏林斯基（John Berlinski）说，一些一线明星是该律所的客户。以前的合同就像一张“彩票”，他说。制作出一部能连播六七季的热播剧，那你有可能拿到一亿美元的提成，要是能制作出像《宋飞正传》（Seinfeld）这样的超级大热剧，你能拿到十亿。

个别明星制作人仍然可以拿下九位数的合同，例如奈飞多部热播电视剧的制作人珊达·瑞姆斯（Shonda Rhimes）。但成功剧集的创作者更多的情况会是每年到手两三百万美元的奖金。如今演员拿到的片酬对于流媒体电影而言似乎已属不菲，据报道巨石强森因将出演《Red One》从亚马逊拿到了五千万美元，但在过去，演员可以靠片酬入股获得两倍的收入。

一些创作者抱怨流媒体新贵根本不懂娱乐业。一位经纪人抱怨说，有线电视巨头AT&T于2018年收购了华纳媒体，用它的“电话公司思维”让这家好莱坞最富盛名的影视公司沦为了“你不到万不得已都不想登门的那几个合作方”。迪士尼的新老板鲍勃·查佩克（Bob Chapek）是从公司的主题公园部门晋升上来的。硅谷的流媒体公司更擅长电子表格而不是银幕造梦。

但它们不愿推崇一线明星也有经济上的原因。电影公司创建了造星系统，让演员阿奇博尔德·里奇（Archibald Leach）变成偶像加里·格兰特，目的是降低电影制作的财务风险。如今拍一部大片的成本可能高达两亿美元，还要花同样多的钱做宣发，但在影院只有昙花一现的机会来回报。如果有明星坐镇吸引来观众，投资风险就会小一些。

如今，电影公司降低投资风险不是依靠明星，而是借助知识产权。票房赢家迪士尼靠的是各种系列电影，比如漫威系列，其成功并不取决于塞进弹力紧身衣的是哪些演员。迄今为止，亚马逊成本最高的作品是投资4.65亿美元的电视剧版《指环王》，该剧并没有巨星加盟。今年9月，奈飞以约7亿美元的价格收购了儿童作家罗尔德·达尔（Roald Dahl）全部作品的版权，这是它迄今最大的一笔收购。

而且，流媒体打造大热门的方式也不一样。分析公司MoffettNathanson指出，通常赢得票房要靠对几部大制作下重注，但奈飞的方法“更像是‘随机游走’模式，让订阅用户先发现‘热剧’，然后通过算法提升热度”。今年第三季度Netflix推出了共824集新剧，是Amazon Prime或Disney+的四倍多。它最火的剧集《鱿鱼游戏》的演员在韩国以外几乎闻所未闻。“竞争不只是看谁有最好的内容，还要看谁有最好的技术”来发现最好的内容，MoffettNathanson称。在今天的好莱坞，明星既不是造出来的，也不是天生的，他们是算法生成的。





The flywheel delusion

Uber, DoorDash and similar firms can't defy the laws of capitalism after all

The mania over ride-sharing and delivery companies has at times been absurd

IN THE REAL world a flywheel is a mechanical contraption that stores rotational energy. In Silicon Valley it has come to mean something else: a perpetual-motion business that not only runs forever but is self-reinforcing. Thanks to powerful network effects, the theory goes, a digital platform becomes more attractive as it draws in more users, which makes it even more attractive and so on. The end state is a venture that has gathered enough energy to self-levitate and throw off tons of cash.

The payout on one of the most richly funded bets of the past decade or so revolves around whether ride-sharing and delivery firms—which once were part of something known as the “sharing economy” but are better described as the “flywheel economy”—can actually ever live up to their heady promise. The outcome will matter to more than just venture capitalists who backed their growth. Whether these flywheels do gather unstoppable momentum is also of interest to regulators worried about technology’s propensity for winner-takes-all business models, not to mention paid-by-the-gig workers caught in its cogs.

Consider the results of Uber and DoorDash, the largest Western ride-sharing and delivery apps respectively. Optimists will have seen plenty to cheer them. On November 4th Uber proclaimed it was at last profitable, albeit only on the flattering metric of “adjusted EBITDA”. Strong third-quarter figures from DoorDash, which were released on November 9th, fuelled an already heady rally in its shares (the firm also announced the acquisition of Wolt, a Finnish food-delivery company, for \$8bn).

But look deeper and evidence is mounting that business flywheels are not defying the laws of capitalism. The money that went into building them recalls the railway mania among other past speculative investment crazes. The nine firms that have gone public so far—Uber and its American rival Lyft; Didi, a Chinese ride-sharing app; and six delivery firms, from DoorDash and Delivery Hero, which is based in Berlin, to China's Meituan and India's Zomato—collectively raised more than \$100bn. In most cases, the capital was intended to jumpstart those network effects and make market dominance a self-fulfilling prophecy. Seemingly bottomless pits of investors' cash went to subsidising rides and deliveries to juice demand. This reached absurd points: a pizzeria could make money by ordering its own food for a discounted price on DoorDash (which then paid back the regular amount). To justify such profligacy, interested parties pointed to the huge "total addressable market", another popular term in Silicon Valley. Bill Gurley of Benchmark, an early investor in Uber, argued in 2014 that the firm could vie for as much as \$1.3trn in consumer spending if one saw it as an alternative to car ownership.

Measured against such visions, the flywheel economy has proven a dud. To be sure, the nine listed flywheel firms are still growing nicely—at 103% on average in their latest reporting period compared to the same period the previous year. This explains why they are collectively worth nearly \$500bn. But self-levitating they are not. Nor are they profitable. Sales for the group amounted to \$75bn over the past year and the operating loss to nearly \$11.5bn.

As the firms have discovered, their businesses are less perpetual motion machines than real-world flywheels that inevitably lose energy to friction, says Jonathan Knee of Columbia Business School and the author of a book entitled "The Platform Delusion". The network effects in fact have proved much weaker than expected. Many users switch between Uber and Lyft. Drivers also flit between them, or to delivery apps, depending on which

model offers the best pay. This bargaining power from both sides means the system does not become self-reinforcing after all.

Technology, too, has turned out to be less beneficial than expected. Data collected by the firms help optimise their operations, but are not the decisive factor some had hoped for. Regulators keep pushing back. In London they have forced Uber to pay drivers minimum wages and pensions. In San Francisco they capped the fees DoorDash can charge restaurants for delivering their meals.

Uber's tortuous path to stemming losses should temper investor optimism. It eked out a profit of \$8m on revenues of \$4.85bn. That excludes expenses that are unlikely to disappear, such as stock-based compensation. The company has crawled out of its sea of red ink mostly by slashing costs, shedding technology assets such as its autonomous-car unit, charging higher prices and increasing its "take rate", the share of the fares it keeps. As a result, an Uber is now no cheaper—and often more expensive—than conventional cabs, plenty of which can be hailed via apps these days.

What is more, the company, which has a market capitalisation of \$85bn, is now more of a delivery service than a ride-hailing app: Uber Eats generates more than half of sales. DoorDash's own punchy valuation, of \$65bn, rests on revenue that has grown more than fourfold since the last quarter of 2019, albeit during a time when people dined at home more often. But it also bakes in success in new markets that it has recently entered, including groceries and pet food.

Real business flywheels do exist. Software makers have managed to lock users in and thus generate gross margins typically above 70%. Venture capitalists are hoping against all hope to find new ones. They are already pouring money into the next generation of flywheel contenders: instant-delivery startups, which offer gratification in 30 minutes or less. Coupon-

collecting consumers in cities such as New York now get at least a week's worth of groceries for nothing from such services as Buyk, Fridge No More and Gopuff. Eventually, these firms' champions promise, their economics will be far better than those of an Uber or a DoorDash. In the flywheel economy hope and hype spring eternal, at least as long as interest rates remain low and capital is essentially free. ■

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飞轮幻觉

优步、DoorDash及其同类终究无法违背资本主义规律

对拼车和外卖公司的狂热有时堪称荒谬

在现实世界里，飞轮是一种机械装置，储存旋转产生的能量。在硅谷，飞轮有了不一样的含义：一个不仅会不停运转，还能自我增强的永动企业。其中的逻辑是，由于强大的网络效应，数字平台在吸引到更多用户的同时会变得更具吸引力，而这又会让它吸引更多人，如此循环往复。最终结果就是一个企业会积累起足够的能量，能自己飞起来并抛甩出漫天飞舞的钞票。

过去十年左右的时间里，被押注最多的领域之一当属拼车和外卖公司——它们曾经属于所谓的“共享经济”，但现在把它们称作“飞轮经济”更为恰当。能赢回多少钱得看它们能否真的兑现那些让人兴奋陶醉的承诺。最终结果不仅对支撑其增长的风险投资家很重要。监管机构也在关注这些飞轮能否积聚起不可阻挡的动能，它们担心技术总是催生赢家通吃的商业模式，更别提困在齿轮里的零工工人了。

来看看西方最大的拼车应用优步和外卖应用DoorDash的成绩吧。乐观主义者会看到很多让他们振奋的数字。11月4日，优步宣布它终于盈利了，尽管只是按更好看的“调整后的EBITDA（税息折旧及摊销前利润）”来计算的。11月9日，DoorDash公布了强劲的第三季度数据，让之前已大幅反弹的公司股价更上一层楼（它还宣布以80亿美元收购芬兰外卖公司Wolt）。

但深入观察会发现，越来越多的证据表明商业飞轮并没能违背资本主义的规律。大笔资金涌向搭建这些飞轮，让人想起昔日的铁路热等投机性投资热潮。迄今为止已经上市的九家公司共融资逾一千亿美元，它们是：优步及其美国竞争对手Lyft、中国打车应用滴滴，以及六家外卖公司，包括DoorDash、总部位于柏林的Delivery Hero、中国的美团和印度的Zomato等。这些投资大多数情况下都是为了启动它们的网络效应，让雄霸市场的

预言自我实现。仿佛源源不断的投资被拿来补贴拼车和外卖以刺激需求。这套做法已经走到了荒谬的地步：披萨店可以靠在DoorDash上下订单买自己店里的东西来赚钱，因为支付给平台的是折扣价，而之后平台会按原价打款给店里。为了证明这样烧钱合情合理，利益相关方搬出了巨大的“潜在市场规模”（TAM），这是硅谷的另一个流行词。Benchmark是优步的早期投资方之一，该公司的比尔·格利（Bill Gurley）在2014年提出，如果人们选择不再自己买车而使用优步，那它争夺的将是高达1.3万亿美元的消费者支出。

与这样的愿景相比，飞轮经济已然失败。当然了，这九家上市的飞轮公司仍保持着不俗的增长——在最近的财报期内，它们平均同比增长了103%。这解释了为什么它们的总市值接近5000亿美元。但它们还没能自己飞起来，也没能盈利。过去一年这九家公司的销售额总计达到750亿美元，运营亏损近115亿美元。

《平台幻觉》（The Platform Delusion）一书的作者、哥伦比亚商学院的乔纳森·尼恩（Jonathan Knee）说，正如这些公司已经发现的，它们的业务与其说是永动机，不如说是现实世界的飞轮，不可避免地会因摩擦而损耗能量。实际上，网络效应远不如预期的那般强大。许多用户在优步和Lyft之间切换。司机也在这两家公司之间跳来跳去，或者转去送外卖，就看哪种模式给的报酬最高。这两方的议价能力意味着这个体系终究无法实现自我强化。

技术带来的好处同样不如预期。这些公司收集的数据帮助它们优化运营，但没有像一些人希望的那样成为决定性因素。监管机构一直在压制它们。在伦敦，监管机构迫使优步向司机支付最低工资和养老金。在旧金山，它们对DoorDash向餐厅收取的送餐费用设定了上限。

优步曲折的止损道路应该会让投资者的乐观情绪降点温。它的营收为48.5亿美元，只是勉强实现了800万美元的利润。这还没计入一些不太可能省去的支出，比如股权激励。优步主要是通过削减成本、剥离自动驾驶部门等技术资产、涨价和提高车费中的“抽成”摆脱巨额亏损的。结果是优步现

在并不比传统出租车便宜——往往还更贵，而且现在很多传统出租车都可以通过应用叫到。

此外，这家市值850亿美元的公司现在更像一个外卖平台，而不是叫车应用：Uber Eats贡献了一半多的销售额。DoorDash的估值同样高至650亿美元，主要是基于其营收自2019年第四季度以来增长了三倍多——不过这与这段时期人们更多在家就餐密不可分。但这一估值也已反映了它近来在新市场获得的成功，包括日用杂货和宠物食品。

真正的商业飞轮确实存在。软件开发商成功地锁定了用户，由此产生了通常超过70%的毛利。风险投资家们心存一线希望，想要找到新的飞轮。他们已经将大量资金倾入下一代飞轮竞争者：提供30分钟内即时满足的即时送货创业公司。在纽约等城市，喜欢收集优惠券的消费者现在可以从Buyk、Fridge No More和Gopuff等服务平台上免费获得至少一周的食品杂货。这些公司的支持者许诺，最终它们的经济效益会比优步或DoorDash好得多。不管怎样，只要利率保持在低位、资本基本上自由，飞轮经济中的希望和炒作就会转个不停。





Material needs

China seeks to extend its clout in commodity markets

Aside from its big appetite for energy and metals, it is also opening up to international traders

FEW CRISES highlight China's weight in commodity markets as clearly as the global energy crunch. Though analysts attribute the shortages to many different causes, all mention China. Its post-covid economic recovery, coupled with a hot summer, produced a surge in demand for power. Supplies of its two main sources of electricity, coal and hydropower, were curbed by environmental crackdowns and droughts respectively.

At first China tried to supplement power generation with liquefied natural gas (LNG). Its imports of LNG so far this year are 14% higher than in the same period last year. That has caused prices to surge and has had ripple effects around the world. As LNG cargoes have been rerouted east, for instance, Europe has found itself short of gas. Rising gas prices have only underscored the importance of coal in China, which already consumes 55% of the world's supply of the stuff. In October China imported nearly twice as much coal as it had in the same month in 2020, causing prices to boom. Even oil has risen on expectations that China will burn that too, if necessary, to keep its electricity plants running. As usual in commodity markets, other factors are also at play. But China still shakes the world.

China's heft is partly the result of its size. As a huge consumer and, in some cases, producer of materials, it can disrupt global markets even with modest tweaks to policy. Its clout is growing on the financial side of commodity trading too, thanks to China's three big futures exchanges; international traders say that you cannot be successful without dealing on them. Now China wants to extend its influence over commodities further still. Officials

are aiming to turn the proliferation of local contracts, for instance, into international price standards.

The rule of thumb for commodity traders is that China consumes “half of everything”. For some materials, such as iron ore, even this is an understatement (see chart 1). China’s big appetite alone gives it influence in markets. But it also means that the authorities deem many commodities strategically important. And they are not shy about intervening.

Take maize. A glut in China in 2010-15 pushed government inventories up to unprecedented levels and led the authorities to reduce financial incentives to corn farmers. But the resulting fall in output was too sharp, forcing China to look overseas to replenish stocks. Corn imports jumped from less than 5m tonnes a year in 2013-18 to almost 30m tonnes in 2020. Partly as a consequence, American corn prices doubled over the first half of last year.

China’s strategies also involve boosting supply to keep prices low. In order to keep a lid on infrastructure costs in the 2000s, it invested in a huge number of aluminium smelters and encouraged producers to raise output. Graeme Train of Trafigura, a trading firm, estimates that the smelters cost around \$70bn. But without them, the price of aluminium would probably have increased in line with that of copper, says Mr Train. And that would have raised China’s infrastructure costs by an extra \$1trn or so between 2000 and 2015.

In some cases China’s appetite has helped create new financial systems. Iron ore, the main ingredient of steel, is a good example. Between 2003 and 2016 China’s imports of the ore rose tenfold as it built masses of steel-intensive infrastructure. Today it is the world’s biggest consumer of iron ore, for which it has also become “the world’s most sophisticated” market, says a manager at a big mining firm.

Buyers in other countries, such as Japan and South Korea, tend to prefer long-term contracts. In China a dynamic spot market has emerged, which gives punters opportunities to resell excess ore and informs the price of long-term contracts. Dozens of seaports act as mini iron-ore exchanges. They have storage facilities and serve as places where customers can buy and sell ore. Analysts look at the portside price to gauge the outlook for the market.

Chinese trading firms are becoming more sophisticated, too. The biggest, such as PetroChina and Sinopec, two state-owned oil companies, are getting better at strategically steering the market, notes Michal Meidan of the Oxford Institute for Energy Studies. They mimic tactics used by European traders. That includes placing bets to shift the price of the Dubai benchmark which, in part, helps inform the prices in their long-term contracts. Other Chinese traders are scaling up. In March COFCO, a food giant, announced plans to float its trading arm.

China's commodity-futures exchanges are now world-beating. The three big ones are in Dalian, Shanghai and Zhengzhou. The number of contracts traded on these in 2020 was six times higher than on America's CME Group's exchanges (see chart 2). In terms of value they were roughly equivalent. From January to June this year the ten most-traded agricultural futures contracts were all Chinese. So were eight of the top ten metals contracts and five of the top ten energy contracts.

Chinese exchanges look different from Western ones. They are dominated by retail investors (who are nicknamed "chives" because when they get cut down, they soon grow back). Estimates from 2016 suggest that this group holds around 85% of open positions, compared with 15% on Western bourses. They trade smaller lots, too, and hold them for less time, which adds to liquidity. A lack of expertise means retail investors tend to

accentuate price swings. For the most part, they are losing money, says Xiao Jin of Orient Futures, a broker.

For officials in Beijing, the next step in the development of China's commodity markets is to turn the country's benchmarks into global standards. One reason for this is to boost use of the yuan, which is used to conduct only 2-3% of cross-border commodity trades, compared with the dollar's share of 38%. Another is that officials are wary of Western benchmarks, suspecting that they may have been manipulated.

Until now China's way of protecting its manufacturers and consumers from price volatility had been through isolation. Only select state firms could trade on foreign commodity-futures exchanges, and only a small group of international traders could access Chinese ones. Those exchanges have no warehouses—which are where physical commodities are delivered—outside the mainland. Foreign exchanges are not allowed warehouses inside China.

But the new strategy of benchmark nationalism is leading China to slowly loosen the rules for international traders. Around 80 commodity-futures contracts are traded on its big exchanges, nine of which are available to foreign punters. That covers mostly imported commodities, such as copper and oil. Some of these trade on Shanghai's International Energy Exchange, a subsidiary of the city's Futures Exchange designed to appeal to traders abroad. As more investment firms take advantage of arbitrage opportunities, the prices of futures contracts on Western and Chinese exchanges are more often moving in tandem.

More opening up is in the works. In September the State Council, China's cabinet, said it would launch more futures contracts, accelerate the participation of overseas traders in Chinese markets and build another yuan-denominated exchange aimed at such punters.

Two big problems stand in the way of these ambitions, though. One is shifting commodity demand. Over the next decade this is likely to become more evenly spread around the world, argues Jeffrey Currie of Goldman Sachs, a bank. Climate-friendly policies require vast amounts of metals to build wind turbines and power grids. Meanwhile, China's economy will slowly become more services-oriented, reducing the need for commodities. Its consumption of some metals, such as aluminium, is expected to peak in the next few years.

Another hurdle is trust. China's commodity exchanges are closely tied to the state. Senior managers move between exchanges and government departments. Authorities intervene readily in markets. Investors point to China's intervention in equity markets after a downturn in 2015. Back then, it banned short-selling and told investors with big stakes in companies that they could not sell shares. All this makes commodity investors worry about the predictability of Chinese markets.

Indeed, China has dabbled with commodity-market intervention in the past year, as prices have gone berserk. Authorities worry that rising costs will squeeze the manufacturing sector. To offset this, in the summer they sold some of their metal reserves and cracked down on speculative hoarding. In September they auctioned off oil reserves, too. In both cases the extra supply was so small that it had no lasting effect on prices. But analysts think the goal was not to move the market but to signal to investors that regulators are watching it.

The energy transition will probably make commodity prices much more volatile, as demand and supply adjust over time and one occasionally overshoots the other. Chinese authorities will have to decide whether to interfere or let markets respond. The path they choose will determine the future of commodity markets far beyond their borders. ■



实质需求

中国寻求扩大在大宗商品市场上的影响力

除了对能源和金属需求庞大以外，它还在逐步向国际贸易商开放

这轮全球能源荒可说是前所未有地突显出中国在大宗商品市场中的分量。尽管分析师们把能源短缺归咎于许多不同因素，但都提到了中国。中国疫后经济复苏，加上夏季天气炎热，使得电力需求激增。中国的煤电和水电这两大电力来源的供应却分别受到了环保政策收紧和旱灾的制约。

起初，中国试图用液化天然气发电来填补缺口。今年到目前为止，中国的液化天然气进口量比去年同期高出14%。这导致价格飙升，在全球造成连锁反应。例如，随着液化天然气改道输向东方，欧洲发现自己陷入了天然气短缺。天然气价格的上涨继而又更突显出煤炭在中国的重要性。中国本身已经消耗了全球煤炭供应量的55%，而它在10月进口了接近去年同期两倍的煤炭，导致煤炭价格暴涨。市场预期中国在必要时会以石油为燃料来维持发电厂运行，所以连石油价格也跟着涨。当然，一如大宗商品市场的常见情形，其中还有其他因素在起作用。但中国依然是冲击全球的力量。

中国的影响力有一部分源自其规模。作为一个庞大的消费市场，有时还是原料生产者，中国即使只是对政策稍作调整，也能扰乱全球市场。中国的三大期货交易所使它在大宗商品交易上的金融影响力也在不断增强；国际贸易商表示，不通过这些交易所买卖难以成事。现在，中国希望进一步扩大对这个市场的影响。比如，官员们希望借助激增的本地合约打造国际价格标准。

大宗商品交易商的经验法则是中国消耗“一切的一半”。对于铁矿石等一些原料，这么说都还太过保守了（见图表1）。中国仅凭它庞大的胃口就获得了市场影响力。但这也意味着中国政府会认为许多大宗商品都具有战略重要性。而它也并不避忌施加干预。

以玉米为例。在2010年至2015年间，中国玉米供应过剩，政府库存上升至前所未有的高水平，于是政府降低了对玉米种植的财政补贴。但这又导致产量下降过快，迫使中国从海外进口来补充库存。玉米进口量从2013年至2018年的每年不足500万吨跃升至2020年的近3000万吨。这在一定程度上致使美国玉米价格在去年上半年翻了一番。

中国的战略还包括增加供应以维持低价。在本世纪头十年，为控制基础设施成本，中国投资兴建大量炼铝厂，并鼓励生产商提高产量。据大宗商品贸易公司托克（Trafigura）的格雷姆·特雷恩（Graeme Train）估计，建设这些冶炼厂的成本约为700亿美元。但是，如果没有这些冶炼厂，铝价本可能会和铜价同步增长，特雷恩说。而那会让中国在2000年至2015年间的基建成本多出一万亿美元左右。

在某些情况下，中国的胃口帮助创建了新的金融系统。钢铁的主要原料铁矿石就是一个很好的例子。2003年至2016年期间，中国大举兴建高耗钢基础设施，中国的铁矿石进口量增长了十倍。今天，中国是全球最大的铁矿石消费国，也是“世界上最成熟的”铁矿石市场，一家大型矿业公司的主管说。

日韩等其他国家的买家倾向于选择长期合约。中国形成了活跃的现货市场，让交易者可以转售多余的铁矿石，也影响长期合约的价格。数十个海港起到了小型铁矿石交易所的作用。它们拥有储存设施，客户可以在这里买卖铁矿石。分析师会根据港口交易价来评估市场前景。

中国的贸易商也越发老练精明。牛津大学能源研究所（Oxford Institute for Energy Studies）的米哈尔·梅丹（Michal Meidan）指出，中国最大的贸易公司越来越懂得战略性引导市场，比如中石油和中石化这两家国有石油公司。它们仿效欧洲贸易商的策略，包括押注以影响迪拜基准价，这一价格在一定程度上影响它们的长期合约价格。其他中国贸易商正在扩大规模。今年3月，食品巨头中粮集团宣布了将其国际贸易部门挂牌上市的计划。

中国的大宗商品期货交易所如今已属世界一流。它的三大交易所分别位于大连、上海和郑州。2020年在这些交易所交易的合约数量是在美国芝加哥商品交易所集团（CME Group）的六倍（见图表2）。在总交易额上两者大致相当。今年1月到6月，中国包揽了农产品期货品种全球交易量前十，在金属和能源的前十名里分别占了八个和五个。

中国的交易所看起来和西方的不同。参与其中的主要是一些散户投资者（被戏称为“韭菜”，因为韭菜被收割后很快又会长出来）。2016年的估计表明，这一群体持有约85%的未平仓合约，而西方交易所的这一比例仅为15%。他们的交易量也较小，且持仓时间较短，令流动性加大。散户投资者缺乏专业知识，往往导致价格波动加大。上海东证期货的金晓说，他们多数情况下都是亏钱的。

对北京的官员来说，中国大宗商品市场发展的下一步是要把本国基准变成全球标准。一个原因是扩大使用人民币，目前的跨境大宗商品交易只有2%至3%是以人民币结算，而以美元结算的占38%。另一个原因是官员们对西方基准心存警惕，怀疑它们可能受到操纵。

迄今为止，中国一直通过设立隔绝屏障的方式来保护自家生产商和消费者免受价格波动的影响。只有特定的国有企业可在外国商品期货交易所交易，只有一小批国际贸易商可进入中国的交易所。这些交易所在大陆以外没有仓库（商品在那里做实际交割）。外国交易所不被允许在中国境内设立仓库。

但是，基准民族主义的新战略正让中国慢慢放松对国际贸易商的限制。目前约有80个大宗商品期货合约在中国的大型交易所交易，其中九个向外国交易者开放，包括铜和石油等主要为进口的商品。其中一部分是在上海国际能源交易所交易，该交易所是上海期货交易所为吸引海外交易者而设立的子公司。随着越来越多的投资公司利用套利机会，西方和中国交易所的期货合约价格走势渐趋一致。

还有更多的开放举措在酝酿中。9月，中国国务院表示将推出更多期货合

约，加速推进海外交易者参与中国市场，并针对这些交易者再建立一个人民币计价的交易所。

不过这些宏大抱负有两大拦路虎。一是大宗商品需求的变化。高盛的杰弗里·柯里（Jeffrey Currie）认为，未来十年，需求可能会在全球更均匀地分布。气候友好型政策需要用到大量金属去建设风力涡轮机和电网。与此同时，中国的经济将慢慢变得更加侧重服务业，大宗商品需求随之下降。中国对铝等金属的消费预计将在未来几年内触顶。

另一个障碍是信任。中国的商品交易所与政府关系紧密。高级管理人员在交易所和政府部门之间流动。有关部门随时会干预市场。投资者指出，中国政府在2015年股灾后就采取了干预行动。当时，政府禁止卖空，且不准拥有大量公司股权的投资者出售股份。这一切令大宗商品投资者对中国市场的可预测性感到担忧。

事实上，过去一年，随着大宗商品价格暴涨，中国也曾试着干预。政府担心成本上升会挤压制造业。为了消除这种影响，政府在夏天卖出了部分储备金属，同时打击投机性囤积。9月，政府又拍卖了部分储备石油。这两次拍卖增加的供应量都不大，对价格没有造成持久影响。但分析师认为，政府的目标不是影响市场走势，而是向投资者发出信号，表明监管部门在密切关注情况。

能源转型很可能将大幅增加大宗商品的价格波动，因为需求和供应将逐渐调整，时不时会出现需求或供应过剩的情况。中国政府将不得不决定是插手干预还是让市场自行调节。它所选择的道路将决定大宗商品市场的未来，而这市场远远超越其国界。 ■



Free exchange

Janos Kornai understood capitalism by studying its opposite

Prices cannot work if losses do not hurt

IN HIS CABIN aboard the SS Bashan, a luxury river boat sailing to Wuhan, Janos Kornai was sleepless with excitement. The Hungarian economist, who died last month, was one of seven foreign experts invited in 1985 to share their views on China's economic reforms. As Julian Gewirtz recounts in his book "Unlikely Partners", Mr Kornai stole the show. On a week-long cruise with an audience of Chinese technocrats, he dissected socialism's familiar "cares and woes" (featherbedded firms, rushed growth and consumer shortages). And he offered a hopeful vision of a restrained, guided capitalism. His book "Economics of Shortage" soon became a bestseller in China, although he never saw any royalties.

Forty years earlier, Mr Kornai lay on the roof of a Jesuit monastery in Budapest, hiding from a fascist raid down below, even as Soviet forces dropped bombs from above. The skyline had a "hellish beauty", he wrote. As a Jewish Hungarian who had lost his father and a brother to the Holocaust, he welcomed the Soviets as liberators. He did not even mind when they stole his watch. His gratitude was one reason why he became an enthusiastic communist, so devoted to his work on a party newspaper that he missed the birth of his first child. His communism, in turn, explains why he became an economist. He pored over Karl Marx's "Das Kapital". Enlightenment radiated from it "like sunshine", he later wrote. "I had no more doubts about what profession to choose."

The spell of Marxism broke when he met a victim of the torture it entailed. He also came to hate the improvised haste of journalism. He turned instead to research at Hungary's Institute of Economics. But his reporter's habits

served him well in his dissertation. By interviewing managers, grumbling with them about bureaucratic idiocy, wastage and “disregard for customer needs”, he crafted a rare systematic account of how a planned economy actually worked, as opposed to how it was supposed to work. The book also served as an index of shifting political winds. It was celebrated in the lead-up to the Hungarian revolution in 1956, denounced after that revolution was crushed by Soviet tanks, then approved for translation into English, all by the same person, the director of the institute.

Some socialist reformers thought that widespread state ownership was compatible with market forces and price signals. But Mr Kornai recognised that getting prices right, even if it were possible, would not be enough. Under capitalism, a firm cannot defy prices for long without going bust. Under socialism, things were different. State-owned firms knew they could always appeal to higher authorities to bail them out. In 1979 Mr Kornai called this a “soft budget constraint”: the sharp line drawn by economists on their blackboards was smudged. If firms do not fear losses, they need not heed prices. This lack of financial restraint also allowed firms to indulge their “investment hunger”, an excessive appetite for resources, which squeezed out consumers and resulted in chronic shortages.

The argument made his name: it was a “congenial” extension of a concept familiar to mainstream economists. Mr Kornai had once had larger ambitions, hoping to smash the crystal through which most economists viewed the world. He had studied neoclassical theorists such as Kenneth Arrow with much the same care he had lavished on Marx. But he could not square their ethereal “general equilibrium” theory with his observations of the living, breathing economy. The mismatch reminded one economist of a line by the poet Edith Sodergran: “You searched for a woman and found a soul—you are disappointed.”

On the China cruise, Mr Kornai convinced his audience of the need to

harden the budget constraints of the country's firms. One of his fellow passengers is now China's banking regulator. But the imposition of financial discipline remains a work in progress. The rise in defaults, even of state-owned firms, in recent years is evidence of some harder financial lines. But it comes only after years of gluttonous investment.

China has not, however, suffered chronic shortages. On the contrary, it is a "super-surplus" economy, marked by massive excess capacity, as Xu Chenggang, one of Mr Kornai's students, has pointed out. One reason is that state-owned enterprises do not have the economy to themselves. They coexist with fiercely competitive private firms. The surpluses may also reflect the dual nature of investment. It is both an immediate source of demand and an eventual source of supply. In the short run, it makes a claim on the economy's resources, which can crowd out consumers. But when the investment bears fruit, it adds to the economy's ability to supply goods and services, resulting in abundance not scarcity.

Like the economies he deciphered, Mr Kornai inhabited two worlds. He was half in the mainstream of economics, half out. From 1983, he was half in America, half out. The transitions were not always easy. It took him time to perfect his English. In his Boston driving test, he declared that a "no hitchhiking" sign was a "no hijacking" sign. In a lecture, he repeatedly mispronounced warehouse as whorehouse. On returning home to Hungary each year, he had to remember to drop his upbeat stateside persona and complain a bit more.

But although he straddled different worlds, he was in no doubt where his allegiances ultimately lay. "Despite its detrimental and morally nasty features...I would sooner live under the capitalist system than in the happiest barrack in the socialist camp," he wrote in his memoir. And although he was intellectually opposed to patriotic bombast, he felt an instinctive pride in the achievements of his compatriots. It was their music

and literature that moved him. Their unillusioned meliorism that animated him. He counted in Hungarian. And when he wasn't sleepless with excitement, he dreamt in it too. ■



自由交流

科尔奈理解资本主义的方法是研究它的对立面

若亏损无所谓，则价格无作用

在驶往武汉的豪华游轮“巴山号”上，雅诺什·科尔奈（Janos Kornai）在他的隔间里兴奋得睡不着觉。这位匈牙利经济学家（于上个月去世）是1985年应邀登上这艘船，分享对中国经济改革的看法的七名外国专家之一。按朱利安·格维兹（Julian Gewirtz）在《不太可能的伙伴》（Unlikely Partners）一书中所述，科尔奈出尽了风头。在为期一周的航程中，他向一众中国技术官僚剖析了社会主义常见的“烦恼和困境”（企业太过安逸、增长急于求成、消费者数量不足）。他提出了一个有前途的愿景：一种受约束、受引导的资本主义。他的著作《短缺经济学》（Economics of Shortage）很快在中国成为畅销书，尽管他从未收到任何版税。

时间再往前倒带40年，科尔奈趴在布达佩斯一个耶稣会修道院的屋顶上，躲避下面法西斯分子的突袭，同时苏军正从天上扔炸弹。天际线有一种“地狱般的美”，他写道。这个匈牙利犹太人在大屠杀中失去了父亲和一个兄弟，将苏联人视为解放者而欢迎他们。他甚至不介意被他们偷去了手表。这种感激之情是他成为一名热情的共产主义者的原因之一。他在一家党报忙得不可开交，错过了自己第一个孩子的出生。对共产主义的热忱又引领他成为了一名经济学家。他一丝不苟地研读马克思的《资本论》，启迪“如阳光般”从书中照耀，他后来写道。“我对职业选择不再有什么疑问。”

当他遇到一个遭受折磨的受害者时，马克思主义的魔力被打破了。他也开始讨厌新闻工作的匆忙仓促。他转去匈牙利经济研究所从事研究工作。但做记者养成的习惯对他撰写研究文章大有裨益。通过采访管理者，并和他们一起抱怨官僚主义的愚蠢、浪费和“漠视客户需求”，他对计划经济的实际运行方式做出了罕见的系统性阐述，呈现它如何与本意背道而驰。这本书也成了政治风向转变的风向标。它在1956年匈牙利革命前夕受到赞誉，

当那场革命被苏联坦克粉碎后又遭到谴责，之后又被批准译成英语，而这种种态度都出自同一个人——该研究所的所长。

一些社会主义改革者认为，广泛的国有制可与市场力量和价格信号兼容。但科尔奈认识到，即使有可能制定出合理的价格，这也是不够的。在资本主义制度下，一家公司不可能长期忽视价格，否则就会破产。而在社会主义制度下，情况就不同了。国有企业知道，它们总是可以请求上级政府帮助它们摆脱困境。1979年，科尔奈将这种情况称为“软预算约束”：经济学家在黑板上画出的那条清晰明确的曲线被抹花了。如果企业不担心亏损，它们就不需要在意价格。这种财务约束的不足也会让企业放纵其“投资饥渴症”——对资源过度渴求，这排挤了消费者，导致了长期短缺。

这个论点使他声名鹊起：它是对主流经济学家都熟知的一个概念“适宜的”延伸。科尔奈曾有过更大的雄心，希望把大多数经济学家拿来观察世界的水晶砸个粉碎。他像当初一头扎进马克思那样研读肯尼斯·阿罗（Kenneth Arrow）等新古典主义理论家。但他无法把他们优雅缥缈的“一般均衡”理论与自己对真实经济的观察统一起来。这种差异让一位经济学家想起了诗人伊迪斯·索德格朗（Edith Sodergran）的一句诗：“你寻找一个女人，却找到一个灵魂——你失望了。”

在中国的那条游轮上，科尔奈让他的听众确信有必要加强对国有企业的预算约束。当时他的同行乘客之一现在是中国银行业监管部门的一把手。但财务纪律的贯彻至今仍未完成。近年来违约增多，甚至包括一些国有企业，体现了更加强硬的财务管控。但这也只是在多年的肆意投资之后才实施的。

然而，中国并没有遭受长期短缺。相反，正如科尔奈的学生许成钢所指出的那样，中国是一个以产能严重过剩为标志的“超级过剩”经济体。原因之一是国有企业并没有完全垄断经济，而是与激烈竞争的私营企业共存。这种过剩也可能反映了投资的二重性。它既是直接的需求来源，最终也是供应的来源。从短期来看，投资占用了大量经济资源，有时排挤了消费者。但当投资取得成果时，它又提升了经济体供应商品和服务的能力，最终导

致供应充足而非短缺。

正如他解读不同的经济体那样，科尔奈生活在两个世界里。他一半在主流经济理论之内，一半置身其外。从1983年开始，他一半时间在美国生活，一半在别处。来回转切有时不容易。他花了一些时间才把英语说熟练。在波士顿考驾照时，他把“禁止搭便车”的标志叫做“禁止劫持”。在一次演讲中，他一再把“仓库”错念成“妓院”。每年回到匈牙利的家中，他都得提醒自己把身上那个快乐的美国人格丢掉，稍微多抱怨一点。

但是，尽管跨越了不同的世界，他对自己心之所属并无疑问。“尽管它有着各种有害和道德上令人厌恶的特征.....我还是宁愿生活在资本主义制度下，而不是在社会主义阵营最幸福的营房里。”他在回忆录中写道。而虽然他理智上反对爱国主义的夸夸其谈，他对自己同胞的成就有一种本能的自豪感。他们的音乐和文学打动着他。他们那种不抱幻想的社会改良主义激励着他。他数数的时候用匈牙利语。而当他没有兴奋得睡不着的时候，他的梦境也是匈牙利语的。 ■



Scott free

MacKenzie Scott is giving away more money, faster, than anyone has before

But America's champion philanthropist operates like a middle-class donor

IN JUNE 2020, Jorge Valencia of the Point Foundation started receiving calls and emails from consultants doing due diligence on his organisation, which helps lesbian, gay, bisexual, transgender and queer (LGBTQ) students into higher education. They wanted financial statements and asked questions about how the group was responding to the pandemic. For a non-profit organisation that relies on donations, it was nothing out of the ordinary.

What came next, however, was. Just a few weeks later they received another call, this time with news that MacKenzie Scott, the former wife of Jeff Bezos, who founded Amazon, wanted to make a large gift. There were no restrictions on how the money was to be spent or plans to monitor the group's work beyond a short annual report—just a request to keep quiet about the source of the donation for a few weeks. Mr Valencia will not disclose how much money Ms Scott gave. But, in the midst of a pandemic, as many non-profit groups are worried about funds drying up, it has allowed the Point Foundation to more than double the number of young people it helps this year. "It was a godsend," Mr Valencia says.

Ms Scott is an unusual billionaire. A novelist by trade, she came into a vast fortune when her 25-year marriage to Mr Bezos came to an end in 2019. As a result of the blockbuster divorce settlement she has become the 22nd-richest person in the world, with a net worth of around \$60bn. Yet she is, by all accounts, an understated sort. She has married a science teacher at the school her children attend in Seattle and signed the Giving Pledge,

promising to devote most of her wealth to giving back. Her only comments on her philanthropy so far are contained in three short blog posts sprinkled with references to poetry by Rumi and Emily Dickinson.

That discretion masks immense power. Over the course of the pandemic Ms Scott has become one of the most generous philanthropists in history, announcing \$8.6bn in gifts in the 12 months to June. That is widely thought to be the largest sum anyone has ever given to operating charitable groups in such a short period. Other wealthy people tend to give to foundations, which then disburse grants over time. The Bill and Melinda Gates Foundation, the largest private development foundation in America, for example, dished out \$5.8bn in 2020.

Ms Scott is also exceptional for the way she donates. Most “mega donors” today take a technocratic approach. They set up a foundation, put potential grantees through a gruelling application process, fund specific projects and monitor them closely. Ms Scott is giving the way middle-class people do: donating to a bunch of organisations and leaving them to get on with their work. As Benjamin Soskis at the Centre on Non-profit and Philanthropy at the Urban Institute, a think-tank, puts it: “Her fundamental priority is getting money out the door.”

The first big decision rich people make when they decide to give money away is who to give it to. Here Ms Scott has relied on outside advisers, including The Bridgespan Group, a non-profit consultancy spun out of Bain and Company, rather than setting up a permanent bureaucracy of her own. The approach she has settled for involves spraying funds across relatively small organisations working on a wide range of concerns, including racial and gender equality.

A good chunk of Ms Scott’s gifts have gone to local groups in America, such

as food banks and YMCAs. Bloomberg News sent a survey to the recipients of all 786 gifts and got responses from 270. They found that half, excluding colleges and universities, have fewer than 50 employees. For nearly 90% of them, Ms Scott's donation is the largest they have ever received. Contrast that with the Gates Foundation, which has handed about 30% of its total funding over the past two decades to ten big international groups, including the World Health Organisation; Gavi, the vaccine alliance; and the Global Fund to Fight AIDS, Tuberculosis and Malaria.

The second step is deciding how to dish out money. Here, Ms Scott's decision to make unrestricted grants is particularly popular with beneficiaries. The leaders of non-profit organisations grumble that donors too often tie money to specific projects, leaving them struggling to finance day-to-day operations. One-third of groups that received funds from Ms Scott are using the money to hire more people and over a fifth plan to invest in technology, according to the Bloomberg poll.

Ms Scott likes to fund people with personal experience of the problems they are trying to solve. The Interfaith Youth Core, for example, which received a \$6m gift, was founded by Eboo Patel, an Indian-American Ismaili Muslim. The Chicago-based non-profit has decided to use some of the money to launch an online magazine that writes about subjects such as Jewish baseball players and voodoo festivals in Haiti. Implicit in Ms Scott's unfenced giving, Mr Patel says, is a recognition that the person with the money doesn't necessarily know best. "It makes the recipient feel honoured and dignified," he says.

The third step is how to evaluate what organisations do with the money. Ms Scott has said little about this, but here too, grantees say, she takes a light-touch approach. One, the National Centre for Family Philanthropy, has been asked to submit a "simple and brief" report every year for the next three years that lays out what the organisation is up to. There is no template for

that report and no effort to advise the organisation along the way. Ms Scott has coined a term for this approach: “seeding by ceding”.

Whether it was her intention or not, Ms Scott has issued a challenge to the bureaucratic, top-down model that has dominated American philanthropy for decades. It already seems to be influencing other rich people. Ms Scott’s ex-husband, for example, is chided for refusing to sign the Giving Pledge and being slow to make donations. But when Mr Bezos landed back on Earth after his first trip into space earlier this year, he announced a £200m gift that was a surprise to the recipients and came in the form of unrestricted grants. “No bureaucracy,” he said.

None of this is to say that Ms Scott has found some magic formula. In pursuit of discretion, she forgoes transparency. She has kept her advisers secret, so non-profit leaders eager to get on her radar have no way to contact her, aside from commenting on her blog. There are so many con artists pretending to dole out cash on her behalf that Ms Scott’s Twitter bio directs victims to a Federal Bureau of Investigation complaints page. And because she is giving as an individual, she doesn’t face the same reporting requirements as a foundation. Rob Reich at Stanford University points out that this opacity is rare among big donors. “It is insulting to democratic citizens because of the kind of power she wields,” he thinks.

Of course, Ms Scott’s strategy could change. She is just getting started with her philanthropy. Even as she announced her first round of grants last year, she vowed “to keep at it until the safe is empty”.

That could be more difficult than it sounds. The source of her fortune is a 4% stake in Amazon she received as part of the divorce settlement in April 2019. Shares in the e-commerce giant have rallied some 95% since then. Ms Scott’s safe is fuller now than it was when she began shovelling money out of the door. ■



斯科特不设限

麦肯齐·斯科特捐款之多之快前无古人

但这位美国头号慈善家捐款的方式却像一位中产人士

去年6月，帮助LGBTQ（女同性恋、男同性恋、双性恋者、跨性别者及酷儿）学生接受高等教育的点基金会（Point Foundation）的豪尔赫·瓦伦西亚（Jorge Valencia）开始接到一些咨询师的来电和电子邮件，对他的基金会展开尽职调查。他们想看看财务报表，并询问一些有关基金会如何应对新冠疫情的问题。对于一个依赖捐赠的非营利组织来说，这并没有什么不同寻常之处。

但接下来发生的事情就不寻常了。几周后，基金会工作人员又接到一个电话，这次他们被告知亚马逊创始人贝索斯的前妻麦肯齐·斯科特

（MacKenzie Scott）想向他们捐一大笔钱。除了要提供一份简明的年度报告外，对方并没有限定这笔钱的用途，也没有打算监督该基金会的工作——只是要求对捐款来源保密几个星期。瓦伦西亚不会透露斯科特的捐款数额。但是，在疫情期间，在许多非营利组织都在为资金枯竭忧心之时，这笔钱让今年获得点基金会帮助的年轻人增加了一倍多。“那真是天赐之福，雪中送炭。”瓦伦西亚说。

斯科特是位与众不同的亿万富翁。2019年，本职是小说家的她结束了与贝索斯25年的婚姻，获得了一大笔财富。那张轰动一时的离婚协议书让她以大约600亿美元的净资产晋升全球第22大富豪。不过，大家都说她是个低调的人。她已经再婚，对象是自己孩子在西雅图就读的学校的一名科学老师。她还签署了“捐赠誓言”（Giving Pledge），承诺将自己的大部分财产回馈社会。到目前为止，她仅有的几条对自己慈善行为的说明出现在她发布的三篇简短的博文中，其中穿插着许多鲁米（Rumi）和艾米丽·迪金森（Emily Dickinson）的诗句。

这种自主而偏隐蔽的做法掩盖了巨大的影响力。疫情期间，斯科特已经成

为有史以来最慷慨的慈善家之一，在截至今年6月的12个月里，她共宣布了86亿美元的捐赠。人们普遍认为，这是迄今为止在如此短的时间内向运作中的慈善组织所做的最大规模个人捐赠。其他富人倾向于向基金会捐款，再由基金会逐步发放赠款。例如，美国最大的私人发展基金会比尔和梅琳达·盖茨基金会在2020年发放了58亿美元。

斯科特的捐赠方式也与众不同。目前，大多数“超级捐赠者”都采用专业化管理的方式。他们成立基金会，那些有望获得捐助的人必须经过艰难的申请过程；只资助特定的项目，并密切监控这些项目。而斯科特捐赠的方式像是位中产人士：直接向一些机构捐款，由它们自行开展工作。正如智库城市研究所（Urban Institute）下属非营利和慈善中心（Centre on Non-profit and Philanthropy）的本杰明·索斯基（Benjamin Soskis）所说，“她的头等大事就是把钱送出去。”

当富人决定把钱捐出去的时候，他们要做的第一个重大决定就是捐给谁。在这一点上，斯科特依靠的是从贝恩公司（Bain and Company）派生出来的非营利咨询公司Bridgespan Group等外部顾问，而不是自己成立一家固定机构。她采用的方法包括将资金分散捐给致力于种族和性别平等各种问题的相对较小型的机构。

斯科特的捐款有很大一部分给了美国的地方团体，比如食品银行和基督教青年会（YMCA）。彭博社对全部786笔捐款的受赠机构发起了调查，收到了270份回复。调查人员发现，排除大学院校之后，一半受赠机构的员工人数都不到50人。对于其中近九成的受赠机构来说，斯科特的捐款是它们收到过的最大笔捐款。相比之下，盖茨基金会在过去20年里把总金额的30%捐给了十家大型国际组织，包括世界卫生组织、全球疫苗免疫联盟（Gavi），以及抗击艾滋病、结核病和疟疾全球基金。

第二步是决定如何分配资金。在这一点上，斯科特选择了非限定性捐赠，这是一种受赠方特别欢迎的方式。非营利机构的负责人常常抱怨捐赠者总是把资金捆绑在特定项目上，让他们很难把钱用于日常运营。彭博的调查

显示，在获得斯科特捐款的机构中，有三分之一正把捐款用于雇请更多人手，超过五分之一计划把钱投入到技术上。

斯科特喜欢资助那些对自己尝试解决的问题有亲身体验的人。例如，由印度裔美国人、伊斯玛仪派穆斯林埃布·帕特尔（Eboo Patel）创办的跨信仰青年核心组织（Interfaith Youth Core）得到了斯科特600万美元的捐款。这家总部位于芝加哥的非营利组织已经决定把其中一部分用于推出一份在线杂志，撰写有关犹太棒球运动员和海地巫毒教节日等主题的文章。帕特尔表示，斯科特对捐款用途不设限制，隐含着她认可这样一种观点，即捐赠者不一定是最了解情况的人。“这让受赠者感到光荣而有尊严。”他说。

第三步是如何评估受赠机构对资金的使用情况。斯科特很少谈及这一点，不过受赠人表示，她同样采取了减少干预的做法。比如说，她只要求国家家庭慈善中心（National Centre for Family Philanthropy）在未来三年每年提交一份“简明扼要”的报告，说明自己在做些什么。这份报告没有模板，而且整个过程中也不对该中心提什么建议。斯科特把这种方法称作“无为而治”。

无论是否是斯科特的本意，她的做法已经向数十年来主导美国慈善事业的自上而下的官僚模式发起了挑战。这似乎已经开始对其他富人产生影响。例如，斯科特的前夫因拒绝签署“捐赠誓言”以及捐款迟缓而受到指责。不过当贝索斯今年早些时候结束首次太空之旅返回地球时，他宣布捐赠两亿英镑，受赠者事先全不知情，而且是非限定性捐赠。“没有官僚程序。”他说。

这一切并不说明斯科特找到了某种魔法。为能自主行事，她牺牲了透明度。她一直不公开自己的顾问方，因此渴望引起她注意的非营利组织负责人没法联系她，只能到她的博客上留言。有非常多的骗子冒用斯科特的名义假做捐款行骗，以至于她推特上的个人简介会把受害者指引到FBI的投诉页面。并且因为她是以个人身份捐赠的，所以不需要面对像基金会那样的报告要求。斯坦福大学的罗伯·赖克（Rob Reich）指出，这种不透明的做法在捐款大户中很罕见。“这是对公民民主精神的冒犯，因为她能产生

那么大的影响力。”他认为。

当然，斯科特可能会改变策略。她的慈善事业才刚刚起步。就在去年她宣布第一轮捐款的时候，她就誓言要“坚持到底，直到把保险箱捐空”。

这或许听起来容易做起来难。在2019年4月的离婚协议中，她获得了亚马逊4%的股份，这是她的财产来源。自那以后，这家电子商务巨头的股价拉升了大约95%。如今，斯科特的保险箱比她刚开始往外铲钱的时候更满了。 ■



Solar-cell census

An accurate tally of the world's solar-power stations

The method should work for other energy infrastructure, too

REBUILDING AN ENTIRE planet's energy system is a big job. Just ask the delegates at the COP-26 climate conference held in Britain last month. The most basic problem is knowing what, exactly, you are trying to rebuild. Academic-research groups, think-tanks, charities and other concerned organisations try to keep track of the world's wind turbines, solar-power plants, fossil-fuelled power stations, cement factories and so on. To this end, they rely heavily on data from national governments and big companies, but these are often incomplete. The most comprehensive database covering American solar-power installations, for instance, is thought to miss around a fifth of the photovoltaic panels actually installed on the ground.

In a paper just published in *Nature*, a team of researchers led by Lucas Kruitwagen, a climate scientist and AI researcher at Oxford University, demonstrate another way to keep tabs on the green-energy revolution. Dr Kruitwagen and his colleagues have put together an inventory of almost 69,000 big solar-power stations (defined as those with a rated capacity of 10kW of electricity or more) all over the world—more than four times as many as were previously listed in public databases. This new inventory includes their locations, the date they entered service and a rough estimate of their generating capacity.

Conceptually, the team's method is simple. Instead of relying on top-down reports, they worked from the bottom up, looking at the entire planet from space and counting how many solar panels they could see. This is not the first time people have hunted from orbit for solar-power stations. But

previous analyses have been limited to a few countries. As far as Dr Kruitwagen knows, his is the first attempt to survey the entire planet for a particular type of infrastructure. Earth is a big place, of course, which means practice is a great deal harder than theory. His approach has been made possible by two big technological trends.

