



Chaguan

Nostalgia for China's boom years drives a TV hit

A drama series presents 1990s capitalists as heroes, not villains

CHINA CENTRAL TELEVISION, the flagship network of the country's propaganda machine, has a new hit on its hands. "Blossoms Shanghai", a big-budget melodrama in 30 parts, has enjoyed huge audiences since its first episode aired on December 27th. The show's success—boosted by approving coverage in official and commercial media outlets—is at once unexpected and revealing. It is a surprise because its heroes are swashbuckling capitalists in the Shanghai of the early 1990s. A hard-living bunch, they cut deals, swap stock tips and scheme against rivals over an endless succession of boozy late-night banquets, filmed in demonic shades of black, gold and red. It is all a far cry from the prim, flag-waving dramas that have become the norm on state TV during Xi Jinping's rule. Typically, such series depict crime-fighting police officers, Communist Party officials toiling to serve the masses, brave Chinese soldiers or other model citizens.

Enthusiasm for the drama, the first TV series to be directed by Wong Kar-wai, a pillar of Hong Kong's film industry, sheds light on the Chinese public's mood. Much praise for the show has a distinctly backward-looking feel to it. Online, fans share their memories of boom years when ordinary Chinese could transform their fates with a lot of luck, good connections and hard work.

At the same time, the show's endorsement by government media is revealing about the hopes and fears of the country's rulers. This official embrace is rather tactical and forward-looking. Boosterish coverage of the drama is in line with a broader campaign by party leaders to cheer up Chinese consumers, whose post-pandemic caution is one reason why the economy is in a funk. Party newspapers credit the drama with sparking a

measurable surge in Shanghai hotel and restaurant bookings. Arguably, a show whose stars are heroic entrepreneurs also aligns with current official efforts to reassure China's private sector. Business types have been battered by heavy-handed regulation in recent years and left feeling generally unloved.

The hero is A Bao, a former factory worker shown making and almost losing a fortune on the stockmarket and in domestic and foreign trade. He is guided by an old man whose counsel runs from business strategy to the right cut for a three-piece suit. ("It has to be British-woven, pure wool," the sage sternly instructs a local tailor, summoned to make A Bao a new wardrobe.) The drama, adapted from a novel by Jin Yucheng, portrays capitalism as something between a test of nerves, a cruel game and a form of madness, capable of inducing a frenzy in consumers and investors alike. Characters cheat one another and commit suicide when ruined. Yet time and again the survivors are drawn to feast together at the same few restaurants, to plot and show off and drink. In contrast with the real 1990s, official corruption is nowhere to be seen. Indeed, the only important character with a public-sector job (at Shanghai's agency for foreign trade) is a paragon of honesty who uses her savings to repay businessmen for gifts they offer her.

To learn more about the show's success, Chaguan caught a fast train to Shanghai and headed to Huanghe Road, a street of restaurants and Art Deco mansions from the 1930s where much of the drama is set. He found a throng of fans taking photographs and filming themselves for social media, over the shrill, electronic whistles of police officers controlling crowds and directing traffic.

Chinese public opinion is rarely monolithic, and responses to the drama divided along lines of home town, age and social class. Locals are happy that the whole series was filmed in Shanghai dialect, with a second version

dubbed into Mandarin for nationwide release. Several Shanghainese pensioners shared strong views about the drama's realism, or lack of it. Back in the 1990s a lot of business was done over dinner, agreed an old man who worked in Shanghai's finance sector. But overall the series is a "fantasy", he scowled. "Those who went into the stockmarket and business were the rare bold ones. Most people worked in factories."

Three older women taking pictures had dressed for a fine dinner, though it was noon. They recalled neon signs that lit up Huanghe Road in those boom years. "Many businessmen gathered here, with their huge mobile phones," remembered one of the women. The trio were not among them. They were assigned jobs in a state-owned textile factory and stayed there until retirement. Modern life offers more choices but more pressure, they declared. In their telling, the series brings the Shanghai of their youth back to life. "But what use is nostalgia?" asked the same woman.

| *Nostalgia as a veiled form of complaint*

The sharpest opinions came from middle-aged fans, some of whom carried small dogs or trailed bored-looking husbands. The early years of China's "reform and opening" era were a time of hope, filled with new experiences, said a 50-year-old woman. She sighed: "We were lucky that we were born in a good age." In her view, life is very different now, and more stressful. Asked why, she replied that it is "hard to talk openly" about this. "There are so many reasons, political factors, among many others."

Young fans sounded more wistful than cross. For two female students, a lesson of the series is that there were more opportunities to move up in the world in the 1990s than now. A 25-year-old man had travelled from Hangzhou, an hour away by train, to take pictures of Huanghe Road. The series may inspire some viewers to start businesses, he enthused. Alas, capitalism is all about timing, he went on. Some may feel they have missed their moment.

Still, China's entrepreneurs should not become cocky about being cast as on-screen heroes. "Blossoms Shanghai" may be a runaway success, but at moments in early January the most-watched show on state TV was a documentary series about officials corrupted by business interests. Back when China first embraced market reforms, party leaders declared: "To get rich is glorious." In the Xi era, the lure of money remains distinctly dangerous. ■



茶馆

对中国经济繁荣年代的怀旧推动一部电视剧爆火

这部剧把1990年代的资本家塑造成英雄而非反派

中国宣传机器的头牌电视网中央电视台最近播出了一部大火的新剧。自12月27日开播第一集以来，30集的大制作情节剧《繁花》吸引了大批观众收看。该剧的成功——受到官方和商业媒体正面评价的推动——既出人意料，也耐人寻味。说出人意料是因为该剧的主角是1990年代初上海一些大胆冒险的传奇资本家。在黑、金、红色交织的暗黑影调中，一群恣意人生的人在无休止的深夜酒局上谈生意、交换股票内幕消息、算计对手。这一切都与习近平执政后国家电视台上常见的那些正经八百、民族情绪高涨的电视剧大相径庭。通常，这些剧集描画的都是打击犯罪的警察、为人民鞠躬尽瘁的共产党官员、勇敢的中国军人或其他模范公民。

观众对该剧（它是香港电影界中流砥柱王家卫执导的首部电视剧）的追捧反映了中国民众的心境。对该剧的赞誉大多带有明显的怀旧色彩。剧迷们在网上分享他们对那个繁荣年代的回忆，那时普通人可以凭借好运、人脉和奋斗改变自己的命运。

与此同时，官方媒体对该剧的认可透露出上层的期盼和忧虑。这种官方的肯定在某种程度上是策略性和前瞻性的。对该剧的积极报道配合了党的领导人提振消费者信心的宏观举措，中国民众在疫情后不敢消费，是如今经济低迷的原因之一。据各家党报报道，在该剧带动下，上海的酒店和餐馆的预订量显著增加。可以说，这部以英雄企业家为主角的电视剧也配合了当前官方为安抚中国私营部门所做的努力。近年来，商界人士受到监管的重拳打压，感到在社会上不受待见。

剧中主人公阿宝原本是工厂工人，后来通过炒股和从事国内外贸易发家致富，最后又几乎倾家荡产。他得到一位长者在方方面面的指点，从商场上的策略到三件套西装的正确剪裁等。（“一定要英纺、纯羊毛的。”这位智者严格叮嘱被召来给阿宝做新衣服的一位本地裁缝）。这部改编自金宇澄的

小说的电视剧把资本主义描绘成某种介于胆量的考验、残酷的博弈和某种癫狂之间的东西，能在消费者和投资者中引发狂热。剧中人物尔虞我诈，在生意失败后自杀。然而，那些熬过来的人却一次又一次回到同样那几家餐厅吃饭、密谋、炫耀、喝酒。与真实的1990年代不同，剧中看不到腐败的官员。实际上，唯一一个公营部门的重要角色（在上海外贸局工作）堪称正直的典范，商人给她送礼物，她会拿自己的积蓄来付钱。

为更多了解该剧爆火的情况，笔者乘坐高铁来到上海，直奔遍布餐馆和上世纪30年代装饰艺术风格洋房的黄河路，该剧大部分剧情都在这里展开。在控管人群和指挥交通的警察那尖锐的电子警哨声中，笔者看到一大群剧迷在那里拍摄照片和视频，准备发到社交媒体上。

中国的公众舆论很少能众口一词，人们对该剧的反应也因家乡、年龄和社会阶层的不同而各异。让上海人开心的是《繁花》全部用沪语拍摄，另有一个普通话配音的版本在全国播放。几位上海退休老人对该剧的写实或不够写实有着强烈的看法。在上世纪90年代，很多生意的确是在饭桌上谈成的，一位曾在上海金融界工作的老人对此表示赞同。但总的来说，这部电视剧是一种“幻想”，他皱着眉说。“那些炒股经商的是极少数胆子大的人。大多数人都是在工厂工作。”

虽是中午时分，有三位在那里打卡拍照的老阿姨却是一身要赴晚宴的打扮。她们回忆起那个繁荣年代黄河路上闪烁的霓虹灯。“当年有许多生意人聚在这里，手里拿着大哥大。”其中一人回忆说。三位阿姨并不在其中。她们被分配到一家国有纺织厂工作，直到退休。她们表示，现代生活提供了更多选择，但也带来了更多压力。在她们看来，《繁花》重现了她们年轻时上海的模样。“但怀旧有什么用呢？”还是那位阿姨问道。

丨 怀旧是一种隐晦的抱怨

表达最尖锐看法的是中年剧迷，他们当中有人抱着小狗，有人拽着神情无聊的丈夫。一位50岁的女士说，中国“改革开放”初期是个充满希望和新体验的时代。她叹道：“我们出生在一个好时代，那会儿是幸运的。”在她看来，现在的生活已经大不一样，压力也更大。当被问及原因时，她回答说

“很难公开谈论”这个问题。“原因太多了，比如政治因素。”

年轻剧迷表达的更多是怅然，而非怨怒。两名女学生表示，《繁花》带来的启示是，与现在相比，1990年代有更多出人头地的机会。一名25岁男子从杭州坐一小时火车来到黄河路打卡拍照。他兴奋地说，这部剧可能会激励一些观众创业。可惜啊，资本主义讲究的是时机，他接着说道。有些人可能会觉得自己已经错过时机了。

尽管如此，中国的企业家们也别因为在荧屏上被塑造成英雄而自鸣得意。

《繁花》可能一炮而红，但在1月初时，央视收视率最高的节目是一部讲述官员被商业利益腐蚀的系列专题片。在中国开展市场改革之初，党的领导人宣称“致富光荣”。而在习时代，金钱的诱惑显然还是洪水猛兽。■



Free exchange

Robert Solow was an intellectual giant

His criticisms were energetic and witty, which could make them harder to take

ENSCONCED IN A lorry, hidden from the enemy by the brow of a hill, the young Robert Solow decoded the radio signals of Nazi platoons across Italy. “We were very, very good at it,” he said. The trick was to get close to the enemy but not too close: near enough to pick up their transmissions, but not so near as to risk capture.

The codes were not fancy—it was “combat stuff”. But if they could be broken quickly, they might reveal an ammunition delivery that could be thwarted. The radiomen were not fancy either. Most were high-school graduates. Even Solow, who would go on to earn a Nobel prize in economics, the Presidential medal of freedom and a Portuguese knighthood, before his death on December 21st 2023, was “middle-middle-class”. He was educated at Brooklyn state schools. He preferred softball to books, and was destined for Brooklyn College until a teacher spotted his potential, broadened his reading, and encouraged him to apply to Harvard University, which he joined two years early and rejoined after the war.

Solow’s years as a soldier only strengthened his egalitarian streak. He declined to become an officer, so he would not have to boss anyone around. When the Massachusetts Institute of Technology (MIT) offered him a job in 1949, he asked what the lowest paid professor earned, and accepted the same. When he served in President Kennedy’s Council of Economic Advisers, the Swiss embassy wanted to know his protocol rank. His answer was that he was a full professor at MIT and the government had no rank as high. Informed in the predawn hours in October 1987 that he had won the Nobel prize, his first instinct was to go back to sleep.

What he craved was more precious than prizes: the esprit de corps that comes from membership of a small, highly motivated band of colleagues. “If you’re in a group that is doing good work, it’ll have a high morale. And if it has high morale, it’ll do good work,” he once said. As an economist, he liked formal models and mathematics. But nothing too fancy. Over-refinement reminded him of the man who knew how to “spell banana” but did not “know when to stop”. His strategy was to break big questions—about growth, resources, unemployment—into littler ones, in the hope that small answers would aggregate into larger ones.

The MIT culture he embodied disdained hierarchy, cherished collegial lunches and made time for students, many of whom became illustrious friends. Four of Solow’s students later received their own sleep-disturbing calls from Sweden. Economics, Solow maintained, was a “handicraft” industry, often driven by the “extraordinarily powerful research apparatus” of one professor and one undergraduate assistant.

Something he liked about academia was that ideas, no matter how prestigious their source, could be scrutinised by anyone. His own criticisms were energetic and witty, which could make them harder to take. He found the “freshwater” school of macroeconomics, identified with the University of Chicago, preposterous, especially in its early incarnations, which assumed a “representative agent” could stand in for the many actors in an economy. To get into a technical discussion with freshwater types was like discussing cavalry tactics with someone claiming to be Napoleon, he said. The claim is absurd, however well they know their stuff.

The work that made his name began as criticism of the growth theories of the 1930s and 1940s. In these, investment added both to national spending and the economy’s productive capacity. There was no guarantee these additions to demand and supply would stay in line with each other. Moreover, excessive spending, by boosting demand, would inspire firms to

invest even more, whereas inadequate investment would induce firms to spend still less. The economy was for ever poised on a “knife-edge” between deepening unemployment or intensifying labour shortages.

This precariousness was hard to square with the relatively stable progress of advanced economies like America, where even the Great Depression eventually ended. Solow showed that the knife-edge disappeared if economies could vary the capital-intensity of production. Strong investment would not then be destabilising. It would merely result in higher capital per worker.

High investment would not, however, result in faster growth over the long run. At some point, capital would run into diminishing returns, leaving growth to be dictated by other factors. Solow calculated that capital accumulation could explain less than 13% of the growth in income per person in America from 1909 to 1949. The remainder was attributable to other forces, which he loosely labelled “technical change”. This vast unexplained portion of growth became known as the “Solow residual”.

| *Tough paternal love*

Although his work created reams of subsequent research, the father of growth theory was not impressed by many of his progeny. He was sceptical of statistical exercises that dissected growth rates across countries at every stage of development. Nor had he intended to imply that technological progress, which he did not model, fell entirely outside economics. A lot of innovation was “dumb luck”. And much of it emerged on the factory floor, “invented” by unheralded foremen. But some was the result of profit-driven investment in research. Later attempts to create formal theories of technological progress nevertheless asked more questions than they answered, he argued.