One is a growing abundance of cheap, easily available satellite imagery. In the 20th century, reconnaissance satellites were the jealously guarded property of a handful of governments. These days, a cottage industry of Earth-observation firms and agencies sells images on the open market. Dr Kruitwagen's pictures came from two sets of satellites, Sentinel-2 and SPOT, run by the European Space Agency and Airbus respectively. These peer down on the world, recording visible light and also the infrared and ultraviolet parts of the spectrum. The images Dr Kruitwagen used amounted to around 550 terabytes of data, spanning the period between 2016 and 2018. That is enough to fill more than a hundred desktop hard drives.

Sifting through this many pictures by eye would have been impractical. That is where the second technological trend comes in. Dr Kruitwagen and his colleagues trained a machine-learning system to spot the solar panels for them.

Computer vision is a hot field. But the specifics of orbital reconnaissance meant that off-the-shelf software was not suitable for the task the researchers had in mind. Machine-learning systems are taught what to do by examining a "training set", which contains examples of what is being searched for. For common tasks such as facial recognition, pre-built training sets are often available. But Dr Kruitwagen's team had to build their own.

For this, they turned to OpenStreetMap, an open-source rival to Google Maps

in which volunteers had already tagged large numbers of solar plants. But there was little consistency. “Some people had just drawn rough outlines around an entire field,” Dr Kruitwagen says. “Others had gone in and traced the outline of each row of panels separately.” Fixing that involved a great deal of manual labour.

Once the training data had been cleaned up, the learning algorithms had to be tweaked as well. From space, even big solar installations look small. Each pixel in the Sentinel images represented a ten-by-ten-metre square. Even for the higher-resolution SPOT satellites, the squares’ sides are one and a half metres long. Existing classifiers, trained for things like facial recognition or self-driving cars, are used to spotting objects that loom large in their field of vision. Hunting for smaller ones meant tinkering with the software to boost its ability to detect tiny features. False positives—things like tennis courts and agricultural greenhouses that resemble solar panels from space—had to be removed.

Though extraordinary, Dr Kruitwagen’s results are already out of date. The data-gathering phase of the project ended in 2018, meaning that the thousands of new plants built since then are not included. But the project, he says, proves that the method works. He intends to make his results, including the labour-intensive training set, available for others to use. One logical extension of his project, he says, would be to expand the analysis to include solar panels installed on domestic rooftops. Such “behind-the-meter” installations are particularly tricky to track in other ways.

More generally, Dr Kruitwagen hopes that his eye-in-the-sky approach—which, despite the planetary scale of the project, cost only around \$15,000 in cloud-computing time—could presage more accurate estimates of other bits of climate-related infrastructure, such as fossil-fuel power stations, cement plants and terminals for ships carrying liquefied natural gas. The eventual result could be the assembly of a publicly

available, computer-generated inventory of every significant bit of energy infrastructure on Earth. Quite apart from such a model's commercial and academic value, he says, an informed public would be one better able to hold politicians' feet to the fire. ■

For more coverage of climate change, register for The Climate Issue, our fortnightly newsletter, or visit our climate-change hub ■



太阳能图谱

准确统计全球太阳能发电站

这种方法应该也适用于其他能源基础设施

重建整个地球的能源系统是一个大工程。问问上月在英国出席COP26气候会议的代表们就知道了。最基本的问题是弄清楚到底要重建什么。学术研究团体、智库、慈善组织和其他相关机构想要追踪记录世界上所有的风力涡轮机、太阳能发电站、化石燃料发电厂、水泥厂等。为此它们非常倚重各国政府和大公司的数据，但这些数据往往并不完整。例如，统计全美太阳能设施的最完整的数据库据信遗漏了约五分之一实际已经安装好的光伏面板。

在刚刚发表于《自然》期刊的一篇论文中，牛津大学的气候科学家、人工智能研究员卢卡斯·克鲁特瓦根（Lucas Kruitwagen）领导的研究团队展示了另一种统计绿色能源革命的方法。克鲁特瓦根和他的同事们整理出了一份全球近6.9万座大型太阳能发电站（定义为额定容量在10千瓦及以上的发电站）的清单——数量是之前在公共数据库中列出的四倍多。这份新清单列出了它们的位置、投用日期和对其发电容量的粗略估计。

从概念上讲，这个团队的方法很简单。他们不再依赖自上而下的报告，而是自下而上地调查，从太空观察整个地球，数数他们能看到多少太阳能板。这不是人们第一次从轨道上寻找太阳能发电站。但之前的分析仅限于几个国家。据克鲁特瓦根所知，像他这样调查整个地球上某一类基础设施的尝试还是第一次。当然，地球非常大，这意味着实践起来要比理论上困难得多。有两大技术趋势让他的方法成为可能。

其一是越来越多价格低廉且容易获取的卫星图像。在20世纪，侦察卫星是少数几个国家才有的财产，被政府小心翼翼地守护着。如今，一小批分散的地球观测公司和机构在公开市场上出售图像。克鲁特瓦根的照片来自两个卫星系统——“哨兵2号”（Sentinel-2）和SPOT，分别由欧洲航天局和空

中客车运营。它们俯视着世界，记录可见光以及光谱中的红外和紫外光。克鲁特瓦根使用的图像大约有550TB，时间跨度从2016年到2018年。这足以装满100多个电脑硬盘。

靠肉眼筛选这么多图片可不现实。这里就用到了第二个技术趋势。克鲁特瓦根和他的同事们训练了一个机器学习系统来帮他们找出太阳能板。

计算机视觉是一个热门领域。但是卫星侦察的特性意味着现成的软件并不适用于研究人员所设想的任务。机器学习系统通过仔细观察“训练集”来学习该做什么，“训练集”包含了正在搜寻的内容的示例。对于像面部识别这样的常见任务，通常有预先建好的训练集可用。但克鲁特瓦根的团队必须自己建立训练集。

为此，他们求助于OpenStreetMap，这是谷歌地图的一个开源竞争对手，在这个平台上，志愿者们已经标注了大量太阳能发电厂。但这些标注很不统一。“有些人只是绕着整片区域画出了粗略的轮廓，”克鲁特瓦根说，“有的人走进去了，分别画出了每排面板的轮廓。”解决这个问题要耗费大量的人力。

一旦整理好了训练数据，学习算法也必须做微调。从太空看，即使是大型太阳能装置看起来也很渺小。“哨兵”卫星图像中的一个像素代表一个 10×10 米的正方形。即使是分辨率更高的SPOT卫星，这样一个正方形的边长也只有1.5米。已有的分类器接受的是面部识别或无人驾驶汽车等方面的训练，用来识别在它们视野中赫然出现的物体。寻找更小的物体意味着要修补软件，提高其识别微小特征的能力。误报必须被剔除，比如从太空看起来像是太阳能板的网球场和温室大棚等物体。

克鲁特瓦根的研究成果很亮眼，却已经过时了。该项目的数据收集于2018年结束，所以自那以后建造的成千上万座新太阳能电站没有被包括在内。但他说，这个项目证明了这种方法是有效的。他打算将他的研究成果——包括辛辛苦苦建成的训练集——提供给其他人使用。他认为该项目的一个合理延伸是扩大分析范围，将安装在家庭屋顶上的太阳能板也包括在

内。这类“表后”装置尤其难以通过其他方式追查到。

更广泛地看，克鲁特瓦根希望他的“天空之眼”法（尽管该项目覆盖全球，在云计算时代仅花费了1.5万美元左右）将帮助开启对其他气候相关基础设施更准确的统计，包括化石燃料发电站，水泥厂和运送液化天然气的码头等。最终的结果可能是组合成一个公开的、由计算机生成的清单，涵盖地球上每一个重要的能源基础设施。他说，撇开这种模式的商业和学术价值不提，公众知情将能给政客们带去更大的压力。





Bartleby

Chief executives are weirder than ever

An impossible job has become even tougher

CELEBRITY BOSSES used to have nicknames that made a virtue of short fuses and brutality. “Chainsaw Al” and “Neutron Jack” sounded more like wrestlers than men in suits. That kind of moniker would jar today. Inclusivity and empathy are what matter: think “Listening Tim” and “Simpatico Satya”. But just because chief executives seem more normal does not mean that they actually are. The demands of the job require an ever-stranger set of characteristics.

In some ways the path to the top of the corporate pyramid is unchanged. It requires people to compete with each other over an extended period. It demands evidence of financial and operational success. It uses the prospect of money—lots of it—as a lever to incentivise ambitious people. And it selects for familiar traits: hard work, impatience, self-confidence and extroversion. If you would rather stay in and watch “The Great British Bake Off” than wine and dine clients, the role is not for you.

A recent study by Steve Kaplan of the University of Chicago and Morten Sorensen of the Tuck School of Business looks at assessments conducted by ghSMART, a consulting firm, of more than 2,600 candidates for different leadership positions. Candidates for CEO jobs emerge as a recognisable type. Across a range of characteristics they have more extreme ratings on average: they shine in what the academics term “general ability”.

They also differ from other executives in the particulars. Where aspiring chief financial officers are more analytical and focus on the detail, would-be CEOs score higher on charisma, on getting things done and on strategic

thinking. These traits also seem to be predictive. By tracking the subsequent careers of candidates, the academics find that people who were applying for a different position but had “CEO-like” characteristics were more likely eventually to wind up in the top job.

Yet firms today are after more than a type-A personality. Mr Kaplan and Mr Sorensen note that CEO candidates with better interpersonal skills are more likely to be hired. Another new piece of research, from academics at Imperial College London, Cornell University and Harvard University, analyses the lengthy job descriptions that companies draw up when they work with headhunters to recruit a new leader. Cognitive skills, operational nous and financial knowledge are prerequisites for success. But over the past two decades these descriptions have placed more and more emphasis on social skills—the ability of bosses to co-ordinate and communicate with multiple people.

Why are these softer skills prized? The answer, according to Stephen Hansen of Imperial College, lies partly in the rise of knowledge workers. Firms increasingly depend on developers, data scientists and IT managers who are used to operating independently. Chief executives are not going to tell these kinds of workers what to do; their job is to make sure that people understand the firm’s goals and toil together effectively. Sure enough, the paper shows that demand for these skills goes up in larger and more information-intensive firms. Social skills matter more when bosses need to persuade as much as instruct.

The wider environment also rewards softer skills. Polling by Edelman, a public-relations firm, suggests that majorities of customers and employees make choices on what to buy and where to work based on their beliefs. Chief executives must mollify politicians, respond to activists and dampen social-media firestorms. It helps if the boss comes across as a relatable member of society, not a volcano-dwelling villain.

It is not yet time to call time on old-fashioned narcissism. Another study, by a quartet of researchers at Stanford Graduate School of Business, surveyed 182 directors about the personalities of their chief executives. The answers suggest as many as 18% of bosses are considered narcissists by their own board members, a prevalence rate perhaps three times that of the general American population. The researchers also find that firms with narcissistic CEOs tend to have higher scores for their environmental, social and governance policies. What better way for an egomaniac to come across as empathetic than to save the planet?

The demands on chief executives make for an increasingly strange mixture. Be more talented than others in the firm, but don't tell them what to do. Crush the competition while exuding empathy. Listen charismatically. Be likeably aggressive. CEOs have always been abnormal. The trick now is not to show it.

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巴托比

古怪CEO变本加厉

一项本就艰巨的工作变得越发难做了

从前名人老板们的那些绰号让脾气急躁和性情暴虐听起来都像是什么美德似的。“电锯艾尔”和“中子弹杰克”听上去更像是摔跤手，而不是西装革履的男人。这样的绰号今天听来会很刺耳。包容性和同理心才是要紧的品质：“倾听者蒂姆”和“可爱鬼萨提亚”怎么样？但是，CEO们看似变得更正常并不意味着他们真的就正常了。为了胜任这份工作，他们需要具备一套越来越奇怪的特质。

在某些方面，通往企业金字塔塔尖的途径并没有什么变化。它要求人们在很长一段时间内相互竞争。它需要人们证明自己在财务和运营上的成功。它用“钱途”——许多的钱——来激励雄心勃勃的人。它认可那些耳熟能详的特质：勤奋、热切、自信和外向。如果你宁愿待在家里看《英国烘焙大赛》（The Great British Bake Off）也不愿意陪客户吃吃喝喝，那这个角色就不适合你。

芝加哥大学的史蒂夫·卡普兰（Steve Kaplan）和塔克商学院的莫滕·索伦森（Morten Sorensen）近期的一项研究查看了咨询公司ghSMART对2600多名不同领导职位的候选人的评估结果。CEO一职的候选人成了一眼就能认出的类型。平均来看，他们在多种特征上的总体得分更高：他们在学者们称为“一般能力”的特质上出类拔萃。

他们在细分的特征上也与其他高管不同。有志担任首席财务官的候选人更善于分析和注重细节，而想要当CEO的候选人在个人魅力、把事情做成和战略思维方面得分更高。这些特征似乎还具有预测的功能。学者们跟踪了候选人随后的职业生涯，发现曾经申请过其他职位但具有“类似CEO”特征的人最终更有可能做了一把手。

然而，如今的企业想要的不仅仅是一个A型人格的人。卡普兰和索伦森指

出，人际交往能力更强的CEO候选人更有可能被聘用。在另一份新研究中，来自帝国理工学院、康奈尔大学和哈佛大学的学者分析了企业在与猎头合作招聘一位新掌门人时起草的冗长的职位描述。认知能力、运营常识和财务知识是成功获聘的先决条件。但是在过去的二十年里，这些职位描述越来越强调社交技能——老板们与各色人等协调和沟通的能力。

这些比较软的技能为什么受到了重视？帝国理工学院的斯蒂芬·汉森（Stephen Hansen）认为，答案部分在于知识工作者的崛起。企业越来越依赖开发人员、数据科学家和IT管理人员，而这些人习惯了自主工作。CEO不会告诉这类员工该做什么；他们的工作是确保大家理解公司的目标，并有效率地共同努力。果不其然，汉森的论文显示，在更庞大、信息密集度更高的公司中，对这些软技能的需求也更高。当老板既需要给予指导又需要做出劝导时，社交技能就更重要了。

软技能在更广泛的环境中也会收获回报。公关公司爱德曼（Edelman）的民意调查显示，大多数顾客和员工会基于自己的信念选择买什么和在哪里工作。CEO必须安抚政客，回应活动人士，尽力平息社交媒体上的风暴。如果老板给人的印象是一个能引发共鸣的社会一份子而不是一个住在火山上的恶棍，事情就能好办些。

现在还不到时候宣告老式的自恋已经行不通。来自斯坦福大学商学院的四名研究人员也开展了一项研究，他们向182名董事询问了他们各自公司的CEO的性格。他们的答案显示，多达18%的老板被自己的董事会成员认为是自恋型人，是这一型人在美国总人口中占比的三倍。研究人员还发现，拥有自恋型CEO的公司往往在环境、社会和治理政策方面得分更高。对于一个自大狂来说，还有什么比拯救地球更能让他显得有同理心的呢？

对CEO的各种各样的要求如此就形成了一个越发奇怪的混合物。他们要比公司里的其他人更有才干，但又不能对这些人指手画脚。他们要摧毁对手，同时又要展现同理心。要细心聆听。要有攻击性，但又不能招人厌。CEO向来都不正常。如今的诀窍就是别被看出来。





Perilous plastic

Microplastics in household dust could promote antibiotic resistance

Polyester and nylon seem to be common sources

PLASTICS ARE man-made materials that are unnatural to this world, but that does not stop the natural world from interacting with them. Indeed, dozens of studies show that when plastics get into the sea many ocean-dwelling microorganisms aggressively colonise them. This might help break plastics down, but these oceanic colonies are also hotbeds of antibiotic-resistant genes. Now, it seems, something similar might be going on in the dark recesses of your home.

Lei Wang suspected as much, and along with his colleagues at Nankai University in Tianjin, China, set out to gather the necessary evidence. Their search began at an apartment building in Tianjin. The plastics Dr Wang was concerned about are the tiny bits that break away from synthetic fibres, like polyester and nylon, commonly found in clothing and other textiles. The microplastics then accumulate around the home as dust. He reasoned that if these particles were being colonised by bacteria then they too might be harbouring antibiotic-resistant genes.

The researchers chose ten homes in the apartment block, each with just one male tenant. Each apartment had hard flooring, rather than any carpets, and a similar general layout. A team used sterilised brooms to sweep the bedrooms and to collect dust samples as they went. These samples were then brought back to the lab and analysed for microplastics, bacteria and antibiotic-resistant genes.

As they report in Environmental Science and Technology, 21 types of microplastics were found, the most common from polyester and nylon.

Using DNA extracted from microbes, they identified 1,385 genera of bacteria along with 18 genes associated with antibiotic resistance.

The analysis also revealed that the apartments with dust that were rich in microplastics had bacterial communities that were different from those apartments with dust that did not contain as many microplastics. Crucially, the work also showed that the relative abundance of antibiotic-resistant genes was higher in the presence of microplastics than it was when these were less common.

Precisely why microbes dwelling with plastics are more likely to carry antibiotic-resistant genes is not clear. It is possible that plastics themselves are driving bacteria to develop this trait. The researchers suggest, however, that it is more likely that specific groups of bacteria are capable of eking out a living on plastics, and these bacteria also happen to be of a type that more readily develop antibiotic resistance.

To support this argument, Dr Wang points out that Proteobacteria is both highly antibiotic-resistant and also commonly found encrusting oceanic plastics. Members of this same phylum were the most common type found among the polyester and nylon fibres swept up in the apartments, too. This suggests that, just as plastics are changing the nature of bacterial communities out at sea, they are also changing them within homes. How much of a threat this will ultimately be to human health is not known, but it cannot be doing people much good. ■



危险塑料

家庭灰尘中的微塑料可能会加剧抗生素耐药性

聚酯和尼龙似乎是常见的来源

塑料是人造材料，对这个世界来说是非自然的，但这并不能阻止自然界与它们相互作用。事实上，数十项研究表明，当塑料进入海洋时，许多海洋微生物会积极地在其上定殖。这可能有助于分解塑料，但这些海洋中殖民地也是抗生素抗性基因的温床。现在，你家黑暗的角落里似乎正在发生类似的事情。

汪磊也有此怀疑，并与南开大学的同事一起着手收集必要的证据。他们的搜索始于南开所在的天津市的一栋公寓楼。汪磊担心的塑料是从合成纤维（如聚酯和尼龙）上脱落的细小碎片，这些纤维通常存在于服装和其他纺织品中。然后微塑料以灰尘的形式在家里堆积。他推断，如果这些颗粒被细菌定殖，那么它们也可能藏匿带有抗生素抗性的基因。

研究人员在公寓楼中选择了10套住宅，每套住宅只有一名男性租户。每间公寓都是硬地面，没有地毯，总体布局相似。一个团队使用无菌扫帚清扫卧室，一路收集灰尘样本。然后将这些样本带回实验室并分析微塑料、细菌和抗生素抗性基因。

他们在《环境科学与技术》期刊上报告称，发现了21种微塑料，最常见的是聚酯和尼龙。使用从微生物中提取的DNA，他们鉴定了1385个菌种以及18个与抗生素耐药性相关的基因。

分析还显示，灰尘富含微塑料的公寓中的细菌群落与那些灰尘含微塑料较少的公寓不同。至关重要的是，这项研究还表明，存在微塑料时，抗生素抗性基因的相对丰度要比微塑料较少时来得高。

生活在塑料中的微生物究竟为何更可能携带抗生素抗性基因尚不清楚。塑料本身可能会促使细菌产生这种特性。然而，研究人员认为，更可能的

是，擅长以塑料为生的特定细菌群恰好属于更容易产生抗生素耐药性的类型。

为了支持这一论点，汪磊指出，变形菌不仅具有高抗生素抗性，而且在海洋塑料的表面也很常见。而同一门的细菌也是在公寓中扫出的聚酯和尼龙纤维中最常见的类型。这表明，正如塑料正在改变海上细菌群落的性质一样，它们也在改变住宅中的细菌群落。这最终会对人类健康造成多大的威胁还是未知数，但它不可能对人类有多大好处。■



The future of the internet

The video-game industry has metaverse ambitions, too

Where the tech titans have money, the games industry has experience

THE PLANET is black, perfectly spherical, does not really exist, and is exactly 65,536km around (being the sixteenth power of two, a number any hacker worth their salt would recognise). A single 100-metre-wide road runs round it. All the real estate on the virtual planet is owned by the Association for Computing Machinery, an academic body.

The Association sells parcels of land to enterprising programmers wishing to develop them. Many do: their efforts are responsible for the houses, bars and skyscrapers that line the great road. At any given hour the road bustles with people, or at least, with their 3D avatars. Some are going to work, some are going on dates, many are just milling around in the way that people have done since the invention of streets. A few take their cars—like everything else in that world, really just bundles of computer code—out off the highway and “race [them] in the black desert of the electronic night”.

That is how Neal Stephenson, a science-fiction author, aptly described what he called the “metaverse”, in a tongue-in-cheek cyberpunk novel called “Snow Crash” (1992). Three decades later, the metaverse—a sort of immersive sequel to today’s text-and-picture-based internet—has been anointed as Silicon Valley’s latest Next Big Thing. Microsoft is integrating virtual-reality offices and avatars into its “Teams” remote-collaboration software. Mark Zuckerberg, the founder of Facebook, is so enamoured of the concept that on October 28th he renamed the firm “Meta” to signal its focus on this new “north star”.

It sounds like west-coast techno-utopianism. But some glimpse of the

potential could be seen on November 8th, when Roblox, an online game with 200m monthly users, reported its quarterly results. The number of daily players rose 31% year-on-year, to 47.3m, propelling revenue to \$509m. David Baszucki, Roblox's co-founder and boss, said that the firm had predicted the rise of what is now called the metaverse when its first business plan was written 17 years ago. In 2020, when it was still privately held, Roblox was valued at \$4bn. Today it is listed and worth \$68bn, not least thanks to an over-60% bump in its shares in the past month.

For metaverse enthusiasts like Matthew Ball, a venture capitalist, online games such as Roblox—and “Minecraft”, “Fortnite”, “Animal Crossing” and “World of Warcraft”—serve as proof that immersive virtual worlds can be popular and profitable. According to Newzoo, a market-research firm, consumers spent \$178bn on video games in 2020. Besides blasting each other, many gamers use them to keep in touch with distant friends. And they are already happy to spend cash on virtual property. Newzoo thinks around 75% of the industry’s revenue comes from games that allow the sale of virtual goods, for example powerups or clothes for players’ avatars. The video-game industry has been experimenting with virtual worlds for decades, says Raph Koster, a veteran designer, exploring how players use them to socialise, create and run entire economies based on virtual goods. Interest waxes and wanes as each generation’s ambitions bump up against technical limitations, he says. But now that the subject is in the air again, some metaverse enthusiasts reckon that the benefit of all that experience might let video-game firms like Roblox, Epic Games and Unity beat the tech titans to the punch.

Roblox is both a game and a platform. In the same way firms such as Squarespace provide tools that allow tech neophytes to create websites, Roblox comes with a set of easy-to-use programs that let punters build and monetise their own 3D games and experiences. “Piggy”, for instance, is a user-created horror game inspired by “Peppa Pig”, a cartoon. In “Adopt

Me”, users rear, collect and trade exotic virtual animals. (The latest craze is programmes based on “Squid Game”, a Netflix series.)

“Every experience is built by our community,” says Manuel Bronstein, Roblox’s chief product officer. The firm busies itself handling behind-the-scenes problems, providing server space and infrastructure to support its users’ creations. It has its own currency, called Robux, which is paid for with real cash. Users can spend it in what is, in effect, an app store that sells the powerups or cosmetic items like shirts, hats or pairs of angel wings which avatars need to stand out. The developers of those virtual items get a cut—around 27%—from each sale.

The game’s popularity has led to other firms offering experiences within Roblox as a marketing strategy—a simple but effective way to merge the digital and the real. Users can wander round a virtual version of the Starcourt Mall, a place in “Stranger Things”, another Netflix series. In May one user resold a virtual copy of a real Gucci handbag for around \$4,100. On November 15th Roblox announced grants worth \$10m to develop educational experiences, including a simulated trip to the International Space Station.

Mr Baszucki is not the only boss in the games industry with metaverse ambitions. Tim Sweeney, chief executive of Epic Games, the privately held firm that develops “Fortnite”, has been a fan of the idea since he wrote “Unreal”, an early multiplayer 3D-shooter, in 1998. Like “Roblox”, “Fortnite”—which is, at least on the surface, a straightforward action game—has been flagged as an early example of what a metaverse might look like. “We don’t see ‘Fortnite’ as the metaverse,” says Marc Petit, a vice-president at Epic, “but as a beautiful corner of the metaverse.”

Also like Roblox, it has seen crossovers from the real world. In 2019 “Fortnite” hosted a virtual space battle to promote “Rise of Skywalker” (the

“Star Wars” film, in turn, referred back to the in-game event—very meta). In July Ferrari uploaded a virtual version of one of its luxury sports cars into the game for players to drive around. It is not quite the same as renegade hackers racing virtual cars in the “black desert of the electronic night”. But it is not a million miles away, either.

The best-known uses of “Fortnite’s” virtual world have come from the music industry. In 2020 Travis Scott, a rapper, hosted a virtual concert. The malleable physics of the digital world allowed him to do things no amount of stagecraft could accomplish in reality. His hundred-foot-tall avatar, wreathed in lightning, danced and stomped through the game’s pixellated universe, shaking the ground with every step. Around 12.3m people attended, around 60 times more than can fit onto the fields of Glastonbury, a big music festival.

The second prong of Epic’s strategy, besides “Fortnite” itself, is to sell pickaxes in a gold rush. Here it is in competition with Unity, a firm founded in Denmark in 2004 and which went public last year. Both firms sell sophisticated software “engines” that were originally designed to power video-games. Now they are touting them as pieces of general-purpose simulation software that they hope will become a common language in which 3D worlds are built, in the same way HTML underpins websites.

They are already partway there. Games engines are finding uses outside the gaming business. Architectural firms, for instance, use them to build virtual versions of buildings to dazzle clients before construction. Some use them to help manage the build itself. A collaboration between Epic and Cesium, a startup that maps cities and landscapes, allows virtual copies of real cities such as Melbourne or Detroit to be dropped into Unreal, the engine that powers “Fortnite”.

Mr Ball points out that much of “The Mandalorian”, a “Star Wars” TV show,

was shot within a virtual world generated by Unreal. Since they are built with the same software, he writes, “audiences could freely investigate much of these sets [in an Unreal-powered world]”—a metaversey twist on charging fans for tours of film sets. Unity recently paid \$1.6bn for Weta Digital, a visual-effects studio founded by Peter Jackson, who directed the special-effects-heavy “Lord of the Rings” films. It also unveiled Metacast, a piece of software designed to broadcast sports events into virtual worlds. The firm showed off a mixed-martial-arts bout that viewers could watch from any angle—even the point of view of one of the fighters.

Whether the games firms can compete with the tech titans remains to be seen. Meta’s annual revenues, at \$86bn in 2020, make it half the size of the entire gaming industry by itself. But Mr Ball points out that big changes in technology often lead to the rise of new players despite the efforts of old incumbents. And, besides experience, the games industry has plenty of ready-made early adopters for whom virtual worlds are already an established cultural norm. “You have at least two generations of kids who’ve grown up playing online games,” says Mr Bronstein. “Navigating a 3D environment. Hanging out in a virtual world with friends. This stuff is commonplace for them.” ■



因特网的未来

电子游戏业也有元宇宙野心

在这个领域，科技巨头有钱，游戏公司有经验

这个星球是黑色的，呈完美球形，并不真的存在，周长正好是65,536公里（也就是 2^{16} 次方，任何正儿八经的黑客都能认出这个数字）。一条100米宽的道路环绕着它。这个虚拟星球上的所有物业都归学术机构计算机协会（Association for Computing Machinery）所有。

该协会把这些地块出售给想要开发它们的雄心勃勃的程序员。许多人都感兴趣，他们的努力带来了那条宽阔大道两旁的房屋、酒吧和摩天大楼。任何时候路上都挤满了人——或者至少是人们的3D化身。有些人是在上班的路上，有些人是去赴约，很多人就只是在闲逛——自街道出现以来就总有人在没事闲逛。一些人驾车（和那个世界中的所有其他事物一样，这些车实际上只是一堆计算机代码）驶离高速公路，“驰骋在电子夜幕下的黑色沙漠中”。

这是科幻小说家尼尔·斯蒂芬森（Neal Stephenson）在他的荒诞赛博朋克小说《雪崩》（Snow Crash，1992年）中对他称之为“元宇宙”的世界的形象描述。三十年后，元宇宙——即如今基于文本和图片的互联网的沉浸式进化版——已被奉为硅谷的下一个大事件。微软正在将虚拟现实办公和虚拟化身整合到它的Teams远程协作软件中。Facebook的创始人马克·扎克伯格对元宇宙这个概念非常着迷，于10月28日宣布将公司更名为Meta，以示对这颗新“北极星”的重视。

这听起来像是美国西海岸的技术乌托邦主义。但当拥有2亿月活用户的在线游戏Roblox在11月8日公布季度业绩后，人们从中窥见了元宇宙概念的潜力。日活用户数量同比增长了31%，达到4730万，推动收入升至5.09亿美元。Roblox的联合创始人兼CEO大卫·巴斯佐兹基（David Baszucki）表示，在17年前公司编写第一份商业计划时，就预见到了如今所谓元宇宙的

兴起。2020年Roblox还未上市时估值40亿美元。如今它已上市，市值达到680亿美元，很大一个原因是其股价仅在过去一个月内就上涨了超过60%。

对于像风险投资家马修·鲍尔（Matthew Ball）这样的元宇宙粉来说，Roblox和《我的世界》、《堡垒之夜》、《动物之森》及《魔兽世界》等在线游戏证明了沉浸式虚拟世界可以风靡全球，也能赚到钱。市场研究公司Newzoo称，2020年消费者在电子游戏上的支出为1780亿美元。除了在游戏中互相射击外，许多玩家也通过游戏与远方的朋友保持联系。而且他们已然很乐意在虚拟财产上花钱。Newzoo估计电子游戏产业约有75%的收入来自可出售虚拟商品（比如玩家虚拟化身的装备或服装）的游戏。这个行业已经在虚拟世界上试验了几十年，探索玩家如何在这样的世界里社交、如何创造和运行基于虚拟物品的虚拟经济，资深游戏设计师拉夫·科斯特（Raph Koster）表示。他说，随着每一代业内人士的雄心遭遇技术上的限制，人们在这方面的兴趣起起落落。但现在虚拟世界再次引起关注，一些元宇宙粉认为，以往的种种经验是一种优势，让Roblox、Epic Games和Unity这样的电子游戏公司有可能先科技巨头一步攻占城池。

Roblox既是游戏也是平台。正如Squarespace等公司提供工具帮助技术新手创建网站一样，Roblox提供了一些易于使用的程序，让用户可以构建自己的3D游戏和体验，并从中获利。例如，《小猪》（Piggy）是一款由用户创造的恐怖游戏，灵感源自动画片《小猪佩奇》。在《收养我吧》（Adopt Me）中，用户可以饲养、收集和交易奇异的虚拟动物。（最近的热点是根据奈飞剧集《鱿鱼游戏》开发的游戏。）

“每一种体验都是我们的用户社群打造的。”Roblox的首席产品官曼努埃尔·布朗斯坦（Manuel Bronstein）说。该公司主要负责幕后事宜，提供服务器空间和基础设施来支持用户的创作。它有自己的货币，叫作Robux，要花真金白银购买。玩家可以在相当于应用商店的营地中消费，购买道具或衬衫、帽子和天使翅膀等饰品，让自己的化身能卓尔不群。这些虚拟物品的开发者可以从每笔销售中提成约27%。

Roblox的流行引得其他公司开始在Roblox中提供产品相关体验，用作自己的一种营销策略。这是一种把数字和现实相融合的简单但有效的方法。用户可以在虚拟版Starcourt Mall中闲逛，这是奈飞另一个剧集《怪奇物语》（Stranger Things）中的一个场所。5月，一位用户以约4100美元的价格转售了一个真古驰包的虚拟版。11月15日，Roblox宣布将投资1000万美元开发教育类游戏，包括模拟国际空间站之旅。

巴斯佐兹基并不是游戏行业中唯一有元宇宙野心的老板。开发了《堡垒之夜》的私人公司Epic Games的首席执行官蒂姆·斯威尼（Tim Sweeney）在1998年编写了早期多人3D射击游戏《虚幻》（Unreal），之后就成了元宇宙粉。和Roblox一样，《堡垒之夜》已被视为元宇宙的一种雏形。至少从表面上来看，《堡垒之夜》就是个单纯的动作游戏。“我们不认为《堡垒之夜》是元宇宙，”Epic的副总裁马克·佩迪特（Marc Petit）说，“我们认为它是元宇宙的一个美丽角落。”

和Roblox一样，《堡垒之夜》也见证了虚拟与现实世界的交汇。2019年，《堡垒之夜》举办了一场虚拟太空大战，以宣传影片《天行者崛起》（Rise of Skywalker）（这部《星球大战》系列电影又交叉提到了这场游戏中的太空大战，够“元”吧？）7月，法拉利将其一辆豪华跑车的虚拟版本上传到游戏中，供玩家驾驶。虽然这和叛逃的黑客在“电子夜幕下的黑色沙漠”中驾驶虚拟汽车不太一样，但也不是天差地别。

说到利用《堡垒之夜》的虚拟世界，最著名的例子来自音乐界。2020年，说唱歌手特拉维斯·斯科特（Travis Scott）举办了一场虚拟演唱会。数字世界的物理特性可以随意改变，让他能够实现任何舞台艺术在现实中都无法做到的事情。他百英尺高的化身被闪电环绕，在游戏的像素宇宙中手舞足蹈，每一步都引得地动山摇。约有1230万人参加了这场演唱会，是大型音乐节格拉斯顿伯里音乐节（Glastonbury）能容纳的现场观众的约60倍。

在《堡垒之夜》之外，Epic战略的第二个方面相当于在淘金热中卖铁镐。它在这方面的竞争对手是Unity，这家公司2004年于丹麦创立，并于去年

上市。两家公司都在销售最初用于支持电子游戏的复杂软件“引擎”。现在，它们将这些引擎作为通用模拟软件的组成部分来出售，希望这样的软件能成为构建3D世界的通用语言，就像创建网页所用的HTML一样。

它们已经取得了一定的成功。游戏引擎的用途正扩展到游戏业之外。例如，建筑事务所在开始施工前用它们来生成虚拟建筑，让客户一睹为快。有些公司用它们来帮助管理施工过程。Epic和绘制城市和景观地图的创业公司Cesium合作，在支持《堡垒之夜》的“虚幻”引擎（Unreal）中添加了墨尔本或底特律等真实城市的虚拟版。

鲍尔指出，《星球大战》的电视剧集《曼达洛人》（The Mandalorian）大部分都是在“虚幻”引擎生成的一个虚拟世界中拍摄的。由于它们是用相同的软件构建，他写道，“观众可以[在一个由‘虚幻’引擎驱动的世界中]自由地探索大部分电视场景”——元宇宙改写了粉丝须付费才能参观电影片场的剧情。Unity最近斥资16亿美元收购了由彼得·杰克逊（Peter Jackson）创立的影视特效公司维塔数码（Weta Digital），杰克逊导演的电影《指环王》采用了大量特效。Unity还推出了可在虚拟世界中直播体育赛事的软件Metacast。该公司展示了一场综合格斗比赛，观众可以从任何角度观看比赛，甚至可以选择选手的视角。

游戏公司能否与科技巨头一决高下还需拭目以待。2020年Meta的年收入达到860亿美元，它一家就抵得上整个游戏业收入的一半。但鲍尔指出，技术剧变往往促成新玩家崛起，老牌企业无论如何阻挠也是徒劳。而且，除了经验之外，游戏业还有大量现成的早期用户，对这些用户来说虚拟世界已经成为一种既定的文化规范。“至少有两代人都是玩网络游戏长大的，”布朗斯坦说，“在3D环境中畅游，在虚拟世界中和朋友们一起玩耍，这些对他们来说已是日常。”■



Bartleby

The business phrasebook

A short guide to what your colleagues really mean

REED HASTINGS HAS built the culture at Netflix around it. Ray Dalio made it a founding principle at Bridgewater, a successful investment fund. “Radical candour” is the idea that bracing honesty is the best way to run a business: no one dances around the truth, and swifter feedback improves performance.

Most firms rely on a messier doctrine. People rarely say what they mean, but hope that their meaning is nonetheless clear. Think Britain, but with paycheques. To navigate this kind of workplace, you need a phrasebook.

Ostensible meaning: You’re making a legitimate point

Actual meaning: Be quiet

Ostensible meaning: We shouldn’t waste other people’s valuable time

Actual meaning: Let’s never speak of this again (see also: “Let’s put a pin in it”)

Ostensible meaning: Shared understanding results in better outcomes

Actual meaning: I need you to know that my job is a living hell

Ostensible meaning: I’d like to know why you think that...

Actual meaning: ...because it makes no sense to anyone else

Ostensible meaning: We’ve raised an important issue here

Actual meaning: We've made absolutely no progress

Ostensible meaning: I am informing you of something minor

Actual meaning: I should have told you this weeks ago

Ostensible meaning: I have something trivial to say

Actual meaning: You are in deep, deep trouble

Ostensible meaning: We'll each work on this task in our own time

Actual meaning: I have to go to my Pilates class now

Ostensible meaning: It'll be done soon

Actual meaning: It won't be done soon

Ostensible meaning: We will work iteratively in response to user feedback

Actual meaning: We're literally planning to go round in circles

Ostensible meaning: It's a rat's nest of old and incompatible systems

Actual meaning: None of this is our fault

Ostensible meaning: We provide an ecosystem in which others can interact

Actual meaning: Let's pretend we are a tech firm and see what happens to our valuation (see also: "as a service", "network effects" and "flywheels")

Ostensible meaning: We are ready for a shared, immersive digital world

Actual meaning: Ooh, look! A bandwagon! (see also: "Web3")

Ostensible meaning: Be authentic and don't be afraid to show vulnerability

Actual meaning: But not those bits of your whole self, obviously

In a world of radical candour, there would be less need for translating. Most managers and colleagues could indeed be better at giving unvarnished feedback. Some words and phrases are so opaque they absorb all visible meaning.

But there is an awful lot to be said for coded communication. Work is where people learn to manage social interactions, not define them out of existence. Transparency doesn't necessarily travel well across borders. And perpetual bluntness is draining; humans constantly finesse and massage the messages they send in order to avoid open conflict. Radical candour is associated with firms that pay very well. That may be because this approach leads to greater success. It may be because otherwise most people wouldn't put up with it.

For more expert analysis of the biggest stories in economics, business and markets, sign up to Money Talks, our weekly newsletter. ■



巴托比

职场黑话手册

你的同事到底说的啥意思？这里有一份简要指南

里德·黑斯廷斯（Reed Hastings）围绕它打造了奈飞的文化。雷·达里奥（Ray Dalio）把它作为桥水（Bridgewater，一家成功的投资基金）的立身之本。“彻底坦诚”的理念认为鼓励诚实是经营企业的最佳方式：每个人都回避事实，更迅速的反馈提升了业绩。

大多数公司都依赖一套更含混的话术。人们很少直白地说出他们的真实意图，却又希望自己的意思已经传达得明白无误。就像是英国人那样说话，但得拿工资。在这样的职场中打拼，你需要一本黑话手册。

表面意思：你的看法有道理

实际意思：别说了

表面意思：我们不要浪费其他人的宝贵时间

实际意思：我们再也别提这事了（“把它放进待议事项”同理）

表面意思：彼此理解能带来更好的结果

实际意思：你看不出我干这份工作是在活受罪吗

表面意思：我想知道你为什么这么想.....

实际意思：.....因为这对我们其他人谁都说不通啊

表面意思：我们启动了一个重要的议题

实际意思：我们毫无进展

表面意思：我要告诉你一件小事

实际意思：我几周前就该告诉你了

表面意思：我有点琐事要说说

实际意思：你有麻烦了，大麻烦

表面意思：我们各自找时间做这项工作

实际意思：我得去上普拉提课啦

表面意思：这很快能做到

实际意思：这不会很快完成

表面意思：我们会响应用户的反馈，不断更新升级

实际意思：我们就打算原地兜圈子

表面意思：这是一大堆老旧又不兼容的系统

实际意思：这压根不是我们的错

表面意思：我们提供了一个生态系统，让其他人可以在这儿互动

实际意思：让我们假装自己是家科技公司，看看我们的估值会如何（“即服务”、“网络效应”和“飞轮”同理）

表面意思：我们已经准备好迎接一个共享的、沉浸式的数字世界

实际意思：喔！看啊！是个风口！（“Web3”同理）

表面意思：做真实的自己，别害怕显现你的脆弱

实际意思：但是，当然也别把你的某些模样亮出来

在一个彻底坦诚的世界里，不需要那么多的翻译。大多数主管和同事的确也都能把话说得不那么拐弯抹角。有些词句太过隐晦了，根本搞不清到底要表达什么。

但有关隐晦沟通可以讲的实在太多了。人们应在工作中学着管理社交互动，而不是列个清单让它们不复隐晦。透明不一定就能很好地跨越人与人的边界。而始终口无遮拦会让人筋疲力尽：为避免外部冲突，人类永远都在寻求更婉转的表达。目前那些推行彻底坦诚的公司薪酬都非常丰厚。可能是因为这种方式带来了更大的成功。也可能是因为，如果报酬不高，大多数人都会受不了这个。





Marking time

How the seven-day week came to rule the world

A new book shows how modern cities embraced the weekly rhythm

The Week. By David Henkin. Yale University Press; 288 pages; \$30 and £20

IN THE AUTUMN of 1853 Thomas Butler Gunn got lost—temporally rather than physically. On a visit to Mammoth Cave in Kentucky, and isolated from the outside world, his diary quickly slipped the moorings of chronological reality. Wednesdays are repeated and days go mislabelled. It took around a fortnight, and renewed contact with civilisation, for Gunn to restore his weekly bearings.

The episode, says David Henkin, suggests how fragile a sense of time can be—especially when it comes to weeks. Unlike months or years, these seven-day groupings have no real basis in astronomy. People from Nigeria to China have thrived without them. And yet the week has become the measure not only of routine, but even of sanity. “Weekly rhythms have become so thoroughly absorbed into ordinary human experience”, Mr Henkin writes, “that forgetting what day it is constitutes a singular symptom and feeling of disorientation.”

His new book shows how the week came to rule the world. Until the 19th century, he explains, the other days were a preamble to the Sabbath for many Protestants. Catholics followed a cycle of feast days and fasts. When newspapers, factory schedules and weekly paydays were all rarer, the weekly structure was less important. People got muddled, not just underground. As late as 1866, the Louisville Courier mentioned a man getting drunk on Friday because he thought it was Saturday.

In outline, the story is one of urban development. As towns grew and society

became more sophisticated, citizens “became differently and more intensely week-oriented, in ways we can now recognise as modern”. When his local benevolent society met on Wednesdays in 1859, and choral concerts were scheduled for Fridays, James Fiske of Massachusetts couldn’t afford to mix up his days. When Every Saturday magazine landed in New York each weekend in 1866, Bayard Taylor was expecting it.

Later anecdotes illustrate the “distinctive air” that individual days came to develop—the particular associations each subliminally carries. Philadelphians once used chains to block horse traffic on Sundays. The advent of washing machines disrupted the weekly cleaning schedule. In due course Westerners exported these feelings to the world. Japan formally adopted the seven-day system only in 1873; all the same, a character in a novel by Haruki Murakami is as sure of something “as I am that today is Wednesday”.

That sort of conviction is now crumbling. French and Russian revolutionaries ultimately failed in their attempts to abolish the seven-day week, but for many people the pandemic has squashed the weekly rhythm into an interminable present. Monday, runs the joke, has been replaced by Noneday. As Netflix offers entertainment on a whim, and morning newspapers become obsolete, Mr Henkin argues that “the hold of the week on our lives loosens, and our place in the cycle becomes in turn less memorable.” Everyone may soon start to feel a bit like Thomas Butler Gunn. ■



标记时间

一周七天的概念何以通行世界

一本新书追溯现代城市如何习惯以“星期”为节奏【《星期》书评】

《星期》，大卫·亨金著。耶鲁大学出版社，288页；30美元/20英镑。

托马斯·巴特勒·冈恩（Thomas Butler Gunn）在1853年的秋天陷入了迷失——不是空间上的迷途，而是时间上的迷失。在探索美国肯塔基州的猛犸洞（Mammoth Cave）时，他与外界完全隔绝，写下的日记很快就脱离了现实的时间顺序。星期三被重复记了好几次，好些日子记录错乱。重回现实社会大约两周后，冈恩才恢复了对星期的准确感知。

大卫·亨金（David Henkin）指出，这一事件表明人们的时间感有多不牢靠，尤其是对“星期”的感知。不同于“年”和“月”，“星期”这种七天周期在天文学中并无实际依据。从尼日利亚到中国，过去人们没有这个概念，也照样过得很好。然而现在“星期”已成为量度生活日常的标尺，甚至还成了判断神智清醒与否的方法。“以星期为单位的时间节奏与普通人的生活密不可分，”亨金写道，“以至于忘记今天是星期几已经成了认知错乱的一个显著症状和自我提示。”

他的新书说明了“星期”的概念是如何通行世界的。他解释说，直到19世纪，对许多新教徒来说，安息日以外的日子都是这天的前奏。天主教徒以节日到斋戒日为周期来循环日子。在报纸、工厂生产排期和每周发薪日都还很稀罕的时候，星期的划分没那么重要。不止在地下工作的人，大家都会搞不清今天星期几。直到1866年，《路易斯维尔信使报》（Louisville Courier）还提到过有人在星期五喝醉，因为他以为那天是星期六。

总的来说，这是个关于城镇发展的故事。随着市镇扩大，社会变得更复杂，市民“越来越多地以不同方式按‘星期’安排生活，也就是如今我们视为现代的方式”。1859年，在马萨诸塞州，詹姆斯·费斯克（James Fiske）所在的当地慈善协会每周三聚会，合唱团每周五排演，他可不能搞混日子。

在1866年的纽约，《每周六》（Every Saturday）杂志开始逢周末出版，贝亚德·泰勒（Bayard Taylor）总是翘首以盼。

再往后的轶事则说明了一周里的每一天如何逐渐发展出了“独特气息”——人们下意识地把星期几和干什么事联系起来。费城人曾在星期日用铁链阻挡马匹通行。洗衣机的面世打乱了人们每周的洗衣安排。之后西方人把这些感受输出到世界各地。日本直到1873年才正式采用星期制，尽管如此，村上春树的小说中就有一个人物在形容自己对于某件事情十分确信时说，“正如我很肯定今天是星期三”。

这种确信现在正在崩解。法国和俄国的革命者最终未能争取到废除星期制，但对许多人来说，新冠疫情已经把星期的轮转碾碎成一个无休无止的当下。有人打趣说，Monday已经变成Noneday了。奈飞在随时供应娱乐节目，晨报变得过气，亨金认为，“‘星期’对我们生活的控制在减弱，我们在这一循环中所处的位置也就不大记得住了”。很快，每个人都可能开始有点像托马斯·巴特勒·冈恩那样不知时日。 ■



Something ventured, something gained

The bright new age of venture capital

The business of funding disruptive businesses is booming—and is itself being disrupted

YOUNG COMPANIES everywhere were preparing for doomsday in March 2020. Sequoia Capital, a large venture-capital (VC) firm, warned of Armageddon; others predicted a “Great Unwinding”. Airbnb and other startups trimmed their workforces in expectation of an economic bloodbath. Yet within months the gloom had lifted and a historic boom had begun. America unleashed huge stimulus; the dominance of tech firms increased as locked-down consumers spent even more of their time online. Many companies, including Airbnb, took advantage of the bullish mood by listing on the stockmarket. The market capitalisation of American VC-backed firms that went public last year amounted to a record \$200bn; it is on course to reach \$500bn in 2021.

With their pockets full, investors are looking to bet on a new generation of firms. Global venture investment—which ranges from early “seed” funding for firms that are only just getting going to funding for more mature startups—is on track to hit an all-time high of \$580bn this year, according to PitchBook, a data provider. That is nearly 50% more than was invested in 2020, and about 20 times that in 2002.

The type of investor piling into venture activity has changed just as dramatically. It was once the preserve of niche venture-capital firms run in Silicon Valley. These raised funds from and invested on behalf of pension funds and other end-investors, often relying on their vast networks of connections with company founders. Now, however, only three of the ten biggest venture investors by assets under management are traditional VC

firms.

Instead, deals led or solely struck by private-equity shops, hedge funds and others that used to conduct little venture activity are on track to nearly double from \$144bn in 2020 to \$260bn this year (see chart 1). That accounts for a staggering 44% of global VC activity, up from 20% in 2002. “Crossover” funds like Tiger Global Management, which straddle public and private markets, are deploying capital at a breakneck pace. Behemoth pension funds are increasingly directly investing in startups.

The flood of money from deep-pocketed investors has helped swell valuations. But it is also flowing to once-neglected corners and new opportunities. Venture activity now extends well beyond Silicon Valley and America more broadly, and is financing enterprises working on everything from blockchains to biotech.

The wave of capital is also transforming how VC works. VC firms are adopting new strategies as they seek to differentiate themselves in some respects, and to mimic their Wall Street competitors in others. That comes with both benefits and drawbacks for the business of innovation.

The modern venture-capital industry sprouted from a laboratory at Fairchild Semiconductor, a Silicon Valley chipmaker, in the 1960s. Arthur Rock, the first to leave Fairchild for investing, raised \$5m in his first fund and returned \$100m over seven years. Eugene Kleiner and Don Valentine soon followed, setting up Kleiner Perkins and Sequoia respectively. Both are still large VC firms today.

The approach was to back risky startups in the hope that the big successes, like Google, would carry an entire portfolio. Seed investments were often made before a startup earned any revenue. Then came an alphabet soup of successive funding rounds, typically ranging from series A to C, as a

company matured. The VCs' funds were closed-ended, meaning they distributed returns to investors, usually pension funds, endowments and other long-term-oriented investors, within seven to ten years, after taking a cut of their own.

The venture capitalists did not just provide finance. They also played consiglieri, often taking a seat on a company's board. They offered a wealth of experience and access to a network of contacts, introducing startups to professional chief executives, for instance. Entrepreneurs flocked to Sand Hill Road, the home of many Silicon Valley VC firms, in the hope of being funded. The industry's reliance on personal connections made it rather like an old boys' club.

The model proved astoundingly successful. Although VC-backed companies represent less than 0.5% of American companies created every year, they make up nearly 76% of the total public-market capitalisation of companies started since 1995. Over time VCs increasingly bet on slightly older "late-stage" startups (which, for their part, delayed going public). Some VC firms opened offices abroad. Andreessen Horowitz, also based on Sand Hill Road, was founded in 2009 and rose towards the top.

Why, then, is the model being disrupted? The frenzy is a result of both the entrance of new competitors and greater interest from end-investors. That in turn reflects the fall in interest rates across the rich world, which has pushed investors into riskier but higher-return markets. It has no doubt helped that VC was the highest-performing asset class globally over the past three years, and has performed on a par with bull runs in private equity and public stocks over the past decade.

End-investors who previously avoided VC are now getting involved. In addition to alluring returns, picking out the star funds may be easier for VC than for other types of investment: good performance tends to be more

persistent, according to research in the *Journal of Financial Economics* published last year. The success of big tech, much of which was backed by VC dollars, may have been another attraction. Investors may have previously underestimated the earning potential of the tech industry, says Fred Giuffrida of Horsley Bridge, a fund that invests in VC funds. They may now be correcting for this.

The rush of capital has pushed up prices. Seed-stage valuations today are close to where series A valuations (of older companies that may already be generating revenue) were a decade ago. The average seed valuation for an American startup in 2021 is \$3.3m, more than five times what it was in 2010 (see chart 2).

But funding is also reaching new terrain. In 2002 84% of venture activity, in terms of value, took place in America. That share is now about 49%. China's share grew from below 5% in the 2000s to 37% in 2018, before its tech crackdown brought it down to nearer 20%. Capital has instead sought greener pastures in Europe. Keith Rabois of Founders Fund, a VC firm, argues that, if done right, investing in less heated sectors can help produce attractive venture returns.

Software startups continue to be popular with venture capitalists. But “you’re seeing a broadening of who gets funded,” says Josh Lerner of Harvard Business School. Riskier biotechnology, crypto and space ideas are being backed. Moderna, a pharmaceutical company that produces covid-19 vaccines, was spun out of Flagship Pioneering, a VC firm. Green tech, which saw a boom and bust in the 2000s, is resurgent. PwC, a consultancy, estimates that between 2013 and 2019 climate-tech venture deals grew at five times the rate of overall startup funding.

For many old-school venture capitalists, this new competitive world is

unsettling. “We need to react,” acknowledges Roelof Botha of Sequoia. Though rising valuations bolster returns on current portfolios, they dry up future returns. Crossover funds are less price-sensitive than traditional VCs. And for later-stage startups, investors’ money is more fungible, says Mr Giuffrida. It matters less who is investing than how much they are willing to pay. Furthermore, the market for orthodox VC firms is becoming tougher. Despite the venture boom, fundraising by new niche VCs in America has fallen from a peak of \$14bn in 2018 to an expected \$5.5bn in 2021.

One part of the traditional firms’ response is differentiation. Many crossover investors tend to take a data-driven approach, building portfolios of startups that resemble an index of top performers in each sector. They eschew playing large roles in their portfolio companies. To contrast with this, some VCs are emphasising their personal touch. Crossover funds “are transactional capital. We are relationship capital,” says one early-stage investor.

One fund in Austin, Texas, 8VC, is expanding its startup “incubator”, which currently nurtures and spins out five or so companies a year. Slow Ventures, another VC firm, is even investing directly in the career paths of individuals, such as online-content creators, who may not yet run a proper business. Without a compelling offering, says Ben Horowitz, co-founder of Andreessen, VCs either need to be willing to overpay or close up shop altogether.

Another response is to scale up. Some angel investors, who invest their own money without a team or firm, are spreading their wings and evolving into solo venture capitalists, who invest external funds. They can move fast—there are no other partners to convince before doing a deal. Elad Gil, a prominent solo VC, made around 20 investments in the first half of 2021 and is raising a \$620m fund, an astonishing sum for an individual investor.

The biggest and best-known VC firms are also expanding. Andreessen has grown its investment team from about 25 to 70 in the past four years. It offers companies support on everything from diversity and inclusion policy to a vast network of potential hires and customers.

The line between VC and other investors is also blurring further, and not just because Wall Street is encroaching onto Sand Hill Road. Big VC firms are becoming more like other asset managers, too. Sequoia is expanding its presence in public markets. In October it said that its American and European venture funds will sit within a larger, timeless fund. When portfolio firms go public, their shares will flow to the superfund instead of to end-investors. This allows Sequoia to capture returns even after an IPO. Crossover funds like Tiger already seamlessly transfer holdings from their private to public funds. Other large VC firms may follow suit.

Sequoia's superfund mirrors Wall Street's fascination with permanent capital. "Many of the dynamics in private-equity markets are now spilling over into venture markets," says Mr Lerner. VCs and private-equity funds used to raise money from investors every few years, which can be costly and prevent them holding on to investments. Leading buy-out firms like Blackstone and KKR found ways around this. Nearly a third of KKR's assets under management are now permanent.

Sequoia is also becoming a registered investment adviser, joining Andreessen and other large funds, like SoftBank. That allows it to hold more "secondary" shares—stakes that are not bought directly from the issuing company. (VCs' secondary holdings are usually capped at 20% of their portfolios.) Andreessen's status as an adviser allowed it to launch a \$2.2bn crypto fund in June that mainly invests in digital tokens, rather than startups.

The biggest funds are best placed to benefit from the new world. Funding

from a top VC firm sends a signal of a startup's quality, argues Mike Volpi of Index Ventures. And because non-traditional investors often rely on such signals to guide their dollars, their value has only risen. The result is that the industry has become more unequal: although the average American VC's assets under management rose from \$220m in 2007 to \$280m in 2020, that is skewed by a few big hitters. The median, which is less influenced by such outliers, fell from \$70m to \$48m. But this is not to say that the industry has become dominated by a few star funds. Market shares are still small. Tiger Global, for instance, led or co-led investments worldwide worth \$5bn in 2020, just 1.3% of total venture funding. Startups have diverse enough needs so there is plenty of scope for a variety of VC firms to exist, reckons Mr Volpi.

Company founders, for their part, have gained bargaining power as investors compete. "There's never been a better time to be an entrepreneur," says Ali Partovi of Neo, a VC firm based in San Francisco. Ten years ago, most new founders had not heard of a term-sheet, a document describing the terms and conditions of an investment, says one venture capitalist. Now, many startups work with "accelerators" like Y Combinator to learn the basics. Cloud computing and other software-as-a-service (SaaS) tools allow some firms to expand without much capital investment.

The time taken to strike a deal has shrunk from several weeks to days, if not hours. Zoom has changed the nature of fundraising. Bidock, a microscopy startup, had ten calls with VCs scheduled in a day, which gave it more power in negotiations, reckons Michael Lee, its founder. Founders receive "refreshes", top-ups of equity during fundraising rounds. To get ahead of the rush, some investors are offering companies cash even before they start looking for more funding.

The shift in power away from investors is welcome in some respects. The

outsized returns of VC firms will be competed down. Moreover, tech is no longer terrain that only well-connected venture capitalists in Silicon Valley can make sense of. The performance of SaaS firms, for instance, can be assessed using data on users' behaviour. The relationship between founder and venture capitalist might matter less than it used to, particularly as the startup grows.

But there are costs, too. Shortened deals can lead to FOMO (fear of missing out) for investors and, sometimes, worse investment decisions, says Mr Partovi. The shift has also weakened governance. As the balance of power tilts away from them, VCs get fewer board seats and shares are structured so that founders retain voting power. Founders who make poor chief executives—such as Travis Kalanick, the former boss of Uber, a ride-hailing firm—can hang on for longer than they should. The relationship between VC firms and a founder lasts about ten years, longer than many marriages, notes Mr Partovi. You wouldn't choose your spouse in a hurry.

Another risk is that the market is too frothy. Some investors point to bumper profits for tech companies and the financial health of even the youngest startups as reasons for being optimistic about valuations. But “companies are being priced on the assumption that everyone will win. Statistically that won’t happen,” says Mr Giuffrida of Horsley Bridge.

Stellar returns for investors, then, are not assured. But the broader question is whether the innovation that is taking place is worth the risk. “If too much stuff gets funded, that’s generally good. It’s much better than nobody funding Moderna,” says Mr Horowitz. And capital can drive new ideas, not just the other way around. Investors have typically been willing to bet on riskier but more innovative startups during past venture booms, finds a study by Ramana Nanda of Imperial College London and Matthew Rhodes-Kropf of MIT Sloan School of Management. Resilience, a capital-intensive drugmaker founded last year, has raised \$800m and already bought several

factories. This would not have been possible even two years ago, says Drew Oetting of 8VC. Venture activity in the space sector grew by 70% globally to \$7.7bn in 2020. “There are more moonshots,” reckons Mr Lerner of Harvard.

In tech the result could be more vibrant competition. The big-tech firms used to gobble up challengers: acquisitions by Amazon, Apple, Facebook, Google and Microsoft rose after 2000 and hit a peak of 74 in 2014. But they have fallen since, to around 60 a year in 2019 and 2020, perhaps owing to a fear of antitrust enforcement. More startups are making it to public markets. Listings, rather than acquisitions or sales, now account for about 20% of “exits” by a startup, compared with about 5% five years ago.

Wherever valuations go, it looks like the changes to the structure of VC will last. Outsized returns in early-stage investing were bound to be bid down eventually. As VC firms themselves are forced to innovate, a broader range of ideas is being backed in a wider variety of places. The pandemic was not the disaster that venture capitalists had first expected. It has nevertheless transformed what they do. ■



有风险，有收获

风险投资的崭新时代

投资颠覆性企业的生意很红火，而它自身也在被颠覆【深度】

去年3月，全球各地的年轻企业都在准备迎接末日。大型风投公司红杉资本警告“末日决战”将至，其他公司预测会出现“大倒退”。爱彼迎等创业公司预计经济会惨遭血洗，纷纷裁员。然而才几个月的时间，阴霾便已散去，一场历史性的繁荣到来。美国推出庞大的刺激政策；因封锁而困居家中的消费者花在网上的时间更多了，让科技公司的主导地位更加稳固。包括爱彼迎在内的许多公司趁市场看涨之机挂牌上市。去年上市的有风险资本支持的美国公司的总市值达到创纪录的2000亿美元，而2021年这个数字直奔5000亿美元。

投资者口袋满满，正在寻找机会押注新一代公司。数据供应商PitchBook的数字显示，全球风险投资（从为刚起步的公司提供早期“种子”资金，到为更成熟些的创业公司注资）今年有望达到5800亿美元的历史新高。这比2020年高出近50%，约为2002年的20倍。

涌入风投圈的投资者也和之前大不相同。这原本只是硅谷少数风投公司的领地。这些公司从养老基金和其他终端投资者那里筹资并代表它们做出投资，其运作往往依赖它们与公司创始人的庞大关系网络。而现在，按管理的资产规模计算，十大风险投资者中只有三家是传统风投公司。

而由私募股权公司、对冲基金和其他过去很少从事风投的机构领投或单独投资的交易额已接近翻倍，从2020年的1440亿美元升至今年的2600亿美元（见图表1）。这在全球风投中占到了惊人的44%，而在2002年为20%。老虎全球管理（Tiger Global Management）等横跨公共和私人市场的“跨界”基金正以惊人的速度配置资本。越来越多的巨型养老基金正在直接投资创业公司。

财力雄厚的投资者大量注资，推高了公司估值。但资金也在流向以往被忽视的角落和新机会。如今，风投活动大大扩展到硅谷乃至整个美国之外，投资对象也扩展到从区块链到生物技术的各式各样的公司。

这股资本浪潮也在改变风投的运作方式。风投公司纷纷采取新战略，试图在某些方面让自己实现差异化，同时在其他方面模仿华尔街的对手。这对创新既有好处也有坏处。

现代风险投资业萌生自上世纪60年代硅谷芯片制造商飞兆半导体（Fairchild Semiconductor）的一个实验室。阿瑟·洛克（Arthur Rock）率先离开飞兆半导体从事投资，他的首个基金筹集到500万美元，在七年内取得一亿美元的回报。尤金·克莱纳（Eugene Kleiner）和唐·瓦伦丁（Don Valentine）随后仿效他，分别成立了凯鹏华盈（Kleiner Perkins）和红杉资本。两者都发展为大型风投公司并屹立至今。

过去的做法是投资高风险的创业公司，希望会出现谷歌这样的巨大成功案例，扛起整个投资组合。种子轮投资往往是在创业公司还没有任何收入的时候进行的。然后，随着公司不断成长，还会有一连串融资，通常从A轮到C轮不等。风投公司的基金为封闭式，也就是说它们在七到十年内向投资者（通常是养老基金、捐赠基金和其他长期投资者）派发回报，当然要先抽走自己那一份。

风投家不仅提供资金，还扮演顾问的角色，常常在公司董事会占有一席。他们提供了丰富的经验，还有广泛的人脉，例如把创业公司介绍给职业CEO。创业者纷纷涌向沙丘路（Sand Hill Road）这一众多硅谷风投公司的所在地争取投资。整个行业很讲个人关系，让它颇有点“校友会”的小圈子氛围。

事实证明，这种模式惊人地成功。尽管每年新创立的美国公司获风投支持的占比不到0.5%，但在1995年以后创立的上市公司中，获风投支持的那些占了近76%的市值。渐渐地，风投公司更加倾向押注略为成熟的“后期”创业公司（而这些公司会推迟上市）。一些风投公司会在国外开设分支机

构。同样位于沙丘路的安德森-霍洛维茨（Andreessen Horowitz）成立于2009年，已跻身顶级风投之列。

那么，为什么这种模式正在被颠覆？这股热潮既有新竞争者入场的缘故，也是终端投资者兴趣大增的结果。而这些又是缘于富裕国家普遍利率下降，促使投资者进入风险更大但回报更高的市场。风投业绩无疑也在推波助澜，过去三年，风险投资是全球表现最好的资产类别，表现与过去十年私募股权和公开股票市场的牛市不相上下。

以往回避风险投资的终端投资者现在也开始参与进来。除了回报诱人外，相比其他类型的投资基金，挑选明星风投基金可能也更容易些：去年发表在《金融经济学杂志》（Journal of Financial Economics）上的研究显示，风投基金的好业绩往往更持久。科技巨头的成功（大部分由风投资金支持）可能是另一个吸引力所在。霍斯利桥公司（Horsley Bridge，一家投资风投基金的基金公司）的弗雷德·朱弗里达（Fred Giuffrida）指出，投资者以前可能低估了科技行业的盈利潜力，他们现在可能正在做出修正。

资本涌入推高了价格。现在的种子轮估值接近十年前的A轮估值（这一阶段的公司可能已产生收入）。2021年美国创业公司的种子轮估值平均为330万美元，是2010年的五倍多（见图表2）。

不过资金也在投向新领域。按价值计算，2002年84%的风投活动发生在美国，现在这一比例约为49%。中国的占比从2000年代的不到5%增长到2018年的37%，但在中国打压自己的科技圈后又下降至接近20%。资本转而在欧洲开拓新天地。风投公司创始人基金（Founders Fund）的基思·拉博伊斯（Keith Rabois）认为，如果操作得当，投资不那么热门的行业有助产生可观的风险回报。

软件创业公司继续受到风投家的青睐。但是“你可以看到投资的对象在扩大”，哈佛商学院的乔什·勒纳（Josh Lerner）说。风险更高的生物技术、加密货币和太空概念正在成为支持对象。研制了新冠疫苗的制药公司莫德

纳（Moderna）就是从风投公司旗舰先锋（Flagship Pioneering）剥离出来的。在2000年代经历了繁荣和萧条的绿色科技正在复苏。据咨询公司普华永道估计，2013年至2019年期间，气候科技风投交易的增长速度是创业公司风投整体增速的五倍。

在许多老派风投家看来，这种竞争的新局面令人不安。“我们需要做出反应。”红杉资本的罗洛夫·博沙（Roelof Botha）承认。尽管估值上升会提高当前投资组合的回报，但会透支未来的回报。跨界基金对价格的敏感度低于传统风投。而对处于发展后期的创业公司来说，投资者的资金更容易替代，朱弗里达指出。谁来投资并不重要，重要的是他们愿意投多少钱。另外，传统风投公司的市场变得越发艰难。尽管风投业势头正旺，美国新成立的利基风投的筹资额已从2018年高峰期的140亿美元下降到2021年预计55亿美元的水平。

传统风投公司的对策之一是差异化。许多跨界投资者倾向采用数据驱动的手段，所建立的创业公司投资组合类似于汇集了各行业中表现最好的公司的指数。它们避免在自己投资的公司中扮演重要角色。为了与此形成区别，一些风投公司着力强调自己的人性化色彩。跨界基金“是交易性资本，我们是关系资本”，一位早期阶段投资者表示。

得克萨斯州奥斯汀的基金8VC的创业“孵化器”目前每年培育和分拆出约五家公司，它正在扩大规模。另一家风投公司慢风投（Slow Ventures）甚至直接投资于个人的职业发展，例如投资线上内容创作者，而这些人可能根本还没创出什么正“业”来。安德森的联合创始人本·霍洛维茨（Ben Horowitz）指出，没看到令人信服的产品时，风投公司要不就得甘愿出过高的价，要不就干脆不做生意。

另一个对策是扩大规模。一些天使投资人（用自己的钱投资，没有团队或公司）正奋翅鼓翼，变身为使用外部资金来投资的solo风投人。他们可以快速行动，在交易前无需说服其他合伙人。著名solo风投人埃尔德·吉尔（Elad Gil）在2021年上半年完成了约20项投资，目前正在募集一只6.2亿美元的基金——这对个人投资者来说是个惊人的数字。

最大、最知名的风投公司也在扩张。过去四年，安德森的投资团队从约25人增员至70人。它在方方面面为企业提供支持，从多样性和包容性政策，到潜在雇员和客户的庞大网络。

风险投资和其他投资者之间的界限也在进一步变模糊，不仅是因为华尔街正在步步侵占沙丘路。大型风投公司也在逐渐变得更像其他资产管理公司。红杉资本正在扩大自己在公共市场中的影响力。10月，该公司表示将设立一只更大的无存续期限的基金，持有自己在美国和欧洲的风投基金。等到投资组合公司上市时，它们的股票将流向这只超级基金，而不是终端投资者。这使得红杉即使在公司IPO之后也能获得回报。老虎全球管理等跨界基金已经把持有的股份从其私人基金无缝转移到公共基金。其他大型风投公司可能也会效仿。

红杉资本的超级基金映照出华尔街对永续资本的迷恋。“私募股权市场的许多动态正在溢出到风投市场上。”勒纳说。风投和私募股权基金过去每隔几年就会向投资者募资，这样做可能成本高昂，还会妨碍它们长期持有投资。黑石和KKR等顶尖并购投资公司找到了规避的方法。现在KKR管理的资产中有近三分之一是永续的。

红杉资本也逐渐化身为注册投资顾问，加入到安德森和其他大型基金（如软银）的行列。这让它能持有更多“二级”股份，即并非直接从发行公司购买的股份。（风投公司可持有二级股份的上限一般为投资组合的20%。）获得顾问资格的安德森得以在今年6月推出一只22亿美元的加密货币基金，主要投资数字货币而非创业公司。

最大的基金最能从这个新世界中获益。指数创投（Index Ventures）的迈克·沃尔皮（Mike Volpi）认为，能获得顶级风投公司投资是一家创业公司潜力突出的信号。而由于非传统投资者往往依靠这种信号来指导投资，这些公司的价值有增无减。结果是这个行业变得更加不平等：尽管美国风投公司管理的平均资产从2007年的2.2亿美元上升到2020年的2.8亿美元，但这是少数大热门拉动的结果。实际上，管理资产的中位数（受少数异常值的影响较低）已从7000万美元下降到4800万美元。但这不是说该行业已

被少数明星基金主导。它们所占的市场份额仍然很小。例如，老虎全球管理2020年在全球的领投或联合领投的投资额为50亿美元，仅占风投总额的1.3%。沃尔皮认为，创业公司的需求极为多样化，各类风投公司因而都有充分的生存空间。

随着投资者之间的竞争加大，公司创始人有了更强的议价能力。“现在是前所未有的创业好时机。”旧金山风投公司Neo的阿里·帕托维（Ali Partovi）说。十年前，大多数新公司的创始人都没有听说过投资条款清单（描述投资条款和条件的文件），一位风投家表示。现在，许多创业公司与Y Combinator这样的“加速器”合作，学习基本知识。云计算和其他软件即服务（SaaS）工具使一些公司不需要很多资本投资也能扩张。

敲定交易的时间已经从几周缩减到几天，甚至几小时。云视频会议平台Zoom改变了融资的特性。显微技术创业公司Biodock在一天内和不同的风投公司开十次会，创始人迈克尔·李（Michael Lee）认为这也让它在谈判中提升了议价能力。创始人会拿到“补充”，也就是在融资轮中获得更多股权。为抢占先机，一些投资者甚至在企业着手寻找更多资金前就向它们提供现金。

在某些方面，权力不再由投资者独揽是值得欢迎的。风投公司的超额回报将在竞争中降下来。此外，科技业不再是只有硅谷那些人脉通达的风投家才能玩得转。例如，软件即服务公司的业绩可以通过用户行为数据来评估。创始人和风投家之间的关系可能没有以前那么重要了，随着创业公司成长壮大就更是如此。

但这也有代价。帕托维表示，交易时间缩短可能令投资者产生错失恐惧症（FOMO），有时还会导致更糟糕的投资决策。权力转移也削弱了公司治理。随着权力的天平向另一方倾斜，风投公司获得的董事会席位变少了，而且股份结构也让创始人能保留投票权。担任首席执行官的创始人即使表现不佳也能赖着久久不下台，比如网约车公司优步的前老板特拉维斯·卡兰尼克（Travis Kalanick）。而风投公司和创始人之间的关系一般会维持

约十年，比许多婚姻还要长，帕托维指出。你总不会匆忙草率地选择配偶吧。

另一个风险是市场泡沫严重。一些投资者指出，科技公司利润丰厚，连最年轻的创业公司也有良好的财务状况，这些都是估值乐观的理由所在。但是，“这些公司的定价靠的是人人都赢钱的假设，而从统计上来说这是不可能的，”霍斯利桥的朱弗里达说。

所以说，投资者不一定能获得丰厚回报。但更广泛的问题是，当前出现的创新是否值得冒险投资。“如果有太多东西得到投资，通常是好事。这比没有人资助莫德纳要好得多。”霍洛维茨说。而且，不仅创意能推动资本，资本也能推动创意。伦敦帝国理工学院的拉玛纳·南达（Ramana Nanda）和麻省理工学院斯隆管理学院的马修·罗兹-克罗夫（Matthew Rhodes-Kropf）的研究发现，在过去的风投热潮中，投资者通常都愿意押注风险较高但更具创新性的创业公司。去年成立的资本密集型制药公司Resilience已融资八亿美元，并收购了多家工厂。即使在两年前，这也是不可能做到的，8VC的德鲁·奥廷（Drew Oetting）说。2020年，太空领域的风投在全球增长了70%，达到77亿美元。“还会有更多的‘登月’式项目。”哈佛大学的勒纳认为。

在科技行业，结果可能是竞争更活跃。以往，大型科技公司会吞并挑战者：2000年后，亚马逊、苹果、Facebook、谷歌和微软加大了收购力度，在2014年达到高峰，当年共有74宗。但之后开始下降，到2019年和2020年约为每年60宗，也许是出于对反垄断执法的担忧。更多创业公司走向公开上市。在创业公司选择的“退出”机制中，上市（而非收购或出售）现在约占20%，而五年前只有约5%。

无论估值走高走低，风投业的结构转变看来将持续下去。早期阶段投资的超额回报最终肯定会因竞争而下降。随着风投公司自身被迫创新，在更多地区里更多种多样的创意正在获得资助。新冠疫情并不是风投家最初预期的那种灾难，但它还是改变了他们的生意。■



The World Ahead 2022

Will the world economy return to normal in 2022?

If it does not, a painful economic adjustment looms

Will the stagflationary forces acting on the world economy last? Throughout 2021, central banks and most economists have said that the factors causing inflation to rise and growth to slow would be temporary. Supply-chain bottlenecks would subside, energy prices would return to earth and the rich-world workers staying out of the labour force—for reasons nobody fully understands—would return to work. And yet as 2021 draws to a close financial markets, the public and even central bankers themselves are beginning to lose faith.

The dilemma facing policymakers is acute. The textbook answer to inflation caused by supply disruptions is to ignore it and let it go away on its own. Why damage economies with higher interest rates, which will not unblock ports, conjure up new supplies of natural gas or bring the pandemic to an end? In 2011 inflation in Britain rose to 5.2% as a result of rising commodities prices, but the Bank of England kept interest rates low. In the euro area the European Central Bank raised rates, helping send its economy back into recession, and before long found itself with inflation well below its target. Like then, inflation in 2022 driven by high energy prices is likely to subside. (Inflation is the rate of change of prices, meaning that even if prices do not return to previous levels, merely not rising as quickly is enough.)

Yet the comparison with the early 2010s is inexact. The woes of global trade in 2021 have not just been caused by disrupted supply, such as covid-19 outbreaks shutting Vietnamese factories. There has also been excess demand. Massive fiscal and monetary stimulus, combined with social distancing, led consumers to binge on goods, from games consoles to tennis

shoes. In the summer of 2021 Americans' spending on physical stuff was 7% above the pre-pandemic trend. In other countries, too, there is only a shortage of goods relative to unusually high demand for them. For the world economy to return to something like normal, consumers need to spend more of their plentiful cash on services, such as restaurant meals and travel.

Unfortunately economies are plagued by shortages of workers needed for service industries to thrive. Wages in leisure and hospitality are soaring. Many economists hoped that workers would return as emergency support for labour markets, such as furlough schemes and emergency unemployment insurance, ended. So far there is surprisingly little sign of that happening. For inflation to be temporary, wage growth as well as price growth probably needs to fall. The alternatives are an unlikely surge in productivity, or lower profit margins, which for businesses such as restaurants are already thin.

Some monetary policymakers are beginning to fear the reverse: wage growth that continues to rise as workers come to expect higher inflation. The rich world has not seen a wage-price spiral since the 1970s, and doves argue that in economies without widespread unionisation, workers are unlikely to negotiate higher wages. But if rising inflation expectations do prove self-fulfilling, central banks' job would suddenly get much harder. They would not be able to keep inflation on target without sacrificing jobs. Emerging markets are used to this painful trade-off between growth and inflation, but it has not bitten hard in the rich world for decades. In big rich countries, the Bank of England is the closest to tightening—purely to preserve the credibility of its inflation target, rather than because it is warranted by underlying economic conditions.

It is easy to imagine monetary policymakers raising interest rates and coming to regret it. Though inflation will remain high in the early months of 2022, central bankers typically think it takes a year and a half for higher

interest rates to have their full effect on the economy. The forces that previously kept global rates and inflation low—demographic change, inequality and rampant global demand for safe assets—may have reasserted themselves by then. Imminent fiscal retrenchment in many countries will help cool economies: Britain has announced large tax rises and President Joe Biden is struggling to get large spending bills through Congress. And slower growth in China, which is struggling with a property-market slowdown, could spill over globally.

Above all else, the pandemic is not over. The spread of the virus could yet disrupt economies once again if immunity wanes and new variants can evade vaccines. But with supply chains at their limits, the world cannot repeat the trick of maintaining economic growth using stimulus that shifts consumer spending towards goods. Instead central banks would have to choke off spending with higher rates to avoid excessive inflation while the supply-side of the economy adapts to patterns of spending and working that are vastly different from what prevailed in the 2010s. If normality does not return in 2022, the alternative is a painful economic adjustment.

Henry Curr: Economics editor, *The Economist* ■



世界展望2022

世界经济会在2022年恢复正常吗？

如果没有的话，痛苦的经济调整隐约逼近

影响世界经济的滞胀力量会持续吗？整个2021年，央行和大多数经济学家都表示，导致通胀上升和增长放缓的因素将是暂时的。供应链瓶颈将消退，能源价格将回落，而出于没人完全理解的原因脱离劳动力队伍的富裕世界工人将重返工作岗位。然而，随着2021年接近尾声，金融市场、普罗大众甚至央行行长们自己也开始失去信心。

决策者面临的两难困境非常严峻。对供应中断引起的通货膨胀，教科书式回答是忽略它，让它自行消失。为什么要以更高的利率损害经济呢，它又不会疏通港口、催生新的天然气供应或结束疫情。2011年，由于商品价格上涨，英国的通货膨胀率上升至5.2%，但英格兰银行将利率维持在低位。在欧元区，欧洲央行提高了利率，导致其经济重新陷入衰退，不久之后就发现通胀水平远低于目标。与那时一样，2022年由高能源价格驱动的通胀很可能会上升。（通胀是价格的变化率，这意味着即使价格没有回到以前的水平，只要涨得不那么快就足够了。）

然而，这种与2010年代初期的比较是不准确的。引起2021年全球贸易困境的不仅仅是供应中断——例如新冠疫情爆发导致越南的工厂关闭。还有需求过大的问题。大规模的财政和货币刺激措施加上社交疏离，导致消费者大肆购买游戏机和网球鞋等商品。2021年夏天，美国人在实物上的支出比疫情前的趋势高出7%。其他国家也只是因为异常高的需求而出现了短缺。为了让世界经济恢复正常，消费者需要将大把现金更多地花在服务上，例如餐厅用餐和旅行。

不幸的是，要让服务业兴旺所需的人手不足，拖累了经济。休闲和酒店业的工资正在飙升。许多经济学家希望，随着对劳动力市场的紧急支持（例如强制休假补助计划和紧急失业保险）的结束，工人将重返工作岗位。出

人意料的是，迄今几乎没有迹象表明这正在发生。要让通胀只是暂时现象，工资增长和物价增长很可能需要下降。另一个实现途径是生产率的大幅提高（这不太可能）或利润率的降低，但对于餐馆等行业来说利润已经很薄了。

一些货币政策制定者开始担心事情的实际走向正相反：随着工人开始预期更高的通胀，工资增长将继续上升。自1970年代以来富裕世界从未出现过工资-价格的螺旋式上升，而鸽派认为，在没有广泛工会化的经济体中，工人不太可能通过谈判获得更高的工资。但是，如果不断上升的通胀预期真的自我应验，那么央行的工作就会瞬间变得困难得多。它们无法在不牺牲就业的情况下将通胀保持在目标水平。新兴市场已经习惯了经济增长和通胀之间这种痛苦的权衡，但富裕国家已经有几十年没有受到它的严重冲击。在富裕大国中，英格兰银行是最接近紧缩的——纯粹是为了保持其通胀目标的可信度，而不是因为背后有经济状况做支撑。

很容易想象得到，货币政策制定者在提高利率后又会后悔。虽然通胀在2022年的前几个月仍将居高不下，但央行官员通常都认为，加息需要一年半的时间才能对经济产生全面影响。而到那时，在过去使全球利率和通胀保持在低水平的力量——人口变化、不平等和全球对安全资产的需求旺盛——可能已经再度显现它们的影响力。许多国家迫在眉睫的财政紧缩将有助于为经济降温：英国已宣布大幅增税，而拜登总统要让大额支出法案通过国会也困难重重。中国正在努力应对房地产市场放缓，其增长减速可能会波及全球。

最重要的是，疫情还没有结束。如果人们的免疫力减弱并且新的变种可以逃避疫苗，病毒的传播可能会再次干扰经济。但是，由于供应链承压已到极限，利用刺激措施将消费者支出转向商品以维持经济增长的方法没法再用一次。相反，央行将不得不以更高的利率来抑制支出以避免过度通胀，而经济的供给侧则需要适应与2010年代时的主导情形大不相同的支出和工作模式。如果2022年不能恢复常态，世界迎来的将是一场痛苦的经济调整。

亨利·科尔（Henry Curr）：经济学编辑，经济学人■



The West's allure

China's globetrotting students are getting back on the road

But Western universities worry that their numbers may dwindle

QIN YIBO is half way through a science degree at the University of Auckland in New Zealand. But she has not been in the country since early 2020 when it closed its borders to prevent the spread of covid-19 (she was back in China at the time). Instead the university has arranged for Ms Qin and other stranded students in China to take up residence on campuses in their own country while they continue their studies remotely. Ms Qin has thought about transferring permanently to a Chinese university, but she still plans to return to New Zealand when it eases its border controls.

Ms Qin is relatively lucky. She has enjoyed seeing parts of her country that she had not visited previously. She spent the early months of this year at a university in Heilongjiang, a north-eastern province with bitter winters. Then, for a change of scenery, she moved to a campus in Fujian in the balmy south. Many thousands of Chinese students who had not yet enrolled at universities abroad when the pandemic began have found their plans upended by covid-related travel restrictions. Universities in the West have lived in fear that young Chinese, whose tuition fees are a lucrative source of revenue, would give up the dream of studying aboard.

There are good reasons for Western universities to be anxious. In 2019 around 700,000 Chinese headed abroad to study, more than three times the number a decade earlier. Most joined universities in English-speaking countries. Chinese students have had several reasons to reconsider their destinations. Foreign travel is difficult during a pandemic, and covid is still rife in Western countries. China has grown more unpopular in recent years, and some Chinese people in the West have suffered racist abuse.

Anti-Western sentiment has also been rising in China, sometimes stoked by ruling-party propaganda. Many Chinese chafe at Westerners who blame China for its initial cover-up of covid, or who fail to give it credit for its subsequent success in curbing the virus.

But the pandemic's impact on Chinese demand for study abroad has not been as bad as many had predicted. Before the crisis about 370,000 Chinese were studying at American universities, where they made up about a third of foreign students. In 2020 the number of Chinese enrolled, including those studying online from abroad, fell by around 15%. That is not the collapse that some in the industry had predicted, says Martin McFarlane of the University of Illinois at Urbana-Champaign. The fall was caused almost entirely by a reduction in the number of foreign students starting new courses, which now seems to be rebounding. The Institute of International Education, an American NGO, says that this autumn the number of foreigners who began studying at American universities for the first time was only 9% lower than in 2019 (though about 35% were taking their classes online).

Australia has kept its borders shut to most foreign students throughout the pandemic. Even now, roughly half of them are studying online from outside the country, including about 65% of those from China. Yet, in Australia, total Chinese enrolment in higher education has fallen only 7%. Chinese students—nervous of the virus but keen to burnish their CVs with a Western degree—have proven more willing to put up with online learning than peers of other nationalities. Enrolments by Indians, for whom in-person classes are a high priority, have fallen by more than a third.

Britain's universities have fared the best. The number of Chinese students was rising fast in the years leading up to the pandemic. This summer the country began allowing foreigners to remain longer after graduation to work or look for a job. Britain's rules on post-study employment are now among

the most permissive in the West. Since the pandemic began, Britain's borders have stayed mostly open to foreign students, as long as they are willing to endure quarantine. In 2020 the number of Chinese accepted for undergraduate studies increased by 30%. This year the number of Chinese applying to start undergraduate courses rose again, by 17%.

In some countries, Chinese demand for tertiary education may yet falter. America is likely to remain the single most-popular destination for several more years. It is still widely regarded in China as having the largest number of great universities. But some Chinese have been put off studying in America by the xenophobic rhetoric of American officials during Donald Trump's presidency, which fuelled perceptions of Chinese as potential spies. Such concerns may have abated a bit since Joe Biden took over. But surveys of Chinese considering study in America have shown that they view America's handling of covid as the worst in the English-speaking world. Chinese students show growing interest in studying in Asia, says Simon Emmett of IDP, a multinational agency that helps universities recruit them. Asian countries are deemed to have a better record with covid.

In Australia there have been big falls in the number of Chinese students taking non-degree courses such as English-language lessons, says Peter Hurley of Victoria University's Mitchell Institute, a think-tank in Melbourne. Students often use these courses as preparation for study at Australian universities. This may suggest that Chinese enrolment at universities in Australia will keep on falling, at least for a while, even after the country reopens.

In China there is another indication of unsettled demand. A large share of the Chinese who leave the country to study commit to doing so at the end of their compulsory education, when they are about 15. At that stage they opt out of preparation for China's university-entrance exam and instead join senior high schools that offer curriculums focused on study abroad. Francis

Miller, a college counsellor at one such school in the city of Xi'an, says the number of 15-year-olds entering its international programme fell sharply in 2020, before recovering somewhat this year. He thinks other, similar schools are having a harder time recruiting students. Xiaofeng Wan, who manages international admissions at Amherst College in America, notes that last year more Chinese children than usual elected to sit the entrance exam for senior secondary schools. Pupils aiming to study abroad sometimes skip this.

There are other, long-term, challenges. The number of Chinese of university age is no longer growing. Amid economic headwinds, fewer families will have the resources to splash out on foreign tuition. Meanwhile, China's own universities are improving. About 47m people are enrolled in tertiary education there, up from around 6m in 1998. Before the pandemic an expert at the British Council, a state-funded cultural organisation, estimated that the number of Chinese seeking a foreign degree could start falling in 2023.

China does not appear keen to deter study abroad. During the pandemic Chinese officials have supported foreign universities' efforts to help Chinese students continue their studies online, says Brett Berquist of the University of Auckland. The Chinese government has stopped issuing passports to most people, but has given them to those planning to study abroad.

Officials still want clever young Chinese to get the best training in science, medicine and engineering, wherever in the world it can be found. After all, about 80% of such students return to China after graduating. For many of them, China's allure ultimately trumps the West's. ■



西方的诱惑

中国留学生重新上路

但西方大学担心他们的人数可能将减少

秦艺波（音译）在新西兰的奥克兰大学（University of Auckland）攻读理科学位，目前学业已经过半。但自2020年初新西兰关闭边境以防新冠疫情传播以来（当时她已返回中国），她就一直没有再回到新西兰。该校安排秦艺波和其他受疫情影响滞留中国的学生迁入在中国的合作院校，通过远程授课继续学习。她曾考虑永久转到一所中国大学，但目前仍计划在新西兰放松边境管制后返校。

秦艺波还算是幸运的。她还有机会去国内一些自己没去过的地方看看。今年头几个月她在东北部省份黑龙江的一所大学里，那里的冬天异常寒冷。后来，为了换换环境，她又搬到位于温暖宜人的南方省份福建的一个校园。疫情爆发时几十万名中国学生尚未在海外大学入学，他们的留学计划被接下来的疫情相关旅行限制彻底打乱。中国学生支付的大笔学费是西方大学的一大收入来源，校方一直非常担心中国的年轻人会因此放弃出国留学的梦想。

西方院校有充分的理由感到焦虑。2019年，约有70万中国人出国留学，是十年前的三倍多。大多数人都选择了英语国家的大学。但现在，中国学生要重新考虑出国目的地了，原因有几个。首先，大流行病期间出国旅行会变得困难，而新冠疫情仍在西方国家肆虐。近年来，中国变得越来越不受欢迎，而一些在西方的中国人遭到了种族主义欺凌。中国的反西方情绪也在升温，有时是受到执政党宣传机器的煽动。许多中国人不满西方人指责中国在最初隐瞒疫情或者不称颂它后来在遏制病毒上的成功。

但是，疫情对中国留学需求的影响并没有预想的那么严重。疫情爆发前，大概有37万中国人在美国大学求学，约占美国国际学生总数的三分之一。2020年，包括在美国以外地点上网课的学生在内，中国在读留学生人数下

降了15%左右。伊利诺伊大学厄巴纳-香槟分校的马丁·麦克法兰（Martin McFarlane）表示，这并不是一些业内人士所预测的暴跌。这一降幅几乎完全源自新入学的外国学生人数的减少，而这部分现在似乎正在回升。美国非政府组织国际教育协会（Institute of International Education）表示，今年秋季，美国大学新入学的外国学生人数仅比2019年减少9%（尽管约35%的人是上网课）。

疫情期间，澳大利亚一直对大多数外国学生关闭边境。即使是现在，其国际学生当中仍有约一半从澳大利亚以外的地点远程上网课，其中约65%来自中国。不过，在澳大利亚高等院校求学的中国学生总数仅下降了7%。中国学生害怕病毒，但又渴望用西方的学位给简历镶金。结果是他们比其他国家的学生更愿意忍受上网课。印度人非常看重面对面教学，他们的在读人数下降了超过三分之一。

英国的大学状况最好。在疫情爆发前的几年里，中国留学生的数量迅速增加。今年夏天，英国开始允许外国人在毕业后居留更长时间工作或求职。英国对毕业后的就业规定是西方国家中最宽松之一。疫情发生以来，只要外国学生愿意忍受隔离，英国的边境基本上对他们保持开放。2020年，本科录取的中国学生人数增加了30%。今年，申请本科课程的中国学生数量再次增加，上升了17%。

在其他一些国家，来自中国的高等教育需求可能会下降。未来几年里，美国很可能仍是最受欢迎的留学目的地。中国人仍然普遍认为美国拥有最多的优秀大学。但在特朗普执政期间，美国官员的排外言论助长了将中国人视为潜在间谍的观念，一些中国人因此对赴美留学望而却步。自拜登登上台以来，这种担忧可能有所缓和。但对有意赴美留学的中国人的调查显示，他们认为美国的防疫表现是英语国家中最差的。帮助大学招收中国学生的跨国机构IDP教育集团的西蒙·艾米特（Simon Emmett）表示，中国学生对在亚洲留学的兴趣越来越浓。亚洲国家被认为在防疫上的表现更好。

在澳大利亚，参加英语语言课程等非学位课程的中国学生数量大幅减少，位于墨尔本的智库维多利亚大学米切尔研究所（Mitchell Institute）的彼

得·赫尔利（Peter Hurley）表示。学生通常利用这些课程来为进入澳大利亚的大学做准备。这可能意味着即使澳大利亚重新开放边境，至少在一段时间内，当地大学的中国学生人数仍将继续降低。

在中国，还能看到另一个需求不稳的迹象。中国留学生大多在他们15岁左右完成义务教育时就开始为出国做准备。在这个阶段，他们放弃备战中国的高考，而是进入提供海外留学准备课程的高中。西安一所此类学校的辅导员弗朗西斯·米勒（Francis Miller）表示，参加该校国际课程的15岁学生人数在2020年大幅下降，今年有所回升。他认为其他类似的学校目前招生也更难了。美国阿默斯特学院（Amherst College）负责国际招生的万晓峰指出，去年有比以往更多的中国孩子选择了参加中考。打算出国留学的学生有时会跳过这个升读普通高中的关口。

还有其他比较长期的挑战。中国的大学学龄人口已经不再增长。在经济逆风期，有能力负担高额海外学费的家庭数量也会减少。与此同时，中国本土的大学也在进步。中国国内大约有4700万在读大学生，而在1998年时只有约600万人。疫情爆发之前，英国政府资助的文化组织英国文化交易协会（British Council）的专家估计，攻读海外学位的中国学生数量可能从2023年开始下降。

中国似乎并没有要积极阻碍出国留学。奥克兰大学的布雷特·贝奎斯特（Brett Berquist）说，疫情期间外国大学尽力安排中国学生在线上继续学习，中国官员对此也提供了协助。中国政府已经停止向大多数人发放护照，但那些计划出国留学的人还是可以拿到护照。

官员们仍然希望聪明的中国年轻人接受最好的科学、医学和工程培训，无论这培训发生在世界何处。毕竟，这些留学生有大约80%都会在毕业后回到中国。对他们中的许多人来说，中国的吸引力最终还是胜过西方。■



Back from the USSR

Vietnam has produced a new class of billionaire entrepreneurs

The renaming of an Oxford college is just one sign of their clout

THE ECONOMIC development of Vietnam now has a permanent monument in one of the world's most prestigious seats of learning. After a \$207m investment announced early last month by Sovico, a Vietnamese holding firm, the University of Oxford's Linacre College (for graduate students) is set to be renamed after Nguyen Thi Phuong Thao, its chairwoman.

Thao College is a marker of a significant shift. As recently as 2012 Vietnam was a land without dollar billionaires. Today six are thought to have joined the club, according to Forbes, a magazine. A surging stockmarket means the list is likely to get longer. Whereas American and Chinese billionaires are in the cross-hairs from their respective governments, Vietnam's wealthy entrepreneurs are the beneficiaries of the authorities' ambition to foster internationally competitive national champions.

Top of the list is Pham Nhat Vuong, founder of Vingroup, a sprawling conglomerate—and the first to enter the billionaires' club, in 2013. It is hard to find parts of the domestic-services sector that Vingroup has not touched, from tourism to hospitals, from pharmacies to education to car-making. It vies with Vinhomes, the property arm it spun off in 2018, as Vietnam's largest private firm by market capitalisation. Each is worth a little over \$15bn, a scale that could admit an American firm to the S&P 500 index.

Mr Vuong has since been joined by more tycoons, including Ms Thao. Masan Group, a consumer-focused conglomerate, and Techcombank, one of the country's largest lenders, have close links through their founders, Nguyen Dang Quang and Ho Hung Anh. All four share a curious start to their

entrepreneurial stories: they originally launched commercial ventures in the former Soviet Union.

The Soviet link is a function of Vietnam's modern economic and political history. In 1985 Vietnam had a GDP per person of around \$500 in today's dollars, one of the lowest in the world at the time. Until the collapse of the Soviet bloc, bright and politically connected students in Vietnam gained opportunities to study in Russia and its various satellites; in 1980 around 3,000 did so, alongside youngsters from other communist-run places.

Those who found themselves in the region in the late 1980s and early 1990s uncovered more opportunities for profit than in Vietnam. Mr Vuong launched a brand of instant noodles, Mivina, which became a domestic staple in Ukraine. Ms Thao made her first million dollars at university in Moscow, importing office equipment and consumer items from East Asia.

Later, as Vietnam's development continued, they were some of the few citizens outside the country with starter fortunes to invest at home. The government welcomed back this so-called "patriotic capital," according to Bill Hayton, author of a book on the country's rapid rise. "They were getting bigger at the time the party state needed them, so it became a sort of symbiotic relationship," he says.

In recent years the state's relationship with the tycoons has grown even closer. Nguyen Xuan Phuc, the prime minister, spoke recently of Vietnam's need to produce internationally competitive business giants to continue its rapid growth. That friendly attitude can translate into an easy ride; such unofficial government assistance is particularly handy for gaining use rights to prime plots of land, which—as in mainland China and Hong Kong—is technically owned wholly by the state. While most of the firms led by the billionaires cater to Vietnam's middle class, much of their wealth comes from property and banking, according to research by Nguyen Xuan

Thanh of Fulbright University Vietnam. Finance and property are the typical domains of oligarchs across the world: operating in a one-party state in such industries requires permissions, licences and close political relationships.

While useful in its own right, diversifying beyond areas that benefit from political patronage can serve as a signal to sponsors that they are backing exciting entrepreneurs. Outside investment brings a further sheen of credibility. Last month SK Group, one of South Korea's largest conglomerates, announced a \$340m investment in Masan Group's consumer-retail arm. That follows a \$400m investment from Alibaba, a Chinese e-commerce giant, earlier this year. SK Group also owns 6% of Vingroup.

Former oligarchs who stuck to the old-school playbook of banking and property have not felt the warm glow of state support consistently. Nguyen Duc Kien, founder of Asia Commercial Bank, and Ha Van Tham, chairman of OceanBank, were given lengthy prison sentences for corruption in 2014 and 2017 respectively. Mr. Tham's deputy was sentenced to death at the same time. As the experience of many oligarchs both in Vietnam and around the world shows, being in government's good books can be a tremendous advantage but also carries risks. For the current crop, their reputation as valuable entrepreneurs and innovators will be key to remaining in the state's good graces. ■



从苏联回来

越南诞生了一个新的亿万富豪企业家阶层

牛津大学一所学院更名只是他们影响力的一个表现

越南的经济发展在世界上最负盛名的学府里竖起了一座永久的纪念碑。在越南的Sovico控股公司于11月初宣布捐赠2.07亿美元后，牛津大学的李纳克尔学院（Linacre College，只招收研究生）决定依照该公司女董事长的名字阮氏芳邵（Nguyen Thi Phuong Thao）给学院更名。

邵学院（Thao College）标志着一个重大的转变。近在2012年时，越南还没有身家超过10亿美元的亿万富翁。据《福布斯》杂志数据，如今已有六人晋身这一俱乐部。股市飙升意味着上榜者很可能还会增加。美国和中国的亿万富翁目前都被本国政府盯牢，而越南的富裕企业家则是该国政府雄心壮志的受益者——它要培养具有国际竞争力的本国领军企业。

排名第一的是Vingroup的创始人范日旺（Pham Nhat Vuong），他于2013年成为越南加入亿万富豪俱乐部的第一人。Vingroup是一个庞大的企业集团，其触角几乎已伸至本国服务业的各个角落：从旅游到医院，从药房到教育，再到汽车制造。它与自己在2018年分拆出来的房地产公司Vinhomes竞争越南（按市值计）第一大私营企业之位。两家的市值都略高于150亿美元，这样的规模足以让一家美国公司入列标准普尔500指数。

自那以后，包括阮氏芳邵在内的更多大亨加入了范日旺的行列。马山集团（Masan Group）是一家主营消费品的企业集团，越南科技商业股份银行（Techcombank）是越南最大的银行之一，这两大公司通过各自的创始人阮登光（Nguyen Dang Quang）和胡雄英（Ho Hung Anh）建立了紧密的关系。这四人的创业故事都有同一个不寻常的开端：他们最初都是在前苏联创办商业企业的。

这种与苏联的联系是越南现代经济和政治历史的一部分。以今天的美元价

值计算，越南在1985年的人均GDP约为500美元，在当时世界上最低之列。在苏联解体之前，聪明且有政治关系的越南学生获得了到俄罗斯及其卫星国学习的机会。1980年，这样的学生大约有3000人，与他们相伴的还有来自其他共产党执政国家的年轻人。

这些在上世纪80年代末到90年代初身在苏联地区的人发现了比越南更多的赚钱机会。范日旺推出了方便面品牌Mivina，后来成了乌克兰的一个主要食品品牌。阮氏芳邵在莫斯科上大学时，通过从东亚进口办公设备和消费品赚到了她的第一个百万美元。

后来，随着越南继续发展，他们成为少数在国外赚到原始资本后投资国内的公民。比尔·海顿（Bill Hayton）曾写过一本书阐述越南的快速崛起，他认为政府欢迎这些所谓的“爱国资本”。“在这个党国体制需要他们的时候，他们越发壮大，从而形成了一种共生关系。”他说。

近年来，越南政府与商界大亨的关系变得更加密切。越南总理阮春福（Nguyen Xuan Phuc）最近谈到，越南需要培养具有国际竞争力的商业巨头，以维持国家经济快速增长。这样的友好态度意味着一路畅通；这类不在明面上的政府支持在获得优质地块的使用权时尤为好用，因为和在中国大陆与香港一样，这些地块从法律上完全归属国有。越南富布赖特大学（Fulbright University）的阮春成（Nguyen Xuan Thanh）的研究显示，虽然这些亿万富翁领导的企业大多面向越南的中产阶级，但他们的大部分财富都来自房地产和银行业。在世界各地，金融和房地产都是典型的寡头领域，而在一党专政的国家中，经营这些行业需要许可、牌照，以及密切的政治关系。

在受益于政治庇护的领域之外追求多元化本身有其益处，但也能向资助者发出信号，表明他们支持的是有活力有创意的企业家。外部投资又进一步镀上了一层值得信赖的光环。11月，韩国最大的企业集团之一SK集团宣布向马山集团的消费者零售部门投资3.4亿美元。在此之前，中国电子商务巨头阿里巴巴已在今年早些时候投资了4亿美元。SK集团还持有Vingroup 6%的股份。

那些坚持按银行业和房地产业老式剧本那一套来的前寡头们没能自始至终感受到政府支持的温暖。亚洲商业银行（Asia Commercial Bank）创始人阮德坚（Nguyen Duc Kien）和海洋银行（OceanBank）董事长何文琛（Ha Van Tham）分别于2014年和2017年因腐败被判处长期监禁。何文琛的副手同时被判死刑。正如越南和世界各地许多寡头的经历所表明的那样，受到政府的青睐可能是一个巨大的优势，但也有风险。对于目前这批人来说，要想继续沐浴在政府的恩宠之中，他们作为有价值的企业家和创新者的声誉将是关键。 ■



The World Ahead 2022

Energy investment needs to increase—so bills and taxes must rise

Shortages and greenflation will end the age of idealism on energy policy

Politicians, consumers and companies are on a journey of discovery about climate change and the energy business. The first stage, in the early 2010s, was characterised by indifference. The second phase, in the past few years, has involved setting idealistic emissions-cutting targets far in the future that cost little today. In 2022 the third stage of the journey will get under way, amid dangerously volatile energy prices, fears of greenflation and rising geopolitical risks. It will require realism about the task ahead.

In 2021 the world was awash in easy promises. Some 70 countries, accounting for two-thirds of global carbon emissions, had net-zero targets, to be met by mid-century. A majority of people in the rich world, including America, expressed concern about climate change. Companies were making ambitious carbon-neutral pledges, too—especially those that didn't emit much in the first place. A boom in green-tech venture capital suggested that funds were being reallocated at scale. And sustainable investing became one of the biggest trends in finance since subprime debt.

When it came, the reality check was brutal. A surging economy in mid-2021 pushed up energy demand. By October the price of a basket of fossil fuels was up by 95% year on year. China and India faced blackouts and Europe a lack of gas (often piped from autocratic Russia). A shortage of fossil fuels, which account for 83% of primary energy use, threatened to push global inflation above 5%, hurt growth and spook the public. In response, politicians turned back the clock. China and India raised coal output, Britain turned its dirtiest power plants back on, and as the oil price hit \$80 a barrel, the White House urged OPEC to boost exports.

In 2022 attention will turn to making the energy system less fragile. The easiest bit is fairly technical. Most grids struggle to handle the intermittent nature of renewable sources such as solar and wind energy, so more reliable base-load power is needed that is not coal-fired. Natural gas will come back in fashion and there will be a global rehabilitation of nuclear power, which produces no greenhouse-gas emissions. In the years since the Fukushima disaster of 2011 its share of primary energy use has faded to 4%, but more countries will seek to emulate France, where the figure is 36%. New battery, hydrogen and carbon-capture technologies may eventually help, but they are not ready for prime time.

Meanwhile a chaos of mixed signals—stigma, virtue-signalling, subsidies, legal cases and regulations—means that investment in the energy industry is running at less than half the \$5trn annual rate needed to get to net zero by mid-century. Sometimes the prevailing incentives are actively counterproductive: too little investment in new natural-gas projects is making it harder for Asia to use gas as a cleaner bridge fuel, as part of the transition from coal to renewables.

In response, governments will expand the use of carbon prices, which act as an economy-wide ratchet on emissions. They will experiment with setting prices far into the future to give investors more predictability over the 20- to 30-year life-cycle of energy projects. America will remain an outlier, with no federal carbon price, but more Republicans will realise that pricing is the capitalist way to reform the energy business.