Part of the problem was that innovation is often peculiar and particular,

whereas growth theorists strive for generality and abstraction. Solow, who had himself observed the research labs at General Motors and collaborated with the McKinsey Global Institute on industry-level studies of productivity, thought model-builders could learn from case studies and business histories. The aim was to “extract a few workable hypotheses” without getting lost in the detail. To understand how the economy works, to decode its secrets, you need to get up close, but not too close. ■



自由交流

罗伯特·索洛，一位思想巨人

他的批判活力十足、机智风趣，这可能让它们更难被接受

年轻的罗伯特·索洛（Robert Solow）躲在一辆卡车里，利用山丘的掩护避开敌人视线，抓紧破译意大利各地纳粹部队的无线电信号。“我们特别擅长干这个。”他说。诀窍是要与敌军若即若离：近到足以接收到他们的信号，但又不能太近，以免被捉住。

这些无线电密码并不复杂——就是些“作战信息”。但如果能迅速将之破解，就可能发现某个弹药运送行动而挫败它。无线电破译员也没什么神秘的，大多数是高中毕业生。即便是索洛——他后来获得诺贝尔经济学奖、总统自由勋章和葡萄牙爵位，于2023年12月21日去世——也只是一个“普通中产阶级”。他在美国布鲁克林的公立学校接受教育。比起读书，他更喜欢垒球，本来打算报读布鲁克林学院（Brooklyn College），直到一位老师发现了他的潜力，拓宽了他的阅读面，并鼓励他报读哈佛大学。他提前两年入读哈佛，战后又重返校园。

在他的从军岁月里，索洛的平等主义倾向进一步强化。他拒绝担任军官，这样他就不必对任何人发号施令。当麻省理工学院1949年聘任他时，他询问了收入最低的教授的薪资水平，并接受了同样的待遇。当他在肯尼迪总统的经济顾问委员会（Council of Economic Advisers）任职时，瑞士大使馆想了解他的礼宾级别。他答说自己是麻省理工的正教授，政府里没有比这更高的级别了。1987年10月的一个黎明时分，他得知自己获得了诺贝尔奖，第一反应是继续睡觉。

他渴求的东西比奖项更珍贵：一小群干劲十足的同事凝聚起的团队精神。他曾说过：“如果你所在的团队工作出色，士气就会高昂。如果士气高昂，工作就会出色。”作为一名经济学家，他喜欢正式的模型和数学。但他不喜欢过于繁复精致的东西。过度精细在他眼里就好像知道如何“拼写banana”却不知道“在哪里停下”。他的策略是将大问题——增长、资源、失

业——分解成若干较小问题，希望小的答案能汇聚成更大的解答。

他身上展现的麻省理工文化对等级制度不屑一顾，珍惜同事共进午餐的时光，乐意为学生抽出时间，其中许多学生日后成为了赫赫有名的友人。索洛的四名学生后来也在深夜被来自瑞典的电话吵醒。索洛认为，经济学是一种“手工艺”产业，常常由一名教授和一名本科生助理组成的“极强大研究器具”驱动。

他喜欢学术圈的一点是，无论提出观点的人地位多么显赫，任何人都可以对观点加以审视。他自己做出的批判活力十足、机智风趣，这可能让它们更难被接受。他认为以芝加哥大学为代表的宏观经济学“淡水”学派是荒谬的，尤其是其早期版本，它假定一个“代表性主体”可以代替经济中的众多参与者。他说，与淡水学派的人做学术讨论就像和某个声称自己是拿破仑的人讨论骑兵战术。无论他们多么懂行，这种自诩都是荒诞的。

他的成名始于对上世纪三四十年代经济增长理论的批判。这些理论认为，投资既增加了国民支出，也提高了经济的生产能力，但谁也不能保证这些需求和供应的增加能够保持相互匹配。此外，刺激需求导致的过度支出将激励企业进一步加大投资，而投资不足则会导致企业进一步削减支出。经济始终悬在失业恶化和劳动力短缺加剧之间的“刀口”上。

这种岌岌可危与美国等发达经济体相对平稳的发展态势并不相符合，因为即使是大萧条最终也还是结束了。索洛表明，如果经济体能够改变生产的资本密集度，刀口就会消失。这时，强劲投资就不会带来不稳定性，而只会导致工人的人均资本量增加。

然而，从长期来看，高投资并不会带来更快的增长。到了一定程度，资本将陷入收益递减，此时经济增长将受到其他因素的支配。根据索洛的计算，从1909年到1949年，美国人均收入的增长只有不到13%能用资本积累解释。其余部分归因于其他因素，他笼统地称之为“技术变革”。增长中这一无法解释的庞大部分后来被称为“索洛残差”。

尽管他的成果引发了大量的后续研究，但这位增长理论之父对众多后辈的表现不甚满意。他对剖析各国在不同发展阶段的增长率的统计学方法持怀疑态度。虽然他没有对技术进步建模，但他也无意暗示技术进步完全跌出了经济学范畴。很多创新“纯属好运”。其中大部分都是名不见经传的工头在工厂车间里“发明”的。但也有一些是源于利润驱动的对研发的投资。他认为，后来人们试图建立关于技术进步的正式理论，相比解答问题，反而提出了更多问题。

这在一定程度上是因为创新往往是特殊且具体的，而增长理论家追求普遍性和抽象性。索洛亲身观察过通用汽车的研究实验室，并与麦肯锡全球研究院合作开展行业层面的生产率研究。他认为，建模者可以从案例研究和商业史中学习。其目标是“提取几个可行的假设”，但不迷失在细枝末节之中。要了解经济的运作规律，破译其秘密，关键是若即若离：要近距离观察，但又不能太近。 ■



Machine of the state

Welcome to the era of AI nationalism

Sovereigns the world over are racing to control their technological destinies

THE HOTTEST technology of 2023 had a busy last few weeks of the year. On November 28th Abu Dhabi launched a new state-backed artificial-intelligence company, AI71, that will commercialise its leading “large language model” (LLM), Falcon. On December 11th Mistral, a seven-month-old French AI startup, announced a blockbuster \$400m funding round, which insiders say will value the firm at over \$2bn. Four days later Krutrim, a new Indian startup, unveiled India’s first multilingual LLM, barely a week after Sarvam, a five-month-old one, raised \$41m to build similar Indian-language models.

Ever since OpenAI, an American firm, launched ChatGPT, its humanlike conversationalist, in November 2022, just about every month has brought a flurry of similar news. Against that backdrop, the four latest announcements might look unexceptional. Look closer, though, and they hint at something more profound. The three companies are, in their own distinct ways, vying to become AI national champions. “We want AI71 to compete globally with the likes of OpenAI,” says Faisal al-Bannai of Abu Dhabi’s Advanced Technology Research Council, the state agency behind the Emirati startup. “Bravo to Mistral, that’s French genius,” crowed Emmanuel Macron, the president of France, recently. ChatGPT and other English-first LLMs “cannot capture our culture, language and ethos”, declared Krutrim’s founder, Bhavish Aggarwal. Sarvam started with Indian languages because, in the words of its co-founder, Vivek Raghavan, “We’re building an Indian company.”

AI is already at the heart of the intensifying technological contest between America and China. In the past year their governments have pledged

\$40bn-50bn apiece for AI investments. Other countries do not want to be left behind—or stuck with a critical technology that is under foreign control. In 2023 another six particularly AI-ambitious governments around the world—Britain, France, Germany, India, Saudi Arabia and the United Arab Emirates (UAE)—promised to bankroll AI to the collective tune of around \$40bn (see chart). Most of this will go towards purchases of graphics-processing units (GPUs, the type of chips used to train AI models) and factories to make such chips, as well as, to a lesser extent, support for AI firms. The nature and degree of state involvement varies from one wannabe AI superpower to another. It is early days, but the contours of new AI-industrial complexes are emerging.

Start with America, whose tech firms give everyone else AI envy. Its vibrant private sector is innovating furiously without direct support from Uncle Sam. Instead, the federal government is spending around \$50bn over five years to increase domestic chipmaking capacity. The idea is to reduce America's reliance on Taiwanese semiconductor manufacturers such as TSMC, the world's biggest and most sophisticated such company. Supplies from Taiwan could, fear security hawks in Washington, be imperilled if China decided to invade the island, which it considers part of its territory.

Another way America intends to stay ahead of the pack is by nobbling rivals. President Joe Biden's administration has enacted brutal export controls that ban the sale of cutting-edge AI technology, including chips and chipmaking equipment, to adversaries such as China and Russia. It has also barred Americans from sharing their AI expertise with those countries.

It is now coercing those on the geopolitical fence to fall in line. In October the American government started requiring companies in third countries, including Saudi Arabia and the UAE, to secure a licence in order to buy AI chips from Nvidia, an American firm that sells most of them. The rules have a "presumption of approval". That means the government will

“probably allow” sales to such firms, says Gregory Allen, who used to work on AI policy at the Department of Defence—as long, that is, as they do not have close ties to China. On December 6th Xiao Peng, who runs a state-backed AI startup in Abu Dhabi called G42, announced that the company would be cutting ties with Chinese hardware suppliers such as Huawei, a Chinese electronics company.

China’s AI strategy is in large part a response to American techno-containment. According to data from JW Insights, a research firm, between 2021 and 2022 the Chinese state spent nearly \$300bn to recreate the chip supply chain (for AI and other semiconductors) at home, where it would be immune from Western sanctions. A lot of that money is probably wasted. But it almost certainly helped Huawei and SMIC, China’s biggest chipmaker, to design and manufacture a surprisingly sophisticated GPU last year.

The central and local authorities also channel capital into AI firms through state-backed “guidance funds”, nearly 2,000 of which around the country invest in all manner of technologies deemed to be strategically important. The Communist Party is guiding private money, too, towards its technological priorities. Often it does so by cracking down on certain sectors—most recently, in December, video-gaming—while dropping heavy hints about which industries investors should be looking at instead. The government is also promoting data exchanges, where businesses can trade commercial data on everything from sales to production, allowing small firms with AI ambitions to compete where previously only large data-rich firms could. There are already 50 such exchanges in China.

Elements of this state-led approach are being emulated in other parts of the world, notably in the Gulf’s petrostates. Being autocracies, Saudi Arabia and the UAE can move faster than democratic governments, which must heed voters’ concerns about AI’s impact on things like privacy and jobs. Being wealthy, they can afford both the GPUs (on which the two countries have

together so far splurged several hundred million dollars) and the energy needed to run the power-hungry chips.

They can also plough money into developing human capital. Their richly endowed universities are quickly climbing up global rankings. The AI programme at King Abdullah University of Science and Technology in Saudi Arabia and the Mohamed bin Zayed University of Artificial Intelligence (MBZUAI) in Abu Dhabi, the world's first AI-focused school, have poached star professors from illustrious institutions such as the University of California, Berkeley, and Carnegie Mellon University in Pittsburgh. Many of their students and researchers come from China. And plenty stick around. Nearly all of MBZUAI's graduates, who number a couple of hundred, stay in the region to work at local firms and labs, says its provost, Timothy Baldwin (himself lured to the Middle East from the University of Melbourne).

The Gulf approach is producing results. The capabilities of the Falcon model, first built by a team of 20 or so engineers, rival those of Llama 2, the most widely used "open-source" model, devised by Meta, an American tech giant. AI71 plans to improve its open-source models using national datasets from fields including health, education and, some day, perhaps oil. "In the last 50 years, oil drove the country...now data is the new oil," says Mr al-Bannai.

| *The alignment problem*

A third group of governments is combining elements of America's approach with those of the Chinese and Emiratis. The EU has its version of America's incentives for domestic chipmaking. So do some member states: Germany is footing a third of the €30bn (\$33bn) bill for a new chip factory to be built there by Intel, an American chipmaker. Outside the bloc, Britain has promised to funnel £1bn (\$1.3bn) over five years to AI and supercomputing (albeit without going into detail about how exactly the money will be spent). India's government is promoting manufacturing,

including of semiconductors, with generous “production-linked incentives”, encouraging big cloud-computing providers to build more Indian data centres, where AI models are trained, and thinking about buying \$1.2bn-worth of GPUs.

Like China and the Gulf but unlike America, where federal and state governments are reluctant to part with public data, India and some European countries are keen on making such data available to firms. France’s government “has been very supportive” in that regard, says Arthur Mensch, Mistral’s boss. Britain’s is considering allowing firms to tap rich data belonging to the National Health Service. India’s government has enormous amounts of data from its array of digital public services, known as the “India Stack”. Insiders expect it eventually to integrate Indian AI models into those digital services.

In contrast to China, which regulates consumer-facing AI with a heavy hand, at least for the time being Britain, France, Germany and India favour light-touch rules for AI or, in India’s case, none at all. The French and German governments have soured on the EU’s AI Act, the final details of which are being hotly debated in Brussels—no doubt because it could constrain Mistral and Aleph Alpha, Germany’s most successful model-builder, which raised €460m in November.

It is natural for countries to want some control over what may prove to be a transformational technology. Especially in sensitive and highly regulated sectors such as defence, banking or health care, many governments would rather not rely on imported AI. Yet each flavour of AI nationalism also carries risk.

America’s beggar-thy-neighbour approach is likely to upset not just its adversaries but also some allies. China’s heavy regulation may offset some of the potential gains from its heavy spending. Building models for local

languages, as Krutrim and Sarvam in India plan to do, may prove futile if foreign models continue to improve their multilingual capabilities. The Gulf's bet on open-source models may misfire if other governments limit their use, as Mr Biden has hinted at in a recent executive order and the EU could do through its AI Act, out of fear that open LLMs could be put to malign uses by mischief-makers. Saudi and Emirati institutions may struggle to hold on to talent; a developer who worked on Falcon admits it greatly benefited from a partnership with a French team of engineers who have since been poached by Hugging Face, a high-flying Silicon Valley AI startup. As one sceptical investor notes, it is not yet clear how vast or useful public Emirati data actually is.

As Nathan Benaich of Air Street Capital, a venture-capital firm, sums it up, most efforts to create national models "are probably a waste of money". Mr Benaich's warning is unlikely to dissuade AI-curious governments, mindful of the rewards should they succeed, from meddling. Mr Macron will not be the only leader to greet it with a Gallic shrug. ■



国家机器

欢迎来到人工智能民族主义的时代

世界各地的主权国家正竞相控制它们的科技运数【深度】

二〇二三年最热门的技术在年末的几周里热闹非凡。11月28日，阿布扎比推出了一家由政府支持的新人工智能公司AI71，致力于把阿联酋领先的“大语言模型”（LLM）Falcon商业化。12月11日，成立七个月的法国AI创业公司Mistral宣布了一轮4亿美元的大手笔融资，知情人士称这将使该公司估值超过20亿美元。四天后，印度新兴创业公司Krutrim发布了印度首个多语言LLM，而不过一周前，创立五个月的Sarvam才刚融资了4100万美元构建类似的印地语语言模型。

自从美国公司OpenAI在2022年11月推出了对话能力接近人类的ChatGPT以来，几乎每个月都会冒出一连串类似的新闻。在这一背景下，最近的这四个公告看似并无特别之处。但仔细观察，就会发现它们透露出某种更深层的动态。这三家公司正在以各自不同的方式竞逐AI国家冠军之位。AI71背后的政府机构、阿布扎比的先进技术研究委员会（Advanced Technology Research Council）的费萨尔·班奈（Faisal al-Bannai）表示：“我们希望AI71能在全球范围里与OpenAI这样的公司竞争。”法国总统马克龙最近喜不自胜地夸赞：“为Mistral喝彩，它是法国人天分的体现。”Krutrim的创始人巴维什·阿加瓦尔（Bhavish Aggarwal）宣称，ChatGPT和其他以英语为先的LLM“无法捕捉我们的文化、语言和精神”。Sarvam的联合创始人维韦克·拉加万（Vivek Raghavan）表示“我们是在建立一家印度公司”，因此Sarvam从印地语开始。

AI已经是美国和中国日益激烈的科技竞争的核心。在过去一年中，两国政府都承诺了四五百亿美元的AI投资。其他国家不想落后或受制于一项由他国掌控的关键技术。2023年，世界上另外六个在AI上格外有抱负的政府——英国、法国、德国、印度、沙特阿拉伯和阿联酋——承诺将总共投入约400亿美元用于支持AI（见图表）。其中大部分资金将用于购买图形处理单元（GPU，用于训练AI模型的芯片）和制造此类芯片的工厂，还有较

少部分用来支持AI公司。意欲成为AI超级大国的国家在政府参与的性质和程度上各不相同。现在一切还只是个开始，但新的AI产业联合体的轮廓正在浮现。

先来看美国，它的科技公司拥有令各方羡慕的AI实力。其充满活力的私营部门正在疯狂创新，而无需山姆大叔的直接支持。美国政府转而致力提升国内的芯片制造能力，正为此在五年内投入约500亿美元。其想法是减少美国对台湾半导体制造商（如全球最大、最先进的台积电）的依赖。华盛顿的安全鹰派担心，如果中国大陆决定对台动武（中国大陆认为台湾是中国领土的一部分），那么来自台湾的供应可能会受到威胁。