The hardest part of the coming year of realism will involve being honest with the public. Because energy investment needs to increase from 2% of world GDP to 5%, bills and taxes must rise. Politicians can try to pre-empt the inevitable backlash by using the proceeds of carbon taxes to help the poor. If energy prices continue to soar in 2022 there will be protests both on the streets and at the ballot box. But if the squeeze eases, then the year

could end with energy policy on a more solid foundation. The chances of the world hitting its net-zero targets will still be remote, but grid designs, investment incentives and fiscal plans may be in better shape.

Huge problems will remain, though. Roughly a fifth of emissions come from industrial users, such as cement-makers. Often there is no immediate clean substitute. The dying fossil-fuel economy will amplify geopolitical risks, with OPEC Russia's combined share of oil output expected to reach 50% by 2030. And some new electrostates may prove to be more volatile than the old petrostates: about 70% of the cobalt used in electric cars comes from the Democratic Republic of Congo, a country of 90m people, whose GDP is roughly the same as the revenue of Tesla, the leading electric-car maker.

The emerging world accounts for two-thirds of energy-related carbon emissions, yet lacks the cash and innovation base to invest or invent its way to a cleaner energy system. The realisation that this is ultimately the rich world's problem, too, will be at the heart of the fourth stage of the climate journey, beyond 2022.

Patrick Foulis: Business affairs editor, The Economist ■



世界展望2022

能源投资需要增加——因此账单和税收都得涨

短缺和绿色通胀将结束能源政策的理想主义时代

政治家、消费者和企业都踏上了探索气候变化和能源业务的旅程。第一阶段是在2010年代初期，其特点是漠不关心。过去几年是第二阶段，大家纷纷设定将于遥远未来实现的理想的减排目标，眼下不需要付出多少成本。2022年，在能源价格危险波动、对绿色通胀的担忧和地缘政治风险上升的情况下，旅程的第三阶段即将开始。它将需要对接下来的任务抱持现实的态度。

2021年，世界上充斥着轻巧的承诺。占全球碳排放量三分之二的约70个国家制定了将在本世纪中叶实现的净零目标。包括美国在内的富裕国家的大多数人都对气候变化表示担忧。企业也在做出雄心勃勃的碳中和承诺——尤其是那些本来排放量就不大的公司。绿色科技风险投资的繁荣表明资金正在大规模重新分配。可持续投资成为自次贷债务以来最大的金融趋势之一。

可一旦需要面对现实，现实却是残酷的。2021年年中的经济飙升推高了能源需求。到了10月份，一揽子化石燃料的价格同比上涨了95%。中国和印度大面积停电，欧洲天然气供应不足（通常产自专制的俄罗斯）。占一次能源使用量83%的化石燃料短缺，有可能将全球通胀推高至5%以上，损害经济增长并吓到公众。作为回应，政客们又把时钟往回调了。中国和印度提高煤炭产量，英国重新启动它最脏的发电厂，而随着油价达到每桶80美元，白宫敦促欧佩克增加出口。

2022年，注意力将转向使能源系统不那么脆弱。最简单的一点是相当技术性的。大多数电网都难以应付太阳能和风能等可再生能源的间歇性问题，因此需要更可靠的非燃煤电力提供基本负载。天然气将重新流行，不会产生温室气体排放的核电将在全球范围内东山再起。自2011年福岛灾难以

来，核电的一次能源使用份额已下降至4%，但更多国家将寻求效仿核电占比达36%的法国。新的电池、氢和碳捕获技术最终可能会有所帮助，但要它们大展身手还为时尚早。

与此同时，混乱的杂音——污名、道德标榜、补贴、诉讼和监管——意味着能源行业的投资还不到要在本世纪中叶达到净零所需的每年五万亿美元的一半。有时，通行的激励措施会适得其反：在从煤炭向可再生能源过渡的过程中，对新天然气项目的投资太少使得亚洲更难把天然气用作更清洁的桥梁燃料。

作为回应，各国政府将扩大运用碳价，将之作为整个经济范围内的排放棘轮。它们将尝试设定未来很远的价格，让投资者在能源项目二三十年的生命周期中获得更多的可预测性。没有联邦碳价格的美国仍将是个局外人，但更多共和党人将意识到定价是改革能源业务的资本主义手段。

未来现实主义的一年中最难的部分是对公众诚实。由于能源投资需要从占世界GDP的2%增加到5%，账单和税收必须要增加。政客们可以尝试利用碳税的收入来帮助穷人，以此预防不可避免的反弹。如果能源价格在2022年继续飙升，街头和投票箱都会发生抗议。但如果压力缓解，那么这一年结束时能源政策可能会拥有更坚实的基础。世界实现净零排放目标的机会仍然渺茫，但电网设计、投资激励和财政计划可能都会变得更好。

不过，巨大的问题仍将存在。大约五分之一的排放来自工业用户，例如水泥制造商。这个部分往往没有直接的清洁替代品。垂死的化石燃料经济将放大地缘政治风险，到2030年欧佩克和俄罗斯在石油产量中的总份额预计将达到50%。而且一些新的电气国家可能会比旧的石油国家更不稳定：电动汽车中使用的钴有大约70%来自刚果民主共和国，这是一个9000万人口的国家，其GDP与领先的电动汽车制造商特斯拉的收入大致相当。

新兴世界占能源相关碳排放量的三分之二，但缺乏现金和创新基础来投资或发明一种更清洁的能源系统。意识到这最终也是富裕世界的问题，将成为2022年之后气候旅程第四阶段的核心。

帕特里克·弗里斯（Patrick Foulis）：《经济学人》商业事务编辑 ■



Schumpeter

Decoupling is the last thing on business leaders' minds

Even as America and China have turned inwards, interdependency remains the dominant theme

IF YOU WANT to understand how Asia's view of the world order has changed, consider the remarks of Lee Hsien Loong, Singapore's prime minister. Asked recently if China was rising and the United States was declining, he replied in a qualified way: "If you take a long view, you really have to bet on America recovering from whatever things it does to itself." Across the region firms and politicians are adapting to a new geopolitical reality, as was evident at the Bloomberg New Economy Forum in Singapore late last month.

Designed to be more useful than Davos, less Utopian than COP26 and less wooden than China's Boao forum, the summit convenes some of the figures who built Sino-American links over the past decades, and bosses and investors responsible for over \$20trn of market value. Amid hygienically controlled flesh-pressing, and relentless nasal swabbing, you could get a sense of the tensions between the world's two biggest economies. It was clear that calls to divide them into two camps are wildly unrealistic.

Asia matters because of its size, with 36% of the world's GDP, 31% of its stockmarket capitalisation, and 11% of the sales of S&P 500 firms. The region is likely to grow faster than the rest of the world. It is also where the struggle between America and China is played out overtly, with the two systems competing side by side. China dominates trade. Of the 20 major Asian economies, 15 have China as their largest goods-trading partner. Yet most countries also rely on America. In many cases it is their defence partner and the dollar is the currency in which most Asian trade and capital

flows take place (in contrast to Europe, which has the euro).

The region's balancing act has got harder as America and China have turned inward, partly in response to the perceived shortcomings of freewheeling global capitalism. A widely held view is that America's system of government has been permanently impaired by cronyism and populism. As a result its promises are taken less seriously. Gina Raimondo, the commerce secretary, said America would launch a new Asian economic "framework" in 2022 (it has not joined CPTPP, a regional free-trade deal). Her proposal was greeted only politely, given the Biden administration's protectionism and the risk that Donald Trump wins the election in 2024.

China has also become unpredictable. Most executives and officials are sanguine about the crisis at Evergrande, a property firm. They believe that China's technocrats are in control and can avoid a systemic financial crisis. Many sympathise with China's antitrust crackdown on big tech. But there is deep unease at Xi Jinping's totalitarian impulses and his broader assault on business. Whereas before, well-connected foreigners would have been given reassurances by China's economic reformers in private meetings, now they have to make do with stilted video calls monitored by the Communist Party. Ties are fraying even within companies. One founder of an Asian firm with a Chinese parent company has not met the owners for two years. Few expect China to reopen its borders until after the Party Congress in late 2022, and even then only if the population has been re-jabbed with better vaccines.

One response to estrangement is separation. America's Trumpian right and progressive left would like their country to be more self-sufficient, while Mr Xi's "dual-circulation" campaign is aimed at producing more goods at home. There are some signs on the ground of Asia's investment patterns shifting and becoming less centred on greater China. India's biggest business, Tata Group, is investing in electric vehicles and battery production at home. On

November 9th TSMC, the world's largest semiconductor company, said it would build a new plant in Japan in co-operation with Sony. Most banks are wary of expanding in turbulent Hong Kong.

But the overall picture is still one of intense interdependency. China has 75% of global battery manufacturing capacity. Even after its new investments, TSMC will have over 80% of its plant in Taiwan, which China claims as its territory. The impossibility of Asia decoupling from China is brought home by a tech boss who reckons 80% of goods sold on South-East Asia's booming e-commerce platforms are from the Middle Kingdom. Were multinational firms to spend as they are today, they would need 16 years to replace the cumulative stock of cross-border investment in Asia. Even if they could, few firms want to exit China's economy.

As you might expect, most firms want to be geopolitical hybrids that hedge their bets. Singapore's firms lead the way. DBS Bank has a third of its deposits in dollars and is expanding in India and China. Temasek and GIC, two sovereign-wealth funds, have about a third of their combined assets in America and a fifth in China. SGX, the exchange, is integrated with Western markets but makes a fifth or so of its business from Chinese investors. American and Chinese firms are adopting Singapore-style dexterity. TikTok, an app owned by ByteDance, a Chinese firm, has an army of staff in Singapore: the idea is to show that it is independent of the Chinese state. Jamie Dimon, the boss of JPMorgan Chase, has just visited Hong Kong and said he was "not swayed by geopolitical winds": the bank has boosted its exposure to greater China by 9% since 2019, to \$26.5bn. On November 24th he apologised for joking that the bank would outlast the Chinese Communist Party.

If the worst relations between China and America for decades have not prompted decoupling in Asia, what might? The confrontation could yet escalate but both sides seem keen to avoid that for now. Wang Qishan,

China's vice-president, declared that "isolation leads to backwardness". Regulatory and technological shifts could eventually end American dominance in finance and drag Asia more firmly into China's orbit. One boss reckons the opening of China's capital markets will ultimately be as consequential in finance as its membership of the World Trade Organisation in 2001 was for trade. But for now investors and firms—and Singaporean prime ministers—face years of carefully straddling the divide.

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熊彼特

脱钩是商界领袖们最少考虑的事

在美中两国都已转向封闭之时，相互依存仍是主旋律

如果你想了解亚洲对世界秩序的看法发生了怎样的变化，听听新加坡总理李显龙是怎么说的。不久前，当被问到是否中国正在崛起而美国正在衰落时，他语带保留地答道：“如果从长远来看，那你真的还是得押注美国会从它对自己做的任何事中恢复过来。”在整个亚洲，企业和政客都在适应地缘政治的新现实，这在11月下旬于新加坡举行的彭博创新经济论坛（Bloomberg New Economy Forum）上显而易见。

这次峰会意图比达沃斯论坛更具实效，不会像联合国气候大会COP26那样乌托邦，也不要像中国的博鳌论坛那样死板拘谨。它召集了过去几十年里为中美关系建桥铺路的一些人物，以及合共掌管着超过20万亿美元市值的企业老板和投资人。在握手礼因防疫严格受限而鼻拭子检测毫不放松的会议现场，你可以嗅到全球两个最大经济体之间紧张拉锯的气味。而很明显的是，叫嚷着要把它们划分成两个阵营是极不现实的。

亚洲之所以重要，是因为它的体量——占全球GDP总额的36%、全球股市总市值的31%、标准普尔500指数公司销售额的11%。该区域的经济增速应该会领先全球。它也是中美公开争斗的场所，两种制度在这里面对面竞争。中国主导了亚洲的贸易。亚洲20个主要经济体中有15个的最大贸易伙伴是中国。但亚洲大部分国家也依赖美国。很多时候，美国是它们的防务伙伴，而亚洲的大多数贸易和资本流动都使用美元（不像欧洲有自己的区域货币欧元）。

随着美国和中国各自向内转，亚洲想要在两国间做到平衡变得更难了。这种内转在某种程度上是因为自由放任的资本主义全球化被认为有缺陷。人们普遍认为，裙带关系和民粹主义对美国的政府体系造成了永久性的损害。结果是人们不再那么确信它的承诺。美国商务部长吉娜·雷蒙多

(Gina Raimondo) 曾表示美国将在2022年启动一个亚洲经济的新“框架”（美国尚未加入区域性自由贸易协定CPTPP）。鉴于拜登政府的保护主义政策以及特朗普赢得2024年大选的风险，她的提议只得到了礼节性的回应。

中国也变得难以预测。大多数企业高管和政府官员对房地产公司恒大的危机持乐观态度。他们相信中国的技术官僚控制着局面，能够避免系统性的金融危机。很多人支持对科技大公司的反垄断整治行动。但人们对习的威权主义冲动以及他对企业广泛的打压深感不安。以前，那些人脉强大的外国人能在和中国的经济改革派私下会面时拿到些定心丸，现在他们只能将就着与之打打受共产党监控的言不由衷的视频电话。甚至公司内部的联系也开始分崩离析。一家亚洲公司的创始人已经有两年没见过中国母公司的高层了。没什么人预期中国会在2022年末党代会结束之前重开国门，而且即使在那以后，也还得等中国人重新接种了更有效的疫苗。

对疏离的一种应对是分割。美国的特朗普右翼阵营和进步左翼希望让自己的国家更加自给自足，而习的“双循环”战略要将更多的商品生产放在国内。确有迹象表明亚洲的投资模式正在发生转变，不再热衷于以大中华区为中心。印度最大的企业塔塔集团（Tata Group）正在本国投资生产电动汽车和电池。11月9日，全球最大的半导体公司台积电表示将与索尼合作在日本新建一座工厂。多数银行对在动荡的香港扩张持谨慎态度。

但总体上还是高度相互依存的局面。中国拥有全球75%的电池产能。即使算上新的投资，台积电80%以上的产能还是设在台湾。亚洲不可能与中国脱钩：一位科技公司老板一语中的地指出，在东南亚蓬勃发展的电子商务平台上销售的商品估计有80%都来自这个“中央王国”。如果跨国公司保持目前的投资转移趋势，它们需要16年的时间才能替换掉现有的在亚洲的跨境投资累积总量。即使做得到，也很少有公司会想从中国市场撤出。

正如你可能料想到的那样，大多数公司都想要在地缘政治中左右逢源，多面下注以对冲风险。新加坡的公司就是这种战略的排头兵。星展银行（DBS Bank）三分之一的存款是美元，同时又在向印度和中国扩张。两家

主权财富基金淡马锡（Temasek）和新加坡政府投资公司（GIC）的总资产约有三分之一在美国，五分之一在中国。新加坡证券交易所（SGX）与西方金融市场紧密融合，但又有约五分之一的业务来自中国投资者。美国和中国的公司也在采取新加坡式的灵活做法。中国公司字节跳动旗下应用TikTok在新加坡有一大批员工，意在表明自己独立于中国政府。摩根大通的老板杰米·戴蒙（Jamie Dimon）不久前刚访问了香港，并表示自己“不会受地缘政治风向的左右”：自2019年以来，摩根大通在大中华区的敞口增长了9%，达到265亿美元。11月24日，他为自己曾戏称摩根大通会比中国共产党长寿而道歉。

如果几十年来最糟糕的中美关系没有在亚洲引发脱钩，那什么因素可能引发脱钩呢？尽管对抗可能还会升级，但眼下双方似乎都在竭力避免这种情形。中国国家副主席王岐山曾说过，“谁封闭，谁就落后。”监管和技术上的变革可能最终会终结美国在金融领域的主导地位，并将亚洲更强有力地拉入中国的轨道。一名老板认为，中国资本市场的开放最终会对金融业产生重大影响，就像2001年中国加入世贸组织对贸易的影响一样。但就目前而言，投资者和企业——还有新加坡的总理们——还有好些年的钢丝要走。





Whose sky is it anyway?

Vast satellite constellations are alarming astronomers

They get in the way of the cosmos

ON MAY 24TH 2019 a Falcon 9 rocket built by SpaceX launched 60 communication satellites into a low orbit around the Earth. That evening they appeared as a string of sunlit dots moving across the sky, many of them as bright as the brightest stars, a source of passing wonder and mystery to casual observers—and a portent of doom to astronomers.

“There were all these panic messages,” remembers Olivier Hainaut of the European Southern Observatory (ESO): “Oh my God, it's the end, it's the end of astronomy as we know it!” Jonathan McDowell, an astronomer at the Harvard-Smithsonian Centre for Astrophysics, says he was “gobsmacked” by how bright the satellites were. “I did some quick mental arithmetic and realised that thousands of satellites that bright would be a substantial fraction of the visible things in the sky...I felt an increasingly large pit in my stomach.”

The panicked messages and the abdominal unease stemmed from the knowledge that those 60 lights were just the beginning. Up until that point communication satellites dealing with large amounts of data had been, for the most part, few and distant, sitting high and invisible over the equator. The largest “constellation” in low Earth orbit was that of Iridium, a satellite phone company, which had around 70 of the things. With 60 satellites SpaceX had almost equalled that with one launch. And there were a lot more launches to come.

As originally proposed, the company's plan for a system that could provide fast internet access to almost all parts of the globe called for 12,000

satellites. In subsequent plans a second phase has been added which brings the total to 40,000 satellites arranged in orbital “shells” at altitudes from 335km to 614km.

The company’s reusable rockets have allowed it to act on those plans at unprecedented speed. The first shell, consisting of 1,584 satellites, was completed in just two years; its services have beta testers over much of the world. SpaceX plans to put up more than a thousand a year from now on, and to pick up the pace when it replaces its Falcons with its next-generation Starships.

The satellites seen on that first evening were, astronomers now know, anomalously bright. And the company has gone some way to making its more recently launched satellites less visible. But Starlink is not the only mega-constellation around town. According to filings made with the International Telecommunication Union (ITU), which regulates the use of different radio-frequency bands, and with national regulatory bodies, 100,000 non-SpaceX communication satellites could be launched into low orbits by 2030.

OneWeb, a firm the British government recently took over, has launched more than 200 already and has filed a request to America’s Federal Communications Commission (FCC) for a total of almost 6,400. The FCC has also approved 3,000 satellites as part of Amazon’s Project Kuiper. China, which has added “satellite internet” to its list of needed infrastructures, has filed with the ITU for 13,000 satellites at altitudes from 500km to 1,145km. The largest ITU filing was made in early November by Greg Wyler, founder and former executive chairman of OneWeb. In partnership with the Rwanda Space Agency he has applied to send up a constellation of 327,000 communication satellites.

The reason that providing high-bandwidth services from space requires

satellites in such large numbers is basically geometrical. Moving large amounts of data quickly is much easier if the receiver and transmitter are quite close. But satellites close to the surface move across the sky very quickly. So to be sure there are always a few in the sky over every user means you have to have a very large number of them.

Big constellations offering broadband-internet services were first proposed in the 1990s. But there was neither the technological base to mass-produce satellites of sufficient sophistication nor the launch capacity to spread them across the sky in sufficient profusion. Now there is. And the smartphone revolution which is partly responsible for producing the robust and highly capable electronics such satellites need has also increased the world's appetite for their services. According to the UN Development Programme only one in five people in developing countries is online. Morgan Stanley, a bank which predicts that the global space economy, worth \$350bn in 2016, will be worth \$1trn by 2040, thinks that 50-70% of that growth will be in satellite-internet services.

That does not mean all the schemes can make a profit, or even get off the ground. But even if only some go ahead, the boom in the satellite population could transform the appearance of the evening and morning sky. How visible they would be to the naked eye and thus the general population is hard to say. If all the operators follow SpaceX's example, maybe not too much; if not, the hours after sunset and before dawn could see dozens of faint lights racing through the sky.

But in either case they will transform the practice of amateur and professional astronomy. A study by the ESO shows that at Paranal, a site in Chile which is home to the organisation's magnificent, if prosaically named, Very Large Telescope (VLT) there might typically be over 500 satellites visible in the sky at the beginning of the night (see chart 1). In long

astronomical exposures, as pictured above, the paths of such satellites streak the sky like the bars of a jail cell.

"It's very much a paradigm shift," says Robert Massey of the Royal Astronomical Society, a British institution. "[The] large-scale utilisation of low Earth orbit is very different from anything we've had in the previous six decades in the space age." That new paradigm raises the urgency of a range of problems: concerns about collisions and debris, the removal of defunct satellites, the effects of that much launch activity on the stratosphere, the allocation of radio frequencies, the need for arms control and so on. As Dr McDowell puts it, "Every time humanity moves into a new domain—the oceans or the air or space—we go, 'Wow, this is enormous and really empty, we can throw as much garbage here as we want, and it'll never fill up, right?' Then pretty soon we go, 'Oops, that wasn't quite true.' And we're reaching that point in space."

Because the worries concerned are not entirely novel, for most of the issues raised by the satellite boom there is at least some sort of pre-existing setting for negotiation or arbitration, and some sense of who is responsible to whom. The Outer Space Treaty requires countries to take responsibility for objects launched from their territory while they are in orbit. Satellite radio emissions are regulated by the ITU. The Vienna convention is where you go to talk about any possibility of damage to the stratosphere. There are evolving procedures for avoiding collisions, and norms for how to dispose of satellites after their lives are over. But there is no forum for discussing what satellites look like from the surface. It is an externality which has never previously been a worry.

This may seem a small thing. Astronomy is not a matter of life or death. But governments and philanthropists spend billions of dollars on it, thereby satisfying some of the world's welcome appetite for wonder. Amateurs in their unknown tens or hundreds of thousands derive great joy from it.

Astronomers may not have an inalienable right to an unobstructed sky. But a meeting on the subject, Dark and Quiet Skies, which was organised by the International Astronomical Union (IAU) and the UN last month, made clear their dismay at companies being able to take it away from them without so much as a by-your-leave.

Conflict between star-gazing and communications is not entirely new. Radio astronomers have had to deal with interference from broadcasters for decades. But radio waves beamed from an antenna, whether on Earth or in orbit, can be regulated. Radio telescopes often sit in “radio-quiet zones” where the use of mobile phones and other devices is either limited or banned to ensure that incoming celestial signals are not drowned out; the ITU sets aside some wavelengths specifically for astronomical use.

This does not mean that radio astronomers do not moan, nor that they do not have cause to. Emissions can often leak out of the intended frequency range. Scientists working on radio astronomy’s next big thing, the Square Kilometre Array, are very worried about the new constellations. The SKA is a €1.8bn (\$2bn) project of 14 countries which will combine thousands of antennae of various types spread across South Africa and Australia into a single vast instrument.

A study released by SKA scientists in 2020 showed that a constellation of 6,400 satellites using frequencies between 10.7 gigahertz and 12.7GHz—the frequencies Starlink is licensed to use—would reduce that instrument’s sensitivity in a neighbouring frequency band allocated to radio astronomy by 70%. By the time the number of satellites reached 100,000, that band would be unusable. That would make some distinctive signals the array will look for impossible to spot. The scientists want to get the satellites’ beams directed away from their antennae.

Radio astronomers have to worry about the satellites all day and all night. Their optical peers focus their concerns on the twilight, or rather the twilights: night-sky professionals recognise a civil twilight, a darker nautical twilight, and a more velvet still astronomical twilight. At these times satellites remain illuminated by a sun which, from the observatory's point of view, is already well below the horizon. The higher the satellite, the longer it remains illuminated, which makes OneWeb and the Chinese plans, both of which use orbits above 1,000km, more worrying than Starlink (see chart 2).

Dr Hainaut reckons that the VLT could lose about 2% of its overall data to satellite streaks during the evening and morning: galling, but not incapacitating. But a revolutionary instrument elsewhere in the Andes will fare considerably worse. America's Vera C. Rubin Observatory is designed not just to survey the whole of the sky in more detail than ever before, but to do so on a weekly basis, thereby capturing telltale changes and one-off events. Looking at lots of sky with a sensitive eye maximises the problems posed by satellites. "All of the features that make Rubin Observatory amazing for discovering unknown things are the exact same features that make it highly vulnerable to lots of bright satellite constellations," says Meredith Rawls, an astronomer at the University of Washington who works at the observatory.

Dr Hainaut reckons up to half of the Rubin Observatory's images at twilight and dawn could feature streaks. Software should be able to remove them without losing more than 30% of the data, and possibly as little as 10%. But the streaks themselves are not the only problem. The chips in the camera's light sensitive focal array—the largest in the world—can get overloaded if too much light hits them, creating electronic overtones and echoes that spoil the whole frame, not just the bit with the streak in it. For a programme devoted to looking for brief glimpses of rare events, that is a serious problem.

Dialogues between astronomers and SpaceX engineers have mitigated the worst of the problems by tweaking the satellites' design. In operation each of the Starlinks looks like a cross between a windsurfer and a junk. They consist of a three-metre-long rectangular board, known as the bus, on the bottom side of which are the antennae used to pick up and transmit signals, and a nine-metre rectangular solar panel that stands above the bus like a sail.

The reason the first Starlinks looked so bright was that when deployed from their Falcon 9 at an altitude of about 300km—they climb to their final orbits under their own steam—their solar panels spread out horizontally, thus maximising the reflecting surface as seen from Earth. Now the satellites keep their solar panels out of sight as much as they can. To minimise reflections from the bottom of the bus once the satellites are in their final orbit SpaceX engineers came up with the idea of a visor mounted to one side that casts a shadow over most of the Earth-facing side. This makes them considerably less visible.

Dr McDowell welcomes these workarounds, but notes that they are not perfect, and that other operators may not be as amenable. The possibility of bright satellites in truly sky-spoiling numbers persists, he says, “even if none of the currently proposed constellations are going to do it. We have to plan for it and we have to regulate against it.”

Regulation, though, will take time. The IAU plans to make recommendations—possibly stipulating that the brightness of space objects in future should be dimmer than magnitude 7 (ie, invisible to the naked eye)—to the UN's Committee on Peaceful Uses of Outer Space. That body may, one day, turn the package into a recommendation for a vote to better protect astronomy at the UN's General Assembly. Such a vote might then lead to a new protocol under the Outer Space Treaty. But even if that all

happens, it will not do so any time soon—not least because other issues raised by the mega constellations, such as risks from debris, will doubtless seem more pressing.

For professional astronomers an alternative solution to the problem might be to get over it not metaphorically, but physically: make ever more of their observations from space. This is not a perfect defence. If the telescope is in a low-ish orbit itself, satellites can still get in the way. A team led by Mark McCaughrean of the European Space Agency has found that in the 2010s the number of 11-minute exposures on the Hubble Space Telescope's widest-field camera scarred by a satellite streak was 3.6%. In the first half of 2021 it was 6.6%. “It’s gone up 80% in the space of a year,” says Dr McCaughrean. “And that’s just at the beginning.” And because the Hubble is closer to the satellites in question, the streaks are out of focus; some show up as bands of light which fill up half the image.

Higher orbits are available. The James Webb Space Telescope (JWST), due to launch this month, will sit 1.5m kilometres from Earth free of all such concerns. Radio astronomers have long fantasised about setting up shop on the far side of the Moon, the only place in the solar system which none of Earth’s radio chatter can reach. But these are terrifically pricey projects. The JWST cost around \$10bn—putting it in the same ball park as the entire Starlink constellation.

The same factors which allow commercial operators to launch many more and cheaper satellites could in time help science, too. But astronomy tends to depend on one-off flagship missions that simply do not respond to the same economies of scale. Changing its culture, and the expectations of its professional practitioners, would be a hard task.

And no satellite can replace the delight of star-gazing from your own back garden, or a local hilltop, with just a telescope or a pair of binoculars and

the whole universe to look at. The intrusion of space-age infrastructure will not worry all such observers all the time—to see a satellite can be a thrilling thing. But the more routine the sight gets, the less likely it will be to elicit a frisson of the technological sublime. Eventually, it will become just another of the mundane ways in which the world obscures its wonder. ■



到底是谁的天空？

庞大的卫星群令天文学家担忧

它们在宇宙中很碍事【深度】

二〇一九年五月二十四日，SpaceX公司制造的猎鹰9号火箭将60颗通信卫星送入近地轨道。那天黄昏，它们仿佛一长串光点划过天际，其中许多明亮如最璀璨的星星。不经意间看到此番景象的人只会一时惊叹和感觉神秘，而对天文学家来说，它却是不祥之兆。

“大伙都在传着恐慌的消息，”欧洲南方天文台（以下简称ESO）的奥利维尔·艾诺（Olivier Hainaut）回忆道，“都在说着‘天呐，完蛋了，我们所知的天文学完蛋了！’”哈佛-史密森天体物理中心（Harvard-Smithsonian Centre for Astrophysics）的天文学家乔纳森·麦克道尔（Jonathan McDowell）说，卫星亮得让他“目瞪口呆”。“我在心里快速估算了一下，要是有成千上万颗这么亮的卫星，它们就会在天上的可见物体里占到相当一部分……我心里越来越慌。”

之所以出现恐慌信息和强烈不安，是因为天文学家知道那60盏“明灯”只是个开始。在那之前，处理大量数据的通信卫星总体而言数量还很少，而且位于赤道上空距离地球很远的地方，不容易被观察到。近地轨道上最大的“卫星群”属于卫星电话公司铱星（Iridium），总共70颗左右。SpaceX一次就差不多发射了这么多。而未来还会发射很多次。

SpaceX打算建立一个可为全球几乎所有地区提供高速互联网接入的卫星系统，按照最初的计划，这需要1.2万颗卫星。随后制定的计划又增加了第二期，预期卫星总数达到4万颗，在335至614公里高空的“轨道壳”（orbital shell）中分组排列。

SpaceX的火箭可重复使用，这让它能够以前所未有的速度实施这些计划。第一个轨道壳有1584颗卫星，仅用两年时间就全部发射完毕；它的服务在世界大部分地区都有Beta测试人员。SpaceX计划从现在开始每年发射一千

多颗卫星，用它的下一代星际飞船（Starship）取代猎鹰火箭后还会加速。

天文学家现在知道了，那晚看到的第一批卫星的亮度是反常的。SpaceX已采取行动让后来发射的卫星不那么显眼。但星链（Starlink）并不是轨道中唯一的超大规模卫星群。根据向管理无线电频段用途的国际电信联盟（以下简称ITU）以及各国监管机构提交的申请，到2030年，除SpaceX外的其他机构可能会向近地轨道发射10万颗通信卫星。

最近被英国政府接管的公司OneWeb已经发射了200多颗卫星，并向美国联邦通信委员会（FCC）提交了总计近6400颗卫星的发射申请。FCC还批准了亚马逊的柯伊伯计划（Project Kuiper）的其中3000颗卫星。中国已将“卫星互联网”列入必要的基础设施建设计划，并已向ITU申请向500至1145公里的近地轨道发射1.3万颗卫星。ITU迄今收到的最大规模申请是由OneWeb的创始人兼前执行董事长格雷格·惠勒（Greg Wyler）于11月初提交的。他与卢旺达航天局（Rwanda Space Agency）合作，申请发射由32.7万颗通信卫星组成的卫星群。

从太空提供高带宽服务之所以需要庞大数量的卫星，基本上是缘于一个几何问题。如果接收器和发射器距离很近，快速传输大量数据就会容易得多。但靠近地表的卫星在天空中的移动速度非常快。因此，要确保每个用户头顶的天空上总有几颗卫星罩着，就必须有非常多的卫星。

提供宽带互联网服务的大型卫星群计划最早是在上世纪90年代提出的。但当时既不具备技术基础来大规模生产足够先进的卫星，也没有能力做覆盖天空的大规模发射。如今这些都有了。智能手机革命在一定程度上带来了通讯卫星所需的稳定且功能强大的电子器件，同时也增加了全球对卫星服务的需求。根据联合国开发计划署的数据，发展中国家只有五分之一的人能够上网。摩根士丹利预测，在2016年规模为3500亿美元的全球太空经济到2040年将达到一万亿美元，它认为其中50%至70%的增长将来自卫星互联网服务。

这并不意味着所有的卫星计划都能盈利，或者甚至能起步。但即使只有一些计划能推进，卫星数量激增也可能改变晨昏时天空的样子。很难说它们的肉眼可见度有多高——也就是普通人是否看得到。如果所有发射机构都效仿SpaceX，可见度也许不会太高；但若不是，那么在日落之后至黎明之前的那一段时间里，就可以看到数十道微弱的亮光迅速划过天空。

但无论哪种情况，这些卫星都将改变业余和专业的天文观测活动。ESO在智利的帕拉纳尔（Paranal）天文台设置有规模宏伟而名字却毫无诗意的“甚大望远镜”（Very Large Telescope，简称VLT）。该机构的一项研究显示，在帕拉纳尔夜晚降临时，天空中一般可能会看到500多颗卫星（见图表1）。在长曝光的天文照片中，这些卫星划过天空的轨迹如同监狱牢房的栏杆（如上图所示）。

“这在很大程度上是一种范式的转变，”英国皇家天文学会（Royal Astronomical Society）的罗伯特·梅西（Robert Massey）说，“对近地轨道的大规模利用和我们在太空时代过去60年里经历过的任何事都很不一样。”这种新范式让一系列问题更显紧迫，其中包括对碰撞和碎片的担忧、废弃卫星的移除、大量发射活动对平流层的影响、无线电频率的分配、军备控制的需要等等。正如麦克道尔所说，“每次人类进入一个新的领域，不管是上天下海还是进入太空，我们都会说，‘哇，这里好大，而且什么也没有，我们可以随便往这扔垃圾，而且永远都填不满，对吧？’然后很快我们又会说，‘哎呀，搞错了。’在太空，我们很快要说这句了。”

因为这些担忧并非全然新鲜，卫星热潮引发的大多数问题在以前都至少有过一些谈判或仲裁，对谁该对什么负责的问题也有一定认识。《外层空间条约》（Outer Space Treaty）要求各国对从其领土发射到轨道上的东西承担责任。卫星无线电发射受ITU监管。当需要讨论可能对平流层造成的任何损害时，有《维也纳公约》作为依据。避免碰撞的规程在不断发展，卫星寿命到期之后的处置规范也在演进。但关于卫星从地球表面上看来是什么样子的问题，目前还没有讨论渠道。这是一个以前未曾引发担忧的外部性问题。

这好像没什么大不了的。天文学研究并不是什么生死攸关的事情。但政府和慈善家在这上头砸下数以十亿美元计的钱，满足这世界上一些受人欢迎的猎奇需求。不计其数的普通业余爱好者从中获得了极大的乐趣。天文学家可能并没有不容剥夺的权利去要求把整片天空尽收眼底。但10月由国际天文学联合会（IAU）和联合国就这个主题举办的“静暗天空”会议（Dark and Quiet Skies）明显传达出，他们对于这些公司都没知会一声就夺走了他们的宁静夜空感到沮丧。

天文研究和通讯之间的冲突也久已有之。几十年来，射电天文学家不得不克服来自广播公司的干扰。但地面或轨道上的天线发射的无线电波都是可以被监管的。射电望远镜通常位于“无线电静区”，此区域内限制或禁止使用移动电话和其他设备，以确保不会淹没传入的天体信号。ITU还划定了天文研究专用的波段。

但这并不意味着射电天文学家就不会抱怨，或者没有抱怨的理由。无线电波经常会跑到预定的频率范围之外。研发平方公里阵列射电望远镜（简称SKA）这个射电天文学“下一个大事件”的科学家对新卫星群非常担心。该项目有14个国家参与，投入了18亿欧元（20亿美元），将把遍布南非和澳大利亚的数千个各种类型的天线整合成一个单一的巨大阵列。

SKA项目的科学家在2020年发布的一项研究显示，当一个由6400颗卫星组成的卫星群使用10.7至12.7千兆赫兹波段（星链已获准使用该波段）时，SKA在相邻的射电天文学波段中的灵敏度会降低70%。当卫星数量达到10万颗时，SKA所在波段将完全无法使用。这将导致它无法发现所要寻找的一些独特信号。这些科学家希望卫星的波束不要扫到他们的天线。

射电天文学家得日夜操心卫星的影响。他们的光学同行担忧的重点是曙暮光，更确切地说是三种曙暮光：夜空专业观测人士可以识别出民用曙暮光、较暗的航海曙暮光和更暗的天文曙暮光。在这些时段，卫星仍然在太阳的照射下发光，但此时从天文台的角度来看，太阳已经远远低于地平线。卫星越高，被照亮的时间就持续得越久，OneWeb和中国的卫星计划

都使用1000公里以上的轨道，比星链更令人担忧（见图表2）。

艾诺估计，VLT在黄昏和清晨可能会因卫星在望远镜上留下的条状轨迹而丢失整体数据的约2%：很烦人，但还不至于影响大局。但在安第斯山脉另一处的一套革命性设备的境遇将会糟糕得多。美国的薇拉·鲁宾天文台（Vera C. Rubin Observatory）不仅要巡视整个天空来拍摄比以往更详细的图像，而且每周都要拍，以捕捉重要的变化和瞬态事件。用高灵敏度望远镜密集地观测天空让卫星带来的问题更加突出。“鲁宾天文台的某些性能让它在发现未知事物方面表现惊人，却也令它极易受到大量明亮卫星群的影响。”在该天文台工作的华盛顿大学天文学家梅瑞迪思·罗尔斯（Meredith Rawls）说。

艾诺估计，在黄昏和黎明时，鲁宾天文台拍摄的图像可能多达一半都有条状轨迹。软件应该能够删除条状轨迹，同时保证丢失的数据不超过30%，甚至可能低至10%。但条状轨迹本身并不是唯一的问题。该天文台的相机有着世界上最大的光敏焦距阵列，如果过多的光线进入其中的感光芯片，就会导致过载，产生电子泛音和回显，破坏整个画面，而不仅仅是条状轨迹的部分。对一个致力于寻找转瞬即逝的罕见事件的天文台来说，这是一个严重的问题。

天文学家与SpaceX的工程师不断对话，通过调整卫星的设计缓解了最严重的问题。现在，星链的每一颗现役卫星看起来就像是帆板和中式平底方帆帆船的混合体。它们由平台、天线和电池板组成，平台是一块三米长的矩形板，用于接收和传输信号的天线在平台底部，九米长的矩形太阳能电池板像风帆一样立在平台上方。

在发射第一批星链时，它们在大约300公里的高度与猎鹰9号火箭分离，依靠自己的动力爬升进入最终的轨道，过程中它们的太阳能电池板会水平展开，从地球上看到的反射面是最大的，因此看起来分外明亮。现在，卫星会尽量让太阳能电池板不被看到。为了在卫星最终入轨后最大程度地减少来自平台底部的反射，SpaceX的工程师想出了一个办法，在平台一侧安装遮阳板，可以在面向地球那一面的大部分面积上投下阴影。这个设计让卫

星的可见度明显降低。

麦克道尔对这些调整表示欢迎，但指出它们并不完美，而且其他卫星运营商可能没那么配合。明亮的卫星多到影响天空的可能性依然存在，“即使目前计划的卫星群还不至于如此，”他说，“我们必须为此做好计划，必须对此开展监管。”

不过，实施监管需要时间。IAU计划向联合国和平利用外层空间委员会（Committee on Peaceful Uses of Outer Space）提议，内容可能是规定未来太空中人造物体的亮度应低于7等（即肉眼不可见）。有朝一日，该委员会可能会将这套提议形成一份建议，在联合国大会上进行投票，以更好地保护天文学研究。投票结果可能会推动根据《外层空间条约》制定新的协议。但即使这一切都能实现，也不会那么快，尤其是因为巨型卫星群引发的其他问题（例如碎片风险）无疑看起来更为紧迫。

对于专业天文学家来说，还有另一种办法来“越过”这个槛，也就是把更多的观测设备放到太空中。这并不是一种完美的防御手段。如果望远镜处于较低的轨道，卫星仍然会碍事。由欧洲航天局（European Space Agency）的马克·麦考林（Mark McCaughrean）领导的一个团队发现，2021年之前的十年里，哈勃太空望远镜最宽的视场相机曝光11分钟的照片中有3.6%受到了卫星条状轨迹的影响。这在2021年上半年上升至6.6%。“一年时间就增加了80%，”麦考林说，“而这才刚刚开始。”并且因为哈勃望远镜与造成问题的卫星距离更近，使得条状轨迹都失焦了，有些呈现为更宽的光带，占了照片一半的面积。

可以利用更高的轨道。计划在本月发射的詹姆斯·韦伯太空望远镜（James Webb Space Telescope，简称JWST）将位于距地球150万公里处，不会有任何此类问题。射电天文学家长期以来都梦想在月球背面架起望远镜，这是太阳系中唯一一个地球无线电波无法到达的地方。但这些都是天价项目。JWST耗资约100亿美元，和整个星链的投入差不多。

让商业卫星运营商能低成本发射多得多的卫星的那些因素最终也能帮到科

学研究。但天文学往往依赖一次性的大型项目，规模经济在这里确实不适用。改变天文学的文化以及专业天文学家的期望将是一项艰巨的任务。

没有卫星可以取代从自家后花园或附近山顶观星的乐趣：只需一架单筒或双筒望远镜在手，整个宇宙就在你眼前铺开。太空时代基础设施的入侵不会让业余观星者一直忧心忡忡，能看到卫星可能还挺令人兴奋的。但是，等到它越来越常见，技术的壮观引发的激动也会越来越少。最终，它成了这个世界遮蔽自身奇观的又一种世俗方式。 ■



Plane wrong

A new book explains the tragic failure of Boeing's 737 MAX

It recounts how an engineering powerhouse succumbed to the bean-counters

Flying Blind: The 737 max Tragedy and the Fall of Boeing. By Peter Robison. Doubleday; 336 pages; \$30. Penguin Business; £20

SHORTLY AFTER take-off, as assorted warnings flashed and sounded, the pilots of two Boeing 737 MAXs—one operated by Lion Air of Indonesia, the other by Ethiopian Airlines—wrestled with shaking steering yokes for control of their planes. Neither overcame the piece of software that was intent on taking over; 346 people died in the two resulting crashes in 2018 and 2019. As Boeing finally admitted on November 10th this year, in a compensation case brought in America by families of the crash victims in Ethiopia, the reason was that it had built a plane with “an unsafe condition”.

The long train of events that led to the tragedies—and the subsequent reputational and financial trashing of one of America’s biggest companies—is expertly dissected in “*Flying Blind*” by Peter Robison, a journalist at Bloomberg. His main argument will be familiar to anyone who has followed Boeing closely. After its merger in 1997 with McDonnell Douglas, stockmarket performance and satisfying investors took precedence over engineering excellence.

The arrival of bean计数 bosses from an erstwhile rival, as well as of a series of executives schooled in the art of financial engineering at General Electric, another American industrial giant, ensured that a “bottom-line mindset” prevailed. In rich detail, Mr Robison chronicles the shortcomings of that approach at a firm where safety should be paramount. And he recounts the regulatory capture of the Federal Aviation Authority (FAA),

which let Boeing take a leading role in certifying the airworthiness of its own planes, even as it engaged in a cut-throat battle for sales with Europe's Airbus. Balancing shareholder returns, competitiveness and investment is a hard task for any firm. Boeing got the equation badly wrong.

It had been considering a new clean-sheet design for its lucrative short-haul workhorse when in 2010 Airbus announced the A320neo, a more fuel-efficient version of its competing plane. Rather than cede market share for several years while developing a new passenger jet, Boeing chose to fit new engines to the 737. But attaching giant turbofans to a plane that first took flight in 1967 with far smaller power units shifted its centre of gravity. The MCAS system, intended to counteract this effect in extreme circumstances by taking control to prevent a stall, merited one mention in the plane's 1,600-page manual—in the glossary.

In both crashes a fault in a tiny sensor engaged this system—of which pilots were unaware—but under normal conditions. Finding the way to regain full control of the plane meant flicking through an inch-thick handbook in the confusion and desperation of the final few minutes in the cockpits of the doomed MAXs. Although some of Boeing's engineers had raised concerns, MCAS had been signed off by a compliant FAA, obviating the need for expensive retraining in a flight simulator. To fly a MAX, pilots trained on the previous generation of 737s were merely required to spend a few hours on an iPad.

Boeing's reaction also betrayed its priorities. After the second crash, the planes were grounded but the company kept making them, suggesting a quick fix was imminent and hinting that the pilots were to blame (the latest court ruling exonerates the Ethiopian crew). Contrition came slowly. In fact the grounding lasted 20 months, during which the pandemic struck, hobbling airlines and resulting in hundreds of cancelled orders.

The crisis has so far cost Boeing \$21bn directly in fines and compensation to airlines for delayed deliveries; the payout to bereaved families has not been finalised. Yet the MAX is now back in the air with a backlog of 3,000 orders from airlines clamouring for more fuel-efficient planes. The Justice Department's investigation of what it called the "737 MAX Fraud Conspiracy" resulted only in one deferred prosecution (a kind of corporate plea deal). An unnamed pilot suggests a different title to Mr Robison: "Boeing got away with it". ■



偏离航道

一本新书解释了波音737 MAX发生坠机悲剧的原因

它讲述了一家工程巨头如何听命于一群精于算计的人【《盲飞：737 Max的悲剧与波音的堕落》书评】

《盲飞：737 Max的悲剧与波音的堕落》，彼得·罗比森著。道布尔戴出版社，336页，30美元；企鹅出版社，20英镑。

就在起飞后不久，两架分别由印尼狮航（Lion Air）和埃塞俄比亚航空（Ethiopian Airlines）执飞的波音737 MAX飞机的各种报警装置就开始闪烁和鸣响。飞行员为了控制住飞机，奋力操纵抖动的驾驶杆，但两人都没能斗过那个执意要接管飞机的软件。在2018年和2019年发生的这两起事故中共有346人遇难。11月10日，在由埃塞俄比亚坠机事件的遇难者家属在美国提出的赔偿案中，波音最终承认失事原因是自己制造的飞机存在“不安全状态”。

彭博记者彼得·罗比森（Peter Robison）在《盲飞》（Flying Blind）一书中非常精到地剖析了导致这两场悲剧的一长串事件，以及身为美国最大公司之一的波音随后在声誉和财务上遭受的重创。但凡密切关注波音的人对他的主要观点都不会陌生。在1997年与麦道公司（McDonnell Douglas）合并后，波音就把股市表现和取悦投资者看得比卓越的工程技术更重要。

一批来自昔日竞争对手的老板降临波音，个个精于财务算计；还有一批出自另一家美国工业巨头通用电气（GE）的高管，他们在通用练就了金融工程的本领。这都让“盈亏底线思维”在波音大行其道。罗比森非常详尽地历数了在一个理应安全至上的公司里这种思维方式的种种缺陷。此外，他还讲述了美国联邦航空局（FAA）沦为“监管俘虏”，让波音主导了对自己飞机的适航认证，其时恰逢它与欧洲的空客展开激烈的销量大战。在股东回报、竞争力以及投资三者间取得平衡对任何公司来说都是件难事。而波音给出的公式严重倾斜。

当空客在2010年宣布推出更省油的A320neo与波音机型竞争时，波音已经在考虑对自己利润丰厚的短途主力飞机进行全新的设计。它不愿因为开发新客机而在几年里拱手让出市场份额，而是选择了给737飞机装上新的发动机。但是，将巨大的涡轮风扇发动机安装到一款1967年首飞、原有的动力装置小得多的机型上改变了它的重心。为了在极端情况下抵消这一影响，它设计了能自行接管和控制飞机以防止失速的机动特性增强系统（MCAS）。737 MAX长达1600页的操作手册里只有一处提到了这个系统——还是在术语汇编部分。

在这两起坠机事故中，一个微型传感器的故障导致该系统在飞机还处于正常状态时启动，而飞行员对此并不知情。要想重新获得对飞机的绝对控制权，就需要在两架厄运降临的MAX飞机的驾驶舱里，在最后几分钟的慌乱和绝望中，快速翻阅一本一英寸厚的手册。尽管波音的一些工程师曾对此提出过担忧，但对波音俯首帖耳的FAA还是批准了MCAS系统，这样就不必花费高价在飞行模拟器中重新培训飞行员。要驾驶MAX飞机，在上一代737飞机上训练过的飞行员只被要求在iPad上学习几个小时。

波音的反应也暴露了它看重的是什么。第二次坠机事件后，737 MAX被停飞，但波音继续生产这款飞机，借此传达出一种问题会很快解决的信号，同时暗示飞行员才是罪魁祸首（最新的法庭裁决宣判埃塞俄比亚机组人员无罪）。悔悟姗姗来迟。事实上停飞持续了20个月，其间新冠疫情爆发，对航空公司造成冲击，导致数百个飞机订单被取消。

截至目前，因为被罚款以及向航空公司缴纳延迟交付的赔偿金，这场危机已给波音带来了210亿美元的直接经济损失；对遇难者家属的赔偿还没有最终确定。然而，MAX已经重新飞上天空，波音还从急切需要更省油的飞机的航空公司那里积累了3000架MAX的订单。美国司法部对它称之为“737 MAX欺诈阴谋”一案的调查最终只是以延迟起诉（一种企业认罪协议）收场。一位未透露姓名的飞行员建议罗比森把书名改成“波音逍遥法外”。■



Omicronomics

China's economy looks especially vulnerable to the spread of Omicron

Disruptions would pose a test for economic policymakers

JACK MA, THE founder of China's giant e-commerce platform, Alibaba, started his first web company after a visit to America in 1995. Cao Dewang, the boss of Fuyao Glass, a Chinese company made famous by the documentary "American Factory", ventured into manufacturing after a trip to the Ford Motor Museum in Michigan. (The museum's significance struck him only on the plane home, he told an interviewer, so he immediately booked a return flight to make a second visit.)

Travel is vital to innovation. Unfortunately what is true of business is also true of viruses. At some point on its journey around the globe the covid-19 virus reinvented itself. The new Omicron variant will further entrench China's tight restrictions on business travel. Indeed it may cause more disruption to China's economy than to other GDP heavyweights. That is not because the virus will spread more widely in China. On the contrary. It is because the government will try so hard to stop it from doing so.

Since the end of May, China has recorded 7,728 covid-19 infections. America has recorded 15.2m. And yet China's curbs on movement and gathering have been tighter, especially near outbreaks (see chart 1). Its policy of "zero tolerance" towards covid-19 also entails limited tolerance for international travel. It requires visitors to endure a quarantine of at least 14 days in an assigned hotel. The number of mainlanders crossing the border has dropped by 99%, according to Wind, a data provider.

These restrictions have stopped previous variants from spreading. But periodic local lockdowns have also depressed consumption, especially of

services like catering. And the restrictions on cross-border travel will inflict unseen damage on innovation. Cutting business-travel spending in half is as bad for a country's productivity as cutting R&D spending by a quarter, according to one study by Mariacristina Piva of the Università Cattolica del Sacro Cuore in Milan and her co-authors.

If the Omicron variant is more infectious than other strains, it will increase the likelihood of covid-19 outbreaks in China, leading to more frequent lockdowns. If the restrictions were as severe as those China briefly imposed in mid-August, when it was fighting an outbreak that began in the city of Nanjing, the toll on growth could be considerable. If imposed for an entire quarter, the curbs could subtract almost \$130bn from China's GDP, according to our calculations based on a model of lockdowns by Goldman Sachs, a bank—equivalent to around 3% of quarterly output.

Omicron is not the only threat to China's economy. Even before its emergence, most forecasters thought that China's growth would slow to 4.5-5.5% next year, as a crackdown on private business and a property slowdown bite.

Worse scenarios are imaginable. If China suffers a property slump as bad as the one it endured in 2014-15, GDP growth could fall to 3% in the fourth quarter of 2022, compared with a year earlier, according to Oxford Economics, a consultancy. That would drag growth for the whole year down to 3.8%. If housing investment instead crashed as badly as it did in America or Spain in the second half of the 2000s, growth in China could fall to 1% in the final quarter of 2022 (see chart 2). That would take growth for the year down to 2.1%. Losses would leave "numerous" smaller banks with less capital than the regulatory minimum of 10.5%, the firm says.

Neither of these scenarios is inevitable. Oxford Economics rates the

probability of a repeat of 2014-15 as “medium” not high. (China’s inventory of unsold properties, it points out, is lower now than it was seven years ago.) It thinks the chances of a repeat of an American or a Spanish-style disaster are low. Both the scenarios assume that China’s policymakers would respond only by easing monetary policy. But a more forceful reaction seems likely. Although the authorities’ “pain threshold” has increased, meaning they do not intervene as quickly to shore up growth, they still have their limits. “I don’t think the Chinese government is dogmatic. It is quite pragmatic,” says Tao Wang of UBS, a bank.

Thus far, the property sector’s pain has been masked by the strength of other parts of the economy. Exports have contributed about 40% of China’s growth so far this year, points out Ting Lu of Nomura, another bank, as China provided the stay-at-home goods the world craved. If the new variant sends people back into their bunkers, China’s exporters may enjoy a second wind. More likely, export growth will slow, perhaps sharply. Mr Lu thinks exports will be flat, in price-adjusted terms, next year, contributing nothing to China’s growth. The economy will therefore need other sources of help.

The most attractive stimulus options bypass the bloated property sector, which already commands too big a share of China’s GDP. The government could, for example, cut taxes on households, improve the social safety-net and even hand out consumption vouchers. The problem is that consumers may be slow to respond, especially if their homes are losing value. Not even China’s government can force households to spend.

A more reliable option is public investment in decarbonisation and so-called “new” infrastructure, such as charging stations for electric vehicles and 5G networks. The difficulty, however, is that these sectors are too small to offset a serious downturn in the property market, as Goldman Sachs points out.

The government will thus try to stop the property downturn becoming too serious. Analysts at Citigroup, another bank, expect that China's policymakers will prevent the level of property investment from falling in 2022. That will allow GDP to expand by 4.7%. To accomplish this, the analysts reckon, China's central bank will have to cut banks' reserve requirements by half a percentage point and interest rates by a quarter-point early next year. The central government will need to ease its fiscal stance and allow local governments to issue more "special" bonds, which are repaid through project revenues.

It will also require more direct efforts to "stabilise", if not "stimulate", the property market. The government will need to make it easier for homebuyers to obtain mortgages and ease limits on the share of property loans permitted in banks' loan books. Citi's economists think the authorities may even show some "temporary forbearance" in enforcing their formidable "three red lines", the most prominent set of limits on borrowing by property developers, which cap developers' liabilities relative to their equity, assets and cash.

The one set of curbs China seems quite unwilling to ease are the covid-19 restrictions on international travel. They will probably remain in place until after the Winter Olympics in February and the Communist Party's national congress later next year. They may remain until China's population is vaccinated with a more effective jab, perhaps one of the country's own invention. (The authorities have been unconscionably slow in approving the vaccine developed by BioNTech and Pfizer.) The government may also want to build more hospitals to cope with severe cases. Before covid-19 the country had only 3.6 critical-care beds per 100,000 people. Singapore has three times as many.

Businesspeople in Shanghai have started talking about travel restrictions persisting until 2024. The virus is highly mutable. China's policy towards it,

however, is strikingly invariant. ■



奥密克戎经济学

中国经济似乎尤其易受奥密克戎毒株扩散的影响

疫情干扰将对经济政策制定者构成考验

中国电商巨头阿里巴巴的创始人马云在1995年访美后创立了他的第一家网络公司。因纪录片《美国工厂》而声名远播的中国公司福耀玻璃的老板曹德旺是在参观了密歇根州的福特汽车博物馆（Ford Motor Museum）后开始涉足制造业。（他告诉一位采访者，他是在回国的飞机上才意识到这座博物馆的重要性，随即就订了返美机票，又去参观了一次）。

旅行对创新至关重要。不幸的是，对商界来说是这样，对病毒也一样。新冠病毒在其环球之旅的某一时刻再度自我重塑。新的奥密克戎毒株将导致中国更进一步收紧对商务旅行的严格限制。事实上，奥密克戎对中国经济造成的干扰可能要大于对其他经济大国的影响。这不是因为病毒会在中国更广泛传播，反倒是因为政府想要极力阻止它传播。

自5月底以来，中国报告了7728宗新冠肺炎确诊病例，美国报告了1520万例。然而，中国对人员流动和聚集的限制更为严格，尤其是在疫情爆发地附近（见图表1）。政府对新冠病毒的“零容忍”政策使得它对国际旅行的容忍也很有限。国际旅客必须在指定酒店接受至少14天的隔离。数据供应商万得（Wind）的数字显示，中国大陆居民出入境人数下降了99%。

这些限制措施阻止了之前的新冠毒株蔓延。但不时的局部封锁也抑制了消费，特别是餐饮等服务业。跨境旅行限制也将对创新造成无形的损害。米兰圣心天主教大学（Università Cattolica del Sacro Cuore）学者玛利亚克里斯蒂娜·皮瓦（Mariacristina Piva）等人合作的一项研究指出，商务旅行支出减半对一国生产率的影响相当于研发支出减少四分之一。

假如奥密克戎的传染性比其他毒株更强，中国爆发局部疫情的可能性将增大，导致更频繁的封锁。如果限制的严格程度与今年8月中旬短暂实施的

封锁措施类似（当时是为了应对从南京爆发的一轮疫情），对经济增长的影响可能就相当大。我们根据高盛银行的封锁模型所做的计算显示，假如这样的限制措施维持一整个季度，中国GDP会损失近1300亿美元，大概相当于季度产出的3%。

奥密克戎并不是中国经济的唯一威胁。甚至在它出现前，大多数分析师就预测，随着私营企业遭到打压和房地产萧条的影响显现，中国明年的经济增速将放缓到4.5%至5.5%。

还可以想象更糟糕的情形。牛津经济研究院（Oxford Economics）的数据显示，如果中国房地产业出现像2014年至2015年那样的滑坡，2022年第四季度的GDP同比增速可能降至3%。这将把全年增速拖低至3.8%。而假如住房投资的下滑严重如美国或西班牙在2000年代中后期的那种崩溃程度，中国在2022年最后一季度的经济增速可能会下降至1%（见图表2）。这将令全年增速下降至2.1%。该研究院表示，损失将使“大量”小银行的资本充足率跌穿10.5%的监管底线。

这两种情境都并非不可避免。牛津经济研究院评估重现2014年至2015年滑坡的概率为“中”，而不是高。（它指出，目前中国待售房产的库存比七年前要低）。它评估中国出现当年美国或西班牙那种崩盘的可能性为低。两种情境都假设中国的政策制定者只通过放松货币政策来应对问题。但中国政府似乎很可能做出更强力的反应。尽管它的“疼痛阈值”已有所提高，不会像以往一样很快就插手干预以支撑增长，但仍然有自己的限度。“我认为中国政府并不教条。它相当务实。”瑞银的王涛表示。

到目前为止，房地产业的痛苦被经济中其他部分的强劲所掩盖。另一家银行野村证券的陆挺指出，随着中国向全球消费者提供他们急需的居家用品，今年到目前为止，中国的经济增长约有40%来自出口。假如新的变异毒株迫使人们躲回家中，中国出口商可能再次得利。但更可能发生的是，出口增长将会放缓，也许还是急剧下降。陆挺认为，按经价格调整后的数字计算，中国出口明年将持平，对经济增长再无贡献。因此，中国经济将

需要其他推动力。

最有吸引力的刺激方案绕开了臃肿的房地产业——它在中国GDP中的占比本来就已经太高了。例如，政府可以对家庭减税，加强社会保障，甚至发放消费券。问题是，消费者可能反应迟缓，尤其是当他们的房子在贬值之时。即便是中国的政府也没法强迫家庭去消费。

一个更可靠的选项是在脱碳和所谓的“新基建”方面的公共投资，如电动汽车充电站和5G网络。然而正如高盛指出的，问题在于这些部门规模太小，无法抵消房地产市场发生一场严重衰退的影响。

所以，政府会努力不让房地产部门的衰退变得太过严重。花旗集团的分析师预计，中国的政策制定者会在2022年阻止房地产投资水平下降。这将把GDP增长拉回至4.7%。分析师认为，为实现这一目标，人行将不得不在明年初把银行的存款准备金率降低0.5个百分点，并降息25个基点。中央政府还需要放松财政管控，允许地方政府发行更多通过项目收入偿还的“专项”债券。

政府还需要采取更直接的措施来“稳定”房地产市场——即便不是要“刺激”它。政府要让买房者能更容易获得房贷，放松对房地产贷款占银行贷款比例的限制。花旗集团的经济学家认为，在施行“三道红线”（对房地产开发商借贷最主要的限制措施，对股权、资产和现金的负债率设定了上限）的重压时，政府甚至可能给予一点“暂时的宽容”。

中国似乎很不愿意放松的一套限制是为防范疫情而实施的国际旅行限制。这可能会延续到明年2月的冬奥会和下半年的党代会之后。也许一直会持续到全国人口都接种了更有效的疫苗——可能是中国自己研发的某种疫苗。（中国政府批准复必泰疫苗的进度慢得不合情理。）政府也可能计划建造更多医院来治疗重症病例。在疫情前，中国每十万人仅有3.6张重症监护病床。新加坡有三倍之多。

上海的商界人士开始谈论旅行限制估计会持续到2024年。新冠病毒极易变异，而中国对病毒的政策却惊人地一成不变。 ■



Against the tide

Single mums in China want the same treatment as married ones

Having a child out of wedlock can mean denial of maternity benefits

SOON AFTER Zhang Jiajia gave birth to a boy in 2017, she went to her local social-security centre in Shanghai to claim maternity benefits. These would include reimbursements for services such as prenatal check-ups and midwifery, as well as compensation for lost workdays. But Ms Zhang (a pseudonym) was turned away. The centre wanted proof of marriage. As a single mother, she had none.

China's government wants citizens to have larger families. With just 12m babies born last year, the country's birth rate was the lowest since 1978, according to recently released data. China's fertility rate—the average number of children a woman is likely to have during her lifetime—is among the lowest in the world, at 1.3. In May officials allowed couples to have three children, having previously limited most to two (a one-child policy was enforced, often brutally, from 1979 to 2016). Local governments are encouraging procreation with new support that includes longer parental leave and fatter subsidies.

Divorced or widowed mothers can claim these benefits, but those who have never married, including lesbians whose unions are not recognised in China, usually cannot. Worse, some of them face fines. In March Ms Zhang took Shanghai's medical-insurance bureau to court to demand equal treatment. "This isn't just about the money," says the 38-year-old, who works in the city's financial district. "It's about the right to give birth."

China does not explicitly ban extramarital births. Its marriage law guarantees the same rights for children born out of wedlock as those born

in it. Yet the family-planning law says that procreation involves “a husband and wife”. Local officials often take that to mean that unwed mothers are in violation of that legislation. In a wealthy city like Shanghai, lost benefits would range from 30,000 yuan (\$4,700) to 120,000 yuan. Unmarried mothers sometimes have to pay the same “social maintenance fees” that are extracted from couples who have more children than allowed. The levies can add up to several years of working-class income.

It used to be that the offspring of unmarried mothers were often denied *hukou*, or proof of a person’s place of origin. This made it hard for them to obtain identity papers, enroll in state schools or receive subsidised health care. In 2016 the government reminded officials that children born outside marriage must be given *hukou*. That seems to have worked.

But public attitudes to single parenthood are changing more quickly than those of officials. In 2015 an unmarried mother launched an online crowdfunding campaign in the hope of raising 40,000 yuan to cover her social maintenance fee. She raised over 9,000 yuan overnight. In 2016 an NGO supporting LGBT rights, called Rainbow Lawyers, published an online questionnaire about single mothers. Though not a representative sample, more than 2,080 people responded. Nearly nine in ten said unmarried mothers should get the same benefits as married women. Three in four said fines for extramarital births should be abolished.

Last year just 8m couples got married in China. The number has fallen for seven years in a row. Cohabitation and conception out of wedlock are becoming more common as sexual mores change. Even so, extramarital births remain widely stigmatised. Research published last year by Li Wenzhen of Renmin University found that 60% of women who get pregnant while in a non-marital relationship go on to marry their partner and give birth to the child. Abortions are also common.

Ms Zhang worries that her son may also be shunned by society. A state kindergarten refused to admit him because she would not give details of his father, whom she had divorced after he abused her. (Her son was conceived during a brief reunion.) She refused on principle, regarding the information as irrelevant since the father had no right of custody. Ms Zhang sent the boy to a private school instead.

Women are beginning to fight back. In 2017 Zou Xiaoqi (pictured on previous page), who is also from Shanghai, became the first single mother to sue the government for maternity benefits. She lost every case over the course of four years.

But her battle was closely watched. Some single mothers have been emboldened by it to take their employers to court. In parts of the country, firms are responsible for paying employees during maternity leave (a minimum of 98 days on full salary) but can claim the money back from the state. Fearing that the government may not reimburse them, some employers refuse to give such pay when the woman is single. Some unmarried women, once pregnant, are even fired. Female job applicants are still often asked about child-rearing plans, despite a ban on this. Ms Zou and Ms Zhang are part of a support group on WeChat, a messaging app, of over 100 unmarried mothers seeking better treatment.

Earlier this year, many in the group cheered when Shanghai appeared to remove a bureaucratic hurdle to obtaining maternity benefits. Rather than requiring proof of marriage, an app allowed mothers to check a box agreeing to take legal responsibility if they were found to be breaking family-planning policies. Ms Zou was one of at least eight unmarried mothers in the city who did so and duly received the amount that married women would get. But within a few months, other mothers' applications were being refused again—Ms Zhang's among them. Officials gave no explanation for the about-turn.

Only in the southern province of Guangdong do single mothers routinely receive benefits. This stems from an overhaul of its family-planning rules in 2016. Progress elsewhere is piecemeal. China bans single women from undergoing procedures such as egg-freezing or in vitro fertilisation to help with reproduction. In August officials in the central province of Hunan said they would consider allowing single women to freeze their eggs. But they insisted that a marriage licence would still be needed to retrieve them.

The shift to a three-child policy has given hope to single mothers that social maintenance fees may be abolished. The central government says this is being considered. The charges are currently imposed mainly on families with four children or more, a rare sort. On November 25th Shanghai published its own rules for implementing the three-child policy. They included incentives to have children and appeared to scrap the fees altogether.

The Communist Party wants to boost births, while preserving traditional values. Chen Yaya of the Shanghai Academy of Social Sciences speculates that extramarital births could become a bountiful source of babies, if they were less stigmatised. In the OECD, a club mainly of rich countries, the proportion of births out of wedlock rose from 6% in 1960 to 40% in 2016, notes Ms Chen. There are exceptions: only 2% of births in socially conservative Japan are non-marital. It is not clear what Chinese women would choose, if officials were to give them the freedom to do so. ■



逆风前行

中国的单身妈妈希望和已婚妈妈享有同等待遇

非婚生育可能意味着领不到生育津贴

在2017年生下儿子后不久，张嘉佳（化名）就去了上海当地的社保中心申领生育津贴。该津贴包括对产检和助产等医疗费用的报销，以及产假期间工资补偿。但张嘉佳的申请被拒绝了。社保中心要求她出具婚姻证明。她是单身妈妈，拿不出需要的证明。

中国政府现在鼓励生育。根据近期公布的数据，去年只有1200万名婴儿出生，出生率为1978年以来最低。中国的生育率（即一名妇女一生中可能生育子女的平均数）为1.3，在全球最低之列。5月，官方放开了“三孩”生育，此前一对夫妇原则上只能生两个孩子（在1979年到2016年期间实施独生子女政策，执行起来往往有些野蛮）。地方政府正在通过延长育儿假和提高补贴等新的支持政策鼓励生育。

离异或丧偶的妈妈可以申请这些福利，而那些从未结过婚的妈妈一般都不行，包括女同性恋者——中国法律不承认同性结合。更糟糕的是，有些人还要被罚款。今年3月，张嘉佳将上海医保局告上法庭，要求平等待遇。“这不光是钱的问题，”这位在上海的金融区工作的38岁妈妈说，“这是生育权的问题。”

中国并没有明文禁止非婚生育。婚姻法保障非婚生子女享有与婚生子女相同的权利。然而，计划生育法规讲到生育时的说法是“一对夫妻”。地方官员通常据此认为非婚妈妈违反了这些法规。在上海这样的富裕城市，无法领取福利可损失3万元到12万元不等。非婚妈妈有时和超生的夫妻一样，必须缴纳相同的“社会抚养费”。这笔费用的总数可达到相当于普通工薪阶层几年的收入。

过去，非婚生子女常常无法办理户口或出生地证明。这让他们难以获得身份证件、入读公立学校或获得医疗补贴。2016年，政府向官员传达必须允

许非婚生子女落户。这似乎奏效了。

但公众对单身父母的态度比官员转变得更快。2015年，一名非婚妈妈在网上发起众筹，希望能凑足四万元缴纳社会抚养费。她一夜之间就筹到了9000多元。2016年，支持LGBT权利的非政府组织彩虹律师团发布了一份关于单身妈妈的在线调查问卷。超过2080人填写了问卷，尽管这一样本不具有代表性。其中近九成的人表示非婚妈妈应与已婚妈妈享受同等福利，四分之三表示应取消对非婚生育的罚款。

去年，中国只有800万对夫妇登记结婚。这个数字已经连续七年下降。随着性观念的改变，同居和非婚生育的情况越来越常见。即便如此，对非婚生育的污名化仍然很普遍。中国人民大学的李文珍去年发表的一项研究发现，在非婚关系中怀孕的女性，有60%日后会与伴侣结婚并生下孩子。堕胎也很常见。

张嘉佳担心她的儿子也可能会被社会排斥。一所公立幼儿园拒收她的孩子，因为她不愿透露孩子父亲的详细信息（她在遭受家暴后和他离婚，儿子是在两人短暂的复合期内怀上的。）她拒绝是因为她认为没有理由要提供这一无关信息，因为孩子父亲并没有监护权。后来她把孩子送进了一所私立幼儿园。

女性开始反抗了。2017年，同样来自上海的邹小琦（见上图）成为第一个状告政府要求获得生育津贴的单身妈妈。在过去四年里，她的每次上诉都失败了。

但她的抗争受到了密切关注。一些单身妈妈受到鼓舞，将雇主告上了法庭。在中国部分地区，企业要在员工休产假期间向其支付工资（至少98天全薪），但可以向政府报销。由于担心政府会因为女员工未婚而不予报销，一些雇主拒绝向非婚女员工支付产假工资。一些非婚女性一旦怀孕，甚至还会被解雇。女性在求职时仍然经常被问及生育计划，尽管这种行为是被禁止的。邹小琦和张嘉佳同为一个微信互助群的成员，在这个群里有100多名寻求改善待遇的非婚妈妈。

今年早些时候，上海看似要消除申领生育津贴的程序障碍，群里许多人都欢呼雀跃。一款申领津贴的应用不要求提供婚姻证明，只要求申领人勾选方框，同意在被认为违反计划生育政策时承担法律责任。邹小琦等至少八名上海市的非婚妈妈通过应用提交了申请，并按时领到了与已婚妈妈一样的津贴。但没过几个月，其他非婚妈妈的申请又被拒绝了，张嘉佳就是其中之一。政府官员没有对政策的逆转做出任何解释。

只有在南方省份广东，非婚妈妈才能常规化地领到津贴。这源于2016年该省对其计划生育规定的全面改革。其他地方的改革都不成系统。中国禁止单身女性借助冷冻卵子或试管婴儿等辅助生育手段。8月，华中地区湖南省的官员表示，他们将考虑允许单身女性冷冻卵子。但他们坚称，如果要使用自己冷冻的卵子，仍需提供结婚证。

三孩政策让非婚妈妈看到了取消社会抚养费的希望。中央政府表示正在考虑这一点。目前，社会抚养费的征收对象主要是育有四个或更多孩子的家庭，不过这种情况很少见。11月25日，上海出台了自己的三孩政策实施细则，其中包括生育激励措施，并且似乎完全取消了社会抚养费。

共产党想要提高生育率，同时又要维持传统价值观。上海社会科学院的陈亚亚推测，如果非婚生育少遭受些污名化，可能会成为生育的一大推动力。陈亚亚指出，在主要由富裕国家组成的经合组织中，非婚生子女的比例从1960年的6%上升到了2016年的40%。也有例外的情况：在社会风气保守的日本，非婚生育的孩子只占2%。假如政府给予中国女性非婚生育的自由，不知她们会做何选择。 ■



The World Ahead 2022

A three-way fight to shape the future of digital finance has begun

Regulators must preserve its potential while guarding against risk

Finance is becoming ever less the domain of sharp-suited bankers and credit-card executives. Instead, a ragtag cast of characters is overseeing an explosion of innovation that seeks to cut out the incumbents altogether. From established tech firms and fintech startups on America's west coast to developers of various "decentralised-finance" (DeFi) applications, they are jostling to reshape digital finance. In 2022 regulators must respond and start setting out their stalls.

This digital revolution encompasses three broad trends. One is the effort to offer an ever-widening range of financial products on a single platform. Facebook's new digital wallet could make inroads. Banks, payment providers and bigger fintechs will continue to gobble up startups, with the aim of offering customers such a breadth of services that they will use a single platform for everything.

The second trend is the nascent attempt to decentralise finance. Developers are building all sorts of financial applications on blockchains, which ensure security and trust without the need for any intermediaries. Novel assets of all kinds associated with the DeFi world, such as non-fungible tokens (NFTs) and other crypto-tokens, will continue to proliferate. Third, central banks, usually bastions of conservatism, are also breaking new ground. As more economic activity moves online and physical cash falls out of favour, many are on the path to introducing digital currencies of their own.

There is plenty of action to come in 2022. The People's Bank of China will launch its e-yuan more widely; central banks from Jamaica and Japan to

Thailand and Turkey will conduct various tests and pilots. Big rich countries will come a step closer to testing their own digital currencies. Innovation will continue in the private sector, too. New ideas have been well funded: venture capitalists poured nearly \$60bn into financial-technology startups in the first half of 2021. More than a hundred DeFi applications are in the works.

Such fast-paced, exhilarating changes provide a stark contrast with retail finance of old, with its sleepy way of doing business, exorbitant fees and dire customer service. There is much to like about the new finance. For customers it should mean a system that uses technology to serve their needs better and at lower cost. Financial inclusion is a problem even in the rich world: one in five Americans were either unbanked or underbanked in 2018. Small firms regularly struggle to access finance.

Competition should also erode the fat margins of the incumbents (Visa and Mastercard make gross margins of 65-80%). Transferring money across borders, such as through remittances from rich countries to poor ones, is still too expensive. And as people conduct more of their lives online, it makes sense for finance to become not just more digital, but also better embedded within other digital activities, such as entertainment and shopping.

Realising this promise, however, requires warding off the threats that fast change also brings. Take the risks to investors. A few new fintech ideas may take off. Others will fizzle out, leaving investors with losses. The hordes of crypto-speculators could meet a similar fate. Paying \$1.3m for an NFT of a picture of a rock, as someone did in August 2021, may turn out not to have been a canny investment. For customers, the risk is that financial platforms' greater access to data might invite misuse of market power. Novel financial products could be more vulnerable to scams—and in a decentralised world it will not be clear how and where to seek recourse.

It thus falls to regulators to preserve the potential, while guarding against the risks. As the boundary between financial firms and tech companies blurs further, and the value of amassing customer data increases, protecting privacy and security will be paramount. But that must be done without compromising the necessary anti-money-laundering checks. This calculation will apply as much to central banks' digital currencies as to private financial services. (China's trial of its e-currency, sadly, will offer little guidance on the matter, given the government's preference for control over privacy.)

Trickier still will be working out how to bring DeFi into regulators' purview. It may be just as well that Gary Gensler, the head of the Securities and Exchange Commission, America's main financial watchdog, once taught a class on blockchain technology at the Massachusetts Institute of Technology.

Just as their financial promise could grow, \$2.5trn-worth of crypto-assets may start to carry risks for the wider financial system. Yet the industry retains an almost ideological resistance to regulation, and its lobbying clout is growing. Advocates of digital finance have been laying out their plans for the future of the industry. Now the time has come for regulators to explain how they see it.

Rachana Shanbhogue: Finance editor, The Economist



世界展望2022

塑造数字金融未来的三线作战已经打响

监管者必须在防范数字金融风险的同时保护其潜力

金融越来越不是西装革履的银行家和信用卡公司高管的地盘。相反，一群乌合之众正在引领一场创新爆发，要把在位者彻底拉下马。从美国西海岸的老牌科技公司和金融科技创业公司，到各种“去中心化金融”（DeFi）应用的开发者，人人都在争相重塑数字金融。2022年，监管机构必须做出回应，开始表明自己的立场。

这场数字革命包含三大趋势。一是力求在单一平台上提供越来越丰富的金融产品。Facebook的新数字钱包可能会攻城掠地。银行、支付供应商和较大型的金融科技公司将会继续吞并创业公司，目标是为客户提供广泛的服务，让他们只用一个平台就可完成所有事情。

第二个趋势是金融去中心化的初步尝试。开发者们正在区块链上构建各种金融应用，无需任何中间人就能确保安全和可信。与DeFi世界相关的各种新型资产将继续激增，例如非同质化代币（NFT）和其他加密代币。第三，通常都是保守主义堡垒的央行也在开辟新天地。随着越来越多的经济活动转移到线上而纸币日益失宠，许多央行开始推出自己的数字货币。

在2022年会有许多行动铺开。中国的人行将在更大范围内推行其电子人民币；从牙买加、日本到泰国和土耳其，各国央行将开展各种测试和试点项目。富裕大国将距离测试自己的数字货币更近一步。私营部门的创新也将继续。新的创意已经获得了充足的资金支持：2021年上半年，风险投资家向金融科技创业公司投入了近600亿美元。一百多个DeFi应用正在开发中。

这种快节奏、令人振奋的变化与老式的零售金融形成了鲜明的对比，后者的经营方式令人昏昏欲睡，而费用很高昂，客户服务又糟糕。新型金融有很多讨人喜欢的地方。对于客户来说，这应该意味着会有一个系统通过运

用技术来更好地满足他们的需求，费用却更低廉。即使在富裕国家，金融包容性也还是个问题：在2018年还有五分之一的美国人要么没有银行账户，要么只能获得十分有限的银行服务。小公司经常贷不到款。

竞争应该还会侵蚀在位者的丰厚利润（Visa和万事达卡的毛利率为65%至80%）。像从富国往穷国汇款的跨境转移资金仍然太过昂贵。随着人们的生活越来越多地在网上开展，光是提升金融的数字化程度还不够，还需要把它更好地嵌入娱乐和购物等其他数字活动中。

然而，要实现这一前景，就需要防范与这场快速变化相伴而来的种种威胁。先来看投资者面临的风险。少数金融科技方面的新创意可能会大行其道，其他的则会偃旗息鼓，令投资者蒙受损失。大批加密投机者可能会遭遇类似的命运。比如有人在今年8月花130万美元买下一张岩石图片的NFT，到头来可能会发现并不是精明的投资。客户面临的风险在于，金融平台获得更多数据可能会导致滥用市场支配力。新颖的金融产品可能更容易遭遇诈骗——而在一个去中心化的世界里，无法可知该如何以及到哪里追索。

因此，保护数字金融潜力的同时又防范风险的责任就落到了监管者头上。随着金融公司和科技公司之间的界限进一步模糊，而积累客户数据愈发有价值，保护隐私和安全性将变得至关重要。但是，保护隐私和安全必须不妨碍必要的反洗钱检查。这样的全盘考量对于央行的数字货币和私人金融服务将同样适用。（遗憾的是，中国的电子货币试验在这个问题上提供不了什么借鉴，毕竟中国政府更倾向于把控隐私。）

还有更棘手的问题：如何将DeFi纳入监管范围？美国主要的金融监管机构证券交易委员会（SEC）负责人加里·根斯勒（Gary Gensler）曾在麻省理工学院开过一门关于区块链技术的课，或许可以提供些启发。

价值2.5万亿美元的加密资产的金融前景可能会拓宽，同样，它们也可能开始给更广泛的金融体系带来风险。然而，该行业对于监管仍保持着近乎意识形态上的抗拒，其游说影响力也在增长。数字金融的倡导者一直在为

这个行业的未来勾画蓝图。现在该是监管者阐述自己看法的时候了。

拉查娜·山博格（Rachana Shanbhogue），《经济学人》金融编辑 ■



The World Ahead 2022

Li Jin on the future of the creator economy

Shared ownership and control of online platforms is the way forward

Imagine a world in which Facebook is owned and operated by its users, who vote to decide its policies on content moderation and data collection. Those users—whose photos, videos and other posts give Facebook its value—collectively co-own the platform, and the earliest adopters have seen the value of their stakes appreciate greatly as it has grown in scale. A core team works day-to-day on platform development, but product strategy and resource allocation are decided upon by all. This imagined future sounds radically different from today's digital world. But it is closer than you might think.

Over the past decade, big online platforms such as Facebook, Snap, TikTok and YouTube have reached multi-billion dollar valuations. They could not have done so without the content posted by their users. The “creator economy”—the platforms and tools that allow creative individuals to share content, build an audience and make money in various ways—is now worth over \$100bn. There are an estimated 50m creators around the world, and it is the fourth most-sought-after career among British children aged 7-11. Creators’ cultural impact is eclipsing that of traditional media. Ryan’s World, a children’s channel on YouTube that features videos of toys being “unboxed”, has over 30m subscribers, and its most popular video has had more than 2bn views. Fewer than a million people, by contrast, watch CNN in prime time.

But cracks are emerging in the creator economy, rooted in the stark imbalance of power between proprietary platforms and the creators who use them. A handful of social-media behemoths act as gatekeepers for

finding and connecting with audiences. Creators are reliant on mercurial algorithms to sustain their relevance. Despite directly contributing to the value of platforms by uploading content that engages users, creators resemble an underclass of workers, lacking the benefits and protections of employees or the share options that would let them benefit from platforms' success. I've called these dynamics "taxation without representation" or "21st-century serfdom".

Creators are in a weak position to push for change. Historically, advances in workers' rights were driven by collective bargaining through unions, which represented one-third of American workers in the mid-20th century. Today, creators are expressing their views via bottom-up organising, for example by highlighting unfair policies to their audiences, or going on "strike" by refraining from posting. But these efforts have had little impact, because ultimately there is nowhere else for creators to go.

The next step is for creators to build, operate and own the products and platforms they rely on. This will shift the balance of power between platforms and their users. Imagine an Uber-like ride-hailing service owned by its drivers and users, or an Etsy-like craft marketplace owned by its merchants and customers. There are already examples. Stocksy, a stock-photography library, is a co-operative that shares profits between its members, who vote on its policies.

To date, co-operative ownership has struggled because of challenges in scaling up decision-making and governance, and in attracting investment. But new technologies promise to remove these barriers. Decentralised networks, like those that underpin cryptocurrencies, allow ownership to be distributed via tokens, which are earned for contributions to the network and which often confer governance rights. It may sound futuristic and abstract, but it is already happening. Axie Infinity, a pet-battle game in which users earn tokens they can sell and convert into income, now has

1.7m daily users, who have traded over \$2bn-worth of game assets to date. SuperRare, a digital-art marketplace, launched a “curation token” in August, decentralising itself and giving users a say in the platform’s future.

In 2022 new, decentralised networks serving the creator economy will reach a tipping-point. The democratisation of wealth-building assets through token distribution is an appealing prospect. For innovators, rewarding users with ownership can help attract the enormous user bases that will enable these new platforms to outcompete existing, centralised ones. Creator ownership eliminates the conflict between platforms and participants and ensures that growth benefits all stakeholders. In the coming months and years, creators will realise and harness their power, leading to the birth of a new set of platforms that confer ownership and control—and treat creators as first-class citizens.

Li Jin: co-founder at Variant Fund and founder of Atelier Ventures ■



世界展望2022

金丽芸谈创作者经济的未来

网络平台共享所有权和控制权是发展方向

想象这样一个世界：Facebook为其用户所有和运营，由用户投票决定其内容审核与数据收集的政策。这些用户的照片、视频和其他发帖赋予了Facebook价值，这个平台也为他们共同拥有；而最早期的用户已经看到，他们的股份随着平台规模的扩大显著升值。一支核心团队负责平台开发，但产品战略和资源分配由所有人共同决定。这一想象中的未来听起来与今天的数字世界有着天壤之别。但它可能比你以为的更快到来。

过去十年间，Facebook、Snap、TikTok和YouTube等大型网络平台的估值已达到几百亿至几千亿美元。如果没有用户发布的内容，它们无法实现这般成就。“创作者经济”——让有创造力的个人分享内容、建立受众并以各种方式赚钱的平台和工具——目前价值超过1000亿美元。据估计，全世界现在有5000万创作者；英国7到11岁儿童将创作者列为第四大理想职业。创作者的文化影响力正在让传统媒体失色。YouTube上的儿童频道“瑞恩的世界”（Ryan's World）专门分享玩具“开箱”的视频，现在有超过3000万订阅者，其人气最高的视频已被播放超过20亿次。相比之下，在黄金时段收看CNN的人数还不到100万。

但是，创作者经济的问题正在显现，根源在于专有平台和使用平台的创作者之间权力严重失衡。少数社交媒体巨头充当了看门人，寻找和连接受众都要由它们把关。创作者只能依赖反复无常的算法来维持人气。尽管创作者通过上传吸引用户的内容，为平台的价值作出了直接贡献，但他们和社会底层工人无异，缺乏员工福利与保障，也没有能让他们从平台的成功中获益的股票期权。我管这样的局面叫“无代表权纳税”或“21世纪农奴制”。

创作者在推动变革方面处于弱势。历史上，工人权利的进步是由工会的集体谈判推动的。在20世纪中期，工会代表了三分之一的美国工人。今天，

创作者正在通过自下而上地组织行动来表达自己的观点，例如向其受众强调不公平的政策，或是通过不发帖的方式“罢工”。但这些努力收效甚微，因为创作者们最终也无处可去。

下一步是让创作者创建、运营并拥有他们所依赖的产品和平台。这将改变平台与用户之间的权力平衡。想象一个类似优步的叫车服务平台由司机和用户所有，或是一个类似Etsy的手工艺电商平台由进驻小商家和顾客所有。这样的例子已经出现。图片库Stocksy是一个合作企业，由成员投票决定政策，利润由成员共享。

迄今为止，由于在扩大决策和治理以及吸引投资方面的挑战，合作所有权举步维艰。但新技术有望消除这些障碍。去中心化的网络，如构成加密货币基础的网络，允许所有权通过代币分配，这些代币通过对网络做出贡献挣得，大多带有治理权。这听上去可能新潮又抽象，但它已经在发生了。在宠物对战游戏Axie Infinity中，用户可以将所获得的代币转售变现，这款游戏的170万日活跃用户至今已经交易了价值逾20亿美元的游戏资产。数字艺术交易平台SuperRare在8月推出了“策展代币”，将自己去中心化，让用户拥有对平台未来的发言权。

在2022年，服务于创作者经济的新的去中心化网络将会达到一个临界点。通过代币分配让创造财富的资产实现民主化，这样的前景很诱人。对创新者而言，用所有权奖励用户有助于吸引庞大的用户群，从而助力新平台超越现有的中心化平台。创作者所有权消除了平台与参与者之间的冲突，确保了增长惠及所有利益相关者。在未来数月乃至数年里，创作者将意识到并运用自身的影响力，一批新平台将应运而生——它们不仅会赋予创作者所有权和控制权，还会视他们为一等公民。

金丽芸：Variant Fund联合创始人，Atelier Ventures创始人 ■



Squeezing the balloon

How piecemeal carbon pricing affects cross-border lending

Banks with domestic carbon-pricing schemes do more dirty lending abroad

IN JUNE THE IMF made the latest of many calls from economists for a market-oriented policy to tackle climate change. “Carbon pricing...is the least-cost option to deliver deep emission cuts,” it argued in a paper written ahead of a meeting of the leaders of the G20 group of large economies. Carbon taxes, as this newspaper has long argued, can be a powerful way to force polluters to pay for the harm they do to the environment by burning fossil fuels.

With the political will for a global tax lacking, many places are going it alone. The World Bank reckons that 45 countries and 34 subnational jurisdictions have adopted some form of carbon pricing, ranging from taxes to emissions-trading systems. But these schemes cover only about a fifth of global greenhouse-gas emissions. New research shows that such piecemeal progress can have unintended consequences.

A recent paper by Luc Laeven and Alexander Popov of the European Central Bank, published by the Centre for Economic Policy Research (CEPR), analyses data on more than 2m loan tranches involving banks doing cross-border lending between 1988 and 2021, during which time many countries imposed carbon pricing. The authors find that carbon taxes at home led banks to reduce lending to coal, oil and gas companies domestically, but also had the perverse consequence of causing them to increase such lending abroad. The effect, they write, is “immediate” and “economically meaningful”. The shift was most pronounced for banks with big fossil-fuel-lending portfolios, and loans were most likely to be directed towards countries lacking a carbon tax.

This conclusion comes on the heels of a related CEPR paper which found that banks increase cross-border lending in response to stricter climate policies at home, with the effect more evident for banks with previous experience of international lending. Steven Ongena of the University of Zurich, one of its authors, argues that banks “use cross-border lending as a regulatory-arbitrage tool” by shifting dirty loans to countries with laxer climate policies.

The findings suggest that cracking down on carbon is a bit like squeezing a balloon. Press too hard all at once and it may pop, but squeeze only in one corner and the air will simply flow to where there is less pressure. Such effects also mirror concerns about leakages in industrial markets. The EU’s carbon-pricing scheme used to grant exemptions to heavy emitters, for fear that they would otherwise move production abroad. Now, as the EU looks to close those loopholes, it is considering a carbon border-adjustment mechanism to level the playing-field.

Yet domestic carbon pricing is still a policy worth pursuing, says Tara Laan of the International Institute for Sustainable Development, a think-tank. Messrs Laeven and Popov conclude that, even after accounting for their efforts to shift dirty lending overseas, carbon taxes do somewhat reduce net fossil-fuel lending by the banks studied, because they lower domestic lending by more. Uday Varadarajan of RMI, another think-tank, agrees, but points out that supplementing domestic carbon-pricing policies with measures to discourage leakage, say by urging greater transparency, could boost the impact of carbon-pricing schemes.

The best solution, of course, would be worldwide adoption. The IMF suggests that high-emitting countries start by embracing a modest carbon “floor”, in order to provide a stepping stone to a global price. As the evidence of perverse consequences arising from localised pricing schemes mounts, the main task for policymakers is to orchestrate a global squeeze. ■



挤气球

零散的碳定价如何影响跨境贷款

国内有碳定价机制的银行增加了对海外的“脏”贷款

经济学家们已经多次呼吁制定市场导向的政策来应对气候变化，最近的一次呼吁是今年6月由国际货币基金组织（IMF）发出的。“碳定价……是实现大幅减排成本最低的选择。”它在20国集团领导人会议召开前的一篇论文中这样写道。正如本刊长久以来主张的那样，征收碳排放税可以成为一种有力手段，迫使污染者为燃烧化石燃料而损害环境买单。

因为缺乏全球统一征税的政治意愿，许多地方都在各行其是。据世界银行估计，45个国家和34个地方政府已经采取了某种形式的碳定价，从征税到排放权交易系统等。但这些机制只覆盖了全球温室气体排放量的约五分之一。新的研究表明，这样零零散散的进展可能会导致意想不到的后果。

欧洲央行的拉克·莱文（Luc Laeven）和亚历山大·波波夫（Alexander Popov）最近的一篇论文由经济政策研究中心（Centre for Economic Policy Research，简称CEPR）发表，文中分析了1988年至2021年间有跨境贷款业务的银行的200多万笔贷款数据，在这段时间里，许多国家实施了碳定价。两位作者发现，一国内的碳排放税导致银行减少了发放给国内煤炭、石油和天然气公司的贷款，但同时也产生了反向的意外结果，导致银行增加了对海外的此类贷款。他们写道，这种影响“立竿见影”，而且“在经济上意义重大”。这种转变对于拥有大量化石燃料贷款组合的银行来说最为明显，而且贷款最可能流向未启征碳排放税的国家。

在得出这一结论前，CEPR刚刚发表过另一篇相关的论文。那篇论文发现，银行为了应对国内更严格的气候政策而增加跨境放贷，这种效应在那些有国际贷款经验的银行上越发突出。该论文的作者之一、苏黎世大学的史蒂文·欧格纳（Steven Ongena）认为，银行将“脏”贷款转移到气候政策宽松的国家，由此“把跨境贷款当成了监管套利工具”。

这些研究结果表明，打击碳排放有点像挤压气球。如果一下子用力太猛，它可能会爆裂，但若只挤压一个点，空气就会流向压力较小的部位。这样的效应也是人们会为工业市场中的“碳泄漏”担忧的原因。欧盟的碳定价机制曾经豁免排放大户，以免它们将生产转移到国外。现在，欧盟想要堵住这些漏洞，为此正在考虑建立一个碳边界调整机制，创造公平的竞争环境。

不过，智库国际可持续发展研究所（International Institute for Sustainable Development）的塔拉·拉恩（Tara Laan）认为，在一国之内实行碳定价仍是一项值得推行的政策。莱文和波波夫总结道，即便考虑到文中所研究的银行将脏贷款转移到海外的举动，碳排放税还是在一定程度上减少了它们对化石燃料的净贷款，因为国内贷款减少得更多。另一家智库RMI的乌代·瓦拉达拉金（Uday Varadarajan）对此表示赞同，但他还指出，采取各种防止泄露的措施来补充国内碳定价政策，比如敦促提高透明度，可以提升碳定价机制的影响。

当然，最好的解决方案是在全球采用碳定价。国际货币基金组织建议高排放国家从接受适度的碳“底价”开始，为通向全球定价铺设一块垫脚石。越来越多的证据表明，本地化的定价机制会产生始料未及的后果，因此，政策制定者的主要任务就是精心组织一场全球范围的“挤气球”。 ■



Mixed signals

Early data on Omicron show surging cases but milder symptoms

The variant's capacity for reinfection appears unprecedented

TWO WEEKS after the Omicron variant was identified, hospitals are bracing for a covid-19 tsunami. In South Africa, where it has displaced Delta, cases are rising faster than in earlier waves. Each person with Omicron may infect 3-3.5 others. Delta's most recent rate in the country was 0.8.

South Africa is not in lockdown, which may partly explain Omicron's rapid spread. However, prior variants benefited from encountering lots of people with no immunity. By now, most South Africans have either recovered from covid or been vaccinated.

In such an environment, there are two ways Omicron could spread so fast. One is greater infectiousness, which depends on such factors as how easily it enters cells. The other is better evasion of immunity.

The Delta variant became dominant mainly because of its transmissibility. In contrast, Omicron seems to have advantages in both areas. Anecdotal evidence for its greater contagiousness is mounting: super-spreader events after which 35-78% of people tested positive have occurred in Norway, Denmark, Spain and Britain.

Moreover, Omicron has unprecedented capacity for reinfection. A recent study led by Juliet Pulliam of Stellenbosch University showed that the number of South Africans who test positive at least 90 days after their last positive test is more than you would expect based on earlier waves. And antibodies generated by Pfizer's vaccine are less effective against Omicron than against earlier variants. However, they still achieved solid

neutralisation in people with booster jabs or prior infections. Current vaccines may offer good protection against severe disease caused by Omicron.

Data on virulence are more heartening. In hospitals Omicron has not yet shown a pattern of worse disease in older people. Among covid-positive hospital patients in the South African city of Tshwane, 70% of those aged 50-69 and 90% of over-80s had severe cases during the Delta wave. This share is now around 30% for all ages.

The average severity of Omicron cases could rise. If it does not, one possible reason is that Omicron's mutations yield milder illness. This would partly offset the impact of a surge in cases, though death rates could yet rise if wards are overwhelmed. Another explanation is that many older South Africans got jabs in recent months. If this is the cause, Omicron would pose a serious threat to the unvaccinated.

Sources: NICD, South Africa; Trevor Bedford; "Increased risk of SARS-CoV-2 reinfection associated with emergence of the Omicron variant in South Africa", by J.R.C. Pulliam et al. (working paper) ■



信号混杂

奥密克戎的早期数据显示病例激增但症状较轻

该毒株的再感染力似乎空前强大

在发现奥密克戎毒株两周后，全球各地的医院都在备战新一波疫情海啸。在南非，奥密克戎已取代德尔塔成为主流毒株，病例增速比之前几波疫情都要快。每个奥密克戎感染者可能平均会再传染3至3.5人。而德尔塔在该国最近报告的复制率仅为0.8。

南非目前没有实施封锁，这也许在一定程度上解释了奥密克戎的快速传播。然而，之前那些毒株的传播是因为有很多人还没有建立免疫力。而现在，大多数南非人要么已经感染过新冠并痊愈，要么已经接种过疫苗。

在这样的环境里奥密克戎能如此快速地传播，可能有两个原因。一是它的传染性更高，这取决于病毒能多轻易入侵细胞等因素。另一个是它的免疫逃逸能力更强。

德尔塔成为主流毒株主要是靠高传染性。相比之下，奥密克戎似乎在两方面都有优势。越来越多的观察性证据表明奥密克戎的传染性更高：在挪威、丹麦、西班牙和英国都发生了超级传播者事件，其中35%至78%的接触者检测呈阳性。

此外，奥密克戎的再感染力也是空前之高。斯泰伦博斯大学

(Stellenbosch University) 的朱丽叶·普利亚姆 (Juliet Pulliam) 近期主持的一项研究显示，在南非，在上次感染至少90天后再次检测为阳性的患者数量高于基于之前几波疫情数据得出的预期。而且辉瑞疫苗产生的抗体对奥密克戎的防范作用弱于对之前的毒株。但是，在已注射加强针或之前感染过新冠的人群中，抗体还是起到了有力的中和作用。现有疫苗或许能很好地预防因奥密克戎导致重症。

有关奥密克戎毒性的数据更让人鼓舞。在感染奥密克戎的住院病例中尚未显现出老年人病情更重的模式。在之前的德尔塔疫情中，南非城市茨瓦内（Tshwane）的住院病例里，有70%的50岁至69岁患者和90%的80岁以上患者属重症。目前奥密克戎在所有年龄组中的重症比例都在30%左右。

奥密克戎病例的平均严重程度或许会上升。如果不，一个原因可能是奥密克戎的变异带来了较温和的病症。这将部分抵消病例激增的影响，但如果医院床位不堪重负，死亡率仍可能上升。另一种解释是，许多南非较年长者在最近几个月接种了疫苗。果真是这个原因的话，那么奥密克戎可能会对未接种人群构成严重威胁。

资料来源：南非国家传染病研究所；特雷弗·贝德福德；《南非出现的奥密克戎毒株导致新冠肺炎再感染风险上升》，朱丽叶·普利亚姆等人的工作论文 ■



Giving less generously

In word and deed, China is easing economic policy

Both the central bank's actions and the Politburo's words point to modest easing

BEN BERNANKE, the former chairman of America's Federal Reserve, entitled his memoir "The Courage To Act". But a lot of what central bankers do these days is talk. They talk about what they are doing, will do and might do. In central banking, words can speak louder than actions.

China is no different. Its macroeconomic policymaking is a combination of acts and signals, execution and exegesis. On December 6th, for example, the People's Bank of China announced that it was cutting the reserve requirement ratio (the amount of money banks are required to hold in reserve, as a share of deposits) by half a percentage point, from a weighted average of 8.9% to 8.4%. That, it said, would "unleash" about 1.2trn yuan (\$190bn) of funding.

The cut was, you might think, a straightforward act of easing—an understandable response to a slowing economy, a mutating virus and the financial risks posed by property developers, two of which (Evergrande and Kaisa) defaulted on their offshore bonds, according to Fitch, a rating agency, shortly after the cut.

But the decision was accompanied by some cautionary talk. "The stance of sound monetary policy remains unchanged," the central bank said. It also pointed out that banks will need part of the additional funds (about 80% of them) to repay medium-term loans from the central bank that are due to mature on December 15th. Much of the extra money would, in other words, soon return to the institution that had unleashed it. The impact of the cut "is likely to be neutral", said one analyst, quoted by Economics Daily, an

official newspaper. An editorial in the same paper cautioned against the “relatively simplistic” view that a cut in reserve requirements amounted to “loose” macroeconomic policy.

So are China’s policymakers easing or not? The short answer is yes, they are indeed easing. But not without qualms and qualifications. They want to stabilise growth. But they do not want to revive speculation, especially in property. Their expansionary actions are therefore accompanied by a lot of clarificatory and cautionary chitter-chatter.

Perhaps the clearest evidence of easing lies not in the deeds of the central bank but in the words of the Politburo, the 25-member body that oversees the Communist Party. After a meeting on December 6th to set the macroeconomic tone for 2022, it emphasised expanding domestic demand and preserving the “six stabilities” (in employment, finance, trade, foreign and domestic investment, and expectations). The Politburo also had some words of comfort for the beleaguered property market. It said the sector should be supported to better serve homebuyers’ “reasonable” demand. (“Reasonable” was not defined. But it is safe to say it does not include buying a property and keeping it vacant in the expectation of selling it for a higher price.)

The debate now is not whether China’s policymakers are easing but by how much. Because stimulus can take many forms, especially in China, measuring its overall scale is not easy. One attempt to do so, by Goldman Sachs, a bank, combines indicators of monetary policy (the benchmark lending rate and market rates), credit policy (including reserve requirements), fiscal policy and housing policy into a single index. In the face of the global financial crisis, this index swung by almost 2.9 points on its scale (see chart). It swung by a little over two in response to China’s 2015 slowdown and by a little less than two after the pandemic began.

The easing in the first ten months of this year was modest by comparison. The latest reserve requirement cut will add to it, but not by much in itself. Policymakers therefore have plenty of scope to loosen before they can be accused of replicating the “flood” of stimulus in 2008-09, which has acquired a reputation for profligacy, despite its brute effectiveness in returning China to its pre-crisis economic trajectory.

If China's policymakers had an equivalent index of their own, their cautionary talk could be more precisely calibrated. “We may ease by one point but not two,” they might say. In the absence of such a measure, China-watchers have the harder task of inferring macroeconomic intentions from vague party slogans. How many cuts in reserve requirement ratios, one wonders, will be necessary to preserve the six stabilities? ■



吝啬一点

中国经济政策放松的言与行

人行的行动和政治局的言论均指向适度宽松

美联储前主席伯南克的回忆录名为《行动的勇气》（The Courage To Act）。但今时今日，央行官员的很多工作其实就是说话。他们会谈论自己正在做什么、将要做什么以及可能做什么。在央行的工作中，言语有时比行动更有威力。

中国也不例外。其宏观经济决策是行动与信号、执行与解读的混合。例如，中国人民银行于12月6日宣布将存款准备金率（银行必须向央行缴存的存款准备金占其存款总额的比例）下调0.5个百分点，其加权平均值从8.9%降至8.4%。人行表示，这将“释放”资金约1.2万亿元。

乍一看，降准似乎是一种直截了当的宽松行为——面对经济放缓、病毒变异，以及房地产开发商构成的金融风险，这是一种可以理解的反应。据评级机构惠誉（Fitch）称，两家开发商（恒大和佳兆业）在降准后不久发生离岸债券违约。

但人行在做出这一决定的同时也发表了一些警告性言论。“稳健货币政策取向没有改变。”它表示。人行还指出，银行将需要使用一部分释放的资金（约80%）来归还12月15日到期的央行中期借贷便利。换句话说，央行释放的资金大部分很快又会回到央行。官方报纸《经济日报》援引一位分析师的话称，此次降准的影响“大概率是中性的”。该报的一篇社论告诫说，不应把降低存款准备金率“简单化”理解为宏观经济政策将走向“宽松”。

那么，中国的政策制定者到底是不是在放松货币政策？简单的回答是肯定的，他们确实在放松。但并非没有疑虑和保留。他们希望“稳增长”，但又不想让投机再度兴起，尤其是在房地产市场。因此，在采取扩张性行动之余，他们也发出了大量澄清和警示性的言论。

政策放松最明确的证据也许不是人行的行动，而是政治局的表态——由25名委员组成的中央政治局是中共的领导机构。12月6日召开的政治局会议为2022年的宏观经济定下基调，强调了扩大内需和做好“六稳”（稳就业、稳金融、稳外贸、稳外资、稳投资、稳预期）。政治局还对陷入困境的房地产市场发出了安抚性的表述，提出要支持商品房市场更好地满足购房者的“合理”住房需求。（对“合理”并没有明确界定，但想必不包括购买房产然后空置，以期涨价后再卖出的行为。）

现在要讨论的不是中国的政策制定者是否在放松，而是放松了多少。经济刺激的形式多种多样，在中国尤其如此，因此要衡量它的总规模不容易。高盛的做法是将货币政策（基准贷款利率和市场利率）、信贷政策（包括准备金要求）、财政政策和住房政策等指标合并成一个指数。在全球金融危机时期，该指数增至接近2.9（见图表）。2015年中国经济增长放缓时，该指数略超过2，而新冠疫情爆发后，该指数略低于2。

相比之下，今年前10个月的宽松程度相对温和。最近这一次降准将使宽松程度有所增加，但它本身的幅度并不大。因此政策制定者距离被指责重复2008至2009年的“大水漫灌”还有很大的政策放松空间。当年粗暴的刺激政策有效地让中国回归了危机前的经济轨道，但也落下了挥霍浪费的名声。

如果中国的政策制定者自己也有一个类似的指数，他们就可以更精确地校准自己的警示言论。他们也许可以说：“我们可能会放松一个点，而不是两个点。”在没有这种尺度的情况下，中国观察人士要从共产党含糊的口号中推断其宏观经济意图就更加困难了。人们不禁想问，要保持六稳，需要下调多少次存款准备金率才够呢？■



Bartleby

The office of the future

Cubicles are out. Bars, neighbourhoods and sensors are in

THE OFFICE used to be a place people went because they had to. Meetings happened in conference rooms and in person. Desks took up the bulk of the space. The kingdom of Dilbert and of David Brent is now under threat. The pandemic has exposed the office to competition from remote working, and brought up a host of questions about how it should be designed in the future.