美国试图保持领先的另一个方式是阻挠竞争对手。拜登政府已实施严厉的出口管制，禁止向中国和俄罗斯等对手销售尖端AI技术，包括芯片和芯片制造设备。它还禁止美国人与这些国家分享他们的AI专业知识。

现在，美国正在迫使那些在地缘上不肯选边的国家站到它这一边。去年10月，美国政府规定，包括沙特阿拉伯和阿联酋在内的第三国公司须获得许可才能从销售了全球大部分AI芯片的美国公司英伟达购货。这些规则有一个“批准假定”。也就是说，美国政府“可能会允许”向这些公司销售，曾在国防部负责AI政策的格雷戈里·艾伦（Gregory Allen）说——只要它们与中国没有密切联系。12月6日，掌管由政府支持的阿布扎比AI创业公司G42的肖鹏宣布，公司将切断与电信公司华为等中国硬件供应商的联系。

中国的AI战略在很大程度上是对美国技术遏制的回应。根据研究公司集微咨询的数据，2021年至2022年间，中国政府花费了近3000亿美元在国内重建芯片供应链（包括AI和其他半导体），以求对西方制裁免疫。其中很多钱可能被浪费掉了。但它几乎肯定帮助华为和中国最大的芯片制造商中芯国际在去年设计和制造了一款先进程度出人意料的GPU。

中央和地方政府还通过政府“引导基金”将资本导向AI公司，全国有近2000个此类基金投资于各种被认为具有重要战略意义的技术。共产党也在引导私人资金投向它要优先发展的技术。为实现这一目标，它通常会打击某些

行业——最近一次是在12月整顿电子游戏业——同时重点提示投资者应该转而关注哪些行业。中国政府还在推动建立数据交易所，企业可以在这里交易从销售到生产的各类商业数据，使怀抱AI雄心的小公司能够在过去唯数据充足的大公司才能立足的领域里竞争。中国已有50个此类交易所。

这种政府主导的模式中的一些要素正被世界其他地区仿效，尤其是海湾的石油国家。沙特和阿联酋这样的威权国家可以比民主政府行动更快，后者必须听取选民对AI影响隐私和就业等方面的担忧。而由于国家富有，它们既买得起GPU（这两个国家到目前为止已经为此花费了几亿美元），也能负担运行这些高耗能芯片所需的能源。

它们还能投资发展人力资本。它们的大学资金充裕，全球排名正在迅速攀升。沙特的阿卜杜拉国王科技大学（King Abdullah University of Science and Technology）的AI项目，以及阿布扎比的穆罕默德·本·扎耶德人工智能大学（MBZUAI，世界上第一所专注于AI的大学）已经从加州大学伯克利分校和匹兹堡的卡内基梅隆大学等声名赫赫的院校挖走了明星教授。它们的许多学生和研究人员来自中国，而且其中很多人留了下来。MBZUAI的毕业生大约有几百人，几乎全部留在了中东地区，在当地的公司和实验室工作，MBZUAI的教务长蒂莫西·鲍德温（Timothy Baldwin）说。他本人也是从墨尔本大学被吸引到中东的。

海湾国家的模式正在取得成果。最初由大约有20名工程师的团队构建的Falcon模型的性能可媲美美国科技巨头Meta设计的最广泛使用的“开源”模型Llama 2。AI71计划利用健康、教育等领域的国家数据集改进其开源模型，有朝一日或许还会包括石油领域。“过去50年里，石油驱动了这个国家……现在数据是新的石油。”班奈说。

｜ 对齐问题

第三类政府正在把美国模式与中国和阿联酋的模式中的要素结合起来。欧盟有类似美国的国内芯片制造激励措施。它的一些成员国也有这类措施：德国承担了美国芯片制造商英特尔将在该国建造的新芯片工厂300亿欧元（330亿美元）造价的三分之一。在欧盟之外，英国承诺在五年内向AI和

超级计算领域投入10亿英镑（13亿美元），尽管没有详细说明这笔钱会怎么用。印度政府正在推动包括半导体制造在内的制造业，它提供慷慨的“生产挂钩激励”，鼓励大型云计算提供商在印度建设更多可用于训练AI模型的数据中心，并考虑购买总价值12亿美元的GPU。

印度和一些欧洲国家热衷于向企业提供公共数据，这与中国和海湾国家相似，而与美国不同（联邦和州政府不愿分享这类数据）。法国政府在这方面“非常支持”，Mistral老板亚瑟·门什（Arthur Mensch）说。英国正在考虑允许企业获取国家医疗服务体系（NHS）中的丰富数据。印度政府拥有大量来自各类数字公共服务（被称为“印度堆栈”）的数据，知情人士预计它最终将把印度的AI模型整合到这些数字服务中。

中国对面向消费者的AI实行严格管制，而英国、法国、德国和印度则倾向于宽松监管AI——至少在目前是如此，印度更是完全不加管束。法国和德国政府对欧盟的《人工智能法案》（AI Act）感到不满。谈判代表们正就该法案的最终细节在布鲁塞尔激烈辩论——毫无疑问，这是因为它可能会限制Mistral和德国最成功的模型开发公司Aleph Alpha（它在去年11月融资4.6亿欧元）。

各国想要对一项可能具有变革性的技术有所控制是自然的事。尤其是在国防、银行或医疗等敏感且受高度监管的领域，许多政府不愿意依赖进口AI。然而，各色AI民族主义也会带来风险。

美国以邻为壑的政策不仅可能激怒对手，也很可能惹恼一些盟友。中国的严格监管可能会抵消其大量支出带来的潜在收益。在印度，Krutrim和Sarvam计划为本地语言构建模型，但如果外国模型继续提高其多语言能力，这些努力就可能是无用功。如果其他政府担心开放式LLM可能被图谋不轨者恶意使用而限制对开源模型的使用，海湾国家对这类模型的押注可能会落空。拜登在最近的行政命令中已暗示会限制使用开源模型，欧盟也可能通过其《人工智能法案》这样做。沙特和阿联酋的机构可能难以留住人才；一位参与Falcon项目的开发人员承认，该项目从与一个法国工程师团队的合作中受益匪浅，这些工程师后来被高歌猛进的硅谷AI创业公司

Hugging Face挖走。正如一位持怀疑态度的投资者所指出的，阿联酋公共数据实际上有多丰富和有用还是个未知数。

正如风险投资公司Air Street Capital的内森·贝奈奇（Nathan Benaich）所总结的那样，大多数创建国家模型的努力“可能是浪费钱”。贝奈奇的提醒不太可能说服那些对AI兴致盎然的政府不插手，它们一心想着如果成功将能获得的回报。马克龙不会是唯一以耸耸肩来回应的领导人。■



The Gulf between them

Can Sino-Arabian business ties replace Sino-American ones?

The Middle Kingdom gets cosy with the Middle East

WHEN CHINESE and Middle Eastern money men meet, it is usually behind closed doors. Last month they mingled openly in the lobby of the Hong Kong Stock Exchange, at the “FII Priority” summit, an event organised by the Public Investment Fund (PIF), a \$780bn vehicle for Saudi sovereign wealth. It was the first meeting of its kind in east Asia. It will not be the last. The PIF announced it was planning to set up an office in China. Mubadala and the Investment Corporation of Dubai, two Emirati sovereign wealth funds, the Qatar Investment Authority and Kuwait Investment Authority are all said to be preparing to deploy more capital in the world’s second-biggest economy. They think they can do this without angering the increasingly China-wary West. “We are friendly people, we are friends with everyone,” Jerry Todd, an executive at the PIF, told the conference in Hong Kong.

China’s investment firms and the companies they back need friends right now. As Sino-American geopolitics sour, American investments in China have collapsed. Chinese tech firms got \$1.2bn from American venture capitalists in 2022, down from \$14bn in 2018. Mergers and acquisitions (M&A) by American firms in China fell below \$9bn in 2023, down from \$20bn five years earlier. Meanwhile M&A deals by Gulf entities have ballooned—from next to nothing in 2019 to nearly \$9bn in 2023, according to data from LSEG, a financial-information firm (see chart).

Last month NIO, a Chinese Tesla wannabe, said it had received \$2.2bn from CYVN Holdings, a firm controlled by Abu Dhabi’s government that had previously put more than \$1bn into the electric-car maker. The NEOM Investment Fund, part of a pharaonic Saudi project to build a futuristic city

in the desert, has backed Pony.AI, a part-Chinese developer of self-driving tech. Earlier in the year Saudi Aramco, the kingdom's oil colossus, invested \$3.6bn in a Chinese petrochemical refinery called Rongsheng, and entered into a joint venture with the PIF and Baosteel, one of China's largest steelmakers, to produce high-quality metal plates in Saudi Arabia. Chinese VC firms are tight-lipped in public about their limited partners but privately confirm that in the past two years interest from Middle Eastern ones has jumped.

Tech talent, of which the Gulf is short but China has aplenty, is flowing in the other direction. The Shenzhen campus of the Chinese University of Hong Kong and the Shenzhen Research Institute of Big Data are helping Saudi Arabia's King Abdullah University of Science and Technology (KAUST) build an artificial-intelligence model to power an Arabic-language chatbot called AceGPT. Around one in five of KAUST's students and one in three of its postdoctoral researchers are Chinese.

The budding Sino-Arabic relationship will not replace the wilting Sino-American one. Dubai and Riyadh cannot match the depth of Silicon Valley's expertise and New York's capital markets. The Gulf wealth funds mostly cut cheques for a few hundred million dollars, whereas Americans also back early-stage startups in need of a few million. And for the Gulf, America remains a vital partner. In December an Emirati AI startup called G42, whose backers include Mubadala and Silver Lake, an American investor, said it would sever ties with Chinese firms rather than lose access to American technology. "We cannot work with both sides," its chief executive, Xiao Peng, told the Financial Times. So much for being friends with everyone. ■



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中阿经贸关系能否取代中美经贸关系？

中国与中东关系拉近

中国和中东的金融家会面时一般都是闭门会议。上月，在港交所的大会堂里，他们在“未来投资倡议优先事项”峰会（FII Priority summit）上举行了公开会谈。组织此次活动的公共投资基金（PIF）是手握7800亿美元的沙特主权财富基金。这是东亚地区首次举行此类会议。但不会是最后一次。PIF宣布计划在中国设立办事处。据称，阿联酋两家主权财富基金穆巴达拉（Mubadala）和迪拜投资公司（Investment Corporation of Dubai）、卡塔尔投资局（Qatar Investment Authority）以及科威特投资局（Kuwait Investment Authority）都准备在这个全球第二大经济体部署更多资本。它们认为可以在不激怒日益警惕中国的西方世界的情况下做到这一点。“我们与人为善，我们和所有人都是朋友。”PIF高管杰里·托德（Jerry Todd）在香港的会议上表示。

中国的投资公司以及它们所支持的公司现在需要朋友。随着中美地缘关系恶化，美国在中国的投资已经崩溃。2022年，中国科技公司从美国风险投资机构那里仅获得12亿美元，低于2018年的140亿美元。2023年，美国公司在中国的并购交易还不到90亿美元，低于五年前的200亿美元。与此同时，根据金融信息公司伦敦交易所集团（LSEG）的数据，由海湾实体达成的并购交易激增——从2019年的几乎为零飙升到2023年的近90亿美元（见图表）。

上个月，想要成为中国版特斯拉的电动汽车制造商蔚来表示从CYVN Holdings获得22亿美元，此前它已经从这家由阿布扎比政府控制的公司获得超过10亿美元投资。NEOM投资基金（NEOM Investment Fund）是沙特一个在沙漠中建造未来城市的宏大项目的一部分，该基金投资了有中国背景的自动驾驶技术开发商小马智行。2023年更早时，沙特石油巨头沙特阿美（Saudi Aramco）向中国炼油企业荣盛石化投资36亿美元，并与PIF和中国最大钢铁企业之一宝钢成立了一家合资企业，在沙特生产高质量的金

属板材。中国的风投公司在公开场合对其有限合伙人的信息守口如瓶，但私下证实过去两年里来自中东的风投兴趣大增。

中国盛产海湾缺乏的技术人才，这些人才正涌向海湾。香港中文大学深圳校区和深圳大数据研究院正在帮助沙特阿拉伯的阿卜杜拉国王科技大学（KAUST）搭建一个人工智能模型，来驱动一个名叫AceGPT的阿拉伯语聊天机器人。KAUST大约五分之一的学生和三分之一的博士后研究人员是中国人。

萌芽中的中阿关系不会取代日渐枯萎的中美关系。迪拜和利雅得没有硅谷那么丰富的专业知识，也没有纽约那样深厚的资本市场。海湾的财富基金开出的大多是数亿美元的支票，但美国人还支持需要数百万美元的早期创业公司。而对海湾来说，美国仍然是一个至关重要的伙伴。上月，一家名为G42的阿联酋人工智能创业公司表示，宁愿切断与中国公司的联系，也不愿失去获得美国技术的机会。G42的投资者包括穆巴达拉和美国投资公司银湖（Silver Lake）。该公司首席执行官肖鹏向《金融时报》表示，“我们不能跟两边都合作。”所谓的和所有人做朋友看来也就这样了。■



Life ACWAtic

Meet ACWA Power, Saudi Arabia's unlikely solar star

The utility has green ambitions beyond its desert home

SITTING ATOP a fifth of the world's oil reserves, Saudi Arabia doesn't spring to mind when you think about renewables. Muhammad bin Salman, its crown prince and de facto ruler, would like this to change. He wants half of Saudi electricity to come from wind and solar farms by 2030. Two-thirds of that capacity, or around 40 gigawatts (GW) will, if Prince Muhammad gets his wish (as he tends to do), be courtesy of one firm: ACWA Power.

For most of its 19-year existence the utility was a relatively anonymous family-run affair. No longer. Since it went public in Riyadh in 2021 its market value has swelled nearly four-fold. It is now worth \$50bn. The Public Investment Fund (PIF), the steward of Saudi sovereign wealth, owns a 44% stake. ACWA has 24GW of green projects at home and abroad either already running or at an advanced stage, up from 0.3GW in 2014. Add its other capacity under construction and the total is 54GW. Its original business of desalinating water went from 1m cubic metres a day in 2006 to 7.6m cubic metres in December. Its newish boss, Marco Arcelli, a seasoned Italian energy executive, expects assets it has a stake in to triple between now and 2030, to \$250bn. Its projects will, he hopes, help create a broader domestic green-energy supply chain. "We are a big enabler," he says.

ACWA has thrived as many other renewables operators around the world have struggled. Whereas those rivals are seeing the cost of projects soar as a result of rising interest rates, ACWA has received non-interest-bearing loans from the PIF, in addition to debt secured against individual projects and loans from banks to tide it over while it raises more equity capital and brings in partners. Access to easy money has allowed ACWA to expand capacity, while lowering costs for customers. This has helped make the

levelised cost of Saudi solar energy, which takes into account both construction and operation of a power plant, among the lowest in the world.

Nevertheless, ACWA's returns on domestic projects are low by global standards. Mr Arcelli is thus keen to take advantage of juicier ones on offer abroad. He is investing nearby (in Bahrain, Egypt, Jordan, Oman, Turkey and the United Arab Emirates) and farther afield (Azerbaijan, Morocco, South Africa and Uzbekistan). Two-fifths of ACWA's overall capacity is to be found outside Saudi Arabia. It is also eyeing China, a highly competitive market but one where ACWA could, thinks Mr Arcelli, gain both scale and technology partners in the form of Chinese manufacturers of wind turbines and solar panels.