Start with what the office is for. In the past it was a place for employees to get their work done, whatever form that took. Now other conceptions of its role jostle for attention. Some think of the office as the new offsite. Its purpose is to get people together in person so they can do the things that remote working makes harder: forging deeper relationships or collaborating in real time on specific projects. Others talk of the office as a destination, a place that has to make the idea of getting out of bed earlier, in order to mingle with people who may have covid-19, seem attractive.

In other words, a layout that is largely devoted to people working at serried desks alongside the same colleagues each day all feels very 2019. With fewer people coming in and more emphasis on collaboration, fewer desks will be assigned to individuals. Instead, there will be more shared areas, or “neighbourhoods”, where people in a team can work together flexibly. (More hot-desking will also necessitate storage space for personal possessions: lockers may soon be back in your life.)

To bridge gaps between teams, one tactic is to set aside more of the office to showcase the work of each department, so that people who never encounter

each other on Zoom can see examples of what their colleagues do. Another option is to ply everyone with drink. Expect more space to be set aside for socialising and events. Bars in offices are apparently going to be a thing. Robin Klehr Avia of Gensler, an architecture firm, says she is seeing lots of requests for places, like large auditoriums, where a company's clients can have "experiences".

Designs for the post-covid office must also allow for hybrid work. Meetings have to work for virtual participants as well as for in-person contributors: cameras, screens and microphones will proliferate. Gensler's New York offices feature mini-meeting rooms that have a monitor and a half-table jutting out from the wall below it, with seating for four or five people arranged to face the screen, not each other.

Variety will be another theme. People may plan to work in groups in the morning, but need to concentrate on something in the afternoon. Ryan Anderson of Herman Miller, a furniture firm, likens the difference between the pre- and post-pandemic office to that between a hotel and a home. Hotels are largely given over to rooms for individuals. "Home is thought of as a place for a family over years, hosting lots of different activities."

All of which implies the need for flexibility. Laptop docking stations are simple additions, but other bits of office furniture are harder to overhaul. Desks themselves tend to be tethered to the floor through knotted bundles of cables and plugs. The office of the future may well feature desks with wheels, which ought to go well with all that extra alcohol. Meeting rooms are likely to be more flexible, too, with walls that lift and slide.

If socialising and flexibility are two of the themes of the post-pandemic office, a third is data. Property and HR managers alike will want more data in order to understand how facilities are being used, and on which days and times people are bunching in the office. Workers will demand more data on

health risks: the quality of ventilation within meeting rooms, say, or proper contact-tracing if a colleague tests positive for the latest covid-19 variant.

And data will flow more copiously in response: from sensors in desks and lighting but also from desk-booking tools and visitor-management apps. The question of who owns data on office occupants and what consent mechanisms are needed to gather this information is about to become more pressing.

Put this all together and what do you get? If you are an optimist, the office of the future will be a spacious, collaborative environment that makes the commute worth it. If you are a pessimist, it will be a building full of heavily surveilled drunkards. In reality, pragmatic considerations—how much time is left on the lease, the physical constraints of a building's layout, uncertainty about the path of the pandemic—will determine the pace of change. Whatever happens, the office won't be what it was. ■



巴托比

未来的办公室

格子间过时了。吧台、社区和传感器开始流行

过去，人们去办公室是因为不得不去。会议得在会议室开，还得亲身到现场。办公桌占据了大部分空间。不过呆伯特（Dilbert）和大卫·布伦特（David Brent）的王国现在受到了威胁。疫情让办公室直面来自远程办公的竞争，并提出了关于未来办公室应该如何设计的种种问题。

先从办公室的用途说起。在过去，它是员工完成工作的地方，无论是以任何形式。现在，关于其角色的其他种种构想争相提起人们的注意。有些人认为办公室是个新的团建场所，目的是让人面对面聚在一起，这样他们就能去做远程工作难以达成的事情：建立更深入的关系，或就特定项目展开实时合作。另一些人则认为办公室是一个目的地，它的设计得能让人心甘情愿早早起床，就算要跟可能感染新冠肺炎的人密接也在所不辞。

换句话说，那种基本上就是让人们日复一日跟同一批同事坐在挨挨挤挤的办公桌前的布局太过时了，简直就像2019年一样古老。进办公室的人越来越少，加上越来越强调协作，分配给个人的办公桌也会越来越少。取而代之的是更多的共享区域，或者“社区”，让同团队的人可以灵活地在一起办公。（随着办公桌轮用制越发普遍，为个人物品提供收纳空间也很有必要：储物柜可能很快就会回到你的生活中。）

要弥合不同团队间的鸿沟，一种策略是留出更多办公空间来展示各个部门的工作，这样那些从不在Zoom上见面的人就可以见微知著地了解下同事们在忙什么。另一个选择是给所有人提供喝不完的酒水。等着瞧吧，今后用于社交和活动的空间会更多。办公室吧台貌似会成为一个热门事物。建筑公司Gensler的罗宾·克雷尔·艾维亚（Robin Klehr Avia）说，她看到像大型会厅这样能让公司的客户获得“体验”的场所需求很旺盛。

后新冠时代的办公室设计还必须考虑到混合工作的需求。除了现场参与者

外，会议还必须服务虚拟参与者：摄像头、屏幕和麦克风的数量会猛增。Gensler在纽约的办公室设有迷你会议室，里面有一台显示器，显示器下方的墙壁伸出一张半桌，设有四五个人的座位，与会者坐下后会望向屏幕，而不是彼此的脸。

多样化将是另一个主题。人们可能会计划在上午分组共事，但下午还是需要各自集中精力做些事情。家具公司赫曼米勒（Herman Miller）的莱恩·安德森（Ryan Anderson）拿酒店和家来形容办公室在疫情前后的差别。酒店的空间基本上都拿来做客房。而“家被认为是一个供家庭成员在多年里相聚的地方，容纳了许多不同的活动。”

所有这些都意味着需要保证灵活性。增加笔记本电脑扩展坞很简单，但其他类型的办公家具就没那么容易大修大换了。办公桌本身往往由缠成一团的线缆和插头固定在地板上。在未来的办公室里，桌子很有可能会安着轮子，这和供应充足的酒水应该很相配。会议室也可能会更加灵活，墙壁可以升降和滑动。

如果说社交和灵活是后疫情时代办公室的两大主题，那么第三个主题就是数据。物业和人力资源管理人员都希望获得更多数据，以便了解设施的使用情况，以及人们在那天和哪个时间段聚集在办公室。员工将要求获取更多关于健康风险的数据，比如会议室的通风质量，或者如果有同事在新冠病毒最新变种的检测中呈阳性，就需要展开恰当的接触追踪。

面对这样的需求，数据的流动将会更加汹涌——它们不仅来自桌子和照明中的传感器，还来自办公桌预订工具和访客管理应用。办公室使用者产生的数据归谁所有？需要什么样的同意机制来收集这些信息？这些问题将变得更加紧迫。

这一切会给人们带来什么？如果你是个乐观主义者，那么未来的办公室将是一个宽敞、便于协作的环境，会让通勤变得很值得。如果你是个悲观主义者，那它将是一个到处晃荡着被严密监视的酒鬼的建筑。而在现实中，租约还剩多长时间、建筑布局的物理限制、疫情发展的不确定性这些务实

的考虑将决定变化的速度。无论发生什么，办公室都不会是原来的样子了。 ■



The Economist Film

High inflation: should we be worried? (trailer)

Is this high inflation just a temporary blip or could it spiral out of control?



经济学人视频

高通胀值得担心吗 - 预告

目前的高通胀是暂时现象还是会不断加剧而失控？



Buttonwood

Why the dollar's ascendancy won't last

All it takes is a slowdown in America, lower inflation and a Fed pivot

THERE IS SOMETHING slightly tedious about the dollar's rude health. It seems as inevitable as lying politicians and stormy winters. The DXY, a gauge of the dollar against half a dozen other rich-world currencies, is up by almost 7% since the start of the year. The broad dollar index, which measures the dollar against 26 of America's trading partners, has also risen markedly since June. It is difficult to imagine what might check its rise. But it is still worth trying. You may find that the case for a reversal of the dollar in 2022 is more plausible than you had thought.

The dollar's current strength is tied to American exceptionalism of a sort. The S&P 500 index of leading shares consistently outperforms the stockmarkets of other countries. America's economy has proved to be a reliable source of growth. It has emerged from the pandemic more strongly than just about anywhere else. After a brief loss of energy in the summer it is now showing renewed vigour.

As a consequence, inflation is stubbornly high. The chairman of the Federal Reserve, Jay Powell, has already said that the Fed will move faster towards ending its bond purchases, thus paving the way for interest-rate increases. Elsewhere things are running less hot. China's GDP growth is sluggish. In Europe a wave of covid-19 infections has led to some restrictions on business activities. And while the full implications of the Omicron variant are not certain, there is a general feeling it will prove to be more of an economic headwind outside America.

One currency that has kept up with the dollar is the yuan. This is because

more money is flowing into China than out of it. Bumper exports to America have contributed to a huge trade surplus. Portfolio capital is washing in. Foreign investors are loading up on bonds and stocks, which are now a bigger part of their benchmarks. Meanwhile less money is leaking out. Spending abroad by Chinese tourists has all but vanished, as a consequence of travel bans. Still, the risks seem tilted towards a fall in the yuan against the dollar. China is leaning towards a looser monetary setting, as policymakers grapple with distress in the property sector. Earlier this month's reduction in reserve requirements might even be a hint that Beijing would prefer a weaker yuan.

Put this all together, and the argument for a strong dollar looks watertight. But the situation is fluid. There is a decent case that the dollar will peak in the coming months and then weaken. For that to happen, three conditions need to be fulfilled. First, the global growth gap must narrow. America's economy has more than recovered. Other countries still have ground to make up. They will eventually do so. Too much of the sluggishness of Asia is put down to China's slowdown and not enough to the lingering effects of the pandemic across the region. Europe has never quite reopened fully. And there is fiscal stimulus from the EU recovery fund in the pipeline. America may still lead the pack. But the race will be closer.

A second condition is lower inflation. Oil prices have fallen already. There are tentative signs that bottlenecks are easing. Business surveys in goods-producing hubs, such as Taiwan and Vietnam, show a pickup in delivery times. If these developments translate into lower headline inflation, says Mansoor Mohi-uddin of the Bank of Singapore, it will allow the Fed to pivot towards a less hawkish stance—a third condition for a weaker dollar. It is hard to be an interest-rate dove when inflation is so high. But if it falls back during 2022, and the economy slows, the Fed's focus could easily tip back to the "jobs" part of its mandate. By the spring or early summer, markets may find themselves pricing in more interest-rate rises than the Fed is minded

to deliver.

It is easy to forget, but other central banks get to do monetary policy, too. A recovering euro-zone economy might easily stir the hawks at the European Central Bank, says Kit Juckes of Société Générale, a bank. Even the hint of an interest-rate rise in the euro zone could be a game-changer for currency markets.

For dollar bulls, this might all sound a bit far-fetched. A lot of their enthusiasm is tied to high inflation and its implications for interest rates. But this carries dangers. Inflation is not a high-quality reason for backing a currency, says Steven Englander of Standard Chartered, another bank. Quite so. If inflation in America proves stubborn in the medium term, that is not obviously good for the dollar either. For now, the greenback is a winning currency. But there are still a few ways it could lose. ■



梧桐

美元强势为何不会持久

只要美国经济放缓、通胀降低以及美联储转向，它就不会

美元坚挺的话题多少有些乏味。它似乎像政客会撒谎、冬天有风雪一样理所当然。衡量美元对其他六个富裕经济体货币的汇率变化的美元指数

(DXY) 自今年年初以来上涨了近7%。6月以来，衡量美元对美国26个贸易伙伴的货币的广义美元指数也显著上涨。很难想象有什么可以阻止美元走高。但仍然值得设想一下。你可能会发现，美元在2022年下挫的可能性比你预想的更大。

美元目前的坚挺和某种美国例外论有关联。集合了500只优秀股票的标准普尔500指数的表现一贯优于其他国家的股票市场。美国经济已经证明了自己是可靠的增长源。它从新冠疫情中恢复的力度超过了几乎所有其他地区。在经历了今年夏天短暂的乏力之后，它如今又展现出新的活力。

这样的结果是通胀居高不下。美联储主席杰伊·鲍威尔 (Jay Powell) 已经表示，美联储将加快结束其购债计划，从而为加息做好准备。其他地方的情况没有这么火热。中国的GDP增长缓慢。在欧洲，一波新冠病毒感染导致部分商业活动受限。尽管奥密克戎毒株的整体影响还不明确，但人们普遍感觉到它一定会对美国以外的经济增长造成更大的压力。

与美元并驾齐驱的货币是人民币。这是因为中国的资本流入多于流出。对美国的大量出口为中国带来了巨额贸易顺差。投资组合资本正在涌入。外国投资者正在大举买入债券和股票，这些目前在他们的投资基准中占据了更大的份额。与此同时，资本流出正在减少。由于旅行禁令，中国游客的海外消费几乎消失殆尽。尽管如此，人民币对美元的汇率似乎还有下跌的风险。随着政策制定者努力应对房地产行业的困境，中国正倾向于营造更宽松的货币环境。本月稍早时降低存款准备金率的举动甚至可能反映出北京更愿意让人民币走弱。

综上所述，认为美元会保持强势的理由似乎无懈可击。但形势易变。也有很好的理由认为美元将在未来几个月达到高点，然后走弱。要出现这种情况，需要满足三个条件。首先，全球经济增长的差距必须缩小。美国的经济的反弹程度已经不止于收复失地。其他国家仍有一段距离要追赶。它们最终也会赶上来。亚洲经济的疲软被过度归因于中国经济的放缓，却没有充分认识到疫情对整个亚洲挥之不去的影响。欧洲从未完全实现过重新开放。由欧盟复苏基金支持的财政刺激计划正在筹划之中。美国可能仍然处于领先地位，但各方之间的差距将会缩小。

第二个条件是通胀降低。油价已经下跌。有初步迹象表明，瓶颈问题正在缓解。在台湾和越南等制造业中心进行的商业调查显示，交付速度正在提升。新加坡银行的曼苏尔·莫希·乌丁（Mansoor Mohi-uddin）表示，如果这些走势转化为较低的整体通胀，就可以让美联储的立场变得不那么强硬——这是美元走弱的第三个条件。在通胀如此高的情况下，很难在利率上保持温和政策。但如果通胀在2022年回落，同时经济放缓，美联储就很可能把工作重心放回到“就业”这个任务上。到明年春季或夏初，市场可能会发现自己计入的加息幅度超过了美联储的打算。

虽说人们很容易忽略，但其他国家的央行也会调整货币政策。法国兴业银行的基特·朱克斯（Kit Juckes）表示，欧元区正在复苏的经济很可能让欧洲央行的鹰派按捺不住。哪怕欧元区有一些加息的征兆，都有可能扭转货币市场的格局。

对美元多头来说，这一切听起来可能有点牵强。他们的热情很大程度上依赖于高通胀及其对利率可能产生的影响。但这也带来了风险。渣打银行的史蒂文·英格兰德（Steven Englander）表示，通货膨胀并不是下注某种货币的很好理由。的确如此。如果事实表明美国的通胀在中期内难以消除，这对美元显然也不是什么好事。就目前而言，美元跑赢了其他货币。但它仍可能因为一些原因而败北。 ■



The World Ahead 2022

What next? 22 emerging technologies to watch in 2022

New ideas can emerge seemingly overnight

The astonishingly rapid development and rollout of coronavirus vaccines has been a reminder of the power of science and technology to change the world. Although vaccines based on new mRNA technology seemed to have been created almost instantly, they actually drew upon decades of research going back to the 1970s. As the saying goes in the technology industry, it takes years to create an overnight success. So what else might be about to burst into prominence? Here are 22 emerging technologies worth watching in 2022

It sounds childishly simple. If the world is getting too hot, why not offer it some shade? The dust and ash released into the upper atmosphere by volcanoes is known to have a cooling effect: Mount Pinatubo's eruption in 1991 cooled the Earth by as much as 0.5°C for four years. Solar geoengineering, also known as solar radiation management, would do the same thing deliberately.

This is hugely controversial. Would it work? How would rainfall and weather patterns be affected? And wouldn't it undermine efforts to curb greenhouse-gas emissions? Efforts to test the idea face fierce opposition from politicians and activists. In 2022, however, a group at Harvard University hopes to conduct a much-delayed experiment called SCOPEX. It involves launching a balloon into the stratosphere, with the aim of releasing 2kg of material (probably calcium carbonate), and then measuring how it dissipates, reacts and scatters solar energy.

Proponents argue that it is important to understand the technique, in case

it is needed to buy the world more time to cut emissions. The Harvard group has established an independent advisory panel to consider the moral and political ramifications. Whether the test goes ahead or not, expect controversy.

Keeping buildings warm in winter accounts for about a quarter of global energy consumption. Most heating relies on burning coal, gas or oil. If the world is to meet its climate-change targets, that will have to change. The most promising alternative is to use heat pumps—essentially, refrigerators that run in reverse.

Instead of pumping heat out of a space to cool it down, a heat pump forces heat in from the outside, warming it up. Because they merely move existing heat around, they can be highly efficient: for every kilowatt of electricity consumed, heat pumps can deliver 3kw of heat, making them cheaper to run than electric radiators. And running a heat pump backwards cools a home rather than heating it.

Gradient, based in San Francisco, is one of several companies offering a heat pump that can provide both heating and cooling. Its low-profile, saddle-bag shaped products can be mounted in windows, like existing air conditioners, and will go on sale in 2022.

Electrifying road transport is one thing. Aircraft are another matter. Batteries can only power small aircraft for short flights. But might electricity from hydrogen fuel cells, which excrete only water, do the trick? Passenger planes due to be test-flown with hydrogen fuel cells in 2022 include a two-seater being built at Delft University of Technology in the Netherlands. ZeroAvia, based in California, plans to complete trials of a 20-seat aircraft, and aims to have its hydrogen-propulsion system ready for certification by the end of the year. Universal Hydrogen, also of California, hopes its 40-seat

plane will take off in September 2022.

Carbon dioxide in the atmosphere causes global warming. So why not suck it out using machines? Several startups are pursuing direct air capture (DAC), a technology that does just that. In 2022 Carbon Engineering, a Canadian firm, will start building the world's biggest DAC facility in Texas, capable of capturing 1m tonnes of CO₂ per year. ClimeWorks, a Swiss firm, opened a DAC plant in Iceland in 2021, which buries captured CO₂ in mineral form at a rate of 4,000 tonnes a year. Global Thermostat, an American firm, has two pilot plants. DAC could be vital in the fight against climate change. The race is on to get costs down and scale the technology up.

A new type of agriculture is growing. Vertical farms grow plants on trays stacked in a closed, controlled environment. Efficient led lighting has made the process cheaper, though energy costs remain a burden. Vertical farms can be located close to customers, reducing transport costs and emissions. Water use is minimised and bugs are kept out, so no pesticides are needed.

In Britain, the Jones Food Company will open the world's largest vertical farm, covering 13,750 square metres, in 2022. AeroFarms, an American firm, will open its largest vertical farm, in Daneville, Virginia. Other firms will be expanding, too. Nordic Harvest will enlarge its facility just outside Copenhagen and construct a new one in Stockholm. Plenty, based in California, will open a new indoor farm near Los Angeles. Vertical farms mostly grow high-value leafy greens and herbs, but some are venturing into tomatoes, peppers and berries. The challenge now is to make the economics stack up, too.

Ships produce 3% of greenhouse-gas emissions. Burning maritime bunker fuel, a dirty diesel sludge, also contributes to acid rain. None of this was a

problem in the age of sail—which is why sails are making a comeback, in high-tech form, to cut costs and emissions.

In 2022 Michelin of France will equip a freighter with an inflatable sail that is expected to reduce fuel consumption by 20%. MOL, a Japanese shipping firm, plans to put a telescoping rigid sail on a ship in August 2022. Naos Design of Italy expects to equip eight ships with its pivoting and foldable hard “wing sails”. Other approaches include kites, “suction wings” that house fans, and giant, spinning cylinders called Flettner rotors. By the end of 2022 the number of big cargo ships with sails of some kind will have quadrupled to 40, according to the International Windship Association. If the European Union brings shipping into its carbon-trading scheme in 2022, as planned, that will give these unusual technologies a further push.

Most people do not do enough exercise. Many would like to, but lack motivation. Virtual reality (VR) headsets let people play games and burn calories in the process, as they punch or slice oncoming shapes, or squat and shimmy to dodge obstacles. VR workouts became more popular during the pandemic as lockdowns closed gyms and a powerful, low-cost headset, the Oculus Quest 2, was released. An improved model and new fitness features are coming in 2022. And Supernatural, a highly regarded VR workout app available only in North America, may be released in Europe. Could the killer app for virtual reality be physical fitness?

The impressive success of coronavirus vaccines based on messenger RNA(mRNA) heralds a golden era of vaccine development. Moderna is developing an HIV vaccine based on the same mRNA technology used in its highly effective coronavirus vaccine. It entered early-stage clinical trials in 2021 and preliminary results are expected in 2022. BioNTech, joint-developer of the Pfizer-BioNTech coronavirus vaccine, is working on an

mRNA vaccine for malaria, with clinical trials expected to start in 2022. Non-mRNA vaccines for HIV and malaria, developed at the University of Oxford, are also showing promise.

For years, researchers have been developing techniques to create artificial organs using 3D printing of biological materials. The ultimate goal is to take a few cells from a patient and create fully functional organs for transplantation, thus doing away with long waiting-lists, testing for matches and the risk of rejection.

That goal is still some way off for fleshy organs. But bones are less tricky. Two startups, Particle3D and ADAM, hope to have 3D-printed bones available for human implantation in 2022. Both firms use calcium-based minerals to print their bones, which are made to measure based on patients' ct scans. Particle3D's trials in pigs and mice found that bone marrow and blood vessels grew into its implants within eight weeks. ADAM says its 3D-printed implants stimulate natural bone growth and gradually biodegrade, eventually being replaced by the patient's bone tissue. If all goes well, researchers say 3D-printed blood vessels and heart valves are next.

Long seen as something of a fantasy, flying taxis, or electric vertical take-off and landing (evtol) aircraft, as the fledgling industry calls them, are getting serious. Several firms around the world will step up test flights in 2022 with the aim of getting their aircraft certified for commercial use in the following year or two. Joby Aviation, based in California, plans to build more than a dozen of its five-seater vehicles, which have a 150-mile range. Volocopter of Germany aims to provide an air-taxi service at the 2024 Paris Olympics. Other contenders include eHang, Lilium and Vertical Aerospace. Keep an eye on the skies.

After a stand-out year for space tourism in 2021, as a succession of

billionaire-backed efforts shot civilians into the skies, hopes are high for 2022. Sir Richard Branson's Virgin Galactic just beat Jeff Bezos's Blue Origin to the edge of space in July, with both billionaires riding in their own spacecraft on suborbital trips. In September Elon Musk's company, SpaceX, sent four passengers on a multi-day orbital cruise around the Earth.

All three firms hope to fly more tourists in 2022, which promises to be the first year in which more people go to space as paying passengers than as government employees. But Virgin Galactic is modifying its vehicle to make it stronger and safer, and it is not expected to fly again until the second half of 2022, with commercial service starting in the fourth quarter. Blue Origin plans more flights but has not said when or how many. For its part, SpaceX has done a deal to send tourists to the International Space Station. Next up? The Moon.

They are taking longer than expected to get off the ground. But new rules, which came into effect in 2021, will help drone deliveries gain altitude in 2022. Manna, an Irish startup which has been delivering books, meals and medicine in County Galway, plans to expand its service in Ireland and into Britain. Wing, a sister company of Google, has been doing test deliveries in America, Australia and Finland and will expand its mall-to-home delivery service, launched in late 2021. Dronamics, a Bulgarian startup, will start using winged drones to shuttle cargo between 39 European airports. The question is: will the pace of drone deliveries pick up—or drop off?

For half a century, scientists have wondered whether changes to the shape of a supersonic aircraft could reduce the intensity of its sonic boom. Only recently have computers become powerful enough to run the simulations needed to turn those noise-reduction theories into practice.

In 2022 NASA's x-59 Quesst (short for "Quiet Supersonic Technology") will

make its first test flight. Crucially, that test will take place over land—specifically, Edwards Air Force Base in California. Concorde, the world's first and only commercial supersonic airliner, was not allowed to travel faster than sound when flying over land. The x-59's sonic boom is expected to be just one-eighth as loud as Concorde's. At 75 perceived decibels, it will be equivalent to a distant thunderstorm—more of a sonic “thump”. If it works, NASA hopes that regulators could lift the ban on supersonic flights over land, ushering in a new era for commercial flight.

Architects often use 3D printing to create scale models of buildings. But the technology can be scaled up and used to build the real thing. Materials are squirted out of a nozzle as a foam that then hardens. Layer by layer, a house is printed—either on site, or as several pieces in a factory that are transported and assembled.

In 2022 Mighty Buildings, based in California, will complete a development of 15 eco-friendly 3D-printed homes at Rancho Mirage. And ICON, based in Texas, plans to start building a community of 100 3D-printed homes near Austin, which would be the largest development of its kind.

It's become a craze in Silicon Valley. Not content with maximising their productivity and performance during their waking hours, geeks are now optimising their sleep, too, using an array of technologies. These include rings and headbands that record and track sleep quality, soothing sound machines, devices to heat and cool mattresses, and smart alarm clocks to wake you at the perfect moment. Google launched a sleep-tracking nightstand tablet in 2021, and Amazon is expected to follow suit in 2022. It sounds crazy. But poor sleep is linked with maladies from heart disease to obesity. And what Silicon Valley does today, everyone else often ends up doing tomorrow.

Diets don't work. Evidence is growing that each person's metabolism is unique, and food choices should be, too. Enter personalised nutrition: apps that tell you what to eat and when, using machine-learning algorithms, tests of your blood and gut microbiome, data on lifestyle factors such as exercise, and real-time tracking of blood-sugar levels using coin-sized devices attached to the skin. After successful launches in America, personalised-nutrition firms are eyeing other markets in 2022. Some will also seek regulatory approval as treatments for conditions such as diabetes and migraine.

Remote medical consultations have become commonplace. That could transform the prospects for wearable health trackers such as the Fitbit or Apple Watch. They are currently used primarily as fitness trackers, measuring steps taken, running and swimming speeds, heart rates during workouts, and so forth. But the line between consumer and medical uses of such devices is now blurring, say analysts at Gartner, a consultancy.

Smart watches can already measure blood oxygenation, perform ecgs and detect atrial fibrillation. The next version of the Apple Watch, expected in 2022, may include new sensors capable of measuring levels of glucose and alcohol in the blood, along with blood pressure and body temperature. Rockley Photonics, the company supplying the sensor technology, calls its system a "clinic on the wrist". Regulatory approval for such functions may take a while, but in the meantime doctors, not just users, will be paying more attention to data from wearables.

Coined in 1992 by Neal Stephenson in his novel "Snow Crash", the word "metaverse" referred to a persistent virtual world, accessible via special goggles, where people could meet, flirt, play games, buy and sell things, and much more besides. In 2022 it refers to the fusion of video games, social

networking and entertainment to create new, immersive experiences, like swimming inside your favourite song at an online concert. Games such as Minecraft, Roblox and Fortnite are all stepping-stones to an emerging new medium. Facebook has renamed itself Meta to capitalise on the opportunity—and distract from its other woes.

An idea that existed only on blackboards in the 1990s has grown into a multi-billion dollar contest between governments, tech giants and startups: harnessing the counter-intuitive properties of quantum physics to build a new kind of computer. For some kinds of mathematics a quantum computer could outperform any non-quantum machine that could ever be built, making quick work of calculations used in cryptography, chemistry and finance.

But when will such machines arrive? One measure of a quantum computer's capability is its number of qubits. A Chinese team has built a computer with 66 qubits. IBM, an American firm, hopes to hit 433 qubits in 2022 and 1,000 by 2023. But existing machines have a fatal flaw: the delicate quantum states on which they depend last for just a fraction of a second. Fixing that will take years. But if existing machines can be made useful in the meantime, quantum computing could become a commercial reality much sooner than expected.

Unlike a human influencer, a virtual influencer will never be late to a photoshoot, get drunk at a party or get old. That is because virtual influencers are computer-generated characters who plug products on Instagram, Facebook and TikTok.

The best known is Miquela Sousa, or “Lil Miquela”, a fictitious Brazilian-American 19-year-old with 3m Instagram followers. With \$15bn expected to be spent on influencer marketing in 2022, virtual influencers are

proliferating. Aya Stellar—an interstellar traveller crafted by Cosmiq Universe, a marketing agency—will land on Earth in February. She has already released a song on YouTube.

In April 2021 the irrepressible entrepreneur Elon Musk excitedly tweeted that a macaque monkey was “literally playing a video game telepathically using a brain chip”. His company, Neuralink, had implanted two tiny sets of electrodes into the monkey’s brain. Signals from these electrodes, transmitted wirelessly and then decoded by a nearby computer, enabled the monkey to move the on-screen paddle in a game of Pong using thought alone.

In 2022 Neuralink hopes to test its device in humans, to enable people who are paralysed to operate a computer. Another firm, Synchron, has already received approval from American regulators to begin human trials of a similar device. Its “minimally invasive” neural prosthetic is inserted into the brain via blood vessels in the neck. As well as helping paralysed people, Synchron is also looking at other uses, such as diagnosing and treating nervous-system conditions including epilepsy, depression and hypertension.

Winston Churchill once mused about “the absurdity of growing a whole chicken to eat the breast or wing”. Nearly a century later, around 70 companies are “cultivating” meats in bioreactors. Cells taken from animals, without harming them, are nourished in soups rich in proteins, sugars, fats, vitamins and minerals. In 2020 Eat Just, an artificial-meat startup based in San Francisco, became the first company certified to sell its products, in Singapore.

It is expected to be joined by a handful of other firms in 2022. In the coming year an Israeli startup, SuperMeat, expects to win approval for commercial sales of cultivated chicken burgers, grown for \$10 a pop—down from \$2,500

in 2018, the company says. Finless Foods, based in California, hopes for approval to sell cultivated bluefin tuna, grown for \$440 a kilogram—down from \$660,000 in 2017. Bacon, turkey and other cultivated meats are in the pipeline. Eco-conscious meat-lovers will soon be able to have their steak—and eat it.

By the Science and technology correspondents of The Economist ■



世界展望2022

接下来呢？2022年值得关注的22项新兴技术

新的创意也许会看似在一夜之间出现

新冠疫苗研发和铺开的速度之惊人，提醒人们科学技术拥有改变世界的强大力量。虽然基于新的mRNA技术的疫苗仿佛横空出世，实际上它们运用了可追溯至1970年代的数十年来的研究成果。科技行业有句俗语：十年寒窗无人问，一举成名天下知。那么，还有什么可能即将脱颖而出呢？以下是2022年值得关注的22项新兴技术

道理似乎再简单不过：如果地球变得太热了，何不给它加点遮光物？众所周知，火山释放到高层大气中的灰尘和灰烬具有冷却作用：1991年皮纳图博火山的喷发使地球在四年内降温0.5摄氏度。太阳地球工程（也称为太阳辐射管理）将会蓄意来做这件事。

这是极具争议的。它能起作用吗？降雨和天气模式会受到怎样的影响？而且，它难道不会削弱减排的决心吗？测试这个构想的努力面临来自政客和活动人士的强烈反对。不过，在2022年，哈佛大学的一个小组希望开展一项拖延已久的名为SCOPEX的实验。它会把一个气球发射到平流层，目的是释放二公斤的材料（很可能是碳酸钙），然后测量它如何消散、反应和散射太阳能。

支持者说，理解这种方法的利弊很重要，因为世界可能需要争取更多的时间来实现减排。哈佛团队已经成立了一个独立的顾问小组来考量道德和政治影响。无论实验是否得以推进，争议将无可避免。

在冬季为建筑取暖的能耗约占到全球能耗的四分之一。大多数取暖都依赖燃烧煤炭、天然气或石油。如果世界要实现其气候变化目标，就必须改变这一点。最有前景的取暖替代方案是使用热泵——它们本质上是反向运作的冰箱。

热泵不是从一个空间中抽出热量来冷却它，而是迫使热量从外部进入，使空间升温。因为它们只是转移现有的热量，所以可以非常高效：每消耗一千瓦电可提供三千瓦热量，运行成本低于电暖炉。而反向运行热泵可为房屋降温。

总部位于旧金山的Gradient是提供兼有制暖和制冷功能的热泵的几家公司之一。其低调的马鞍袋形产品可以像现有的空调那样安装在窗户上，将于2022年上市销售。

道路交通电气化是一回事。飞机是另一回事。电池只能为短途飞行的小型飞机供电。但是，氢燃料电池（只排放水）提供的电力是不是能够解决问题呢？将在2022年试飞的氢燃料电池客机包括正在荷兰的代尔夫特理工大学（Delft University of Technology）建造的双人座飞机。总部位于加州的ZeroAvia计划完成一架20座飞机的试飞，并在明年底前为其氢电推进系统获得认证做好准备。同样来自加州的“环球氢能”（Universal Hydrogen）公司希望其40座飞机能在2022年9月起飞。

大气中的二氧化碳导致全球变暖。那何不用机器把它吸走呢？几家创业公司正在研发直接空气捕获（DAC）技术来做这件事。2022年，加拿大的碳工程公司（Carbon Engineering）将开始在德克萨斯州建造世界上最大规模的DAC设施，每年将能捕获100万吨二氧化碳。瑞士公司ClimeWorks于2021年在冰岛开设了一座DAC工厂，以每年4000吨的速度以矿物形式掩埋捕获的二氧化碳。美国公司“全球温控”（Global Thermostat）有两座试点工厂。DAC技术可能在应对气候变化之战中扮演至关重要的角色。一场降低成本和规模化的竞赛正在上演。

一种新型农业正在茁壮成长。垂直农场在封闭且受控的环境中把作物种在堆叠的托盘上。高效的LED照明已经使这一过程变得更便宜，但能源成本仍然是一个负担。垂直农场可以开设在靠近客户的地方，减少了运输成本和排放。用水量被降至最低，虫子被拒之门外，因此不需要杀虫剂。

在英国，琼斯食品公司（Jones Food Company）将于2022年设立全球最大的垂直农场，占地13,750平方米。美国公司AeroFarms将在弗吉尼亚的丹尼维尔开设它最大的一个垂直农场。其他公司也将扩张。北欧丰收

（Nordic Harvest）将扩建其位于哥本哈根郊外的垂直农场，并在斯德哥尔摩新建一个。总部位于加州的Plenty将在洛杉矶附近投产一个新的室内农场。垂直农场大多种植高价值的绿叶蔬菜和香料，但也有一些开始尝试种西红柿、辣椒和浆果。当前的挑战是让它的经济效益也能堆叠累积。

船舶产生的排放占温室气体排放总量的3%。燃烧海上船用燃料——一种高污染的泥状柴油——也是酸雨的成因。在风帆时代，这一切都不是问题。这就是为什么风帆正在以高科技形式卷土重来，以求降低成本和减少排放。

2022年，法国米其林将为一艘货轮配备充气帆，预计可减少20%的油耗。日本航运公司MOL计划于2022年8月在一艘船上安装伸缩式刚性帆。意大利的Naos Design预计将为八艘船配备可旋转、可收叠的硬“翼帆”。其他方法包括风筝、内部装有风扇的“吸翼”，以及名为弗莱特纳转子

（Flettner）的巨大的旋转圆柱体。根据国际风船协会（International Windship Association）的数据，到2022年底，带有某种帆的大型货船的数量将翻两番，达到40艘。如果欧盟按计划在2022年将航运纳入其碳交易计划，将进一步推动这些不寻常的技术。

大多数人都缺乏运动。许多人希望自己能多动动，但又缺乏动力。虚拟现实（VR）头显让人们在玩游戏的过程中燃烧卡路里，他们可以击打或劈开扑面而来的各种形状，或蹲下和扭动身子以躲避障碍物。疫情封锁期间健身房纷纷关门，同时功能强大的低价头显Oculus Quest 2发布，让VR健身变得更加流行。这款头显的一个升级型号和新的健身功能将于2022年推出。备受推崇的VR健身应用Supernatural目前仅在北美可用，明年可能也会在欧洲发布。虚拟现实的杀手级应用会不会是健身？

基于信使核糖核酸（mRNA）的冠状病毒疫苗取得了令人瞩目的成功，预

示着疫苗研发的黄金时代到来。Moderna正在开发一种HIV疫苗，它背后的mRNA技术就是它在自己高效的新冠疫苗中使用的那一种。它已在2021年进入早期临床试验，预计2022年将有初步结果出炉。辉瑞/BioNTech新冠疫苗的联合开发商BioNTech正在研发一种针对疟疾的mRNA疫苗，预计将于2022年开始临床试验。牛津大学研发的非mRNA技术HIV和疟疾疫苗也显现了潜力。

多年来，研究人员一直在探索使用3D打印生物材料来创造人造器官。最终目标是从患者身上提取一些细胞并创造出功能齐全的移植器官，解决器官移植需要长久排队、做匹配测试和有排异风险的问题。

要制造肉质器官还有一段路要走。但骨骼就没有那么难。两家创业公司Particle3D和ADAM希望在2022年打印出可被植入人体的骨骼。两家公司都用钙基矿物质来打印，依照患者的CT扫描量身定制骨骼。Particle3D在猪和小鼠身上的试验发现，在完成移植后的八周内，骨髓和血管开始在植入物内生长。ADAM公司说，它的3D打印植入物会刺激自然骨骼生长，与此同时自身逐渐生物降解，最终被患者的骨组织取代。如果一切顺利，研究人员表示，接下来将会3D打印血管和心脏瓣膜。

长期以来，“会飞的出租车”——在这个新兴行业的内部被称为“电动垂直起降（eVTOL）飞机”——在人们眼里和白日梦无异，现在它越来越像是真的了。分布在世界多地的几家公司将在2022年加紧试飞，目的是在接下来的一两年内让他们的飞机获得商业用途认证。总部位于加州的Joby Aviation计划打造十多辆续航150英里的五座飞机。德国的Volocopter的目标是为2024年巴黎奥运会提供空中出租车服务。其他竞争者包括亿航、Lilium和垂直航空航天（Vertical Aerospace）等。留心看天吧。

在经历了异常亮眼的一年后，太空旅行在2022年被寄予厚望。2021年，一连串由亿万富翁出资的努力将平民送入太空。7月，理查德·布兰森爵士的维珍银河抢在杰夫·贝索斯的蓝色起源之前率先抵达太空边缘。两位亿万富翁都乘坐自己的航天器完成了一次亚轨道旅行。9月，伊隆·马斯克的

SpaceX运送四名乘客开展了一次为期多日的环绕地球轨道飞行。

三家公司都希望在2022年把更多游客送上太空。在这一年，进入太空的付费乘客有望首次多过政府雇员。但维珍银河正在改装其飞行器，使其更坚固和安全，预计要到2022年下半年才能再次飞行，并将于第四季度开始商业服务。蓝色起源计划增加航班，但尚未说明时间和数量。SpaceX已达成一项协议，要把游客送往国际空间站。下一站？月球。

它们起飞所花的时间比预期更久。但2021年生效的新规则将让无人机送货在2022年越飞越高。爱尔兰创业公司Manna一直在戈尔韦郡（County Galway）递送书籍、膳食和药品，目前计划把服务扩展到爱尔兰其他地区以及英国。谷歌的姊妹公司Wing一直在美国、澳大利亚和芬兰测试送货，它将扩大2021年底推出的购物中心递送到家服务。保加利亚创业公司Dronamics将开始使用有翼无人机在39个欧洲机场之间运货。问题是，无人机快递业的发展会提速还是减速？

半个世纪以来，科学家一直都想弄清楚改变超音速飞机的形状是否会降低其音爆强度。直到最近，计算机才变得足够强大，可以运行把这些降噪理论付诸实践所需的模拟。

2022年，美国国家航空航天局（NASA）的x-59 Quesst（“静音超音速技术”的缩写）将首次试飞。至关重要的是，这次测试将在陆地上进行——确切的说是加州的爱德华兹空军基地（Edwards Air Force Base）。世界上第一架也是唯一一架商用超音速客机协和飞机（Concorde）被要求在陆地上空飞行时速度不可超过音速。x-59的音爆预计仅为协和的八分之一。在75分贝时，它听起来差不多像是远处的雷雨——所以更像是音“敲”而非音“爆”。如果可行，NASA希望监管机构能够解除对超音速陆上飞行的禁令，开创超音速商业飞行的新时代。

建筑师常用3D打印来搭建楼房的比例模型。但这项技术可以扩大规模，用于建造真正的房子。泡沫状的材料从喷嘴中喷出后固化。一栋房子就这样

一层一层地被打印出来——要么是在现场打印，要么是在工厂里打印完局部，再运到现场组装起来。

2022年，总部位于加州的威力楼宇（Mighty Buildings）将在兰乔米拉市（Rancho Mirage）完成开发15套环保3D打印房。总部位于德克萨斯的ICON计划在奥斯汀附近开建一个百套3D打印房社区，将是同类开发项目中规模最大的一个。

这已成为硅谷的风潮。极客们不满足于在自己醒着的时候最大限度地提高工作效率和表现，他们现在也用一系列技术来优化自己的睡眠。这包括记录和跟踪睡眠质量的戒指和发带、舒缓音效设备、加热和冷却床垫的设备，以及能在完美时刻唤醒他们的智能闹钟。谷歌在2021年推出了追踪睡眠的床头柜平板电脑，亚马逊有望在2022年效仿。这听起来很疯狂，但睡眠不佳与心脏病和肥胖症等多种疾病有关。而硅谷今天在做的，明天往往就传遍了世界。

节食没有用。越来越多证据表明，每个人的新陈代谢都是独一无二的，对食物的选择也应该如此。个性化营养时代来了：手机应用会告诉你该吃什么，什么时候吃。其中用到了机器学习算法、对你的血液和肠道微生物组的检测、运动等生活方式因素的数据，以及使用硬币大小的贴在皮肤上的装置实时跟踪你的血糖水平。在美国成功启动后，个性化营养公司在2022年会瞄准其他地区的市场。一些公司还将寻求监管部门批准，参与对糖尿病和偏头痛等疾病的治疗。

远程医疗咨询已经司空见惯。这可能会改变Fitbit或Apple Watch等可穿戴健康追踪器的前景。它们目前主要用作健身追踪器，测量步数、跑步和游泳速度、锻炼期间的心率等。但咨询公司Gartner的分析师表示，此类设备的消费和医疗用途之间的界限正在变得模糊。

智能手表已经可以测量血氧饱和度、监测心电图和房颤。预计在2022年推出的新版Apple Watch可能带有新传感器，能测量血液中的葡萄糖和酒精

含量，以及血压和体温。提供这一传感器技术的罗克利光子Rockley Photonics称其系统为“手腕诊所”。此类功能的监管审批可能需要一段时间，但与此同时，不仅仅是用户，医生也会更关注来自可穿戴设备的数据。

1992年，尼尔·斯蒂芬森（Neal Stephenson）在他的小说《雪崩》（Snow Crash）中创造了“元宇宙”一词，指的是一个可以通过特殊目镜进入的持久存在的虚拟世界，人们可以在那里碰面、调情、玩游戏、买卖东西，以及做其他许许多多事。在2022年，它指的是视频游戏、社交网络和娱乐的融合，创造出新的身临其境的体验，例如在一场线上音乐会中遨游在你最喜欢的歌曲中。我的世界（Minecraft）、Roblox和堡垒之夜（Fortnite）等游戏都是这个新兴媒体的铺路石。Facebook已将自己更名为Meta以抓住这个机遇——也是为转移外界对它的其他麻烦的注意力。

一个在1990年代只存在于黑板上的想法已经发展成各地政府、科技巨头和创业公司之间的一场天价竞赛：利用量子物理学反直觉的特性来建造一种新型计算机。对于某些类型的数学，量子计算机可以胜过任何能被造出来的非量子机器，快速处理密码学、化学和金融中涉及的运算。

但这样的机器何时会有呢？衡量量子计算机能力的一种方法是它的量子比特数。一个中国团队建造了一台66比特计算机。美国公司IBM希望在2022年实现433量子比特，2023年达到1000比特。但现有的机器有一个致命缺陷：它们所依赖的微妙量子态只能持续以微秒计的时长。改善这一点将需要多年时间。但是，如果与此同时可以使现有的机器变得有用处，那么量子计算可能会比预期更快地成为一种商业现实。

与人类网红不同的是，虚拟网红永远不会在拍宣传照时迟到、在聚会上喝醉，也不会变老。这是因为虚拟网红是计算机生成的角色，他们在Instagram、Facebook和TikTok上推销商品。

现在首屈一指的红人是蜜奎拉（Miquela Sousa），人们喜欢叫她“Lil

Miquela”。这个虚构的19岁巴西裔美国人在Instagram上拥有300万粉丝。预计2022年全球将有150亿美元用于网红营销，虚拟网红随之激增。由营销公司Cosmiq Universe打造的星际旅行者Aya Stellar将于2月登陆地球。她已经在YouTube上发布了一首单曲。

2021年4月，精力过人的企业家马斯克在推特上兴奋地表示，一只猕猴“真的在用脑芯片通过心灵感应玩电子游戏”。他的公司Neuralink在这只猴子的大脑中植入了两套微小的电极。来自这些电极的信号以无线方式传输，由附近的计算机解码，使猴子能够仅仅用意念就在一个乒乓球游戏中移动屏幕上的球拍。

Neuralink希望2022年在人类身上测试其设备，让瘫痪人士能够操作电脑。另一家公司Synchron已经获美国监管机构批准，开始对一套类似的设备进行人体试验。其“微创”神经假体通过颈部血管插入大脑。除了帮助瘫痪人士，Synchron也在探索其他用途，例如诊断和治疗神经系统疾病，包括癫痫、抑郁症和高血压等。

温斯顿·丘吉尔曾经思考“为了吃鸡胸肉或鸡翅而养殖一整只鸡的荒谬”。近一个世纪后，大约有70家公司正在生物反应器中“培育”肉类。在不伤害动物的情况下从它们身上提取细胞，将之投入富含蛋白质、糖类、脂肪、维生素和矿物质的液体中养育。2020年，总部位于旧金山的人造肉创业公司Eat Just在新加坡获得许可，成为全球首家获准销售的人造肉厂。

预计2022年将有少数其他公司加入它的行列。以色列创业公司SuperMeat预计将在明年获准商业销售人造鸡肉汉堡。该公司称每个汉堡的培育成本为10美元，2018年时为2500美元。总部位于加州的“无鳍食物”(Finless Foods)希望获准销售人造蓝鳍金枪鱼，每公斤培育成本440美元，2017年时为66万美元。接下来还会有培根、火鸡和其他培育肉。生态环保意识强烈的肉食爱好者很快就可以大快朵颐了。

撰文：经济学人科技记者 ■



Missing links

Mexico could benefit from China's exclusion from supply chains

If Andrés Manuel López Obrador, the populist president, doesn't hold it back

THE CHUNKS OF metal being worked on do not look terribly special. But the factory of BAP Aerospace, a chemical-processing firm in Tijuana, hints at Mexico's importance to global supply chains. These are components, from tray tables to door parts, for aircraft made by companies including Boeing, Cessna and Lockheed Martin. BAP applies surface treatments to the pieces, from submerging them in big vats of chemicals to meticulous work done by hand, before shipping them north.

Mexico has long been a hub for manufacturing. Toyota, a Japanese carmaker, has had a plant in Tijuana since 2002. Honeywell, an American industrial giant, opened one in 2010. But increasingly the country is moving into higher-value processes. It now accounts for 3-4% of aerospace imports to the United States, up from 1.5% in 2010. By contrast China's share, which was the same as Mexico's a decade ago, is now just 1%. American sanctions on China and tariffs on Chinese goods explain much of this change, as well as rising wages in China and the difficulty of doing business there. The trend has accelerated recently. Pandemic-induced border closures, increased freight costs, and consumers' demands for instant gratification have all nudged firms around the world to consider shortening their supply chains.

"This is a golden opportunity for Mexico," says Helen Wang, a consultant. The country has some natural advantages, not least a long land border with the United States. Mexico is party to fully 23 free-trade deals. Manufacturing wages are lower than in China. A survey this year by the American Chamber of Commerce of Shanghai found that a fifth of its members were considering moving some work out of China; more than a third of those

who were thinking of moving were looking to Mexico.

In Tijuana the mood among many Mexican businesspeople is optimistic. Several big firms have expanded recently. Panasonic, a Japanese electronics company, opened a plant in 2018 to make cables for aerospace. Other companies are diversifying into logistics and distribution. In September this year Amazon, an e-commerce giant, opened a warehouse there, though the company denied that it would use it to serve customers in the United States.

In addition to aerospace, the manufacturing of medical devices and other electronics is booming. “We are doing things [in Mexico] that once would have had to be done in Japan or Germany,” boasts Eduardo Salcedo, the manager of the local operations of Össur, an Icelandic medical-devices company. “We have guys running a million-dollar machine with their right hand and another one with their left hand.”

The result is that the richest part of the country, by the border, is becoming even better off. “Northern Mexico is growing at similar rates to Asia,” says Luis de la Calle, a consultant who used to work at Mexico’s economy ministry. Elsewhere, however, the picture is mixed. FDI fell from 3.1% of GDP in 2018 to 2.3% in 2019, compared with 3.7% in Brazil or 6.2% in Vietnam.

And despite its proximity to the United States, Mexico has its shortcomings. Business parks provide world-class facilities but the infrastructure outside—from roads to ports—is of poor quality, says Mr de la Calle. Businesses complain of problems obtaining inputs. The likes of Panasonic and Össur import many of the materials they need. Similarly Össur nearly pulled out of Tijuana because it could not find a company to apply chemical processes to its products, which include prosthetics. (BAP eventually stepped in.)

Some of the causes of Mexico's problems are outside its control. When the government of the United States talks about "near-shoring", it really means onshoring, says Bill Reinsch of CSIS, a think-tank in Washington. It can be protectionist in negotiations with Canada and Mexico. USMCA, the revised trade deal agreed in 2020 between the three countries, is stricter than its predecessor, NAFTA—indeed it was negotiated in part to preserve manufacturing jobs in the United States.

But Andrés Manuel López Obrador, Mexico's populist president, has not helped. In 2018 his administration replaced one of the most business-friendly (if corrupt) governments in Mexico's history, that of Enrique Peña Nieto. Mr López Obrador, in contrast, seems to enjoy unnerving investors.

Soon after taking office he cancelled a new airport for Mexico City, after the diggers had been working for three years, at a cost of at least \$5bn. In 2020 he also pulled the plug on a \$1.4bn investment in a new factory by Constellation Brands, an American brewer, which was near completion. He has weakened independent regulators by absorbing them into government or slashing their budgets.

Mr López Obrador is also reversing his predecessor's opening of the energy industry to private firms and favouring inefficient state-owned outfits. Along with making electricity dirtier and less reliable, this sends forbidding signals to investors. In November the boss in Mexico of General Motors (GM), an American carmaker, said the company would not invest further in the country without laws that promote renewable energy. Earlier this year GM had said it would invest more than \$1bn to make electric cars in Mexico from 2023. Last year Tesla, a leading maker of such cars, considered opening a factory in Mexico but opted instead for Texas. Although Tesla did not explain its reasons, Elon Musk, its boss, has grumbled about the Mexican government's closure of some of the factories of its suppliers during covid-

related lockdowns.