ACWA has its work cut out. To meet Prince Muhammad's domestic goals for it, the company must add 6-7GW of capacity—equivalent to three or four big projects—every year for the rest of the decade. It currently has just 14GW at various stages of development. Managing fast expansion will require a laser focus on costs (those of its nascent hydrogen venture has already risen by 70% from initial estimates, to \$8bn). It will also require more debt. In September ACWA was already sitting on \$7bn of it, equivalent to seven times its earnings before interest, taxes, depreciation and amortisation. Such a ratio would be considered a red flag at most firms.

ACWA may yet rise to the challenge. It can count on the PIF's deep pockets. And it is a fast learner; its domestic 1.5GW Sudair solar project may be fully up and running in just over two years, reckons Oliver Connor of Citigroup, a bank, brisk by industry standards. Mr Arcelli wants things to go faster still. Given that the prince is watching, that is no surprise. ■



ACWA生平

认识下ACWA Power，沙特冷门的太阳能明星

这家公用事业公司的绿色雄心冲出了沙漠家园

说到可再生能源，你通常不会想到坐拥全球五分之一石油储量的沙特阿拉伯。沙特的实际统治者、王储穆罕默德·本·萨勒曼想要改变你的想法。他希望到2030年，沙特一半的电力都来自风能和太阳能。如果这位王储得偿所愿（通常都能），那么其中三分之二也就是大约40GW的发电能力都将由一家公司提供：沙特国际电力和水务公司（ACWA Power）。

在成立的19年间，这家公用事业公司大多数时候都只是个不大起眼的家族企业。现在不一样了。自2021年在利雅得上市以来，ACWA的市值已经增长了近三倍，目前为500亿美元。管理着沙特主权财富的公共投资基金（PIF）持有44%的股份。ACWA在国内外已运营的或处于收尾阶段的绿色项目的总装机容量达24GW，而2014年仅为0.3GW。如果加上其他在建项目，总装机容量达到54GW。ACWA以海水淡化业务起家，其淡化水产量从2006年的每天100万立方米增加到去年12月的每天760万立方米。ACWA上任不久的意大利老板马尔科·阿尔切利（Marco Arcelli）有丰富的能源业管理经验，他预计从现在到2030年ACWA参与投资的项目资产将增长两倍，达到2500亿美元。他希望这些项目能够帮助建立一个更广泛的国内绿色能源供应链。“我们是大型赋能者。”他表示。

ACWA蓬勃扩张之时，世界各地的许多其他可再生能源运营商却在艰难求生。上升的利率让这些竞争对手的项目成本飙升，而ACWA除了以单个项目为抵押来借债和从银行贷款，还从PIF获得了无息贷款以度过难关；同时它还筹集更多股权资本、引入合作伙伴。能轻易获得资金让ACWA得以扩大发电能力，同时降低客户的成本。这使得沙特太阳能发电的平准化成本（将发电厂的建设和运营成本都考虑在内）在全球处于最低水平。

然而按照全球标准来看，ACWA国内项目的回报率处于低水平。因此阿尔切利迫切想利用在国外可以拿到的利润更高的项目。他投资的项目有近有

远，近的有巴林、埃及、约旦、阿曼、土耳其和阿联酋，远的有阿塞拜疆、摩洛哥、南非和乌兹别克斯坦。ACWA总装机量有五分之二位于沙特以外。它还瞄准了中国，尽管这是个竞争激烈的市场，但阿尔切利认为ACWA可以形成业务规模，还能找到中国的风力涡轮机和太阳能电池板制造商做自己的技术合作伙伴。

ACWA面临巨大挑战。为了实现穆罕默德王储为它设立的国内目标，它必须在2030年前每年新增6至7GW的装机量，也就是要有三到四个大型项目。而目前它在国内处于各种开发阶段的项目加在一起也只有14GW。管理快速扩张需要高度聚焦成本（其新兴的氢能业务的成本已经比最初估计高出70%，达到80亿美元）。此外也需要借更多债。去年9月，ACWA的债务就已经达到70亿美元，相当于其税息折旧及摊销前利润的七倍。这样的比率在大多数公司都会被视作危险信号。

但ACWA仍可能临危不乱。它可以倚赖PIF的雄厚财力。而且它学得很快；花旗银行的奥利弗·康纳（Oliver Connor）认为，ACWA的体量1.5GW的国内太阳能项目Sudair可能会在两年多一点的时间内就全面建成并投入运营，这以行业标准来看已经很高效率。但阿尔切利希望项目进展得更快些。这也难怪，毕竟穆罕默德王储在背后盯着呢。■



Hacker heaven

Why is Brazil a hotspot for financial crime?

Its success as a fintech hub is mostly to blame

BRAZILLIANS HAVE long been early adopters of fintech. In 2017 EY, an accounting firm, found that two-fifths of Brazilians regularly used online banking, one of the highest rates worldwide. In 2020 44% of customers had a digital-only account, compared with less than 20% in the United States and Canada, according to a survey by Accenture, a consulting firm. That year the central bank released Pix, an instant-payments platform. It has been wildly successful. Today it has 3bn transactions a month. That is five times more than transactions by debit and credit cards combined.

This bonanza has attracted cyber-criminals. Their main weapon has been the “banking trojan”, a programme that steals users’ account information. According to Kaspersky Lab, a cyber-security firm, Brazil is the top country for attacks by banking trojans, with 1.8m attempted infections from June 2022 to July 2023 (the latest data available). Globally eight of the 13 most popular types of trojans are made in Brazil.

Cyber-criminals initially focused on trojans as they require little skill to use. However, as banks developed better defences, criminals were forced to branch out into more complex and lucrative attacks. Brazil’s underworld has developed the most advanced “point of sale” malware, which scammers use to filch bank details from card readers, according to Kaspersky Lab. Known as Prilex, this application can block contactless payments by stopping the short-range connection between a credit card and the payment terminal. The terminal reads: “Error. Please Insert.” When a customer inserts her card and PIN, the malware uses the credentials to authorise a fraudulent transaction. During Rio’s carnival in 2016, a hacker used a basic version of this software to remotely take over 1,000 ATMs.

Another example is ransomware, which gangs use to scramble computers and demand money to restore them. In October last year Brazil's lawmakers met to discuss the increasing use of artificial intelligence in cyber-crime, too.

The financial losses are big. According to Andre Fleury of Accenture, Brazil is in the top five countries for the cost of cyber-crime. He estimates the figure is around \$20bn per year. That is the equivalent of 0.9% of GDP. There is some hope, though. In 2022 a hefty data-protection law came into effect, forcing companies to defend consumers' data. In 2023 Brazil's banks spent \$9bn on cyber-security, nearly double the amount in 2019, according to the Brazilian Federation of Banks. The bigger problem is naive customers who fall for scams, says Eduardo Mônaco of ClearSale, a Brazilian fraud-management company. Until they fully know the risks, there will be plenty more phish in the sea. ■



黑客天堂

巴西为什么是金融犯罪的高发地？

成功跻身金融科技中心是主要原因

在采用金融科技方面，巴西人早就走在了前面。2017年，安永会计师事务所发现，五分之二的巴西人经常使用网上银行，这一比例在全球属于第一梯队。根据咨询公司埃森哲的一项调查，2020年，巴西44%的消费者拥有一个纯数字账户，而在美国和加拿大这一比例不到20%。同年，巴西央行推出了即时支付平台Pix并大获成功。如今，每月通过Pix进行的交易达30亿笔，是借记卡和信用卡交易总和的五倍。

这一富矿带吸引了众多网络犯罪分子。他们主要利用“银行木马”程序来窃取用户的账户信息。根据网络安全公司卡巴斯基实验室（Kaspersky Lab）的数据，巴西是遭受银行木马攻击最多的国家——从2022年6月到2023年7月（可获得的最新数据），未遂的银行木马攻击有180万次之多。全球最流行的13种银行木马中有八种是在巴西编写的。

网络犯罪分子最初主要利用木马，是因为使用它们不需要什么技能。但随着银行加强了防御，犯罪分子不得不转而采取更为复杂、也更能获利的攻击手段。卡巴斯基实验室称，巴西黑社会开发出了最先进的针对POS机的恶意软件，骗子利用该软件从读卡器窃取银行账户的详细信息。这款名为Prilex的应用程序可以通过中断信用卡与支付终端之间的短程连接来阻止非接触式支付。支付终端会显示：“错误。请插卡。”当顾客插入银行卡并输入密码时，这个恶意软件就会使用认证信息授权欺诈性交易。在2016年里约狂欢节期间，一名黑客使用该软件的基础版远程控制了1000多台自动取款机。

另一种方式是勒索软件，犯罪团伙用它来扰乱电脑，然后索要赎金以换取电脑恢复。去年10月，巴西的立法者也开会讨论了不断增长的利用人工智能实施网络犯罪的问题。

这带来了巨大的经济损失。埃森哲的安德烈·弗勒里（Andre Fleury）表示，巴西是为网络犯罪付出最高代价的五个国家之一。他估计巴西每年遭受的损失约为200亿美元，相当于其GDP的0.9%。不过情况有望获得改善。2022年，一部严格的数据保护法生效，强制要求企业保护消费者的数据。巴西银行业联合会（Brazilian Federation of Banks）表示，巴西的银行在2023年为网络安全花费90亿美元，几乎是2019年的两倍。巴西一家防欺诈公司ClearSale的爱德华多·莫纳戈（Eduardo Mônaco）表示，更大的问题是消费者太轻信，容易上当受骗。在他们完全了解风险之前，网络海洋中还会有很多诱饵等着鱼儿上钩。 ■



Towering ambition

Can India, Indonesia and Saudi Arabia be the next great economies?

Meet the countries making bold—and risky—bets on growth

POLITICIANS AND policymakers all over the world share a preoccupation: how to make their countries richer. The trouble is that the route to prosperity looks ever more daunting. The global economy is changing, as new, green technologies emerge and trading relationships fragment. In countries that are already rich the state, after decades of free-market rhetoric, is back in a big way. Governments are spending hundreds of billions on handouts for industries they deem to be strategically important.

In the face of this, many developing countries' ideas for growth are staggeringly ambitious. India and Indonesia hope to become high-income countries within 25 years. Muhammad bin Salman, Saudi Arabia's crown prince, wants to diversify and develop its economy just as rapidly. Refreshingly, such plans are more outward-looking than many development strategies of old. But they contain pitfalls, too.

In many ways, the developing world is choosing to bank on globalisation. Indonesia wants a bigger role in green supply chains. It seeks to do everything from mining and refining nickel, even to building the electric vehicles that run on it. It then wants to export the finished products to the rest of the world. Countries in the Gulf want to become attractive homes for global business, and are opening up to flows of people, cargo and cash. Narendra Modi envisions India as a high-tech manufacturer for the world, churning out microchips and smartphones.

That is a welcome shift. Less than 50 years ago India hoped to grow by closing itself off from the global economy. It turned out to be an approach that failed miserably. Some still suggest that India's domestic demand

could carry its growth.

But serving foreign markets plays a vital role in development. It keeps firms honest, by forcing them to compete in markets that their governments do not control. It lets them reach the largest possible scale. And foreign customers can teach firms how to serve them better. In East Asia export performance was also a useful yardstick for policymakers, because it revealed which industries deserved their continued backing.

Nonetheless, today's development strategies also hold dangers. In many countries governments are running the risk of warping the economy in the name of nurturing it. Saudi Arabia's onslaught of industrial policy, mainly disbursed as handouts from the Public Investment Fund, exceeds the spending even of America's Inflation Reduction Act. In order to help exporters grow, India is seeking to fence off its high-tech manufacturers behind tariffs and subsidies. Indonesia's all-in bet on nickel leaves it perilously exposed, should other battery chemistries prevail.

The rich world's new-found zeal for protectionism may make it tempting for poorer countries to follow suit. Yet floods of cash and shelter from foreign competition make it impossible to know whether a government's development gambles are paying off. A bet on one technology could go wrong if others emerge.

Parts of the developing world have paid dearly to learn these lessons before. For most of the 1960s Africa's policymakers had the same ideas as East Asia's, and the continent grew as fast, until picking the wrong champions left it languishing between 1975 and 1985. It is the poorest region in the world today.

Picking winners is also harder than it was 60 years ago. Then the choice was over which form of manufacturing to promote. Cheap, abundant

workforces gave poor countries an edge. Manufacturing was the only sector in which poor countries got better faster than rich countries.

Today, however, factories have become more capital-intensive. Though manufacturing still offers a way to boost a country's productivity, it is less certain to become a poor country's comparative advantage. That makes it even harder for policymakers to spot a good industry for them to place their bets. Rather than gambling with the public's money, they would be better off keeping it off the table.

There are, after all, plenty of other worthwhile things to spend it on. The state has a vital role in providing public goods by investing in infrastructure to stitch regions together, or education to boost workers' skills. That might still favour some industries over others. But if economies stay open, then they will at least experience the disciplines and benefits of trade.

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The stakes are high. The developing world is home to over 6bn people and some of the most fragile democracies. Getting growth wrong would keep such places poorer for longer. That would be not just a human tragedy, but also a potential source of political instability. To avert it, the developing world needs to be bold—and resist the urge to build walls around itself. ■



【首文】凌云壮志

印度、印尼和沙特能否成为下一批大经济体？

来看看这些押下大胆而冒险的赌注追求增长的国家

全世界的政客和政策制定者都操心同一件事：如何让自己的国家更加富裕。问题是，通往繁荣的道路看起来越发艰巨了。随着绿色新技术的出现和贸易关系四分五裂，全球经济正在发生变化。在那些已经富裕起来的国家，自由市场的口号喊了几十年后，政府干预又大举回归。各国政府正在斥资数千亿美元补贴它们认为具有重要战略意义的产业。

面对这样的情形，许多发展中国家关于增长的想法展现出了惊人的雄心。印度和印度尼西亚希望在25年内成为高收入国家。沙特阿拉伯王储穆罕默德·本·萨勒曼（Muhammad bin Salman）希望以同样快的速度实现经济多元化和经济发展。这些计划比以往的许多发展战略更加开放外向，令人耳目一新。但它们也存在隐患。

在许多方面，发展中国家选择指望全球化。印尼希望在绿色供应链中发挥更大作用。它希望把触角伸到方方面面，要开采和提炼镍，甚至还要制造使用镍的电动汽车。接着它还想把制成品出口到世界其他地方。海湾国家希望成为对全球商业有吸引力的家园，正在向人员、货物和现金的流动开放。而在莫迪的展望中，印度将成为世界的高科技制造商，大量生产微芯片和智能手机。

这是一个值得欢迎的转变。将近50年前，印度希望通过将自己隔绝在全球经济之外来实现增长。事实证明，这种做法一败涂地。如今仍有一些人认为印度的内需可以支撑其经济增长。

但服务外国市场在发展中起到至关重要的作用。企业将不得不在其政府无法控制的市场上参与竞争，也就不得不诚信经营。服务外国市场还能让企业达到尽可能大的规模。外国客户可以教会企业如何更好地为他们服务。在东亚，出口业绩对政策制定者来说也是个有用的衡量标准，可以揭示哪

些行业值得他们继续支持。

然而，如今的发展战略也存在危险。在许多国家，政府面临着以培育经济为名扭曲经济的风险。沙特推出了一连串产业政策，主要通过公共投资基金（PIF）拨款，其支出甚至超过了美国的《通胀削减法案》。为了帮助出口商发展壮大，印度正试图筑起关税和补贴的高墙来保护本国的高科技制造商。倘若最终是其他电池化学材料大行其道，印尼对镍的全盘押注就将使它落入岌岌可危的境地。

看到富裕国家新萌生的保护主义热情，较贫穷国家可能也会想要效仿。然而，大量的现金补贴和免受外国竞争的庇护让人无法判断政府在发展上的押注是否在收获回报。如果其他技术崭露头角，对某一种技术的押注可能就会打水漂。

部分发展中国家此前付出了惨痛的代价得到这些教训。在20世纪60年代的大部分时间里，非洲政策制定者的想法与东亚政策制定者相同，非洲大陆的发展速度也同亚洲差不多，直到因为选择了错误的扶持对象而在1975年至1985年间裹足不前。非洲如今是世界上最贫穷的地区。

挑选国家冠军的难度也比60年前更大。当时只需要选择促进哪种形式的制造。廉价、充足的劳动力给贫穷国家带来了优势。制造业是穷国唯一比富国进步更快的部门。

然而今天，工厂已变得更加资本密集。尽管制造业仍然是提高一国生产率的途径之一，但它能否成为贫穷国家的比较优势却不再那么确定无疑。这就让政策制定者更难找到一个好的行业来押宝。相比拿民众的钱去赌，他们不如谨慎行事。

毕竟，还有其他很多地方值得花钱。国家在提供公共产品方面发挥着至关重要的作用，它可以投资基础设施，将各个地区连接起来，还可以投资教育，提高劳动者的技能。这可能仍然会导致对不同的行业厚此薄彼。但如果经济体保持开放，那么它们至少会体验到贸易带来的纪律约束和好处。

这一切事关重大。发展中世界有60多亿人口和一些最脆弱的民主国家。如果没有把增长这件事做对，这些地方就会久久无法摆脱更贫困的处境。这不仅会是一种人道悲剧，也可能成为政治不稳定的源头。为了避免这种情况的发生，发展中世界需要大胆行动，还要克制在自身周围筑起围墙的冲动。■



Stockmarkets

Is America's raging bull market exhausted, or taking a breath?

Investors have a slight hangover

IF YOU HAD an overindulgent Christmas, you may have begun the new year in a more austere frame of mind. Recent goings-on in the markets may therefore seem familiar. As 2023 drew to a close the American stockmarket was on a ripping run. It ended the year with nine consecutive weeks of gains, the longest winning streak since 2004. The S&P 500 index of leading American stocks was a whisker away from its all-time high, set on January 3rd 2022, when investors thought that interest-rate rises would be small and slow. Now punters are suddenly in a more sober mood, with stocks falling by 1.4% in the first two trading days of the new year. Such modest fluctuations are hardly unusual. Nonetheless, they raise the question of whether the blistering bull market is over, or has further to go.

For the first ten months of 2023, the market rally was largely concentrated in seven tech stocks, led by Nvidia, a maker of the computer chips that are used to process artificial-intelligence (AI) algorithms. Since then, however, it broadened and gained pace. Firms that mirror the wider economy, such as retailers and banks, soared—JPMorgan Chase is up by a quarter since late October. The S&P 500 rose by 14% in the final two months of 2023, and towers 31% above its most recent trough, well above the 20% that is often used to define a bull market.

The explanation for the run was a happy mix of strong economic growth, an orderly reduction of inflation and, crucially, an enormous shift in interest-rate expectations over the past two months. America's economy expanded at an impressive annualised pace of 4.9% in the third quarter; real-time estimates suggest it grew at a still-robust 2.5% in the last three months of the year. In the past three months "core" consumer prices have

risen at an average annualised pace of just 2.2%, only a smidgen above the Federal Reserve's inflation target.

That led to a big shift in investors' expectations for interest rates. In October they thought one-year rates in a year's time would be close to 5%. Thanks to lower inflation data and a doveish set of forecasts from the Fed, that has fallen to 3.5%. Bond investors see the central bank cutting rates as soon as March—and continuing in almost every meeting in 2024. This tantalising prospect of immaculate disinflation, robust growth and the promise of easier monetary policy has underpinned the rally.

Can the bull market be sustained? Asset prices still have room to rise. Although markets are close to the heights they reached after the protracted mania of 2021, that does not mean that things are as excessive now as they were then. In real terms, stock prices remain lower; valuations are therefore not quite as elevated. Participation by retail investors, which reached a giddy peak of 24% of daily trading volumes in early 2021, was steady at around 18% in 2023.

Moreover, although tech led the charge in both 2021 and 2023, investors this time have been discerning. They have lifted up Nvidia and Microsoft but Alphabet, Amazon and Tesla are all trading below their peak valuations. It is not just Americans excited about AI who are buoying stocks: in dollar terms European and Japanese equity indices are also within touching distance of their level two years ago.

| *Rude awakening*

Yet everything hangs on whether investors' ideal economic scenario comes to pass. The expectation that it will helped lift stocks close to a record high last year. But risks to the outlook abound, and may have given investors pause in the cold light of January. Inflation in America may not be fully vanquished, not least with the economy still in rude health and the fiscal

deficit unusually wide. Strife in the Middle East could cause another commodity-price shock; the one-time easing of the supply-chain disruptions of the pandemic may be keeping inflation low only temporarily.

A downturn may merely be delayed, not dodged. Rises in interest rates may not yet have fully fed through to borrowers. Indeed, history suggests that recessions are hard to spot in real time, and tend to catch out central banks. If a recession does not arrive, it is still possible that the Fed will not move with as much alacrity as investors hope. To see what will happen in the markets in 2024, watch the real economy. ■



【首文】股票市场

美国的红火牛市是精疲力竭了，还是暂时喘口气？

投资者略感宿醉

如果你在圣诞节肆意狂欢了一番，可能就会以更加冷静节制的心态进入新年。你对近期市场上的动态可能也就不会觉得陌生。2023年接近尾声时，美国股市一路狂飙，最终以连涨九周走完了2023年，创下自2004年以来的最长连涨纪录。主要股指标普500距离2022年1月3日（当时投资者预测加息将会是“小步慢跑”）的历史最高点仅一步之遥。现在，投资者突然变得更冷静了：股市在新年的头两个交易日下跌了1.4%。这种小幅波动并不稀奇，但还是引发了一个疑问：这轮大牛市是走到头了，还是能再往前一步？

在2023年的头十个月，美股上涨主要集中在七支科技股上，由制造处理人工智能（AI）算法的计算机芯片的英伟达领跑。之后上涨范围扩大，增速也加快。零售商和银行等反映更广泛经济的公司股价飙升，摩根大通的股价自10月底以来上升了四分之一。标普500指数在2023年最后两个月上涨了14%，比最近期的低点高出31%，明显高于通常用来定义牛市的20%。

对这轮牛市的解释是几方面因素恰好叠加：经济增长强劲、通胀有序回落，最关键的是过去两个月里利率预期的巨大转变。美国经济第三季度的年化增长达到可观的4.9%；实时估算显示，2023年最后一季度的增长仍相当稳健，达到2.5%。过去三个月里，“核心”消费价格的平均年化增长只有2.2%，仅略高于美联储的通胀目标。

这让投资者对利率的预期有了巨大转变。10月时，他们认为一年后的一年期利率将接近5%。随着通胀数据下降及美联储发布一系列鸽派预测，这个预期数字已降至3.5%。债券投资者认为美联储最快会在3月降息，而且在2024年几乎每次议息会议上都会继续降息。“完美去通胀”、增长强劲，以及货币政策有望放宽的诱人前景支撑了市场上涨。

牛市能否持续？资产价格仍有上升的空间。尽管市场已接近2021年持续大热后达到的高点，但这并不意味着现在就和当年一样过热。按实际价值计算，股票价格仍然低于当时，所以估值也没当时那么高。散户投资者的交易在2021年初达到令人眩晕的高峰，占日交易量的24%，2023年则稳定保持在18%左右。

此外，虽然在2021年和2023年领涨的都是科技股，但这次投资者是挑剔的。他们推高了英伟达和微软的股价，而Alphabet、亚马逊和特斯拉的股价则均低于各自的最高点。不仅是兴奋于AI发展前景的美国人在提振股市：以美元计算，欧洲和日本的股指也回升至接近两年前的水平。

| 猛然觉醒

然而，一切取决于投资者理想中的经济情景能否实现。认为能够实现的预期推动股市在去年创下历史高点。但这样的展望面临各种风险，可能会让投资者在经历新年的冷静思考后暂时停手。美国的通胀也许不会完全受控，尤其是在经济依然强劲而且财政赤字异常庞大的情况下。中东的冲突可能引发另一轮大宗商品价格冲击；新冠疫情过后，供应链中断的缓解是一次性的，这也许只能暂时压低通胀。

经济衰退可能只是延后了，最终仍难以躲开。加息的影响可能尚未完全传导至借款人。事实上，历史表明，经济衰退很难被及时发现，而往往会把央行打个措手不及。假如衰退不来，美联储仍有可能不像投资者希望的那般欣然快速行动。想知道2024年的市场走势，请关注实体经济。■



Free exchange

How to put boosters under India's economy

With the right policies, growth could be astonishing

LAND IN ANY Indian city, such as Bangalore or Hyderabad, and you will be struck by its heady optimism. India's economy may be in the early stage of a historic boom. Recently released figures show that economic growth roared to an annualised pace of 7.6% in the third quarter of 2023. In the past few weeks four international forecasters have raised their growth projections for the year, from an average of 5.9% to one of 6.5%. The National Stock Exchange of India is now neck-and-neck with Hong Kong's stock exchange for the title of the world's seventh-largest bourse.

Pause for breath, though, and India's performance looks a little less impressive. GDP growth has been slightly slower under Narendra Modi, India's prime minister, who was elected in 2014, than in the decade before. Labour-force participation is a paltry 40-50%, and only 10-24% for women. Subsidies are distorting the economy. A semiconductor plant in Gujarat will create 5,000 jobs directly and 15,000 indirectly. But a state handout covered 70% of its \$2.7bn cost. Assuming rather generously that the factory would not have been built without government support, each job cost \$100,000—nearly 40 times India's average income per person.

Grappling with the tension between India's enormous potential and an often messy reality is the task of a new book by Raghuram Rajan, a former governor of the Reserve Bank of India, and Rohit Lamba of Pennsylvania State University. The pair sketch out a vision that amounts to an entirely new model of development for India—one that they argue is better suited to its strengths than its current model. Three lessons stand out from their work.

The first is that India should stop fetishising manufacturing—an obsession born of East Asia's growth miracle. In the 1960s India's income per person was on a par with that of China and South Korea. By 1990 South Korea had taken off, while India remained level with China. Today China is three times richer and South Korea is seven times richer, adjusted for purchasing power. The growth of India's rivals was driven by low-skilled manufacturing, which received plenty of state support. Globalisation created a vast market, leading to previously unheard of double-digit growth rates. Once workers and companies got good at the easy stuff, they began to tackle more complex tasks with their newfound skills. Why shouldn't India follow its rivals' example?

As Messrs Rajan and Lamba explain, the problem is that East Asia has made manufacturing so competitive there is little profit left to be captured. Moreover, automation has reduced the number of available jobs—and manufacturing is no longer where value is to be found. Apple is worth \$3trn because it designs, brands and distributes its products. By comparison, Foxconn, which actually makes Apple's iPhones, is worth a mere \$50bn.

The second lesson concerns the export of services, which some in India's government think is a fresh way to tap into global demand. Modern technology, especially the internet, has made services far more tradable. Remote work has accelerated this trend. Meanwhile, governments around the world are desperate to shore up domestic industries. Partly as a result, global trade in goods has declined over the past decade. Yet trade in services has continued to grow. It is hard to argue against seeking a slice of the cushiest part of the global value chain, especially when the line between services and manufacturing is blurring. Some 40% of the value-added in a Chevrolet Volt, for instance, comes from its software.

In places, India is finding success. Its famed IT service sector has moved from mostly providing back-office work to more complex front-office fare.

According to one estimate, 20% of the global chip-design workforce can already be found in the country. But profound reforms will be required if India is to succeed more broadly. Spending on education as a share of GDP is 3-4%—middling relative to others of similar income. The bigger problem is that India appears to get little bang for its buck. By the latter half of high school, around half of students have dropped out. Bosses report that many of those who graduate are still not ready for work. Getting a new business off the ground is such a nightmare that many startups incorporate in Singapore. Labour laws make workers difficult to sack once they have been employed for more than a year, which incentivises the use of intermittent contracts. France and Italy have global brands, point out Messrs Rajan and Lamba. India does not. It is these sorts of problems that help explain why.

The last big item on the authors' wishlist is liberalism—of both the economic and political varieties. Politicians should start, they write, by jettisoning protectionism. From 1991, when India opened up to global markets, to 2014, when Mr Modi took power, average tariff levels fell from 125% to 13%. They have since risen to 18%, raising the cost of intermediate inputs for producers. India has refused to join regional free-trade agreements, which inhibits the ability of its exporters to reach customers abroad. And Mr Modi's authoritarian tendencies make it difficult for business leaders to criticise the government when a change of tack is required.

| *Hear the roar*

Messrs Rajan and Lamba paint a lovely picture of what could be. A better governed, more open India would be wonderful. But whether their ambitions are politically feasible is another question. For example, better public services probably mean devolving power from the central and state governments to localities. And who wants to give up power? Certainly not Mr Modi; probably not his rivals. Moreover, a country can endure quite a lot

of illiberalism before growth starts to falter. Until recently, China was humming along just fine. The Asian tigers only became more politically free when they were rich. India's economy is already growing at north of 6% a year with a policy mix that is far from the perfect.

In a strange way, though, this ought to provide Indian reformers with encouragement. Even if only half of what would be ideal is feasible, India's boom may only just be getting started. ■



自由交流

如何给印度经济加助推器

政策若得当，增长可能是惊人的

踏上印度任何一座城市，比如班加罗尔或海德拉巴，都会感受到那里洋溢的乐观情绪。印度经济可能正处于一段历史性繁荣的开端。近期公布的数据显示，在2023年第三季度，印度经济年化增长率飙升至7.6%。过去几周，四家国际预测机构上调了对2023年印度经济增长的预测，从平均5.9%调至6.5%。印度国家证券交易所（National Stock Exchange of India）现在与香港证券交易所旗鼓相当，竞逐世界第七大证券交易所的头衔。

但停下来缓口气，就会觉得印度的表现看起来没那么惊人了。在2014年当选印度总理的莫迪治下，印度的GDP增速略低于之前十年。劳动力参与率仅在40%至50%之间，女性更是只有10%至24%。政府补贴正在扭曲经济。古吉拉特邦的一家半导体工厂将直接创造5000个工作岗位，间接创造1.5万个。但政府补贴覆盖了其27亿美元成本的70%。做个豪气的假设，如果该工厂的建设没有政府支持，每个岗位的成本就会高达10万美元，几乎是印度人均收入的40倍。

印度前央行行长拉古拉姆·拉詹（Raghuram Rajan）和宾夕法尼亚州立大学的罗希特·兰巴（Rohit Lamba）合撰的新书探讨了印度的巨大潜力与往往混乱的现实之间的矛盾。二人为印度的发展勾画愿景，搭建出一个全新模式，他们认为比当前的模式更利于印度发挥自身优势。他们的研究结果凸显了三条经验教训。

首先，印度应停止痴迷制造业，这种迷恋源于当年东亚的增长奇迹。上世纪60年代，印度的人均收入与中国和韩国相当。到1990年，韩国经济腾飞，印度仍与中国持平。而现在，按购买力调整后，中国的人均收入是印度的三倍，韩国更是印度的七倍。印度这些竞争对手的增长是由政府大力支持的低技能制造业推动的。全球化创造了巨大的市场，带来了前所未有的两位数增长率。一旦工人和企业掌握了简单的技能，就会开始利用这些

新学到的技能处理更复杂的任务。那么印度为何不该效仿竞争对手？

正如拉詹和兰巴所解释的，问题是东亚已经让制造业竞争激烈到几乎无利可图的地步。此外，自动化减少了制造业所能提供的工作岗位，而且制造本身也不再是价值所在。苹果市值三万亿美元是因为它设计、打造品牌并销售产品。相比之下，实际制造苹果iPhone手机的富士康价值仅为500亿美元。