Mexico risks “shooting itself in the foot” by not taking advantage of shorter supply chains, says Michael Camuñez, who started a series of meetings to boost the economic relationship between Mexico and the United States during Barack Obama’s administration. (Mr López Obrador and President Joe Biden relaunched this “economic dialogue” in September.) Unfortunately it is Mr López Obrador who has his finger on the trigger and, if his past treatment of foreign investors is any guide, seems likely to pull it. ■



缺失的环节

中国被排除在供应链之外，墨西哥可能坐收渔利

如果民粹主义总统洛佩斯不从中作梗的话

这些正在加工的大块金属看上去并没有多么特别。但位于蒂华纳（Tijuana）的化学加工公司BAP航空航天（BAP Aerospace）旗下的这家工厂却透露出墨西哥对于全球供应链的重要性。这些为波音、塞斯纳（Cessna）和洛克希德马丁等飞机制造商加工的部件从小桌板到舱门配件，不一而足。BAP对这些部件做表面处理，包括将它们浸泡在大罐的化学品中，或者做些非常精细的手工，然后将它们运往美国。

墨西哥长期以来一直是制造业中心。日本汽车制造商丰田2002年就在蒂华纳建立了自己的工厂。2010年美国工业巨头霍尼韦尔（Honeywell）也在这里开设了一家工厂。但墨西哥正越来越转向更高价值的工序。在美国进口的航空航天产品中，墨西哥产品的占比从2010年的1.5%上升到今天的3%至4%。而十年前就有墨西哥如今份额的中国目前只有1%。之所以有这样的变化，除了中国的劳动力成本上涨以及在中国做生意的难度之外，更主要的原因是美国对中国的制裁以及对中国商品征收的关税。这一变化趋势近期还在加速。新冠疫情导致的边境关闭、货运成本的上涨以及消费者对即时满足的要求，都促使世界各地的企业考虑缩短自己的供应链。

“这对墨西哥来说是个绝佳的机会。”咨询顾问海伦·王（Helen Wang）表示。墨西哥有一些得天独厚的优势，尤其是它与美国漫长的陆地边界。墨西哥加入的自由贸易协定足足有23个之多。它的制造业工资水平低于中国。上海美国商会今年的一项调查发现，该商会五分之一的会员正考虑将部分生产迁出中国；这其中又有超过三分之一的会员考虑迁往墨西哥。

在蒂华纳，许多墨西哥商人都对前景感到很乐观。几家大公司不久前开始了扩张。日本电子公司松下2018年在当地开设了一家航空电缆制造厂。其他公司也在扩大业务范围，进军物流和分销。今年9月，电子商务巨头亚

马逊在蒂华纳开设了一个仓库，但否认会用它来服务美国客户。

除了航空航天产品，医疗和其他电子设备生产也在蓬勃发展。“我们现在（在墨西哥）做的事情，以前只有在日本或德国才能做到。”冰岛医疗设备公司奥索（Össur）的本地主管爱德华多·萨尔塞多（Eduardo Salcedo）自豪地说，“我们有些员工可以左右手开弓，同时操作两台价值百万美元的机器。”

结果就是墨西哥靠近美国边境的那些最富裕的地区变得更加富有。“墨西哥北部的经济增速与亚洲差不多。”曾在墨西哥经济部任职的咨询顾问路易斯·德拉卡列（Luis de la Calle）表示。然而其他地方的情况却喜忧参半。外国直接投资占GDP的比重从2018年的3.1%降到2019年的2.3%，而巴西和越南的这一比例分别为3.7%和6.2%。

尽管有毗邻美国的优点，墨西哥也有自己的缺点。德拉卡列表示，商业园区提供了世界一流的设施，但园区之外的公路、港口等各种基础设施都很差。企业抱怨难以获得投入品。像松下和奥索这类公司需要的材料很多靠进口。同样，由于找不到对假肢等产品做化学处理的公司，奥索差一点就搬离了蒂华纳。（最终是BAP成为合作方解了围。）

墨西哥这些问题的根源有一部分是它自己无力解决的。华盛顿智库战略与国际研究中心（CSIS）的比尔·雷施（Bill Reinsch）表示，美国政府说的“近岸外包”其实是在岸生产。在与加拿大和墨西哥的谈判中，美国可能采取贸易保护主义立场。2020年三国达成的修订版贸易协定《美墨加协议》（USMCA）相比其前身《北美自由贸易协定》（NAFTA）更加苛刻——事实上，该协定的目的之一就是要保住美国的制造业就业岗位。

但墨西哥的民粹主义总统洛佩斯也没起到什么正面作用。2018年，他的政府取代了墨西哥历史上最亲商（尽管腐败）的政府之一涅托政府。相比之下，洛佩斯似乎很喜欢让投资者紧张不安。

上任后不久，他就叫停了开工已三年的墨西哥城新机场的建设，至少损失

50亿美元。2020年，他还终止了美国啤酒制造商星座集团（Constellation Brands）对一家接近完工的新工厂14亿美元的投资。通过将独立监管机构并入政府或削减其预算，他削弱了它们的权力。

此外，洛佩斯还在逆转其前任向私营企业开放能源行业的做法，转而支持效率低下的国有企业。此举除了让电力变得更加不环保、不稳定之外，还向投资者发出了令人生畏的信号。11月，美国汽车制造商通用汽车墨西哥分公司的总裁表示，如果没有促进可再生能源发展的法律，通用汽车将不会在墨西哥进一步投资。而今年早些时候，通用汽车还曾表示，将从2023年起投资逾10亿美元在墨西哥生产电动汽车。去年，领先的电动汽车制造商特斯拉曾考虑在墨西哥开设一家工厂，但最终却选择了得克萨斯州。虽然特斯拉没有解释原因，但其老板马斯克抱怨过在新冠疫情封锁期间，墨西哥政府关闭了其供应商的一些工厂。

如果墨西哥不利用供应链缩短这个优势，就有可能“搬起石头砸自己的脚”，迈克尔·卡姆尼斯（Michael Camuñez）表示。他在奥巴马执政期间开启了一系列旨在促进墨西哥和美国经济关系的对话。（洛佩斯和拜登在今年9月重启了这一“经济对话”。）不幸的是，洛佩斯已经搬起了石头，并且从他以往对待外国投资者的方式看，他很可能会把石头砸下去。■



The World Ahead 2022

Ugur Sahin and Ozlem Tureci on the future of mRNA therapies

The founders of BioNTech are looking beyond covid-19

The rapid development of multiple covid-19 vaccines is an unprecedented achievement in drug development that has offered a way out of the pandemic. But there is more good news to come. The role of vaccines based on messenger RNA (mRNA) technology in this success heralds a new era in the development of therapies for other diseases.

The mRNA breakthrough was made possible by scientific co-operation over three decades that helped transform a promising concept into a highly potent and versatile biopharmaceutical platform. We believe that in 15 years, one-third of all newly approved drugs will be based on mRNA.

Rather than relying on complex and time-consuming fermentation processes to produce drugs, mRNA therapies instead turn the recipient's own cells into drug factories. Each mRNA molecule is a recipe that instructs the cells to manufacture a specific desired protein. Our covid-19 vaccine prompts cells to manufacture the "spike" protein found in the coronavirus's outer coating, thus priming the immune system so that it can subsequently recognise and fend off the virus.

This technology is a turning-point in the pharmaceutical industry, comparable to the inauguration of recombinant DNA technology (allowing the production of human-protein drugs such as insulin), or monoclonal antibodies in laboratory fermenters, more than 40 years ago. The roll-out of this concept into readily available drugs promises to disrupt and transform the industry—and global health.

The development of covid-19 vaccines based on mRNA has proved the

efficacy and safety of this approach in preventing infectious diseases. The fact that a safe and effective vaccine could be developed in less than 12 months, in the midst of a pandemic, and then manufactured at scale, suggests that mRNA vaccines will play an important role in future pandemic-preparedness programmes, which are high on governments' agendas.

It also paves the way for mRNA vaccines to be deployed against other infectious diseases. Many existing vaccines for such diseases might be reformulated using mRNA, making them more efficient. We believe that the versatility of mRNA technology offers opportunities to go further, and to combat currently undefeated diseases.

At BioNTech, we are now going beyond covid-19 and investing in mRNA-vaccine programmes to deal with diseases such as malaria, tuberculosis and HIV, which are still responsible for many deaths in lower-income countries. The prospect of being able to bring mRNA technology to bear is creating a spirit of optimism in the fight against these human scourges.

The pandemic has forced people to work better together. Recently initiated projects have seen a high degree of co-operation between institutions such as the World Health Organisation, international regulatory authorities and funding organisations, supported by experts who have been researching the pathogens of interest for more than 30 years. The first mRNA-vaccine candidates for these diseases are expected to enter clinical trials in 2022 and 2023.

We also face increasingly challenging health problems on a global scale, such as age-related diseases in developed countries and the growing need for affordable primary health-care in low-income countries. These can be conquered only by sustainable innovation that is versatile and cost-efficient, and can enable the individualisation of treatment and targeting

of rare diseases. We believe these needs could be perfectly addressed by mRNA.

The rich toolbox of mRNA technologies includes an increasingly diversified portfolio of mRNA formats, some with the ability to multiply in cells, and a plethora of ways to deliver mRNA to different organs and cells in the body. In the future, mRNA drugs could be used for individualised cancer therapies, regenerative medicine, and for a wide variety of diseases such as allergies, autoimmune conditions and inflammatory diseases.

The stage is set for the emergence of a new health-tech industry that will redefine the biotech-pharmaceutical landscape. A key enabler of success will be that health-tech leaders and pioneers welcome and support new disruptors to the market. Only by further encouraging investment in innovation and fostering a culture of co-operation and cross-fertilisation will this new industry become a changemaker for public health. This new generation of tech-pharma players may reshape the world's health in 2022—and beyond.

Ugur Sahin and Ozlem Tureci: founders of BioNTech ■



世界展望2022

沙欣和图雷西谈mRNA疗法的未来

BioNTech的创始人把目光投向新冠以外

多种新冠疫苗的快速研发是药物研发中前所未有的成就，为摆脱这场全球疫情提供了一条出路。但还有更多好消息会来。基于信使核糖核酸（mRNA）技术的疫苗在这一成功中所扮演的角色预示着一个研发其他疾病疗法的新时代。

三十多年来的科学合作使这一mRNA突破成为可能，这种合作帮助把一个有前景的概念转变为一个非常有效且多功能的生物制药平台。我们相信，不出15年光景，所有新批准药物中有三分之一都将基于mRNA技术。

不同于依赖复杂又耗时的发酵工艺来生产药物，mRNA疗法把接受者自己的细胞变成了药厂。每个mRNA分子都是一个配方，指导细胞制造某种需要的蛋白质。我们的新冠疫苗促使细胞制造在新冠病毒的外壳中存在的“刺突”蛋白，从而让免疫系统做好准备，在日后识别出病毒并抵御它。

这项技术是制药行业的一个转折点，其重要性可媲美40多年前的重组DNA技术（带来了胰岛素等人类蛋白质药物）或实验室发酵罐中单克隆抗体的诞生。把这一概念变成现成可用的药物有望颠覆和改造制药业——以及全人类的健康。

基于mRNA的新冠疫苗的研发证明了这种方法在预防传染病上的有效性和安全性。疫情期间，一种安全有效的疫苗在不到12个月的时间内研发完成，然后大规模投产，这样的事实表明mRNA疫苗会在未来的疫情防范计划中发挥重要作用，而这类计划已是政府议程中的优先项之一。

这也为针对其他传染病部署mRNA疫苗铺设了道路。针对这类疾病的许多现有疫苗可能会用mRNA技术重新配制，让它们变得更高效。我们相信，mRNA技术的灵活性可以让它走得更远，与人类目前尚未战胜的疾病作斗争。

争。

在BioNTech，我们现在不只对付新冠，也在投资于抗击疟疾、肺结核和HIV病毒等疾病的mRNA疫苗计划，这些疾病在低收入国家仍在导致大量死亡。展望将mRNA技术付诸实践的前景，人们对于战胜这些给人类带来苦难的祸患更加乐观了。

这场疫情迫使人们改善合作。最近启动的项目在世卫组织、国际监管机构和资助组织等机构之间展开了高度合作，并得到了研究相关病原体长达30多年的专家们的支持。预计这些疾病的首批mRNA候选疫苗将在2022年和2023年进入临床试验阶段。

我们还面临全球范围内日益棘手的健康问题，比如发达国家的老龄化疾病，以及低收入国家越来越需要价格合理的初级卫生保健。只有靠灵活且经济的可持续创新才能克服这些难题，并可实现对罕见疾病的个性化和靶向治疗。我们相信mRNA完全可以满足这些需求。

mRNA技术丰富的工具箱包括日益多样化的mRNA格式组合——其中一些格式具有在细胞中繁殖的能力——以及大量将mRNA递送到体内不同器官和细胞的方法。未来，mRNA药物可被用于个性化癌症治疗、再生医学，以及过敏、自身免疫性疾病和炎症性疾病等各种各样的疾病。

一个新的医疗科技产业崛起的舞台已经搭建完毕，它将重新定义生物科技制药的格局。成功的一个关键推动因素，将是医疗科技的领军者和先驱欢迎并支持新的颠覆者进场。唯有进一步鼓励对创新的投资，并营造合作和交叉孕育的文化，这个新行业才有机会成为公共卫生的变革者。这新一代科技制药业者可能会重塑世界在2022年乃至以后的健康状况。

乌格·沙欣（Ugur Sahin）和奥兹莱姆·图雷西（Ozlem Tureci）：
BioNTech创始人■



Plugging the gap

The tricky business of charging electric cars

Building public networks will require business and government to work together

TAKE THE wheel of an electric vehicle (EV) and prepare to be astounded. The smooth, instant acceleration of battery power makes driving easy and exciting. The latest technology is there, with tablet-like screens instead of old-fashioned switches. Add falling prices which make owning and running many EVs as cheap as fossil-fuel alternatives, and the open road beckons.

Except when you look under those sleek exteriors. The tangle of cables in the boot is a reminder of the need to plug in and recharge cars roughly every 250 miles (400km). And when you do find a public charging point, it is sometimes damaged or inaccessible. Little wonder that one of the main reasons drivers give for not buying an EV is “range anxiety”.

A society-wide switch from hydrocarbons to electrons is required if the world is to stand a chance of reaching its net-zero emissions targets. However as EVs become more common, the charging problem will become more severe. Today’s mostly wealthy owners can often plug in their EV at home or at work. But many less-well-off EV drivers will not have a drive in front of their house or a space in the executive car park.

By 2040 around 60% of all charging will need to take place away from home, requiring a vast public network of charging stations. At the end of 2020 the world had just 1.3m of these public chargers. By some estimates, to meet net-zero emissions goals by 2050 will require 200m of the things.

Who might install them? Drivers will need a mix of fast “long-distance” chargers installed near motorways that can rapidly add hundreds of miles

to battery ranges and slower “top-up” chargers available at kerbsides or in the car parks of shopping centres, restaurants and so on. The private sector, sensing an opportunity to make some money from surging EV ownership, is already showing an interest. Dedicated charging firms and carmakers are investing in infrastructure. Oil companies, with Shell to the fore, are putting chargers in petrol stations and buying charging companies. Utilities, which have plenty of electricity to sell, are also starting to sniff around.

Yet the charging business suffers from big problems. One is how to co-ordinate between the owners of charging points, the owners of the sites where they will be installed, planning authorities and grid firms. Another is the cost. According to one estimate, the bill for the chargers needed to reach net-zero by 2050 will be \$1.6trn. To start with, profits may be elusive because the networks will not at first be heavily used. A related risk is that the coverage will have gaps. California is a choice spot for installing chargers, but is anyone keen on investing in Nebraska? And then there is the question of competing networks. Drivers should be able to switch from one to the other without the hassle of having to sign up to them all.

What to do? Governments are experimenting. As well as subsidising EV sales many are throwing cash at public chargers. America’s infrastructure law sets aside \$7.5bn to create 500,000 public stations by 2030. Britain plans to require new buildings to install chargers. Yet the sums are puny and the problems of co-ordination, coverage and convenience will remain.

Governments should learn from telecoms. Most countries auction or issue a limited number of licences or spectrum rights to firms to run regional and national mobile networks. In return the firms have to build networks according to a schedule, offer universal coverage and compete with each other. Regulators set rules to allow roaming between them.

This approach has its flaws. Poorly designed auctions in Europe left firms

with too much debt, and competition has become less intense in America. But in the past two decades the world has marshalled over \$4trn of spending on telecoms infrastructure. And the mobile phone has turned from a shiny object for rich people into something in everyone's pocket. The bright sparks running climate policy should take note. ■

For more coverage of climate change, register for The Climate Issue, our fortnightly newsletter, or visit our climate-change hub ■



【首文】填充缺口

给电动汽车充电这件麻烦事

要建立公共充电网络需要企业和政府共同努力

手握电动汽车方向盘，准备大吃一惊吧。电池动力瞬间就能实现平稳加速，给你轻松而又刺激的驾驶体验。最新的技术触手可及，平板电脑般的屏幕取代了老式的开关。再加上价格的下降让许多电动汽车的拥有和行驶成本都变得跟化石燃料汽车一样便宜，你看到宽广的大路在前方召唤。

只不过你不能去看这拉风外观之下的东西。后备箱中杂乱的线缆提醒你，差不多每行驶250英里（400公里）你就要给汽车充电了。而当你好不容易找到了一个公共充电点，它有时已经损坏了或者不匹配。难怪驾驶者给出的不买电动汽车的一个主要原因就是“里程焦虑”。

如果世界想要有机会实现净零排放目标，就需在全社会实现从碳氢化合物向电子的转变。然而，随着电动汽车愈加普及，充电的问题将变得更加严峻。如今大多数富有的车主通常都能在家或公司给车充电。但是许多没那么富裕的驾驶者自家房前不会有私家车道，也没有老总专用停车库。

到2040年，大约有60%的充电需要在家以外的地方进行，这就需要建造庞大的公共充电站网络。2020年底，全球只有130万个公共充电桩。一些估计显示，要在2050年前实现净零排放，将需要2亿个公共充电桩。

谁可能会来安装它们？驾驶者将既需要快速的“长途”充电桩，也需要较慢的“补充”充电桩；前者安装在高速公路附近，可以快速增加数百英里的续航里程，后者可以在路边或商场、餐馆的停车场里找到。私营部门嗅到了电动汽车保有量激增带来的赚钱机会，已经表现出了兴趣。专门的充电公司和汽车制造商正在投资基础设施。以壳牌为首的石油公司正在加油站安装充电桩，并收购充电公司。手头有大量电力可卖的公用事业公司也开始四处嗅探。

然而，充电业务也受困于一些重大问题。一是如何协调充电桩的所有者、充电桩安装地点的所有者、规划部门和电网公司之间的关系。另一个是成本。根据一项估计，要在2050年前实现净零排放，在充电桩上的投入将需要达到1.6万亿美元。首先，利润可能难以实现，因为充电网络起初并不会被大量使用。一个相关的风险是覆盖面会有缺口。加州是安装充电桩的首选地，但有谁会很想在内布拉斯加州投资呢？还有不同网络间的竞争问题。驾驶者应该能够从一个网络切换到另一个，而不必大费周章注册所有的网络。

那该怎么办？各地政府正在展开试验。除了补贴电动汽车销售，许多政府还在砸钱安装公共充电桩。美国基础设施法拨出了75亿美元，要在2030年前设立50万个公共充电站。英国计划要求新建筑配备充电桩。然而，这些全加起来也还是微不足道，而且协调、覆盖面和便利性的问题仍将存在。

政府应该向电信行业学习。大多数国家向企业拍卖或发行有限数量的许可证或频段使用权，让它们经营区域和国家级的移动网络。作为交换，这些公司必须按照时间表建设网络、提供普遍的覆盖，并相互竞争。监管机构制定规则，让用户能在它们之间漫游。

这种方法也有缺陷。欧洲的拍卖设计不佳，导致企业背负了过多的债务；而在美国，竞争也不再那么激烈。但是在过去的20年里，全世界已经在电信基础设施上投入超过四万亿美元。而手机也从有钱人专属的光鲜玩意变成了人人口袋里都有的东西。那些执行气候政策的聪明人应该记得这一点。





Crowd behaviour

What architects can learn from bull-running

A Spanish tradition offers insight into how crowds behave

EVERY YEAR thousands of people converge on the city of Pamplona, in north-eastern Spain, for the opportunity to run for their lives as six fighting bulls are released to charge through the town. There are dozens of injuries every year, and there have been at least 15 deaths recorded since 1910. But the event is of interest to more than just adrenaline junkies and animal-rights activists. A paper just published in Proceedings of the National Academy of Sciences describes the insight the event offers into the psychology of panicked crowds.

That is a useful topic to explore. Architects, civil engineers and urban planners must try to work out how people will behave in the event of a disaster like a fire, a flood or a terrorist attack so they can design their creations to avoid potentially lethal crushes. Unfortunately, solid information is hard to come by. Ethics-review boards, after all, are likely to frown on researchers putting volunteers into deadly danger simply to study how they might behave. But Daniel Parisi, a physicist and computer scientist at the Technical Institute of Buenos Aires, and the paper's lead author, realised that the Pamplona bull-runs offered the perfect natural experiment.

Dr Parisi and his team went to two different rooftop locations in Pamplona in July 2019, and recorded footage of the runners as the animals were released. A wave of people running at top speed raced past their cameras a few seconds ahead of the bulls. The researchers brought their recordings back to the lab to calculate the velocities of the runners, the density of the crowd and the probability of a runner tripping and falling. They also

examined the trajectories of the bulls, the responses of individual runners as bulls came near to them, and the relationship between runner-group density and velocity.

Perhaps unsurprisingly, the researchers found that runners picked up speed when the bulls drew near. Less expected was the finding that the speed of individual runners increased with the density of the crowd. At the crowd's maximum speed of around four metres per second, density reached roughly one pedestrian per square metre. This finding is at odds with a long-held assumption in architectural and urban-design circles that people will slow their pace as group density goes up, in order to lower the risk of a collision, which could lead to a fall and, perhaps, injury or death as a runner is trampled by others. Dr Parisi's data suggests that groups of fast, crowded runners are indeed at risk: of 20 people who fell, all did so within a fast-moving, dense group. Most (14 of the 20) involved two or more people, with one person tripping another.

Yet it seems that, in the heat of the moment, people pay little heed to the danger of colliding with each other, and do not slow down. The onus therefore falls upon urban designers to work out how best to plan the construction of future alleys, tunnels, bridges and other passages that restrict flow. The only option may well be to make them wider.

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群体行为

建筑师可以从奔牛节中学到什么

西班牙的一项传统活动揭示了群体行为模式

每年都会有成千上万人聚集在西班牙东北部城市潘普洛纳

(Pamplona)，就为等六头公牛出栏后在市内横冲直撞时奔走逃命。每年都会有几十人受伤，自1910年以来至少已有15人丧命。但关注这项活动的不是只有追求刺激的人和动物权益保护者。刚刚发表在《美国国家科学院院刊》(Proceedings of the National Academy of Sciences)上的一篇论文从中解读了恐慌人群的心理状态。

这是个值得探讨的话题。建筑师、土木工程师和城市规划师必须想办法了解发生火灾、洪水或恐怖袭击等灾难时人们的行为模式，做出相应的设计，避免出现可能致命的踩踏事件。可惜，这方面的可靠数据不易获取。毕竟，仅仅为了研究人群行为模式就把志愿者置于致命危险中，很可能受到科研伦理审查委员会的干预。而布宜诺斯艾利斯理工学院

(Technical Institute of Buenos Aires)的物理学家和计算机科学家丹尼尔·帕里西(Daniel Parisi，前述论文的第一作者)意识到，潘普洛纳奔牛节倒是个完美的自然实验。

2019年7月，帕里西率团队来到潘普洛纳，在两处屋顶架起摄像机，记录公牛出栏后人群奔跑的那一刻。只见一群人以高速闪过镜头，仅仅几秒后公牛就紧追而至。研究人员把录像带回实验室，计算出人群的奔跑速度、人群密度及他们绊倒的几率。分析内容还包括公牛的奔跑轨迹、它们逼近时奔跑者的反应，以及奔跑人群密度和速度之间的关系。

研究人员发现，公牛逼近时，奔跑者的速度会加快，这也许在意料之中。而较令人意外的是，他们发现个人奔跑速度会随着人群密度而提高。在人群以约每秒四米的最高速度奔跑时，密度达到了大概每平方米一人。这一发现有别于建筑和城市设计界长期以来的假设，即随着人群密度上升，人

们会放慢步伐，以减低发生碰撞的风险，避免因跌倒被踩踏而致伤亡。帕里西的数据表明，挤在一起快速奔跑确实有风险：摔倒的20人都是身在快速奔跑的密集人群中。大多数（20人中的14人）都是两人或更多人一起摔倒，一个绊倒另一个。

但看起来，在非常恐慌的一刻，人们顾不上相互碰撞的危险，也不会放慢速度。因此，重任就落在了城市设计师们的身上，他们需要寻找最佳方案来规划建设未来的街巷、隧道、桥梁和其他会限制人流的通道。唯一的选择很可能是把它们建得更宽。





On the rails

The economics of a new China-Laos train line

Why connectivity matters

IN THE LATE 1860s, French sailors who had set off from Saigon to find the source of the Mekong river encountered the precipitous Khone Falls between Laos and Cambodia, and realised that the waters would be impassable for larger trading vessels. Their dreams of reaching the riches of southern China by river were dashed. Quixotic plans for rail networks followed, first from British and French imperialists, and then from the Association of South-East Asian Nations (ASEAN), which in 1995 outlined its ambition to connect Singapore with Kunming, in China's Yunnan province.

On December 3rd, at long last, a portion of those aspirations was realised. A high-speed rail line connecting Kunming to Vientiane, the capital of Laos, was opened after five years of construction. The route is part of China's Belt and Road Initiative, and the completed section comes with a hefty price tag of \$5.9bn—equivalent to nearly a third of Laos's annual GDP before the pandemic.

For China, the rationale for closer links with South-East Asia is clear. Rising factory wages at home make the case for moving low-complexity manufacturing to cheaper nearby locations. In 2019 Vietnam was China's fourth-largest trading partner for intermediate goods, between America and India, and up from 15th place a decade ago. China's intermediate-goods trade with Cambodia and Laos has risen nine- and 11-fold, respectively, in the same time.

The strategy has historical precedent. Until the 1970s Japanese firms' main interest in South-East Asia was buying raw materials. Then they began

moving production to the region. The shift took off after the Plaza Accord of 1985, at which Japan agreed to let the yen appreciate, which widened the gap between domestic wages and those in low-cost countries. Firms were able to preserve their competitive advantage by moving, while also fostering technological expertise elsewhere.

What does the new train line mean for Laos? The landlocked country suffers most from South-East Asia's limited connectivity. The World Bank has been cautiously optimistic about the new route: Vientiane, it reckons, could become a logistical hub into China from Thai ports, but only if the Lao customs system were made more efficient and connecting roads improved. Although Laos has a land border with Yunnan and no coastline, as recently as 2016 almost two-thirds of its exports to China were transported via maritime routes.

Other assessments, however, are less optimistic. A paper published by the Asian Development Bank Institute last year suggested that the investment was unlikely to be profitable given its expense. Opinions of the Belt and Road Initiative have soured since 2016, and fears have risen that the infrastructure acts as a debt trap which gives China influence over borrowers. Laos has assumed 30% of the liability for the project, most of the funding for which was borrowed from the Export-Import Bank of China. Nor will the line bring in Chinese tourists for the foreseeable future, given China's zero-covid policy.

A wider network across the region would yield greater economic benefits for everyone, but that is outside any one country's control. Thailand approved the first step of a Chinese-built high-speed line in March; it is intended to reach the Lao border at a later stage. Even the first half is not expected to be completed for five years, however, and such schemes often miss their deadline, if they materialise at all. The Malaysian government is studying a high-speed link to Bangkok, but serious discussion has barely begun. Until

those longer-term benefits arrive, Laos may mainly be stuck with the bill. ■

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走上轨道

中老铁路的经济账

连通为什么很重要

在19世纪60年代末，从西贡出发去寻找湄公河源头的法国水手遇到了位于老挝和柬埔寨之间险峻的孔恩瀑布（Khone Falls），意识到大型商船无法通过这片水域。他们通过水路到达中国南方富裕地区的梦想破灭了。之后是唐吉诃德式不切实际的铁路网计划，首先来自英法的帝国主义者，然后是东盟——它在1995年勾勒了连接新加坡和中国云南省会昆明的蓝图。

终于，在12月3日，这些抱负部分实现了。经过五年的建设，一条连接昆明和老挝首都万象的高铁开通了。这条铁路线是中国“一带一路”倡议的一部分，耗资高达59亿美元——几乎相当于疫情爆发前老挝年GDP的三分之一。

对中国来说，与东南亚建立更紧密联系的理由显而易见。随着国内工人工资不断上涨，将复杂程度低的制造业转移到附近劳动力成本更低的地方就成了合理之举。2019年，越南是中国中间产品的第四大贸易伙伴，排在美国和印度之间，而10年前它还在第15位。同一时期，中国与柬埔寨和老挝的中间产品贸易分别增长了9倍和11倍。

这一策略有历史先例。直到上世纪70年代，日本公司在东南亚主要还只是购买原材料。之后它们开始将生产转移到那里。这一转变始于1985年的《广场协议》（Plaza Accord）。根据该协议，日本同意让日元升值，这扩大了日本国内与低成本国家之间的工资差距。企业可以通过搬迁保持自身竞争优势，还可以在其他地方培育技术能力。

这条新铁路线对老挝意味着什么？东南亚连通性不足对这个内陆国家影响最大。世界银行对这条新铁路线持谨慎乐观的态度：它认为万象可以成为从泰国港口进入中国的物流枢纽，但前提是老挝的海关系统能提高效率，并且与之连接的公路能得到改善。尽管老挝没有海岸线而与云南有陆地接

壤，但直到2016年，它对中国的出口还有近三分之二是通过海上航线运输的。

不过，其他评估却没那么乐观。亚洲开发银行研究所（Asian Development Bank Institute）去年发表的一篇论文表明，考虑到成本之高，这笔投资不太可能盈利。自2016年以来，人们对“一带一路”倡议的看法已趋负面，越来越多人担心这些基础设施会成为债务陷阱，方便中国对借款方施加影响。老挝承担了该项目耗资的30%，其中大部分资金来自中国进出口银行。考虑到中国的疫情“清零”政策，在可预见的未来，这条线路也不会给老挝带来中国游客。

东南亚建立更广泛的交通网络会给各方带来更大的经济效益，但这不是哪一个国家能控制的。今年3月，泰国批准了由中国承建的一条高速铁路的第一阶段项目；在后续阶段这条铁路将延伸到老挝边界。不过即使是前半段，预计五年内也无法完成。而且这类计划往往都会延期完工，甚至根本建不完。马来西亚政府正在研究建设一条通往曼谷的高速铁路，但正式的讨论基本上还没有开始。在那些长期效益到来之前，老挝可能基本上都要对付债务问题了。





Billion-dollar blueprints

A new way of understanding the high but elusive worth of intellectual property

A group of 65 people have each achieved inventions worth \$1bn

IT IS TESTAMENT to human inventiveness that 50m patents are estimated to have been granted globally. But in aggregate much of the collection resembles an intellectual junkyard. Included are plausible ideas that no firm ever wanted to pay for, plausible ideas that fell short, and absurdities. A patent on the crust-less peanut-butter-and-jelly sandwich, for example, failed to be renewed in 2007.

Pare the list to those that are both sensible and in force legally, meaning a fee is paid to a patent office to keep them alive, and there are 16m patents that count. Last year, 1.6m were granted.

Most are the property of companies, but balance-sheets and conventional accounting are ill-suited to capturing their worth. Using acquisition cost, then depreciating it, does not work. Instead, lawyers provide subjective numbers based on factors such as a patent's likely validity, royalties and litigation history. Many firms reckon it is not worth paying the tens of thousands of dollars that it costs for a valuation.

In 2008 an intellectual-property exchange opened in Chicago to do for patents what other bourses did for stocks, bonds and commodities. Its backers were blue-chip firms like Hewlett Packard and Sony, but it closed in 2015. Patents cannot be treated like commodities, said the Cornell Law Review. A subsequent effort to value them used software to read and evaluate the documents. So far, however, not even machine-learning techniques have allowed code to penetrate the opaque legal language in

which patents are couched.

Now a startup called PatentVector, founded by a law professor, an information science professor and a software engineer, is trying something new. It uses a variation of a method started in the 1960s which evolved into tallying up how frequently individual patents are cited (a similar process based on citations is used to evaluate academic research).

Rather than attempting to understand the patent, PatentVector employs artificial intelligence to comb through 132m patent documents kept by the European Patent Office in Munich (the world's biggest collection). Then it evaluates, first, how frequently a patent is cited and, second, how frequently it is cited by patents that are themselves cited frequently. That provides an indication of importance which is then multiplied by a mean value of patents based on an estimate by James Bessen, an economist at Boston University, which has become a reference point. A number of companies, legal firms and institutions (including the Canadian Patent Office) are buying PatentVector's product.

The results contain interesting insights into inventing. Frederick Shelton IV (pictured) does not feature among prominent innovators of the 20th century but he probably should. He works at Ethicon, a medical-devices subsidiary of Johnson & Johnson, and PatentVector values his inventions at a cool \$14bn, placing him aeons ahead of anyone else. His top three are for a mechanical surgical instrument, surgical staples and the cartridge for the staples; in short, tools to cut tissue and bind it up.

Ethicon itself, a medical-device maker, holds 95 of the world's 200 most valuable patents, PatentVector finds. The firm also employs Jerome Morgan, who is listed in second place with \$5bn worth of patents (many overlapping with Mr Shelton's). Only one other person is in the \$5bn club: Shunpei Yamazaki, president of Semiconductor Energy Laboratory, a Japanese

research-and-development firm. Mr Yamazaki's most important patent covers the displays on computers, cameras and other semiconductor devices.

PatentVector found 65 other people each responsible for patents worth in excess of \$1bn. Only 14 of the top 650 tinkerers are women. The highest ranked is Marta Karczewicz, who works for Qualcomm, an American chip designer, and played a vital role in inventing the video-compression technology that makes Zoom and other video services function.

Almost all valuable patents can be found in a few broad industry groups: biopharma, software, computer hardware, medical devices and mechanical equipment. Over the past 40 years the importance of specific categories has marginally expanded and contracted, but biopharma and information technology (IT) have dominated and their significance has grown. The companies with the largest aggregate value of patents are in IT, topped by IBM, Samsung and Microsoft.

PatentVector's figures on the patent holdings of countries are revealing, too. America has the most active patents of any country, at 3.3m, followed closely by China with 3.1m. But there is a world of difference in how frequently they are cited and their imputed value. America's library is calculated to be worth \$2.9trn, compared with China's collection at \$392bn.

Of course, PatentVector's methodology will face scrutiny. Naturally, the startup has patented its own technique. Information about patents, which are critical components of invention, has never been more important. Perhaps it was inevitable that innovation would be applied not only by means of patents, but to them as well. ■

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亿美元蓝图

用新方法解读知识产权那高昂又难以捉摸的价值

有65人各自做出了价值10亿美元以上的发明

全世界迄今估计已经授予了五千万件专利，这是人类创造力的明证。但其中大部分专利总体来看更像是一个知识垃圾场。当中充斥着没有公司愿为之付费的似是而非的点子、看似可行但实际有问题的想法，以及荒唐无稽的念头。例如，一件关于花生酱果冻切边三明治的专利在2007年就没有续期。

把列表清理一番，剩下那些明智合理又有法律效力（也就是向专利局付费来维持存续）的专利共计1600万件。去年一共授予了160万件。

它们大多数属于公司，但资产负债表和传统的会计核算并不适合用来体现其价值。计算获取成本，然后再折旧，这一套是行不通的。相反，律师们会根据专利的可能有效性、专利使用费和诉讼历史等因素给出一个主观数字。许多公司认为不值得花几万美元来给专利估价。

2008年，一家知识产权交易所在芝加哥成立，想要像其他交易所交易股票、债券和大宗商品那样交易专利。它背后有惠普和索尼等蓝筹公司支持，但它却在2015年关闭。《康奈尔法律评论》（Cornell Law Review）称，不能用对待大宗商品的方法来对待专利。后来又有人使用软件来阅读和评估文档，从而给专利估价。然而到目前为止，即使机器学习技术也无法让代码参透那些表述专利内容的晦涩的法律语言。

现在，由一位法学教授、一位信息科学教授和一位软件工程师共同创办的公司PatentVector正在尝试新的思路。它借鉴了一种始于60年代的分析方法，该方法后来演变为用来统计单个专利被引用的频率（评价学术研究成果时也使用类似的引用统计）。

PatentVector没有去试图理解专利，而是使用人工智能来梳理慕尼黑的欧洲专利局（世界上最大的专利库）所保存的1.32亿件专利文件。它首先评估一件专利被引用的频率；然后再评估其他高引用专利对它的引用频率。这就提供了一个有关重要性的指标，然后再乘以一个专利平均价值，这是根据波士顿大学的经济学家詹姆斯·贝森（James Bessen）的估算得出的，现已成为一个参考点。目前已有一批公司、律所和机构（包括加拿大专利局）在购买PatentVector的产品。

它的分析结果中有一些对发明创造的有趣见解。弗雷德里克·谢尔顿四世（Frederick Shelton IV，见图）并未在20世纪的杰出发明家榜上占有一席之地，但他或许本该榜上有名。他在强生的医疗设备子公司爱惜康（Ethicon）工作，PatentVector对他的发明给出了高达140亿美元的估价，遥遥领先于其他任何人。他的前三大专利分别是一种机械外科器械、外科钉合器和钉仓，简而言之就是用来切开和缝合人体组织的工具。

PatentVector发现，在世界上最有价值的200件专利中，医疗器械制造商爱惜康拥有其中的95件。该公司还是杰罗姆·摩根（Jerome Morgan）的东家，此人的专利价值（许多与谢尔顿的专利有重叠）以50亿美元位居第二。另外只有一个人也积累了超过50亿美元的专利价值：日本研发公司半导体能源株式会社（Semiconductor Energy Laboratory）的总裁山崎舜平。山崎最重要的专利涵盖了计算机、照相机及其他半导体设备上的显示装置。

PatentVector发现，另外有65人的专利价值超过10亿美元。在前650名发明家中只有14名女性。其中排名最高的是在美国芯片设计公司高通工作的玛尔塔·卡尔切维茨（Marta Karczewicz），她在发明视频压缩技术方面居功至伟，Zoom等视频服务的运作正是依靠了这种技术。

几乎所有高价值专利都集中在几个行业大类：生物制药、软件、计算机硬件、医疗器械和机械设备。在过去40年里，各个类别的的重要性都会经历轻微的增减变化，但生物制药和信息技术（IT）一直占据主导，且重要性都有所增加。专利总价值最高的企业都在IT行业，IBM、三星、微软位居三

甲。

PatentVector关于各国专利持有情况的数据也很有揭示性。在所有国家中，美国持有的有效专利最多，达到330万件，中国以310万件紧随其后。但在专利被引用的频率及估价上却是天差地别。据估算，美国的专利库价值达2.9万亿美元，而中国的只有3920亿美元。

PatentVector的分析方法必定会受到各方检视。自然，这家创业公司已经为自己的方法申请了专利。作为发明的关键组成部分，关于专利的信息从未如此重要。也许不可避免的是，不仅要通过专利来应用创新，专利本身也需要创新。





Free exchange

Why the demographic transition is speeding up

New research suggests “demographic contagion” could explain falling fertility rates

AS BIRTH ANNOUNCEMENTS go, it was momentous. On November 24th India's government declared that the country's fertility rate had dropped to 2.0 children per woman. That is below the replacement rate—at which new births are sufficient to maintain a steady population—and puts India in the company of many richer economies. Indeed, fertility rates are now below replacement level in all four “BRIC” countries (Brazil, Russia, India and China), with the population probably falling in Russia and China. It is no surprise that emerging economies should follow a demographic trajectory similar to that travelled by rich economies before them. But the pace of change seems to be accelerating, with potentially profound implications for the global economy.

What social scientists refer to as the “demographic transition” has long been an essential feature of economic modernisation. In pre-industrial societies both birth and death rates (annual births and deaths per 1,000 people) were very high, and overall population growth was uneven and slow. But in the 18th century, death rates in parts of north-west Europe began to decline, marking the first stage of a seismic demographic shift. Falling death rates led to rapid population growth; Britain's population roughly doubled between 1760 and 1830. Yet from the late 18th century, fertility rates began to decline as well. By the 20th century, birth and death rates in rich countries stabilised at low levels, leading to slow or even negative population growth in the absence of immigration.

Transitions are complex social phenomena. Falling death rates are easiest to explain, as the product of improved nutrition, medicine and public health.

Falling birth rates are in part a response to economic incentives. As the return to skill increases, for example, families seem to have fewer children in order to invest more in each child's education. But culture matters, too. In a recent paper, Enrico Spolaore of Tufts University and Romain Wacziarg of the University of California, Los Angeles, note that in Europe, new fertility norms first emerged in France in the late 18th and early 19th century. The fashion for fewer births was probably rooted both in changes in outlook associated with secularism and the Enlightenment and in the spread of information about family planning. As birth rates fell across Europe, they did so faster and earlier in places with linguistic and cultural ties to France.

Demographic transitions today follow fairly similar patterns, reckon Matthew Delventhal of Claremont McKenna College, Jesús Fernández-Villaverde of the University of Pennsylvania and Nezih Guner of the Universitat Autònoma de Barcelona, in another new paper. The authors gather data on 186 countries, and find that all but 11 have experienced the transition to lower, more stable death rates that are well below pre-industrial norms. A bevy of about 70 countries began their transition towards low fertility rates between 1960 and 1990. Only one country—Chad—has yet to begin a fertility transition. (In 80 countries, both mortality and fertility shifts towards modern lows are now complete.)

Importantly, the pace at which countries undergo a demographic transition seems to have sped up. While Britain's transition unfolded in a leisurely fashion between the 1790s and the 1950s, Chile's occurred more briskly between the 1920s and the 1970s, and those begun towards the end of the 20th century have taken only a few decades. This acceleration seems at least partly to reflect what the authors call "demographic contagion", or the fact that transitions occur sooner and faster where geographically and culturally proximate places have already undergone a fertility shift. This proximity effect may also mean transitions now start at lower income levels. Whereas fertility transitions over the past two centuries tended to begin at

GDP per person of about \$2,700 (on a purchasing-power-parity basis and in 2011 prices), those begun since 1990 occurred at an income level of around \$1,500.

The upshot of this rush into the demographic transition is a steady drop in global fertility and population growth. The world's fertility rate, which stood at 3.5 births per woman in the mid-1980s, fell to just 2.4 in 2019. Indeed it is possible, given observed declines in rich-world births during the pandemic, that covid-19 may have pushed the world as a whole within sight of a replacement-level fertility rate, if only temporarily. The world's population will continue to grow even after that level is attained, because of the large number of people either at or approaching child-rearing age. India's population, for example, is still expected to rise to about 1.6bn by mid-century. But that is a lower peak (by about 100m people) reached sooner (by about a decade) than previously expected. Similarly, the rapid decline in global fertility may mean that projections by the UN, which show the global population rising towards 11bn by 2100, will ultimately have to be revised downwards.

The global completion of the demographic transition will not be without its headaches. It may complicate long-run macroeconomic problems, for example, or so suggests recent work by Adrien Auclert and Frédéric Martenet of Stanford University, Hannes Malmberg of the University of Minnesota and Matthew Rognlie of Northwestern University. They note that increased saving by ageing populations depresses inflation and interest rates. As the share of world population over 50 rises from 25% today to 40% in 2100, low interest rates may become more entrenched, returns on assets could drop and global imbalances widen.

Yet demographic transitions could also bring a range of economic benefits. Slower population growth could make the challenge of cutting carbon emissions less daunting. And the potential of the fewer workers around

might be better realised, through better education and more women participating in the labour force. The arrival of immigrants, once viewed as a threat, could even become as momentous an occasion as a birth in the family. ■

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自由交流

人口转型为何加速

新研究表明“人口结构传染”或许可以解释生育率的下降

论出生公告，这一条极为重要。11月24日，印度政府宣布，印度的生育率已降至2.0，也就是平均每名妇女生育两个孩子。这个数字低于人口更替率（即新生儿数量足够让人口保持稳定的生育率），让印度进入了许多更富裕经济体的行列。事实上，“金砖四国”（巴西、俄罗斯、印度和中国）的生育率现在都低于人口更替率，俄罗斯和中国的人口可能正在下降。新兴经济体的人口发展进程与富裕经济体经历过的轨迹相似，这一点不令人意外。但这种变化似乎正在提速，可能会对全球经济产生深远影响。

长期以来，社会科学家所说的“人口转型”一直是经济现代化的一个基本特征。在前工业化社会，出生率和死亡率（即每千人每年的出生和死亡数）都很高，总体人口增长不均衡且缓慢。但在18世纪，西北欧部分地区的死亡率开始下降，标志着人口结构巨变的第一阶段来临。死亡率下降导致人口快速增长，从1760年到1830年，英国人口大约翻了一番。然而从18世纪后期开始，生育率也开始下降。到了20世纪，富裕国家的出生率和死亡率都稳定在较低水平，在没有移民补充的情况下，人口增长缓慢，甚至出现负增长。

人口转型是复杂的社会现象。死亡率的下降最容易解释，这是营养、医疗和公共卫生改善的结果。出生率下降的原因之一是经济激励。例如，随着技能取得的回报上升，家庭似乎会少生孩子以增加对每个孩子的教育投入。但文化也很重要。在最近的一篇论文中，塔夫茨大学（Tufts University）的恩里克·斯波劳雷（Enrico Spolaore）和加州大学洛杉矶分校的罗曼·瓦奇亚格（Romain Wacziarg）指出，在欧洲，新的生育常态首先出现在18世纪末和19世纪初的法国。少生孩子的风气可能源自两方面的变化，即人生观受到了世俗主义和启蒙运动的影响，以及节育信息传播开来。当整个欧洲的出生率都在下降的时候，在与法国有语言和文化联系的

地方生育率下降得更快、更早。

如今的人口转型遵循着非常相似的模式，克莱蒙特麦肯纳学院（Claremont McKenna College）的马修·德温莎尔（Matthew Delventhal）、宾夕法尼亚大学（University of Pennsylvania）的赫苏斯·费尔南德斯-比利亚韦德（Jesús Fernández-Villaverde）和巴塞罗那自治大学（Universitat Autònoma de Barcelona）的内兹·古纳（Nezih Guner）在另一篇新发表的论文中指出。三位作者收集了186个国家的数据，发现除11个国家外，其他国家都经历了死亡率降低、趋稳的变化，达到远低于工业化前的水平。1960年到1990年间，约70个国家开始了向低生育率的转变。到现在只有乍得这一个国家尚未开始生育率转变。在80个国家，死亡率和生育率都已完成向现代低水平的转变。

重要的是，各国人口转型的速度似乎加快了。英国的转型在18世纪90年代到上世纪50年代间慢悠悠地推进，智利的转型在上世纪20年代到70年代间更迅速地发生，而那些从上世纪末开始的转型只用了短短几十年。这种加速似乎至少在一定程度上反映了论文作者所说的“人口结构传染”：如果一个地方经历了生育率转变，那么其他与之在地理和文化上相近的地方也会更早、更快地发生转型。这种邻近效应可能还意味着如今人口转型在收入水平较低时就开始启动。在过去两个世纪里发生的生育率转变往往在人均GDP约为2700美元（按购买力平价和2011年物价水平计算）时启动，而自1990年以来开始的生育率转变发生在收入水平约为1500美元之时。

人口转型加速的结果是全球生育率和人口增长稳步下降。上世纪80年代中期，全球平均每名妇女生育3.5个孩子，到2019年下降到仅2.4个。事实上，鉴于新冠疫情期间在富裕世界可观测到的生育率下降，疫情可能推动了全球生育率向人口更替率的水平靠近，即便只是暂时的。即使在生育率真的降到这一水平之后，世界人口仍将继续增长，因为还有大量人口仍处于或接近生育年龄。例如，预计到本世纪中叶，印度人口仍将增至16亿左右。但与先前的预计相比，这个峰值要更低（少了约1亿人），达到的时间也更早（早了约10年）。同样，全球生育率迅速下降可能意味着联合国最终将不得不下调人口增长预测，它之前预计全球人口到2100年将增至

110亿。

全球人口转型的完成将带来棘手的问题。例如，它可能会让长期宏观经济问题更加复杂，斯坦福大学的阿德里安·奥克勒（Adrien Auclert）和弗雷德里克·马太奈（Frédéric Martenet）、明尼苏达大学的汉内斯·马尔姆贝里（Hannes Malmberg）和西北大学的马修·荣利（Matthew Rognlie）最近的一项研究表明。他们指出，人口老龄化会让储蓄增加，进而抑制通胀和利率。全球50岁以上人口所占比例将从现在的25%上升到2100年的40%，低利率局面可能会更加牢不可破，资产回报率可能会下降，全球失衡也会扩大。

然而，人口转型也可能带来一系列经济上的好处。人口增长放缓可能会让减少碳排放的挑战变得没那么艰巨。通过提升教育和让更多女性进入劳动力市场，虽然总劳动人口减少，他们的潜力却可能更好地发挥出来。移民曾被视为威胁，在未来，他们的到来甚至可能会和家里新生儿的诞生一样，成为一件大事。





Demography

An ageing country shows others how to manage

Japan has aged faster than anywhere else, but it is learning how to cope

EVER SINCE 1495 residents of Gojome, a town in northern Japan, have gathered for a morning market. On a recent weekday, along a street of closed shops with almost no people, elderly sellers lay out their autumnal wares: mushrooms and chestnuts, okra, aubergines and pears. It was not always so empty, sighs Ogawa Kosei, who runs a bookshop on the street. He points to pictures his father took that show the scene packed with shoppers.

The population of Gojome has shrunk by half since 1990. More than half its residents are over 65, making it one of the oldest towns in Akita, the oldest prefecture in Japan, which is in turn the world's oldest country. Yet Gojome is less an outlier than a portent. According to the UN, every country is experiencing growth in the size and proportion of its elderly population; by 2050 one in six people in the world will be over 65, up from one in eleven in 2019. The UN also projects that 55 countries, including China, will see their populations decline between now and 2050.

Demographic change has two drivers often lumped together: rising longevity and a falling birth rate. Their convergence demands “a new map of life”, says Akiyama Hiroko, founder of the University of Tokyo’s Institute of Gerontology. Infrastructure created when the population was younger and the demographic pyramid sturdier must be redesigned, from health care to housing to transport. The new reality demands a “completely different way of thinking”, says Kashiwa Kazuyori, head of Gojome’s town-planning department. When he started work in the 1970s, the focus was on growth. Now it is about managing decline.

Part of the challenge is that demographic change affects everyone differently. Two towns or regions may look similar from a distance, but have distinct historical, cultural and environmental conditions; two individuals may be the same age, make the same money and live on the same street, yet have different mental and physical health. “We often miss the context,” says Kudo Shogo of Akita International University. He is one of scores of young outsiders who have been welcomed to Gojome, which was a trading hub at the crossroads of farm districts. Comparable farm-focused neighbours have been less open to incomers.

That makes designing national policy difficult. “There’s not a one-size-fits-all model,” says Iio Jun, a political scientist at GRIPS. While the national government is responsible for finance, including pensions, the new map of life is best drawn from the ground up. Many ideas come from listening to citizens, says Ms Akiyama. “They know what the issues are—and many times they know how to solve them.”

One issue is how ageing is discussed: as a problem or a burden. “Older people feel they’re not needed by society,” laments Hatakeyama Junko, the 70-year-old head of Akita Partnership, a non-profit that manages a community centre. Longevity is not itself a problem—it should be celebrated. The problems arise when people live long but unhealthy, lonely, or dependent lives. The goal in Japan has shifted from increasing life expectancy to enhancing the “healthy, autonomous life expectancy”, says Ms Akiyama.

This means finding ways for old people to keep working. Nearly half of 65- to 69-year-olds and a third of 70- to 74-year-olds have jobs. Japan’s gerontological society has called for reclassifying those aged 65-74 as “pre-old”. Ms Akiyama speaks of creating “workplaces for the second life”. But the work of the second life will differ from that of the first; its contribution may

not be easily captured in growth statistics. “We have to seek well-being, not only economic productivity,” Ms Akiyama says. Experiments abound, from municipalities that train retirees to be farmers, to firms that encourage older employees to launch startups. The elderly “want dignity and respect”, says Matsuyama Daiko of the Taizo-in temple in Kyoto, which has a “second-life programme” that offers courses for retirees to retrain as priests.

The other key is staying healthy, physically and mentally. Wiser municipalities focus on preventive care. At the Kadokawa Care Centre, a sleek facility in a former school in Toyama, north-west of Tokyo, septuagenarians, octogenarians and nonagenarians splash through a swimming pool and pump away at exercise machines. “If not for this place, I’d be in a nursing home,” gushes Kyoda Taketoshi, an 82-year-old. The socialisation is no less important. “It cost a lot to build this place, but it was worth it,” says Saito Yoneaki, 80, before skipping off to join friends in the sauna. Although Japan’s healthy life expectancy trails overall life expectancy by eight to 12 years, the gap fell slightly between 2010 and 2016.

Gojome is a good example. Although the population has been shrinking, “a new wind is blowing in the town”, says Watanabe Hikobe, its mayor. Over the past decade a small group of young outsiders has arrived, drawn by visions of a slow, bucolic life, and the chance to try new models of untethered work and communal living. Yanagisawa Ryu, a 34-year-old with a computer-science degree from Japan’s leading university, ditched his job in Tokyo and became a “social entrepreneur”. He oversees Babame Base, a business hub in an empty school in Gojome that hosts a graphic-design studio, an ecotourism outfit, a local doctor and a firm that trains farmers to use drones, among others.

Such “urban migrants” are still a relative rarity. Mr Yanagisawa admits his university friends find his lifestyle choices “weird”. But in many ways, they are the vanguard. “Rather than trying to recreate the past, we have to think:

what kind of community, what kind of town do we want now?" says Mr Kudo. They are not the only outsiders moving in. ■



人口构成

一个老龄化国家向其他国家展示如何管理

日本比其他任何地方都老得更快，但它正在学习如何应对

自1495年以来，日本北部小镇五城目的居民都会去早市赶集。在最近的一个工作日，在一条商店关闭、几乎空无一人的街道上，上了年纪的店家们展示着他们的秋季商品：蘑菇和栗子、秋葵、茄子和梨。以前不是这么空的，在街上经营一家书店的小川光世（音译）感叹道。他指着他父亲拍的照片，照片上挤满了购物者。

自1990年以来，五城目的人口减少了一半。镇上一半以上的居民超过65岁，这让它成为日本这个世界上最高龄的国家里的最高龄的秋田县中最高龄的城镇之一。然而，与其说五城目是个异类，不如说是一种预兆。据联合国称，每个国家的老年人口规模和比例都在增长；到2050年，世界上六分之一的人口将超过65岁，而2019年这一比例为十一分之一。联合国还预计，从现在到2050年，包括中国在内的55个国家的人口将下降。

人口变化有两个常常叠加在一起的驱动因素：寿命增长和出生率下降。东京大学老年学研究所的创始人秋山弘子说，两者的融合要求“一张新的生活地图”。从医疗到住房再到交通，那些在人口更年轻、人口金字塔更坚固时创建的基础设施必须重新设计。五城目的城市规划部门负责人柏和顺说，新的现实需要一种“完全不同的思维方式”。当他在70年代开始工作时，重点是增长。现在则是管理衰退。

挑战有一部分在于人口变化对每个人的影响不同。两个城镇或地区远看可能差不多，但却有不同的历史、文化和环境条件；两个人可能同岁，赚同样多的钱，生活在同一条街上，身心健康状况却不同。“我们经常忽略了背景。”秋田的国际教养大学的工藤尚悟说。五城目是位于农业区交汇处的贸易枢纽，而他是几十个被欢迎来到这里的年轻外来者之一。附近类似的重农业城镇就不那么欢迎外来者了。

这使得制定国家政策变得困难。“没有一种万能模型。”日本政策研究大学院大学（GRIPS）的政治学家饭尾淳说。虽然中央政府负责包括养老金在内的财政，但新的生活地图最好是从底层开始绘制。秋山弘子说，很多主意都来自听取市民的意见。“他们知道问题是什么——而且很多时候他们知道如何解决这些问题。”

一个问题是是如何讨论老龄化——是把它当做议题还是负担。“老年人觉得社会不需要他们。”管理着一个社区中心的非营利组织秋田合伙企业（Akita Partnership）70岁的负责人畠山順子感叹道。长寿本身不是问题——它应该被庆祝。但当人们长寿，生活却不健康、孤独或依赖他人时，问题就出现了。秋山弘子说，日本的目标已经从提高预期寿命转向提高“健康、自主的预期寿命”。

这意味着要想办法让老年人继续工作。65至69岁人群的近一半、70至74岁人群的三分之一有工作。日本老年学会呼吁将65至74岁的人重新归类为“准老人”。秋山弘子谈到创造“第二次生命的工作场所”。但是第二次生命的工作将与第一次不同，它的贡献可能不容易在经济增长数据中体现出来。“我们必须寻求福祉，而不仅仅是经济生产力。”秋山弘子说。实验比比皆是，有的市培训退休人员务农，一些企业鼓励年长员工创办新公司。京都退藏院的松山大耕说，老年人“想要尊严和尊重”，该寺有一个“第二人生计划”，为退休人员提供再培训为住持的课程。

另一个关键是保持身心健康。明智的市镇专注于预防保健。角川护理中心是在东京西北向富山市一个学校旧址中建起的时尚设施，七旬乃至九旬老人在游泳池里来回，在健身器材上挥汗。“如果没有这个地方，我会住在疗养院里。”82岁的许田武俊（音译）对此赞不绝口。社交同样重要。“建这个地方花了很多钱，但值得。”80岁的斋藤米秋（音译）边说着边赶着和朋友们一起去蒸桑拿了。虽然日本的健康预期寿命比整体预期寿命低8至12岁，但差距在2010年至2016年间略有缩小。

五城目就是一个很好的例子。镇长渡边彦兵卫说，尽管人口一直在减少，

但“镇上正在吹拂新风”。过去十年里，一小群外来年轻人来到这里，他们憧憬着慢节奏的田园生活，也被尝试自由工作和集体生活新模式的机会吸引。34岁的柳泽龙拥有日本一流大学的计算机科学学位，他辞去了东京的工作，成为了一名“社会企业家”。他负责管理Babame Base，这是在五城目一所空置的学校中建起的商业中心，里头进驻了平面设计工作室、生态旅游机构、本地医生和培训农民使用无人机的公司等。

这样的“城市移民”目前还是比较少见的。柳泽龙承认，他的大学朋友觉得他的生活方式选择“很奇怪”。但在很多方面，他们都是先锋。“与其试图重现过去，我们必须思考：我们现在想要什么样的社区，什么样的城镇？”工藤尚悟说。他们不是唯一搬进来的外来者。 ■



Ageing creatively

What the world can learn from Japan

The oldest big country has lessons for those that will soon age and shrink

TWO TALES are often told about Japan. The first is of a nation in decline, with a shrinking and ageing population, sapped of its vitality. The second is of an alluring, hyper-functional, somewhat eccentric society—a nice place to eat sushi or explore strange subcultures, but of little wider relevance to the outside world. Both tales lead people to dismiss Japan. That is a mistake.

As our special report this week argues, Japan is not an outlier—it is a harbinger. Many of the challenges it faces already affect other countries, or soon will, including rapid ageing, secular stagnation, the risk of natural disasters, and the peril of being caught between China and America. The fact that some of these problems hit Japan early makes it a useful laboratory for observing their effects and working out how to respond.

One lesson is that societies must learn to live with risk. As the climate changes and natural hazards proliferate, countries must be able to bounce back from shocks. Painful experience has led Japan to invest in resilience. Bridges and buildings are retrofitted to make them earthquake-proof. After a big quake hit Kobe in 1995, leaving many without water, the city built an underground system to store 12 days' supply for residents.

Many Japanese people understand that responding to disasters is everyone's problem, not just the state's. That has helped during the pandemic: mask-wearing has been virtually universal. Among G7 countries, Japan has the lowest death rate from covid-19 and the highest rate of double-vaccination.

Another lesson is that demography matters. Most societies will ultimately age and shrink like Japan. By 2050, one in six people in the world will be

over 65 years old, up from one in 11 in 2019. The populations of 55 countries, including China, are projected to decline between now and 2050. Recent data suggest India will shrink sooner than expected.

Like climate change, the demographic sort is vast, gradual and seems abstract—until it is not. And like climate change, it will demand a transformation both of institutions and of individual behaviour. Remaining active for longer is essential. The Japanese government urges firms to keep staff until they are 70. Many stay on: 33% of 70- to 74 -year-olds now have jobs, up from 23% a decade ago.

Demographic change brings big economic challenges. Japan owes its sluggish growth in large measure to its shrinking population. If you look at the well-being of individual Japanese people, however, the picture is far rosier. In the decade from 2010 to 2019, Japan enjoyed the third-highest average rate of GDP growth per head in the G7, behind only Germany and America.

Japan is a major creditor and the third-largest economy at current exchange rates. Its people live longer than the citizens of any other country. It is home to the biggest technology investor on the planet, a pioneering 5G firm, and a host of global brands, from Uniqlo to Nintendo. Expertise in robots and sensors will help its firms make money from a wide range of new industrial technologies. Geopolitically, Japan plays a pivotal role between China, its largest trading partner, and America, its key security partner. It should not, in short, be a global afterthought.

Japan's mistakes offer another set of lessons. Living with lots of risk makes setting priorities harder. In the face of so many potential hazards, Japan took its eye off climate change, the greatest ongoing disaster of all. In 2020 it at last pledged to reach net-zero carbon emissions by 2050, but the details are sketchy. Politicians pin their hopes on restarting nuclear plants mothballed

after the Fukushima meltdown in 2011; this is unlikely as long as the public overestimates the dangers of nuclear power. Many bureaucrats, meanwhile, remain stubbornly sceptical of renewable energy. So Japan keeps burning coal, the filthiest fuel.

One way to cope with a shrinking population is to get the most out of people. Japan will never live up to its potential while so many of its highly educated citizens are denied the chance to live up to theirs. Seniority-based promotion at traditional companies, combined with excessive deference to grey hairs, silences young voices and stifles innovation. That is why many of the brightest new graduates prefer to work for startups. Japan has done a good job of getting more women into the workforce in recent years, but they still have too few chances to rise. A dual-track labour system traps young people and women in precarious part-time jobs (which, among other things, makes them less keen to have children).

Politicians tolerate all this in part because they feel little pressure to do otherwise. The Liberal Democratic Party has remained in power almost uninterrupted since 1955, thanks to a pathetically weak opposition. Senior figures, typically old men from political dynasties, are more conservative than the public they supposedly represent. For the public, in turn, today's comfort dulls the impulse to press for a brighter tomorrow. Japan's final lesson is about the danger of complacency. ■



有创造力地老去

世界可以从日本学到什么

这个最高龄的大国为那些即将衰老和萎缩的国家提供了经验教训

关于日本，人们常常会讲述两套故事。第一套是关于一个衰落的国度，其人口日益萎缩老迈，活力不再。第二套说的是一个魅惑的、高速运转又有点古怪的社会——一个吃寿司或探索奇特亚文化的好地方，但它与外部世界没什么更多的关联。两个故事都让人觉得日本无关紧要。而这是错的。

正如我们本周的专题报道所指出的那样，日本并不是局外人——而是先行者。它面临的许多挑战已经或很快就会影响到其他国家，包括快速老龄化、经济长期停滞、自然灾害的风险，以及夹在中美两国之间的危险。一些问题早早地袭击了日本，这使它成为观察相关效应并研究应对方法的一个有用的实验室。

一个教训是社会必须学会与风险共存。随着气候变化和自然灾害激增，各国必须能从冲击中恢复过来。痛苦的经历促使日本投资于复原力。桥梁和建筑物都被翻新以加强抗震。1995年神户发生大地震导致大批人断水后，该市建立了一个地下蓄水系统，为市民储存12天的用水。

许多日本人都明白应对灾难不仅仅是国家面对的问题，也是每个人的责任。这种意识在新冠疫情期间就发挥了作用：在日本几乎人人戴口罩。在G7集团国家中日本的新冠肺炎死亡率最低，完成两剂疫苗接种的比率最高。

另一个教训是人口结构的重要性。大多数社会最终都会像日本那样老化并萎缩。到2050年，世界上六分之一的人口将超过65岁，而2019年时这一比例为十一分之一。预计从现在到2050年，包括中国在内的55个国家的人口将缩减。近期数据表明，印度人口开始萎缩的时间会比预期更快。

和气候变化一样，人口结构的变化是庞大而渐进的，似乎只存在于抽象层

面——直至其影响实实在在显现。也同气候变化一样，它将需要社会制度和个人行为都做出改变。让每个人保持更长久的社会活跃度至关重要。日本政府敦促企业让员工工作到70岁。许多人留在岗位上：现在70至74岁人群中33%有工作，而十年前为23%。

人口变化带来了巨大的经济挑战。日本经济滞涨在很大程度上是缘于人口减少。然而，如果你看看日本人个体的福祉，情况就要好得多。2010年到2019年的十年间，日本人均GDP增速在G7国家中位居第三，仅次于德国和美国。

日本是一个大债权国，也是按当前汇率计算的世界第三大经济体。其民众比任何其他国家的公民都更长寿。日本拥有全球最大的技术投资方、一家5G先驱公司，以及从优衣库到任天堂等众多全球品牌。机器人和传感器方面的专业技术将帮助日本企业从广泛的新工业技术中获利。在地缘政治上，日本在它的最大贸易伙伴中国和首要安全伙伴美国之间扮演关键角色。简言之，它不应该是地球上被轻视的角落。

日本的错误提供了另一套教训。生活在大量风险中让确定优先项变得更困难。面对如此多的潜在危害，日本的注意力从气候变化这一进行中的最大灾难上移开了。2020年它终于承诺到2050年实现净零碳排放，但尚未明确细节。政客们寄希望于重启在2011年福岛核事故后被搁置的核电站项目。但只要公众夸大核能的危险，这就不太可能发生。与此同时，许多官僚对可再生能源仍然顽固地抱持怀疑态度。所以日本还在继续燃烧煤炭这种最肮脏的燃料。

应对人口减少的一种方法是充分利用人们的潜力。当大量受过高等教育的公民被剥夺充分发挥自身潜力的机会时，日本永远也发挥不了这个国家的潜力。传统公司基于资历晋升员工，加上过度尊崇老年人，压制了年轻人的声音，扼杀了创新。这就是为什么许多最聪明的应届毕业生更喜欢去创业公司。近些年，日本在让更多女性进入劳动力市场方面做得很不错，但她们晋升的机会仍然太少。双轨劳动制把年轻人和女性卡在不稳定的兼职工作中（这一点再加上其他一些原因，导致他们更不想生育孩子了）。

政客对这一切听之任之，部分原因是他们没什么压力要去寻求改变。由于反对派的势力小得可怜，自1955年以来自民党几乎不间断地连续执政。高层官员——通常都是来自政治王朝的老年男性——比他们本应代表的公众更加保守。反过来，对于公众来说，今天的舒适削弱了要求一个更美好的明天的冲动。日本的最后一课是安于现状的危险。■



Hidden danger

China's property slowdown sheds light on another worrying debt problem

Local-government financing vehicles, not just developers, are saddled with lashings of debt

WHEN OFFICIALS in the southern city of Liuzhou began a routine auction of parcels of land in June, they found few takers. Only one of five plots received a bid; the rest went unsold. As in many cities across China, a downturn in the property market has meant less demand for the land on which apartment towers are built.

That is bad news for local governments, which rely on the sales for the bulk of their revenues. It is also a troubling sign for the holders of bonds issued by local-government financing vehicles (LGFVs), the half-public, half-corporate concoctions that have become a cornerstone of Chinese development. Cities' land-sale revenues are often used to repay these bonds. After the auctions flopped in Liuzhou, rating agencies downgraded two of the city's LGFVs on fears that the government would struggle to service their debts.

LGFVs are one of China's oddest financial innovations. In the mid-1990s the central government implemented budget laws to stop local bureaucrats building up massive debts. In response, regional governments crafted LGFVs as a workaround. The vehicles, which number in the thousands, became important drivers of economic growth, helping build bridges, homes and roads. They also became one of China's biggest kinds of liabilities, building up some 53trn yuan (\$8.3trn, or 52% of GDP) in onshore and offshore debts, according to Goldman Sachs, a bank. Although such borrowing does not appear on public balance-sheets, local authorities are responsible for paying it back. The runaway debts now threaten to throw the financial system into

turmoil.

The central government has spent years trying to reform China's shadow financial system, but debts that are hidden off balance-sheets have been slow to shrink. Take shadow banking, for instance. Although it has declined as a share of banking-system assets, outstanding shadow loans remain high, at 57.6trn yuan at the end of September. Similarly, a municipal-bond market now lets cities and provinces raise funds. Yet LGFV debts at the end of 2020 still exceeded outstanding central and local government bonds combined.

Many LGFVs make meagre earnings on the bridges, roads and water systems they build. Officials used to be able to make up the shortfall with land-sale revenues, but this is becoming harder. In a round of sales this year for 22 of China's biggest cities, the premium fetched on parcels was just 4.7% above the government's reserve price, compared with 16.7% earlier in the year, according to Enodo Economics, a research firm. The default of Evergrande, a developer with \$300bn in liabilities, and wider malaise in the property industry means demand for land could continue to suffer. New home prices fell for a third consecutive month in November, according to figures published on December 15th.

No LGFV has yet defaulted on a bond. But many market-watchers, such as Larry Hu of Macquarie, a bank, believe it is only a matter of time. The vehicles will face repayments of offshore bonds of \$32.2bn in 2022, up from \$26.9bn in 2021, reckons Nomura, a Japanese bank. Many of them issue short-term debt simply to pay off other maturities. Guangxi Liuzhou Dongcheng, an LGFV that was downgraded by S&P, a rating agency, in October, had 25.7bn yuan (\$4bn) in short-term maturities, for instance. An average of 60% of LGFV bond issuance has gone not to new growth-generating projects but towards paying off maturing debts in 2020 and 2021.

Many local governments appear to be preparing for a financial storm.

Liuzhou has used an estimated 20bn yuan in public funds to make up a capital shortfall at Dongtong Investment and Development Group, a vehicle that was downgraded in August by Fitch, another rating agency. An LGFV in the city of Chongqing defaulted on bankers' acceptance bills in March. Subsidiaries of a provincial vehicle in Guangxi have gone bankrupt. Provincial governments in Jiangsu and Yunnan have issued guidelines calling for collapsing LGFVs to go into formal bankruptcy instead of being hidden under more debt.

Such reforms will not come easily. The value of onshore LGFV bonds stood at 11.9trn yuan in June, six times those issued by developers and a tenth of China's onshore-bond market (see chart). A slight shift in sentiment towards the government's implicit guarantee for LGFVs could roil markets. This was highlighted by the caution around "Document No. 15", an internal circular issued by the banking regulator in July, which told lenders to cut access to working-capital loans for some LGFVs. If upheld, the new rules could have caused a cash crunch for the vehicles—similar to the squeeze that brought down Evergrande. But they were quickly abandoned. Letting LGFVs fail is a line the central government is not yet willing to cross.

The situation illustrates the market-distorting power of missed reforms. Many other sectors, such as property and non-core state-owned enterprises, are no longer seen as backed by the central government. The fact that the authorities did not decisively end their implicit support for LGFVs earlier this year has led many asset managers in China to consider them safe. LGFV bond yields have fallen towards those on government bonds. Funds have poured in. "They are becoming a haven," says Mr Hu. They should be anything but. ■



隐藏风险

中国楼市放缓引出又一个令人忧虑的债务问题

不仅仅是开发商，地方政府融资平台也债台高筑

南方城市柳州今年6月举行了一次例行土地拍卖，但应者寥寥。五宗地块中只有一宗成交，其余全部流拍。与在中国各地的许多城市发生的一样，房地产市场下滑已经使得对住宅用地的需求减少。

这对地方政府来说是个坏消息，毕竟它们的大部分收入都依赖卖地。对于地方政府融资平台发放债券的持有人来说，这也是个令人忧心的信号。这些半公共、半企业性质的平台已成为中国发展的基石。它们的债券通常用所在城市的卖地收入来偿付。在柳州的土拍流拍后，评级机构降低了对该市两个融资平台的评级，担心当地政府难以偿还它们的债务。

地方政府融资平台是中国最奇特的金融创新之一。上世纪90年代中期，中央政府实施了预算法规以防止地方政府大量举债。作为对策，地方政府炮制出了融资平台。成千上万的这类平台为桥梁、房屋和道路建设融资，成为驱动中国经济增长的重要力量。它们也成为中国最大的负债者之一，高盛的数据显示它们积累了约53万亿元（相当于中国GDP的52%）的在岸和离岸债务。尽管这些借款没有列入公共资产负债表，但地方政府负有偿付责任。如今，这些失控的债务威胁到整个金融系统的稳定性。

中央政府多年来一直在努力改革国内的影子金融系统，但隐藏在资产负债表以外的债务迟迟未能缩减。以影子银行为例，尽管它在银行系统资产中所占的份额有所下降，但未偿还的影子贷款数额仍然庞大，截至9月底为57.6万亿元。同样，现在各省市政府可以通过市政债券市场融资。然而在2020年底，地方政府融资平台的债务依然超过中央和地方政府未偿还债券的总和。

许多地方政府融资平台从投资建造的桥梁、道路和供水系统中获得的收益微薄。政府以往可以靠卖地收入弥补缺口，但现在这变得更难了。研究公

司伊诺多经济（Enodo Economics）的数据显示，在今年中国22个最大城市的一轮土拍中，拍卖溢价仅比政府底价高出4.7%，而今年更早时候溢价还有16.7%。负债3000亿美元的开发商恒大出现违约，加上房地产行业普遍萎靡不振，意味着土地需求可能持续走低。12月15日公布的数据显示，新房价格在11月连续第三个月下降。

目前还没有出现地方政府融资平台债券违约的情况。但麦格理银行（Macquarie）的胡伟俊等不少市场观察人士认为这只是时间问题。据日本投行野村证券估计，这些平台在2021年须偿付269亿美元的离岸债券，而到2022年将上升至322亿美元。其中许多平台发行短债不过是为了偿还其他到期债务。例如，10月被评级机构标普下调评级的广西柳州市东城投资开发集团就有257亿元的快到期债务。地方政府融资平台发行的债券平均有60%并不是为能推动增长的新项目融资，而是用于偿还2020年和2021年的到期债务。

许多地方政府似乎正在为一场金融风暴做准备。柳州已调用约200亿元公共资金来弥补东通投资发展有限公司的资本缺口，该公司在8月被另一家评级机构惠誉下调评级。今年3月，重庆市的一家地方政府融资平台出现银行承兑汇票违约。广西一家省级政府融资平台的子公司宣告破产。江苏和云南省政府发布意见，要求失去清偿能力的地方政府融资平台依法实施破产，而非隐藏在更多债务之下。

这样的改革不易实施。6月的在岸地方政府融资平台债券存量达11.9万亿元，是房地产开发商债券的六倍，占中国在岸债券市场的十分之一（见图表）。认为政府为地方政府融资平台提供隐性担保的看法稍有变化都会引致市场大乱。这从围绕银保监会“15号文”的审慎行动可见一斑。这份内部文件在7月发布，要求贷款机构收紧对部分地方政府融资平台的流动资金贷款。如果真的执行了，这些平台可能已经发生现金危机——类似的资金紧缩导致恒大陷入崩溃。但新规很快就被搁置了。任由这类平台破产仍是中央政府不愿跨越的一道线。

这种局面显示了错失改革对市场造成的扭曲。现在，许多其他部门都不再被认为有中央政府的背书，比如房地产和非核心国有企业。官方没有在今年早前果断终止对地方政府融资平台的隐性支持，导致中国许多资产经理认为这些平台是安全的。地方政府融资平台债券的收益率已降至接近政府债券的水平。资金大量涌入。“它们成了资金的避难所。”胡伟俊说。它们可根本不该是。 ■



Plots unearthed in 2021

A year in four charts

Our graphics capture the big business trends of 2021

2021 HAS brought mixed blessings for business. American tech giants thrived while Chinese ones suffered (chart 1). Chip firms couldn't keep up with soaring demand (chart 2), helping snarl up supply chains. Wall Street rainmakers have been working overtime (chart 3). Yet even many of them have toiled from home (chart 4).

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起底2021

四张图表看一年

我们的图表捕捉了2021年的几大商业动态

二〇二一年对商界来说可谓几家欢乐几家愁。美国的科技巨头欣欣向荣，中国的巨子日子难过（见图表1）。芯片公司无法满足不断飙升的需求（见图表2），加剧了供应链阻塞。华尔街的精英们加班加点地工作（见图表3）。但即便他们当中也有不少人是在自己家中奋力苦干（见图表4）。





One woman's trash

Fashion as an asset class

Technology has made it easy and worthwhile to sell old clothes

A FLAT WHITE might last three minutes; a bottle of fine whiskey a year if it is savoured slowly. iPhones are typically replaced after two or three years, and cars after a decade or so. Some possessions are likely to outlive you, most notably your house. Some outlast civilisations: look at Ancient Roman jewellery. Everything you own lies on a spectrum, with consumption goods, such as a coffee or newspaper, at one end and investment goods, such as a house or a diamond, at the other. In the middle are durable or “durable-ish” goods, such as cars, coffee tables and washing machines.

Investment goods decay so slowly that, if scarce, their value may increase. Durable ones have utility and thus value for many years, but tend to depreciate while you own them. (Rare exceptions include vintage cars and Moon-landing editions of the New York Times.)

Where goods lie on this spectrum determines not only how long they last but what sort of market develops to trade in them. Many more people buy used homes or rent properties than buy new-builds, and only around a quarter of car purchases are of new vehicles. No one, by contrast, tries to resell bagged lettuce. Clothing lies in between. Well-made leather or denim items may last for a decade; a flimsy silk camisole for a season. But durability is not the only factor. Fashion matters, too: desirability can be fleeting.

All the more so in an era of just-in-time supply chains and social-media influencers. People now spend a lower share of their income on clothing than ever before, but the number of items purchased each year has

ballooned. Many items are worn a few times before being discarded; 95% of the clothes Americans send to landfills are in good enough nick to be reused or resold. This is wasteful and environmentally troubling. Reliable estimates are scarce, but industry studies reckon that clothing manufacture and distribution account for between 2% and 8% of global carbon emissions. The fashion industry probably emits more carbon than aviation (3% of emissions) or shipping (2%).

Yet technology is reducing the friction in trade of all kinds. This started in financial markets, where whizzy algorithms and vast amounts of data have pushed trading costs practically to zero. More recently online platforms such as OpenDoor and Redfin, which use data about property features and locations to estimate values of homes algorithmically, have started to drive down estate agents' commissions. The trend then extended beyond investment goods. That was entirely more radical since it made markets where none had existed. Look at Airbnb and Uber, which turned empty homes and idle cars into sources of income.

Now it has moved to goods in the middle of the investment-consumption spectrum. A decade ago you would have struggled to offload second-hand clothing, let alone get paid for it. Emptying your closet meant a trip to a charity shop. A few high-value items could be resold, says Julie Wainwright, the founder of The RealReal, an online second-hand-clothing site, but largely in "pawn shops or local consignment stores, where the experience and the payouts were not good".

This all meant that the market, in economist-speak, was thin and illiquid. Matching buyers and sellers was tricky; transactions were rare; commissions were high. "One kind of illiquid market used to be the market for knick-knacks in the attic," says Alvin Roth, an economist at Stanford University who won a Nobel prize for his work on market structure. "But the internet made it possible to have your lawn sale on eBay."

Once Airbnb and Uber had propelled the idea of a sharing economy into the mainstream, firms turning used clothing into an asset class were not far behind. As with accommodation and transport, not just resale but rental was revolutionised. By Rotation and Rotaro act like sharing-economy apps for wardrobes. Now, whether people are reselling knick-knacks, lending out old clothes, renting a spare room or picking up passengers in their spare time, they are making better use of their assets than before.

In 2021 resold clothing fetched around \$15bn, up from less than \$1bn in 2013. A further \$21bn was spent on garments from charity and thrift shops. The total spent on second -hand garb, some \$36bn, is slightly bigger than the \$30bn spent on “fast fashion” in shops such as Zara or H&M. By 2025, according to GlobalData, a research firm, the value of resold and thrifited clothing will climb to \$77bn as resale revenues triple to \$47bn annually and charity-shop revenues climb to \$30bn. Combined revenues will dwarf those from fast fashion which are expected to grow to just \$40bn.

Online clothing resellers’ business models vary. The RealReal and Vestiaire Collective target higher-end fashion—think Chanel bags and Gucci loafers. They make selling easy by, for example, sending couriers to collect items. But they are fussy about what they take. The RealReal charges at least 20% of the sale price (and as much as 60%). In return they stand between buyers and sellers, setting or suggesting prices, organising shipping and authenticating garments so that buyers can trust that their purchases are genuine.

ThredUP also takes possession of items, but will accept anything a seller wants to get rid of, from high-street fast-fashion brands through to designer labels, before sorting, pricing and listing items that pass a quality inspection (rejects are returned or recycled). Users get paid a fraction of the sale price (as little as 5% for a \$5 item; up to 80% for those that sell for more than \$200). Others, such as Depop and Poshmark, are peer-to-

peer platforms. These allow users to list their own items at a price of their choosing, but also leave them to do the legwork and shipping. They take simple flat-rate commissions: Depop's is 10%; Poshmark 20%.

All are now firmly established. The RealReal became the first to go public in 2019. ThredUP and Poshmark listed in 2021. Depop, which was founded in Britain, was acquired by Etsy, a New York-based online marketplace, in June. Vestiaire remains privately held. Between them these fashion resellers are valued at around \$8.4bn, a tiny fraction of the market capitalisation of the fast-fashion giants, Inditex (which owns Zara) and Hennes and Mauritz (which owns H&M along with & Other Stories, COS and Weekday), of \$100bn and \$30bn respectively.

But retailers, too, have cottoned on to the idea that old clothes can sell. ThredUP works with high-street brands such as Madewell, which now offer used (or "preloved") items alongside new stuff in stores and online. Brands can customise what they take. "Madewell wanted to tell a particular story about denim," says James Reinhart, the co-founder of thredUP. Merchandise and tech from thredUP lie behind the resale arms of many major retailers, such as Walmart. The proceeds are split between the retailer, thredUP and the sellers who ship stuff in to be resold.

The boredom of covid-19 lockdowns may have boosted resale by giving people time to clear out their wardrobes and browse second-hand fashion online. According to estimates from GlobalData last year saw over 33m new buyers and 36m new sellers of old garb.

The idea that clothing is for a season, not forever, is even clearer in the peer-to-peer rental market. Eshita Kabra-Davies set up By Rotation, a wardrobe-swapping app, in 2019. It allows users to list items available to borrow. The fee is usually around 5% of a garment's retail price per day. Dresses tend to be rented for three or four days, to wear over a weekend, or to take on

holiday. Ms Kabra-Davies was inspired by trying out an American service that rented garments it owned, only to be disappointed when the selection felt outdated. “I actually want to borrow the outfits that women are wearing on Instagram right now,” she says. “That was when I thought we should just let people share.”

With renting out clothes, as with allowing strangers into your car or home, comes the worry that they will ruin your prize possessions. By Rotation allows lenders to bill borrowers extra if a hem is ripped or a dress stained (it steps in if owner and borrower cannot agree). But mishaps, especially ones requiring intervention, are rare, says Ms Kabra-Davies. And rental yields can quickly add up. Some frequent lenders with big wardrobes make up to £2,500 (\$3,300) per month.

Clothing is not the only high-value durable good being shared for a fee. FatLlama, a British platform, allows people to rent out anything (fancy camera equipment does well). Indeed, the idea of renting out durable, or durable-ish, goods makes such sense that it is surprising that it did not take off before. In the case of clothing that may be because perceptions needed to shift. Only close friends could have been asked for the loan of a jacket or dress—and even then they might not share your taste, or indeed vital statistics.

The very thought that an item might be rented out or resold in the future changes how consumers approach buying it in the first place. Ms Wainwright of The RealReal says that most of its users regularly shop at posh department stores. Its proprietary surveys find that they “are starting to check The RealReal first to see how a luxury item retains value on the secondary market before making primary market purchases”. That is, they are more likely to buy high-quality garments, knowing that at least part of the cost may be recouped.

The biggest shift in perception, however, is not among people who sell or rent their clothing, but at the other end of the deal. A poll in 2016 by GlobalData found that 45% of adults had bought second-hand clothing, or said they would consider doing so. That share is now 86%. Influencers document trips to charity shops and show off their purchases. A decade ago wearing second-hand clothes was uncool, and teens hung out in Abercrombie & Fitch or Jack Wills. Stroll a hipster neighbourhood today—Williamsburg in Brooklyn, say—and passers-by will have bought their outfits in thrift stores like Goodwill and Housing Works, or curated shops like Awoke Vintage.

In this way the shift towards second-hand fashion is self-reinforcing, with fashion tastes changing because...well, because fashion tastes have changed. Once a trendsetter wears something, others seek to emulate the look. The more people sell their old stuff, the cooler wearing it becomes, too. ■

ILLUSTRATION: FRANZISKA BARCZYK ■



你的旧爱我的新欢

时装成为一个资产类别

科技让二手衣物容易出手且有利可图

一杯馥芮白可能存在三分钟。慢慢品的话，一瓶上等威士忌可能存在一年。iPhone通常用了两三年就被换掉，汽车大概十年左右换一次。有些财产存在的时间可能比你久，最明显的就是你的房子。有些东西在某些文明消亡后还留存着，比如古罗马的珠宝。你拥有的一切都位于一张光谱上的某个点，咖啡或报纸等消费品在一头，房屋或钻石等投资品在另一头。中间段是汽车、咖啡桌和洗衣机之类的耐用或较耐用的商品。

投资品破败得非常之慢，如果是稀缺品，价值可能还会增加。耐用品具有实用性，因此可以多年保值，但在你拥有它们的过程中往往会上贬值。（也有少数例外，比如老爷车和《纽约时报》报道阿波罗登月的那几期。）

商品在这张光谱上的位置不仅决定了它们能存在多久，还决定了能发展出什么样的二手交易市场。购买二手房或租房的人远多于购买新房的人，卖出的汽车里只有约四分之一是新车。相比之下，没有人会试着转售袋装生菜。衣服的情况介于中间。制作精良的皮革或牛仔布衣物也许能穿十年，单薄的丝质吊带背心可能只能穿一季。但耐穿与否并不是决定衣服价值的唯一因素。时尚也很重要：对一件衣服的渴望可能转瞬即逝。

在JIT供应链和社交媒体网红的时代更是如此。如今人们的服装消费占收入的比例比以往任何时候都低，但每年购买的衣服数量却已激增。许多衣服穿几次就扔了，美国人扔去垃圾填埋场的衣服有95%都还能再穿或转售。这种现状既浪费，又影响环境。这方面可靠的估计数字很少，但行业研究认为，服装制造和分销占到全球碳排放的2%至8%。时尚业的碳排放可能比航空（占总排放的3%）或航运（2%）还要多。

不过，技术正在减少各种交易中的摩擦。这始于金融市场，先进的算法和海量数据将交易成本降到几乎为零。后来，OpenDoor和Redfin等在线平

台把房产特征和位置数据输入算法来估算房屋价值，房地产经纪人的佣金由此开始降低。这种趋势随后扩展到投资品之外。其结果更为激进，因为它凭空创造了全新的市场。将闲置房屋和汽车变成收入来源的爱彼迎和优步就是典型的例子。

如今这种趋势已经开始覆盖介于投资品和消费品之间的商品。十年前，你想把二手衣服送出去都很难，更别说卖掉了。要清空衣橱你得跑一趟义卖商店。少数高价值衣物可以转售，在线二手服装网站The RealReal的创始人朱莉·温莱特（Julie Wainwright）说，但基本都是在“当铺或本地寄售店出售，体验和收益都不好”。

用经济学家的话来说，这就意味着市场很清淡、流动性很差。匹配买家和卖家很难，交易量少，佣金又高。“塞在阁楼上的小玩意儿过去流动性很差。”阿尔文·罗斯（Alvin Roth）说。这位斯坦福大学的经济学家曾因市场结构方面的研究获得诺贝尔奖。“但有了互联网之后，你可以在eBay上卖家里的旧货了。”

爱彼迎和优步刚把共享经济的理念推向主流，把旧衣服也变成一种资产类别的公司便很快跟了上去。与住宿和交通一样，不仅是转售衣物，连租赁也发生了革命性的变化。By Rotation和Rotaro这类应用启动了衣橱的共享经济。现在，无论是转售小物件、出租二手衣服和空房间，还是在业余时间开网约车，人们对自己资产的利用都比以前更好了。

2021年，转售服装的销售额约为150亿美元，而在2013年还不到10亿美元。另外还有210亿美元的衣物从义卖商店售出。在二手服装上的花费总计约为360亿美元，略高于在Zara或H&M等“快时尚”服装上的300亿美元。据研究公司GlobalData称，到2025年，转售服装的销售额将增加两倍，达到每年470亿美元，义卖商店的销售额将升至300亿美元，两者合计为每年770亿美元。这将让快时尚相形见绌，后者的收入预计将仅增长至每年400亿美元。

在线服装转售商的商业模式各不相同。The RealReal和Vestiaire Collective

瞄准高端时尚，比如香奈儿的手袋和古驰的乐福鞋。它们用派快递员上门收货等方式为卖家提供便利。但它们对收取的物品很挑剔。The RealReal抽取的佣金至少是转售价的两成（最多可达六成）。它们充当了买家和卖家之间的桥梁，设定或建议价格，安排交付，验证货品以让买家可以放心自己买到的是真品。

thredUP也收衣物，但会接受卖家想要清理掉的任何服装——不论是商业大街上的快时尚品牌还是设计师品牌，然后分类、定价并把通过质检的衣物挂牌出售（未通过的会被退回或回收利用）。用户从售价中提成（5美元的商品可低至5%，售价超过200美元的商品则最高能有80%）。还有Depop和Poshmark等P2P平台。它们允许用户自己给要出售的衣服定价，但了解行情和发货等杂务他们也要自己做。平台收取固定比例的佣金，Depop收10%，Poshmark收20%。

这些平台现在都已站稳脚跟。The RealReal于2019年率先上市。thredUp和Poshmark于2021年上市。成立于英国的Depop在6月被总部位于纽约的在线市场Etsy收购。Vestiaire仍为私人持有。这些时装转售商的总估值约为84亿美元，和市值分别为1000亿和300亿美元的快速时尚巨头Inditex（旗下拥有Zara）和海恩斯莫利斯（Hennes and Mauritz，旗下拥有H&M、& Other Stories、COS和Weekday）相比，仍是小巫见大巫。

但零售商也开始明白旧衣服也有市场。thredUP与Madewell等商业街品牌合作，这些品牌现在在实体店和网站上把二手衣物（它们称为“Preloved”）和新品放在一起出售。品牌可以拿收来的衣物做个性化定制。“Madewell想讲述一个关于牛仔布的特别故事。”thredUP的联合创始人詹姆斯·莱因哈特（James Reinhart）说。thredUP为沃尔玛等许多大型零售商的转售部门提供商品和技术。零售商、thredUP和卖家（把衣物寄来转售）共同分享收益。

疫情封锁期间，人们待在家中百无聊赖，有了时间清理衣橱和在网上浏览二手时装，这可能促进了转售生意。据GlobalData估计，去年二手衣物市场涌入超过3300万新买家和3600万新卖家。

在P2P租赁市场上，衣服只穿一季而不是一辈子的理念就更鲜明了。埃希塔·卡布拉-戴维斯（Eshita Kabra-Davies）于2019年创建了衣橱交换应用By Rotation。用户可以在上面挂出可供租借的衣物。日租金通常是服装零售价的5%左右。连衣裙一般会租三四天，周末穿或带去度假。卡布拉-戴维斯的灵感来自于自己一次租衣服的经历，那家美国公司把自家的服装出租，但款式过时，令人失望。“我想要租的衣服就是现在Instagram照片里姑娘们穿的那些，”她说，“就在那时我想到应该让人们共享时装。”

和让陌生人坐进你的车或住进你家里一样，让他们穿你的衣服也会让你担心你的宝贝被弄坏。如果衣服的卷边扯破了或者裙子弄脏了，By Rotation允许出租方向租借方加收费用（如果双方无法达成一致，它就会介入）。但卡布拉-戴维斯说，衣物损坏的情况很少见，需要介入的就更少了。有时候租金收益会很快聚少成多。一些衣服多又频繁出租的人每月能赚到2500英镑（3300美元）。

服装并不是眼下唯一收费共享的高价值耐用品。在英国平台FatLlama上，人们可以出租任何东西（高档摄影器材很抢手）。事实上，出租耐用或较耐用物品的做法非常合理，它没有更早一些兴起才是奇怪的事。就服装而言，这可能是因为需要转变观念。过去，人们只会向亲密的朋友借外套或裙子，即便能借，朋友的品味也可能和你不同，更别说尺码了。

一件衣物在未来有可能出租或转售的想法改变了人们最初买它时的考量。The RealReal的温莱特说，该网站的大多数用户经常在高档百货公司购物。它的自主调查发现，他们“会先在The RealReal上查看一件奢侈品在二手市场上的保值情况，然后再在一手市场购买”。也就是说，他们更有可能购买高品质的服装，因为他们知道至少可以收回部分成本。

然而，观念转变最大的不是转售或出租衣服的人，而是购买或租借二手衣服的人。GlobalData在2016年的一项调查发现，45%的成年人曾购买过二手衣服，或表示会考虑这样做。这一比例现在是86%。网红会拍摄他们去义卖商店的购物之行，并展示战利品。十年前，穿二手衣服可一点也不酷，青少年都是去逛Abercrombie & Fitch或Jack Wills。今天你去布鲁克林

的威廉斯堡（Williamsburg）这样的潮人区看看，许多过路人穿的衣服都是从Goodwill和Housing Works等义卖商店或Awoke Vintage等精选二手商店里淘来的。

就这样，向二手时尚的转变不断自我强化，时尚品味也在随之发生变化，因为……嗯，因为时尚品味变了。潮人们一穿上什么，其他人就纷纷跟上。卖出自已旧衣服的人越多，穿别人的旧衣服也变得越来越酷。

插图：弗兰齐斯卡·巴奇克 ■



Schumpeter

The billionaire battle for the metaverse

Forget space. The race is on to take people beyond reality

YOU HAVE to hand it to Mark Zuckerberg. When the founder of Facebook announced in October that he was changing the name of the social-media network's parent company to Meta Platforms in order to help create an alternative digital reality known as the metaverse, he was mercilessly mocked. To some, he was generating a smokescreen to distract attention from a political furore. To others, he was merely the latest middle-aged tech billionaire to chase a childhood fantasy, much as Amazon's Jeff Bezos and Tesla's Elon Musk were doing with space rockets.

And yet his timing was impeccable. Since October searches on Google for "metaverse" have soared. Wall Street is fanning the hype. According to Bernstein, a broker, the term cropped up 449 times in third-quarter earnings calls, up from 100 in the second quarter. It says markets with potential annual revenue of at least \$2trn could be disrupted by the metaverse. Jefferies, a bank, says that though the phenomenon may be more than a decade away, it has the potential to disrupt "almost everything in human life".

Other tech giants like Microsoft have set out plans to head for the metaverse. But it is big firms still under the control of their founders that may become the most ardent evangelists. Mr Zuckerberg, with a net worth close to \$125bn and almost total control of a company valued at \$908bn, is the most prominent. Others include Jensen Huang of Nvidia, a maker of graphics processors worth \$722bn, and Pony Ma of Tencent, the Chinese tech giant worth \$550bn, whose gaming investment portfolio includes a 40% stake in Epic Games, owner of "Fortnite", one of the world's most popular games.

Epic's founder, Tim Sweeney, is himself a force to be reckoned with. He recently told Bloomberg that the metaverse was a multitrillion-dollar opportunity, and that companies like his were in a race to get to a billion users in order to set the metaverse's standards for the future.

It is shaping up to become a billionaire battle similar to the Bezos-Musk space race. Instead of rocket science, it will be fought with reality-bending headsets, blockchains, cryptocurrencies and mind-frazzling amounts of computing power.

Precisely what these plutocrats mean by the metaverse is as yet unclear. Will it be an all-consuming futuristic world of virtual reality, avatars, oceanside mansions and other online razzmatazz that will make the real world a dull place by comparison? Or will it simply be a richer, more immersive version of what already exists today: a way to socialise, work, shop and play online even as life in the everyday world carries on as normal? It is even less clear whether tomorrow's internet users will be seduced by the dreams of entitled tech billionaires.

A look at the ambitions of Meta, Nvidia, Epic and Tencent give a sense of the scope of the undertaking. Each has their niches. Mr Zuckerberg has earmarked \$10bn this year mostly to develop the virtual- and augmented-reality headsets and glasses that he hopes will provide a dominant access point to the metaverse, much as Apple's iPhone does with the mobile internet. Nvidia is focused on what it calls the omniverse, a technology based on its chips that brings engineers, designers and other creative types together virtually to make things—mostly, for now, in industrial settings. Epic has been creating virtual worlds for years, including "Fortnite". In the metaverse, its killer app may be Unreal Engine, a platform that gives its own and other developers the ability to make lifelike 3D experiences, including games, films, architectural models and industrial designs. Tencent has China to crack. Mr Ma is probably wise to play it carefully, given the

Communist Party's techlash. But his firm's popular WeChat super-app, including WeChat Pay, is already a 2D version of what the metaverse could become in 3D.

Behind their futuristic ambitions lie some common experiences. First, the mobile internet is reaching the end of an era. In America and Europe, politicians are threatening tighter rules against monopolies and privacy abuses, especially with respect to Facebook and Google. In China, the tech industry is reeling from the government onslaught. Not for nothing are some first-generation tech entrepreneurs in America and China calling it quits. Those who remain standing need a compelling new story to tell.

Next, they operate in constrained worlds. Apple is a particular bugbear for Mr Zuckerberg and Mr Sweeney. The iPhone-maker is using the privacy settings in its iOS operating system to control the extent to which Facebook can sell digital adverts. Epic is engaged in an antitrust battle with Apple over the fees its App Store imposes on game developers, which has so far been fairly unsuccessful. That is why both men vow so vehemently to promote interoperability—ie, no closed systems—as well as common standards. They, too, want to be architects of the operating systems of the future.

They won't have the field to themselves. Apple, though so far quiet about the metaverse, is no doubt preparing an offensive. Telecoms firms want a sniff, having invested heavily in ultra-fast, low-latency 5G spectrum. Rapidly growing platforms like Roblox, offering a build-your-own games model that attracts 200m users a month, have already captured young hearts. There are naysayers, too, notably proponents of more distributed technologies that are known as Web3, who argue that blockchains and cryptocurrencies are the next big thing—though as Ben Thompson, a tech pundit, points out, these may find much better use cases in the metaverse than in the real world.

There is a lot to play for. As Mr Thompson says: “Elon Musk wants to go to the Moon. Mark Zuckerberg wants to create entirely new moons in digital space.” But just as space is a race, so is the metaverse. Messrs Zuckerberg, Huang, Sweeney, Ma et al may promise a future for the internet that is more open, immersive and engaging than the mobile one that exists today. But each wants to get there first, so that they can set the rules to their advantage.





熊彼特

亿万富翁的元宇宙之战

忘了太空吧，让人超越现实的竞争已经开始了

你还真得服扎克伯格。10月，这位Facebook创始人宣布把该社交媒体网络的母公司更名为Meta Platforms，以助力打造一个名为“元宇宙”的替代数字现实。他遭到了无情的嘲讽。在一些人看来，他是在放烟幕弹，好让人们不再关注Facebook引发的政治风波。更多人觉得，他不过是又一个追逐儿时幻想的中年科技富豪，就和亚马逊的贝索斯以及特斯拉的马斯克捣鼓火箭是一回事。

然而，他选的时机真是无懈可击。自10月以来，谷歌上“元宇宙”的搜索量猛增。华尔街也在煽风点火。据券商盛博统计，这个词在第三季度财报会议中出现了449次，而在第二季度为100次。盛博表示，可能被元宇宙颠覆的那些市场的潜在年收入总额至少达两万亿美元。杰富瑞表示，元宇宙的实现可能还要十几年，但它却可能颠覆“人类生活的几乎方方面面”。

微软等其他科技巨头都已制定了进军元宇宙的计划。但那些仍由创始人控制的大公司可能会成为最狂热的传道者。最典型的就是扎克伯格，他拥有近1250亿美元的净资产，几乎完全控制着一家价值9080亿美元的公司。另外还有市值7220亿美元的图形处理器公司英伟达的黄仁勋，以及市值5500亿美元的中国科技巨头腾讯的马化腾。腾讯的游戏业投资组合包括持有游戏开发商Epic Games 40%的股份。Epic是全球最受欢迎的游戏之一《堡垒之夜》的开发商，其创始人蒂姆·斯威尼（Tim Sweeney）本人也不容忽视。他最近向彭博表示，元宇宙是价值数万亿美元的机会，Epic等公司正在争先达到十亿用户规模，以抢占先机为元宇宙的未来设定标准。

这场争夺正在演变为如贝索斯和马斯克的太空竞赛那样的亿万富翁之战。只不过不是在火箭科技上的竞逐，而是在扭曲现实的头显、区块链、加密货币和超乎想象的强大运算力方面的竞争。

这些大亨所说的“元宇宙”到底是什么，目前并不清楚。是一个让人全身心投入其中的未来派世界吗？里面充满了虚拟现实、虚拟化身、滨海豪宅以及其他各种各样令人炫目的线上活动，相比之下真实世界变得枯燥乏味？还是说，它只是一个如今已经存在的事物的更丰富、更沉浸式版本：一种线上社交、工作、购物和娱乐的方式，而与此同时日常生活一切如常？更不清楚的一件事是，未来的互联网用户会不会被这些要风得风要雨得雨的科技亿万富翁们的梦想打动。

看看Meta、英伟达、Epic和腾讯的雄心壮志便可领略元宇宙的辽阔。每家公司都有自己的专攻领域。扎克伯格今年已划出100亿美元，主要用于开发虚拟现实和增强现实头显和眼镜，他希望这些工具会成为进入元宇宙的主导接入点，就像苹果的iPhone对移动互联网的作用那样。英伟达专注于它的omniverse技术，这种基于其芯片的技术让工程师、设计师和其他创意人员可以在虚拟空间里共同打造产品——目前主要运用在工业环境中。Epic多年来一直在打造虚拟世界，包括《堡垒之夜》。在元宇宙中，它的杀手级应用可能是“虚幻引擎”（Unreal Engine），这个平台让Epic自家和别家的开发者可以打造逼真的3D体验，包括游戏、电影、建筑模型和工业设计。腾讯有整个中国市场待攻克。鉴于共产党对科技行业的整治，马化腾谨慎行事或许是明智的。但其公司广受欢迎的超级应用微信（包括微信支付）已经是未来3D元宇宙的2D版本了。

在这些公司的未来主义雄心背后是一些共同的经历。首先，移动互联网已经走到了一个时代的终点。在美国和欧洲，政客们威胁要制定更严格的规定打击垄断和侵犯隐私行为，Facebook和谷歌尤其被盯牢。在中国，科技行业也遭到政府的沉重打击。美国和中国的一些第一代科技企业家离场也不无道理。那些仍在坚持的人需要讲出新的吸引人的故事。

其次，他们的作为备受掣肘。苹果尤其令扎克伯格和斯威尼头疼。这家iPhone制造商目前利用其iOS操作系统中的隐私设置来限制Facebook的数字广告销售。Epic就苹果App Store向游戏开发商抽成的问题提出反垄断诉讼，目前看来不怎么成功。这也是为什么这两人都声势浩大地誓言要提高系统间的互操作性（即不能封闭系统）并推行通用标准。他们也希望成为

未来操作系统的设计师。

他们不会独占这一领域。对于元宇宙，虽然苹果至今没有表态，但无疑正在准备发动进攻。在超高速、低延迟的5G频谱上投入了大量资金的电信公司也想分一杯羹。Roblox提供一种自我构建的游戏模式，月活跃用户达到两亿，像它这样快速发展的平台已俘获不少年轻人的心。也有人泼冷水，特别是主张采用更加分布式的技术来构建Web3.0的人，他们认为区块链和加密货币会是下一个大事件，但正如科技业观察家本·汤普森（Ben Thompson）指出的，这些技术可能会在元宇宙中找到比在现实世界中好得多的用处。

可以做的事情有很多。就像汤普森所说的：“马斯克想登月。扎克伯格想在数字太空里打造新的月球。”但正如太空有一场竞赛，元宇宙也是如此。扎克伯格、黄仁勋、斯威尼、马化腾等科技大亨也许都承诺未来的互联网会比今天的移动互联网更开放、更具沉浸感和吸引力。但他们每个人都想捷足先登，从而给元宇宙制定有利自己的规则。■