第二条经验是关于服务出口的。印度有些政府官员认为服务出口是接入全球需求的新途径。现代技术，特别是互联网技术，大大提高了服务的可交易性。远程工作加速了这一趋势。与此同时，世界各国政府都急于扶持本国产业，这在一定程度上导致全球货物贸易在过去十年出现下降。但服务贸易却持续增长。印度想从全球价值链中最轻松的环节分一杯羹，这没什么可反驳的，尤其是如今服务业与制造业之间的界限越来越模糊。举个例子，雪佛兰Volt汽车约40%的附加值来自其软件。

在某些领域，印度正在获得成功。它著名的信息技术服务业已从主要提供后台服务转向更为复杂的前台服务。据估计，印度的芯片设计人员已占到全球的20%。但要在更广泛的领域取得成功，印度还需要深刻的改革。在印度，教育支出占GDP的比例为3%至4%，与收入相近的其他国家相比处于中等水平。更大的问题是，印度的教育投入似乎成效不大。在中学的后半段约有半数学生辍学。而雇主则表示，那些完成了学业的毕业生有许多仍不能胜任工作。在印度要创办一家公司简直就是一场噩梦，许多创业公司宁愿在新加坡注册成立。现行劳动法让雇主很难解雇受雇一年以上的员工，这就促使他们采用断断续续的短期合同。拉詹和兰巴指出，法国和意大利拥有全球品牌，印度却没有。上述这些问题可能是部分原因所在。

拉詹和兰巴的愿望清单上的最后一个大项是自由主义——既包括经济上的，也包括政治上的。他们写道，政客们应从摒弃保护主义开始做起。从1991年印度向全球市场开放到2014年莫迪上台执政时，印度的平均关税水平从125%降至13%。而自此之后又上升到18%，提高了生产商的中间投入成本。印度拒绝加入区域自由贸易协定，抑制了印度出口商争取国外客户

的能力。在需要改变政策方针的时候，莫迪的威权倾向也让商界领袖难以批评政府。

| 听到轰鸣

拉詹和兰巴描绘了一幅可能出现的美好图景。一个治理改善、更加开放的印度将是很美好的。但他们的宏伟构想在政治上是否可行就是另一个问题了。例如，改善公共服务可能意味着要把权力从中央和邦政府下放到地方。谁愿意放弃权力呢？莫迪肯定不会，他的政治对手可能也不会。而且，一个国家有可能经受相当久的不自由，一时并不会出现经济增长减速。直到不久前，中国经济一直发展得不赖。亚洲小龙们是在富起来之后政治上才变得更自由的。在政策组合远非完美的情况下，印度的经济年增长率已超过6%。

不过，这应该能以一种奇怪的方式鼓舞印度的改革者。即使理想图景只有一半有望实现，印度的繁荣也可能才刚刚开始。■



4,000 terabits under the sea

Big tech and geopolitics are reshaping the internet's plumbing

Data cables are turning into economic and strategic assets

WHEN THE navies of Britain, Estonia and Finland held a joint exercise in the Baltic Sea earlier last month, their goal was not to hone warfighting skills. Instead, the forces were training to protect undersea gas and data pipelines from sabotage. The drills followed events in October when submarine cables in the region were damaged. Sauli Niinisto, the Finnish president, wondered whether the Chinese ship blamed for the mischief dragged its anchor on the ocean bed “intentionally or as a result of extremely poor seamanship”.

Submarine cables used to be seen as the internet's dull plumbing. Now giants of the data economy, such as Amazon, Google, Meta and Microsoft, are asserting more control over the flow of data, even as tensions between China and America risk splintering the world's digital infrastructure. The result is to turn undersea cables into prized economic and strategic assets.

Subsea data pipes carry almost 99% of intercontinental internet traffic. TeleGeography, a research firm, reckons there are 550 active or planned submarine cables that currently span over 1.4m kilometres. Each cable, which is typically a bundle of between 12 and 16 fibre-optic threads and as wide as a garden hose, lines the seabed at an average depth of 3,600 metres. Close to half have been added in the past decade. Newer ones are capable of transferring 250 terabits of data every second, the equivalent of 1.3m cat videos. Data may be stored in the cloud, but it flows under the ocean.

Since 2019 demand for international internet bandwidth has tripled to more than 3,800 terabits per second, estimates TeleGeography. The boom in data-hungry artificial intelligence may strengthen this trend. Synergy

Research Group, a data firm, predicts an almost three-fold increase in big cloud providers' data-centre capacity over the next six years. To connect these data centres to the internet, between 2020 and 2025 the data-cable industry will install 440,000km of new subsea lines.

One big shift has come from big tech. Until the early 2000s subsea cables were mainly used for transporting voice traffic across the world. Telecom operators like BT and Orange (formerly France Telecom) controlled most of the capacity. By 2010 the rise in data traffic led internet and cloud-computing giants—Amazon, Google, Meta and Microsoft—to start leasing capacity on these lines.

As their data needs surged, the tech firms began investing in their own pipes. In 2012 the four companies used around a tenth of international bandwidth; nowadays they claim almost three-quarters. Big tech's deep pockets ensure that projects are completed. According to Submarine Telecoms Forum, an industry body, only about half of all announced cable systems actually get built—unless they are backed by tech firms, in which case they almost always do.

Big-tech-backed cables account for almost a fifth of the \$12bn in planned investments in new systems over the next four years. Amazon and Microsoft part-own one and four networks, respectively. Meta owns one cable system outright and is an investor in another 14. Google is the most aggressive—the search giant directly owns 12 of its 26 cables. Last year it completed Firmina, a \$360m project that stretches more than 14,000km from the east coast of North America via Brazil to Argentina.

Dedicated cables allow the tech giants to avoid competing with others for third-party bandwidth, and to react quickly to changes in user demand and to any problems (if a cable on a route is damaged, data can be redirected to another one of the firms' lines). Alan Mauldin from TeleGeography points

out that being owner-operators also gives the tech giants the luxury of designing routes that meet their specific needs. Most telecom carriers rely on public “landing stations”—which connect the cables in the sea to customers’ data centres on land. By owning their cables, the companies can plug these more directly into their own data centres, speeding up traffic.

Their bandwidth and speed is further enhanced thanks to clever technology, which ownership makes easier to deploy. In 2019 Google introduced an innovation (“space division multiplexing”) that increased the number of fibre threads in a cable from 16 to 24. Last year it went further, doubling the number of “cores”—clusters of fibre threads—in its new TPU cable system that links Taiwan, the Philippines and America, increasing capacity while lowering the operating cost per bit.

All this is transforming the business of data cables. Having begun as large buyers of bandwidth from telecom companies, big tech is now leasing capacity on some of its cables to telecom operators. Legacy telecom firms are happy with this arrangement, since they face constant pressure from consumers for more capacity but, unlike big tech, they are desperately short of capital. As for the specialist companies which supply the equipment and lay the cables, these are go-go years.

Like many other global industries, the data-cable business is also being entangled in the tech contest between America and China—a second big shift. Take the Pacific Light Cable Network (PLCN). The 13,000km data pipeline was announced in 2016, with the backing of Google and Meta. It aimed to link the west coast of America with Hong Kong. By 2020 it had reached the Philippines and Taiwan. But in 2022 America’s government denied approval for the final leg to Hong Kong, worried that this would give Chinese authorities easy access to Americans’ data. Hundreds of kilometres of cable that would link Hong Kong to the network are languishing unused on the ocean floor.

America is stymieing China in another way. Laying cables at depth is a complicated job. Only a handful of contractors have the required chops. Three—Alcatel Submarine Networks from France, NEC from Japan and SubCom from America—receive more than 80% of the spending on cable construction. HMN Tech, a Chinese challenger spun out of Huawei, China's telecoms-gear champion, claims 9% of new annual construction spending. But amid Sino-Western tensions, new cables that have links to America, which is to say most of them, avoid HMN Tech as a supplier. Telecoms executives say they are discouraged from using HMN. In 2022 a lucrative contract for SEA-ME-WE 6, a 19,000km line owned by a group of telecoms operators including India's Bharti Airtel and Singapore's SingTel, and linking South-East Asia to Europe, was awarded to SubCom, even though HMN's bid was reportedly lower.

China is responding by charting its own course. PEACE, a 21,500km undersea cable linking Kenya to France via Pakistan, was built entirely by Chinese firms as part of China's "digital silk road", a scheme to increase its global influence. Reuters reported that this year three Chinese carriers—China Telecom, China Unicom and China Mobile Limited—are investing \$500m in a cable network that connects China and France via Singapore, Pakistan and Egypt. The project, to be built by HMN Tech, will compete directly with SEA-ME-WE 6.

Despite the growing Sino-American rivalry, from 2019 to 2023 bandwidth between the two has grown by 20% a year. American and Chinese mobile operators, which also rely on cables, continue to increase network connectivity in each other's territory. The necessary licences are, however, getting harder to secure.

In March America's Federal Communications Commission issued a proposal that would require licensees to provide more information about who owns them. It also acknowledged concerns that the presence in

America of physical infrastructure of China Telecom is “highly relevant to the national-security and law-enforcement risks”. All this is making the route taken by bits and bytes more circuitous than before, and thus costlier. If transpacific tensions continue to mount, those routes may one day vanish altogether. ■



海底4000太比特

科技巨头和地缘纷争正在重塑互联网的管道

数据电缆正在变成经济和战略资产

英国、爱沙尼亚和芬兰的海军于2023年12月上旬在波罗的海进行了联合演习，他们的目标并不是磨练战斗技能，而是操练如何保护水下天然气和数据管道免遭破坏。在此次演习开展前的10月，该地区的海底电缆被损坏。芬兰总统绍利·尼尼斯托在纳闷，被指为肇事者的中国船只究竟是“故意还是因为极差劲的航行技术”在海底拖曳了船锚。

海底电缆曾被视为互联网的平凡无奇的管道。如今，正当中美紧张关系可能令全球数字基础设施分崩离析之时，亚马逊、谷歌、Meta和微软等数字经济巨头在宣示对数据流的更大控制权。其结果是，海底电缆变成了备受重视的经济和战略资产。

海底数据管道承载了几乎99%的洲际互联网流量。研究公司TeleGeography估计，目前有550条在用或计划建造的海底电缆，总长超过140万公里。每根电缆通常包裹着12到16根光纤线，粗细如同花园浇水软管，沿海底铺设，平均深度约为3600米。近一半的电缆是在过去十年里铺设的。较新的电缆能够每秒传输250太比特的数据，相当于130万段猫咪视频。数据可能被存储在云端，但它是在海底流动的。

据TeleGeography估计，自2019年以来，对国际互联网带宽的需求增长了两倍，达到每秒3800太比特以上。数据需求巨大的人工智能的腾飞可能加强这一趋势。数据公司Synergy Research Group预测，在未来六年内，大型云服务提供商的数据中心容量将增加近三倍。为了将这些数据中心连接到互联网，从2020年到2025年，数据电缆行业将新铺设44万公里的海底电缆。

一个大转变源自科技巨头。直到本世纪初，海底电缆还主要用于在全球范围内传输语音流量。像英国电信（BT）和Orange（原法国电信）这样的电

信运营商控制了大部分容量。到2010年，由于数据流量的增加，互联网和云计算巨头亚马逊、谷歌、Meta和微软开始租用这些线路上的容量。

随着它们的数据需求激增，科技公司开始投资自己的电缆。2012年，这四家公司使用了大约十分之一的国际带宽；如今它们几乎占用了三分之二。科技巨头的雄厚资金确保了项目能够完成。据行业组织海底电信论坛（Submarine Telecoms Forum）统计，所有公布投建的电缆系统中只有约一半左右最后会实际完成——除非是由科技公司支持的，那么几乎总能完成。

在未来四年总共120亿美元的新电缆投资计划中，科技巨头支持的项目占到近五分之一。亚马逊部分拥有一个电缆网，微软部分拥有四个。Meta完全拥有一个电缆系统，还是另外14个电缆系统的投资者。谷歌是最积极的——这家搜索巨头直接拥有其26条电缆中的12条。去年，谷歌完成了费尔米纳（Firmina）项目，耗资3.6亿美元，全长超过1.4万公里，从北美东海岸经巴西抵达阿根廷。

专用电缆使科技巨头能够避免与其他公司争夺第三方带宽，并迅速应对用户需求的变化和任何问题（如果某个线路上的电缆损坏，数据可以转移到这些公司的另一条电缆上）。TeleGeography的艾伦·莫尔丁（Alan Mauldin）指出，拥有并运营电缆也使科技巨头得以根据自己的需求设计线路。大多数电信运营商要依赖公共“登陆站”——它们将海底电缆连接到陆地上的客户数据中心。拥有属于自己的电缆，这些公司就可以将电缆更直接地连接到自己的数据中心，加速数据传输。

自己拥有电缆也方便了部署先进技术，进一步提升带宽和速度。2019年，谷歌推出了一项创新（“空间分集复用”），将电缆中的光纤线数量从16根增加到24根。2023年，谷歌更进一步，在其连接台湾、菲律宾和美国的新TPU电缆系统中将“核心”也就是光纤簇的数量翻了一番，增加容量的同时降低了单位流量的运营成本。

所有这些都在改变数据电缆生意。科技巨头最初是从电信公司大量购买带

宽，现在正将自家一些电缆的容量出租给电信运营商。传统电信公司乐于接受这种安排，因为它们持续面临着消费者要求更多带宽的压力，但与大科技公司不同，它们极度缺乏资金。至于那些专门提供相关设备和铺设电缆的公司，它们迎来了生意兴隆的好年景。

与许多其他全球性产业一样，数据电缆业务也被卷入了中美科技战——这是第二个大转变。太平洋光缆网络（Pacific Light Cable Network, PLCN）就是一个例子。这条长1.3万公里的数据管道项目于2016年宣布，得到谷歌和Meta的支持。它想要连接美国西海岸和香港。到2020年，它已经铺设到了菲律宾和台湾。但是2022年，美国政府拒绝批准最后一段通往香港的线路，担心这将让中国当局轻松获取美国人的数据。原本将把香港连接到该网络的数百公里电缆就此被弃用，闲置在海底。

美国也在以另一种方式阻挠中国。在深海铺设电缆是一项复杂的工作。只有少数几个承包商具备所需的技术。全球海底电缆建设支出的超过80%支付给了三家公司——法国的阿尔卡特海底网络（Alcatel Submarine Networks）、日本的NEC和美国的SubCom。中国电信设备巨头华为旗下的中国挑战者华海通信声称在新年度建设支出中拿到9%。但在中西方关系紧张的背景下，与美国有关的新电缆——也就是说大多数电缆——都在绕开华海通信这个供应商。电信业高管表示，他们被劝阻使用华海通信。2022年，连接东南亚与欧洲的SEA-ME-WE 6这个大项目的合同被授予了SubCom，尽管报道称华海通信在投标中的报价更低。SEA-ME-WE 6电缆长1.9万公里，由印度的Bharti Airtel和新加坡电信（SingTel）等一群电信运营商拥有。

中国的回应是绘制自己的电缆航道。PEACE是一条长2.15万公里的海底电缆，连接肯尼亚与法国，中间经过巴基斯坦。它完全由中国公司建设，是中国提升其全球影响力的“数字丝绸之路”的一部分。路透社报道，今年三家中国运营商——中国电信、中国联通和中国移动——正在投资5亿美元建设一条通过新加坡、巴基斯坦和埃及连接中国和法国的电缆网络。该项目将由华海通信建设，会直接与SEA-ME-WE 6竞争。

尽管中美之间的竞争日益激烈，但从2019年到2023年，两国之间的带宽每年增长20%。美国和中国的移动运营商也依赖电缆，都在继续增加在对方区域内的网络连接。然而，获取必要牌照的难度在加大。

2023年3月，美国联邦通信委员会（FCC）提出了一项提案，要求牌照持有人提供更多其所有者的信息。它还承认担忧中国电信在美国境内建设的实体基础设施“与国家安全和执法风险高度相关”。所有这些都使比特和字节的传输路径变得比以往更加迂回，因此成本更高。如果太平洋两岸的紧张局势继续升级，这些路径某天可能会完全消失。■



Desert island dismal science

Why economists love “Robinson Crusoe”

The classic yarn of a shipwrecked sailor reveals a lot about scarcity

AFTER SPENDING 28 years, two months and 19 days marooned on an island, Robinson Crusoe does not lose his nose for adventure or his “native propensity to rambling”. He crosses the Pyrenees, stalked by “hellish wolves”, witnesses the “pomp and poverty” of China and battles Tartars on the Russian steppe.

The character’s strangest adventure, however, is none of these. It is surely his centuries-long ramble through the literature of economics. Crusoe has appeared in Karl Marx’s “Das Kapital”, John Maynard Keynes’s “General Theory” and Milton Friedman’s Chicago lectures on “Price Theory”. He has an entry in the New Palgrave Dictionary of Economics. And he often washes up in economics textbooks.

Crusoe’s economic appeal is unsurprising. The sailor spends a few pages escaping pirates and shooting cannibals. But his real battle is against scarcity, which he defeats through careful deployment of the resources at his disposal, including his own labour.

After being shipwrecked, Crusoe makes his island prison habitable, even hospitable. Salvaging what he can from the wreck, he fortifies a cave (his “castle”), erects a tent (“my country house”), plants crops, tames goats (and a parrot) and fills his improvised shelves with pigeon, turtle and other foodstuffs.

Scarcity also stalked Daniel Defoe, the novelist who created Crusoe in 1719. Over a chequered career he traded in bricks, wines, pickles, tobacco and the glands of civet cats. He dabbled in horse-trading. Literally. He defaulted on

his debts. Twice. “No man has tasted differing fortunes more,” he wrote. “And thirteen times I have been rich and poor.”

He wrote allegories that turned dry economic variables into colourful characters like “Count Tariff”, an English nobleman dressed in domestically manufactured cloth, and “Lady Credit” (“if she be once Disoblig’d; no Entreaties will bring her back again). His publication “The Compleat English Tradesman” has been described as the first business textbook.

But it is his island fable that has most resonated, as Michael White of Monash University has documented. Economists are eager to find behavioural laws that apply anywhere. Crusoe’s isolation thus provides a useful thought experiment. Principles that hold true on his island must be elemental, not socially incidental.

William Forster Lloyd, for example, was keen to show that economics had something to say about value even in the absence of markets and exchange. In a publication in 1834, he pointed out that Crusoe prizes his goods more dearly as they become more scarce (“my ink beginning to fail me”, Crusoe says, “I contented myself to use it more sparingly”). He took that as evidence for the principle of diminishing marginal utility: a second bottle of ink is worth less than the first.

Most economists have turned to the tale not to corroborate a theory but merely to illustrate it. Textbook authors, for example, want to introduce the principles of supply and demand in the simplest possible case, and nothing is simpler than a one-person “Robinson Crusoe” economy.

Such an economy features in a textbook by Hal Varian, chief economist at Google. Crusoe must decide how to divide his day between gathering coconuts and working “on his tan”. In keeping with diminishing marginal utility, each extra coconut or hour of sunbathing is worth less than the last.

Each hour of work also yields fewer coconuts than the last. Under these assumptions, Crusoe should stop working at the point when an extra coconut is worth no more to him than the additional leisure he must sacrifice to gather it.

A one-person economy has several things going for it. There is no waste. If an extra coconut is not wanted, it will not be collected—supply implies its own demand. There is no unemployment. If Crusoe wants the extra coconut more than the leisure, he will employ himself to gather it. Such an economy, Keynes pointed out, cannot suffer the kind of slump that cursed the 1930s—when people fail to spend enough of their income on the goods the economy could produce.

Textbooks present Crusoe's one-man economy as a kind of benchmark, against which more sophisticated economies can be judged. Can its harmony be replicated, even when decision-making is divided up and dispersed—even when consumers and producers do not share the same mind?

The answer is yes, through the magic of flexible prices and wages. In his own more elaborate version of the parable, Daniel McFadden, a Nobel prize-winning economist who was also Mr Varian's thesis adviser, introduces a second character ("Friday"). In this version, Crusoe gathers yams not coconuts. Friday acts as a manager, hiring Crusoe's labour, paying him in yams, and giving him leftover yams as a "dividend".

Mr McFadden shows that there is an hourly wage that will reconcile the demand and supply of labour, and also, miraculously, the demand and supply of yams. But things can go wrong if wages get misaligned or expectations sink too low. If the wage gets stuck at too high a level, for example, Crusoe might find himself unable to work as long as he wants. The yams he could collect in an extra hour may be worth more to him than

the leisure he would lose. But if the wage he must receive is higher still, Friday will deny him the extra employment. The island would suffer a recession, combining unmet needs (for yams) with unused resources (Crusoe's spare labour).

If Friday worries that he will not be able to sell as many yams as he can produce, he may limit his demand for labour. That will curb his customer's purchasing power, thereby seeming to bear out his pessimistic sales forecast. Crusoe will lack work, because Friday lacks sales. And Friday will lack sales, because Crusoe lacks work.

An obvious objection to these parables is their cartoonishness. The concept of a Crusoe economy has become "another cuss-word to people who crave realism and are contemptuous of theory" noted Frank Knight, a Chicago economist, in 1960. But simplification can often aid understanding. Mr McFadden's parable, for example, illustrates that recessions are not necessary or salutary, but absurd and inefficient.

| *Never too late to be wise*

For Crusoe-lovers, however, what is most striking about these exercises is not their distance from reality, but their distance from Defoe's original tale. Neither coconuts nor yams appear in the book. And far from working on his tan, Crusoe took a "world of pains" to hide from the sun, making a "clumsy, ugly, goat's-skin umbrella" to ward off its rays. His island is not in the South Seas, as Mr McFadden maintains, but near Trinidad. And Friday and Crusoe do not bargain over labour or anything else. After Crusoe saves him from the cannibals who have carried him to the island by canoe, Friday in effect indentures himself to the sailor. One of the first English words he is taught is "Master".

Obliviousness to Defoe's tale does not invalidate the textbook parables. Little of importance hangs on whether Crusoe gathers coconuts, yams or

grapes, in the South Seas or anywhere else. But the neglect is nonetheless a missed opportunity. There is a lot of economic incident and insight in the original story. Economists might enjoy rediscovering it.

They could start not with coconut-gathering but with bread-making. “Few people have thought much upon...the strange multitude of little things necessary in the providing, producing, curing, dressing, making, and finishing [of] this one article of bread,” Crusoe says, as he struggles to make some for himself. In trying to start from near-scratch, Crusoe discovers that even the simplest product is a minor miracle of economic choreography. His thoughts resemble the classic essay, “I, Pencil”, written by Leonard Read in 1958, which details the “genealogy” of the humble pencil, with its wood from Oregon, graphite from Sri Lanka and rubber from Indonesia, all collected, transported and refined by machines that have their own even more complex genealogy.

After bread-making, economists could turn to Crusoe’s pottery. It takes him about two months to make a pair of jars—“two large, earthen ugly things”—in which to store his grain. Preserving resources is no easy matter: pests threaten his crops and decay unravels his clothes. In his 1916 book “The Natural Economic Order”, Silvio Gesell imagines how grateful Crusoe would be to lend his spare provisions to another islander, like Friday, in return for similar provisions a few years hence. He would accept the deal even if Friday pays no interest, because merely keeping wealth intact represents a victory against the relentless forces of decay. It is a useful thought experiment for anyone who resents today’s financial system, which for all its flaws, allows people to preserve their wealth in convenient savings accounts, not misshapen jars.

The Crusoe in the textbooks is a rational man, always equating marginal this with marginal that. He is the stock character of economics 101. The Crusoe in Defoe’s story is more mercurial and conflicted. As such, he lends

himself to more recent, psychologically informed theories of decision-making. He could become an icon of “behavioural economics”.

| *The want of thankfulness for what we have*

At one point, Crusoe uses his scarce ink to take stock of his predicament, drawing up a kind of balance-sheet of comforts and miseries, credits and debits. He is a lone castaway (a debit), but he is alive (a credit). The island is uninhabited, but it is not barren. He has no defences, but the island has no obvious predators. No companion survived the wreck, but provisions could be salvaged from it.

Daniel Kahneman, a psychologist who won the Nobel prize in economics, and Amos Tversky have shown that when assessing their lives, people often evaluate not their level of well-being, but their gains or losses from some “neutral” reference point.

The choice of reference point is not always obvious. On each line of his balance sheet, Crusoe entertains alternatives. His shipwrecked isolation represents a grievous loss from where he was. But it counts as a gain from an alternative scenario—not hard to imagine—in which he drowned or washed up on a more perilous shore. Mr Kahneman and Tversky point out that in dreaming up these alternative scenarios, people follow certain rules. They reimagine the chain of events leading up to their predicament, removing any strange or surprising twists of fate.

After Crusoe abandons the wrecked ship, it drifts closer to shore, allowing him to return to it and strip it bare. That, Crusoe recognises, was unlikely (100,000 to one, he says). It is therefore easy for him to imagine an alternative reference point in which he rescued nothing from the wreck. That helps him psychologically.

Behavioural economists stress that more choice is not always better. People

may be unable to resist choices they know will hurt them in the long run. Choice also invites regret. It obliges us to compare our fate with the alternative we could have chosen. Forced to stay on his island, Crusoe can be happy. But if he were to choose his isolation, he would be haunted by the alternative life he could have chosen elsewhere.

Indeed, Crusoe later concludes that he can be happier within the tight compass of his island than he would be in the outside world, where he had once lived a “wicked, cursed, abominable life”. He also immediately admits to himself that if offered the chance to escape, he would nonetheless take it.

As these examples show, economists might profit from greater familiarity with the Crusoe story. And the trade could be two-way. Defoe scholarship could and has benefited from a closer acquaintance with economics. There are several corners of Defoe’s works that require some economic knowledge to appreciate.

When Crusoe embarks on his ill-fated voyage to Guinea to buy slaves, he leaves behind a growing tobacco plantation in Brazil that would soon be worth “three or four thousand pounds”. It is hard for a reader today to make sense of such a figure. Drawing on the work of economic historians, David Spielman, formerly of Penn State University, calculates that the income on such a sum would have put Crusoe in the top 5% of English families at the time. With so much wealth in prospect, Crusoe has no reason to take risks. His voyage was as “preposterous” as he himself admits.

Economists might also resolve some other mysteries. After his return from the island, Crusoe reclaims his plantation and sells it. In the first six editions of the book, he receives 328,000 pieces of eight, worth about £72,000. But in later ones, a zero is deleted. That matters for the interpretation of the story. Does Crusoe finish the novel a rich man or a

very rich one?

Literary scholars pride themselves on their sensitivity to every nuance of a text. But the decimation of Crusoe's wealth has barely registered. "Despite the careful attention that the textual history of Robinson Crusoe has received, no one has even noticed a problem," Mr Spielman has pointed out. Economists may have lost sight of Robinson Crusoe's richness. But literary scholars have overlooked most of his riches. ■



荒岛的惨淡科学

为什么经济学家喜爱《鲁滨逊漂流记》

沉船水手的经典故事揭示了关于稀缺性的许多问题【深度】

在孤岛上度过了28年零2个月又19天后，鲁滨逊·克鲁索并没有失去对冒险的嗅觉，也没有丢掉“四处游逛的天性”。他在“地狱般的狼群”的追逐下穿越了比利牛斯山脉，目睹了中国的“浮华与贫困”，在俄罗斯大草原上与鞑靼人作战。

然而，这个角色最奇特的冒险并不是这些，而无疑是他几个世纪以来在经济学文献中的漫游。鲁滨逊曾出现在卡尔·马克思的《资本论》、约翰·梅纳德·凯恩斯的《就业、利息和货币通论》和米尔顿·弗里德曼在芝加哥主讲的《价格理论》中。《新帕尔格雷夫经济学词典》中有他的条目。而且他还经常冲上经济学教科书的岸头。

鲁滨逊对于经济学的吸引力并不让人惊讶。这个水手花了几页的时间逃离海盗并射杀食人族。但真正的战斗是对抗稀缺——他通过仔细部署他所掌握的资源（包括他自己的劳动力）来战胜稀缺性。

在遭遇海难之后，鲁滨逊把他的小岛监狱改造得适合居住，甚至可说宜人。他从沉船中打捞出一些东西，加固了一个山洞（他的“城堡”），搭建了一个帐篷（“我的乡间别墅”），种植庄稼，驯养了山羊（和一只鸚鵡），在简易架子上摆满了鸽子、乌龟和其他食物。

在1719年创作了《鲁滨逊漂流记》的小说家丹尼尔·笛福也被稀缺所困。在他坎坷的职业生涯中，他做过砖块、葡萄酒、泡菜、烟草和麝猫腺体的贸易。他还搞过马匹交易。他曾债务违约。两次。“没有人比我更饱尝命运转折，”他写道，“我经历过十三次贫富起落。”

他撰写的寓言故事将枯燥的经济变量转化为丰富多彩的人物形象，如“关税伯爵”——一位身穿家纺布料的英国贵族，以及“信用夫人”（“一旦对她

失信，再多的恳求也无法使她回心转意”）。他出版的《英格兰商人全书》（The Compleat English Tradesman）被誉为第一本商业教科书。

但正如莫纳什大学的迈克尔·怀特（Michael White）所写，他的荒岛寓言最能引起共鸣。经济学家渴望找到适用于任何地方的行为规律。因此，鲁滨逊的与世隔绝提供了一个有用的思想实验。在他的岛上适用的原则必然是基本的，而不是因社会而偶然形成的。

例如，威廉·福斯特·劳埃德（William Forster Lloyd）热衷于证明，即使在没有市场和交换的情况下，经济学也能对价值做出解释。他在1834发表的一篇著作中指出，随着商品变得越来越稀缺，鲁滨逊越来越珍视它们（“我的墨水开始不好用了，”鲁滨逊说，“我满足于更加节约地使用它”）。他将此作为边际效用递减原理的证据：第二瓶墨水的价值低于第一瓶。

大多数经济学家引用这个故事并不是为了证实某个理论，而只是为了阐释。例如，教科书的作者们希望在一个尽可能简单的案例中介绍供求原理，而最简单的莫过于一个人的“鲁滨逊·克鲁索”经济了。

谷歌首席经济学家哈尔·瓦里安（Hal Varian）在一本教科书中描述了这样的经济。鲁滨逊必须决定如何将一天的时间在采摘椰子和“晒黑皮肤”上做分配。根据边际效用递减原理，每多收一个椰子或多晒一小时太阳，其价值都会低于上一个椰子或上一小时日光浴。每工作一小时产出的椰子也比上一小时少。根据这些假设，鲁滨逊应该在一个额外椰子的价值已经比不上他为采这只椰子而必须牺牲的额外闲暇时停止工作。

单人经济有几个好处。没有浪费。如果额外的椰子不被需要，它就不会被采摘——供应量就意味着经济本身的需求量。没有失业。如果鲁滨逊想要额外的椰子而不是闲暇，他就会亲自去采摘。凯恩斯指出，这样的经济不会遭受20世纪30年代那样的衰退——当时人们没能将足够的收入用于购买经济所能生产的商品。

教科书将鲁滨逊的单人经济视为一种基准，我们可以用它来评判更复杂的

经济。即使决策被分割和分散——即使消费者和生产者的想法不同，这种和谐能否被复制？

答案是肯定的，这要利用弹性价格和工资的魔力。获得诺贝尔奖的经济学家，也是瓦里安的论文导师的丹尼尔·麦克法登（Daniel McFadden）为这个寓言写了一个更详细的版本。他引入了第二个角色（“星期五”）。在这个版本中，鲁滨逊采集的是山芋而不是椰子。“星期五”充当经理，雇用鲁滨逊的劳动力，用山芋支付报酬，并将剩余的山芋作为“红利”分给他。

麦克法登证明了，存在这样一个时薪水平，它可以协调劳动力的供求关系，还能奇迹般地协调山芋的供求关系。但是，如果工资偏离这个水平或期望值过低就会出问题。举例来说，如果工资停留在过高的水平，鲁滨逊可能会发现自己并不能想工作多久就工作多久。他多工作一小时所能收获的山芋可能对他来说比失去的闲暇更有价值。但是，如果他必须得到的工资比这个价值还要高，“星期五”就会拒绝让他额外工作。这样一来，岛上的需求（山芋）得不到满足，资源（鲁滨逊的剩余劳动力）得不到利用，经济就会出现衰退。

如果“星期五”担心自己生产的山芋卖不出去，他可能会限制对劳动力的需求。这将抑制他的客户的购买力，从而似乎证实了他悲观的销售预测。鲁滨逊缺乏工作，因为“星期五”销售不足。“星期五”销售不足，因为鲁滨逊缺乏工作。

对这些寓言的一个明显反对意见是它们太卡通了。芝加哥经济学家弗兰克·奈特（Frank Knight）在1960年指出，“克鲁索经济”的概念已成为“又一个咒骂那些渴望现实主义且蔑视理论的人的字眼”。但简化往往有助于理解。例如，麦克法登的寓言说明，经济衰退并非必要或有益，而是荒谬和低效的。

| 明智永远不嫌太晚

然而，对于鲁滨逊爱好者来说，这些思想实验最惹眼的地方不是它们与现实的距离，而是它们与笛福原著故事的差异。书中既没有椰子，也没有山

芋。鲁滨逊不仅不求晒黑皮肤，反而“费尽千辛万苦”躲避太阳，制作了一把“笨拙、丑陋的山羊皮伞”来遮挡阳光。他的岛并不像麦克法登所说的那样在南海，而是在特立尼达附近。“星期五”和鲁滨逊并没有就劳动力或任何其他问题讨价还价。食人族用独木舟把“星期五”带到了岛上，鲁滨逊把他解救出来，之后“星期五”实际上成了鲁滨逊的奴仆。他学到的头几个英语单词里就有“主人”。

对笛福原著的忽视并不意味着教科书上的寓言就失效了。鲁滨逊是在南海还是其他地方采集椰子、山芋或葡萄并不重要。但这种忽视仍然是错失了机会。原著中有很多经济事件和见解。重新发现它可能会让经济学家欣喜。

他们可以不从采集椰子开始，而是从制作面包开始。“很少有人考虑过.....在提供、生产、腌制、调味、制作和完成这一个面包时所必需的奇怪的一大堆小事。”鲁滨逊在费劲给自己制作一些面包时说道。在尝试几乎是从头开始的过程中，鲁滨逊发现，即使是最简单的产品也是经济编排的一个小小奇迹。他的想法类似于伦纳德·里德（Leonard Read）在1958年写的经典文章《我，铅笔》（“I, Pencil”），其中详细介绍了不起眼的铅笔的“谱系”：其木材来自俄勒冈州，石墨来自斯里兰卡，橡胶来自印度尼西亚，所有这些都由拥有还更复杂谱系的机器进行采集、运输和精制。

在看完了面包制作之后，经济学家可以看看鲁滨逊的陶器。他花了大约两个月的时间制作了一对罐子——“两个又大又丑的土制东西”——来储存谷物。保护资源绝非易事：害虫威胁着他的庄稼，他的衣服开始腐烂毁坏。西尔维奥·格塞尔（Silvio Gesell）在1916年出版的《自然经济秩序》一书中想象到，如果鲁滨逊能将自己的备用物资借给另一个岛民（比如“星期五”）以换取几年后类似的物资，他会多么感恩。即使“星期五”不支付利息，他也会接受这笔交易，因为仅仅保持财富完好无损就代表着对无情的自然摧毁力量的胜利。对于那些憎恨当今金融体系的人来说，这是一个有用的思想实验：尽管金融体系存在种种缺陷，但它让人们得以将财富保存在方便的储蓄账户而不是畸形的罐子里。

教科书中的鲁滨逊是一个理性人，总是在平衡边际这个和边际那个。他是经济学101的典型人物。笛福故事中的鲁滨逊更加善变和矛盾，让他更适用于阐释更新近的、受心理学启示的决策理论。他可能成为“行为经济学”的偶像。

| 对我们所拥有的事物缺乏感恩之心

有一次，鲁滨逊用他稀缺的笔墨来评估自己的困境，绘制了一份舒适与痛苦的资产负债表，有贷项有借项。他是一个孤独的漂流者（借项），但他还活着（贷项）。该岛无人居住，但并不荒芜。他没有防御措施，但岛上没有明显的掠食者。没有同伴在沉船中幸存，但可以从船上打捞出给养。

获得诺贝尔经济学奖的心理学家丹尼尔·卡尼曼（Daniel Kahneman）和阿莫斯·特沃斯基（Amos Tversky）指出，在评估自己的生活时，人们通常不是评估自己的幸福水平，而是从一些“中立”参考点出发来评估自己的得失。

参考点的选择并不总是显而易见的。在资产负债表的每一行上，鲁滨逊都考虑了其他选择。他遭遇海难，与世隔绝，这代表着他相对于之前身处之地是遭受了严重损失。但这相对于另一种情景来说则是收益——不难想象，他也可能被淹死或被冲到更危险的海岸上。卡尼曼和特沃斯基指出，在想象另外这些场景时，人们会遵循某些规则。他们重新想象导致他们陷入困境的一系列事件，消除任何奇怪或令人惊讶的命运转折。

鲁滨逊抛弃了失事的船后，船漂到了离岸更近的地方，这让他可以回到船上，把能拿的东西扒了个精光。鲁滨逊意识到这是极为难得的好运气（他说是十万分之一的几率）。这就使他很容易想象出另一个参照点：他从沉船上什么也没拿回来。这对他的心理很有帮助。

行为经济学家强调，选择并非越多越好。人们可能无法抵抗明知从长远来看会伤害自己的选择。选择的存在也会让人心生遗憾。它迫使我们把自己的命运与我们本可以选择的其他方案比来比去。当鲁滨逊被迫留在岛上，他可能会很快乐。但如果他是自己选择了与世隔绝，那他本可以选择的另

一种生活就会让他难以释怀。

事实上，鲁滨逊后来得出结论，他在自己小岛的狭小范围内比在外面的世界更快乐，因为他曾经在外面的世界过着“邪恶、受诅咒的、可憎的生活”。但他也立即向自己承认，如果有机会逃离，他还是会抓住的。

正如这些例子所显示的，经济学家可能会从更了解鲁滨逊的故事中获益。这种受益可以是双向的。对笛福的研究也可以（而且已经）受益于对经济学的更深入了解。笛福作品中有几个角落需要一定的经济学知识才能鉴赏。

当鲁滨逊踏上前往几内亚购买奴隶的命运多舛的航程时，他在巴西留下了一个正在生长的烟草种植园，很快就会价值“三四千英镑”。今天的读者很难理解这样一个数字意味着什么。曾任教于宾夕法尼亚州立大学的戴维·斯皮尔曼（David Spielman）根据经济史学家的研究，计算出这样一笔收入将使鲁滨逊跻身当时英国家庭收入的前5%。面对如此丰厚的财富，鲁滨逊没有理由冒险。他的航行就像他自己承认的那样是“荒谬的”。

经济学家还可能解开其他一些谜团。从岛上回来后，鲁滨逊收回了他的种植园并将其出售。在该书的前六版中，他收到了328,000个西班牙银洋，价值约72,000英镑。但在后来的版本中，一个零被删掉了。这对于故事的解释很重要。小说结尾时，鲁滨逊是个有钱人，还是个超级有钱的人？

文学学者为自己对文本每一处细微差别的敏感而自豪。但鲁滨逊的财富十去其九却无人在意。斯皮尔曼指出：“尽管《鲁滨逊漂流记》的文本历史受到了仔细的关注，但没有人注意到有这么个问题。”经济学家可能忽视了鲁滨逊其人的丰富性。但文学学者却忽视了他的大部分财富。 ■



Hollywood and AI

AI is stalking the last lions of Hollywood

The first actors to lose their jobs to artificial intelligence are four-legged

PADDING AROUND his spacious ranch in the hills outside Los Angeles, Luke has the swagger of an actor who has made it in Hollywood. After six successful years in the movies he lives in an open-plan home with mountain views, a large swimming pool and staff who bring him steak or smoothies when required. A driver is on hand to take him into the city when he gets a call to shoot an ad or make a paid appearance at an event, for which he commands a fee equal to a week's pay for a lowlier actor. Luke turns heads like few other artists. His agent's only complaint is that, given half a chance, he might try to eat his co-stars.

As a 500lb African lion, Luke (pictured) has to deal with challenges not experienced by other actors. But lately, he and his human colleagues have found common cause. America's screenwriters and actors spent half of 2023 on overlapping strikes. One of the reasons for their bust-up with the studios was the use of artificial intelligence (AI) in film and television production. Writers worry that AI will soon be churning out scripts, while actors fear that, as the technology improves the quality of computer-generated imagery (CGI), they may be replaced by digital stand-ins.

For most human actors that is still a hypothetical worry. But for four-legged screen stars it is already a reality. Work for animal actors is drying up as computer graphics offer an easier—and, some argue, more humane—way to portray creatures on screen. As AI makes those special effects still more realistic and easier to produce, the replacement of real animals with digital ones is accelerating, in television and advertising as well as in high-end movies. As demand for animal actors declines, their owners and trainers are leaving the business. Luke and his colleague, Maasai, who lies snoozing

in a nearby enclosure, are the last two working lions in Hollywood.

| *Rendered in tooth and claw*

Ever since a lion appeared on the title card of Goldwyn Studios, later part of MGM, animals have been an essential part of the Tinseltown talent pool. The star who saved Warner Bros from bankruptcy in the 1920s was Rin Tin Tin, a German shepherd who was in more than 20 pictures and was so bankable that producers dubbed him “the mortgage lifter”. From the 1950s an annual Oscars-style awards ceremony, first compered by an actor called Ronald Reagan, gave out gongs to stars such as Flipper the dolphin. In 1993 Entertainment Weekly ranked “the most powerful non-humans in entertainment”, including Moose, a dog-actor in “Frasier” (whose human co-stars were smeared with liver pâté to encourage him to nuzzle them).

Animals with the right skills can still find fame. Steve Martin, Luke the lion’s owner and trainer, has been in the business for more than 50 years, supplying everything from the deer in the “The Deer Hunter” to a pair of skunks named Alice and Cooper. One of the first big roles he landed for Luke was in “A Royal Romance”, a TV movie about Prince Harry and Meghan Markle. Luke played a wild lion in Botswana who, the film implied, may have been Princess Diana reincarnated. Another of Mr Martin’s lions, the late Major, had his paw prints set in Hollywood’s Walk of Fame, during an appearance alongside a nervous Sylvester Stallone to mark MGM’s 90th anniversary.

In an enclosure next to Luke and Maasai is Tag, an 11-year-old bear who lumbers over to greet Mr Martin with a lick. For a role in “Action Point”, a film released by Paramount Pictures in 2018, the 1,000lb bear was trained to drink from a beer can. “He never dented one, even,” says Mr Martin, proudly. Earlier this year Tag had to maul a dummy inside a sleeping bag, for an independent movie called “Night of the Grizzly” (Tag is a Kodiak, but he can play a grizzly). Training for that scene took two weeks, and a lot of

biscuits. Like any good film star, Tag has become somewhat fussy about his diet, shunning the raw salmon that a bear might eat in the wild in favour of cooked chicken from Walmart.

Such successful animal-acting careers are increasingly rare. Mr Martin once kept 100 or so animals at his 60-acre ranch, looked after by 15 trainers. Now his staff is down to a core of three, and most of the enclosures on the ranch are empty. Other businesses have closed or radically reduced their stock. Trainers are fewer, too. Moorpark College, on the edge of Los Angeles, has supplied animal wranglers to Hollywood through its Exotic Animal Training Management course since 1974. Gary Mui, a faculty instructor, estimates that when he graduated from the programme in 1995, about 70% of his classmates went into the entertainment industry. These days only about 10% of graduates do.

One reason for the industry's contraction is a growing public sensitivity to animal welfare, a hot topic in Hollywood since animals were first put in front of the camera. Early moviemakers treated animals as disposable props; Westerns used tripwires to make horses fall as if they had been shot. Public outcry greeted a cowboy film, "Jesse James", in 1939 in which a horse was deliberately driven off a cliff into a lake, where it drowned. The following year the American Humane Society, a charity, began providing its now-famous certification that "No animals were harmed" in the making of productions that passed its on-set inspections.

Animals' treatment in Hollywood has vastly improved since the days of "Jesse James". But abuse has not disappeared, and the risk of scandal makes studios nervous. HBO cancelled its racing drama, "Luck", after three horses died on set (poor ratings may have been another factor; one critic quipped that the animals may have died of boredom). "Gladiator 2", currently in production, has faced protests for using macaque monkeys and horses. These days many trainers are reluctant to talk about their work; one, who

says that animal-rights activists once called a police SWAT team to his home, insists (amid deafening squawking) that for security reasons he can no longer disclose whether he keeps animals on the premises.

Truly plausible digital stand-ins are now an alternative to real animals for wary studios. For many years, computer-generated creatures were convincing only in limited circumstances. “Jurassic Park” wowed audiences with its special effects in 1993, but used animatronic dinosaurs more than CGI ones. For years after that, computer models struggled to create realistic hair, which animals tend to have a lot of. Furry CGI creatures looked weirdly smooth—“like Gummi Bears”, recalls Mr Mui. Then, in 1998, came Disney’s “Mighty Joe Young”, whose star is a giant ape created from animatronics and CGI. Mr Mui watched it in dismay. “I said, ‘Oh, our days are numbered now,’” he recalls. For the first time, the hair looked good.

As the effects have got better, directors have relied on them more often. Disney has produced a series of live-action remakes of classic animal-based animations, including “The Jungle Book” (2016) and “Dumbo” (2019), in which it has cast real actors in the human roles but created the leading animals on a screen. In its blockbuster remake of “The Lion King” (2019) every creature, from warthog to wildebeest, was computer-generated. Disney is not alone. The star of Universal’s comedy-horror hit in February, “Cocaine Bear”, was a CGI creation. Tag never even got to audition. “They used to call us for stuff like that,” says Mr Martin. “Those guys really pushed us out of business.”

So far the “exotics” have lost the most work. Chimps have not acted in a big American movie since Paramount’s “The Wolf of Wall Street” in 2013. The last elephants are thought to have lumbered out of Hollywood around the same time. Studios are increasingly unwilling to work with big cats, says Mr Martin. “For wild animals, it’s basically finished,” he concludes.

Trainers of smaller stars are wondering how much further the digital trend will go. An hour or so from Luke the lion's ranch is Studio Animal Services, with an obstacle course in its front yard and multiple dog chews and fly swatters inside. Karin McElhatton, who has trained animals in Hollywood since the 1970s, is the company's owner—though Rumor, a white Pekin duck, appears to believe that he is its real proprietor, as he waddles in from a swim and preens in front of a fan, filling the room with a cloud of feathers and down.

"The business is getting more and more narrow in terms of the animals they want to use," says Ms McElhatton. She once flew a team of five squirrels, raised from babies, to Hungary for a Kinder chocolate ad, which required them to carry a coin to a vending machine. These days such jobs are nearly always computer-generated, she explains.

Ms McElhatton's 35 cats and 25 dogs still find work. Albert, a serene brown tabby on a pink lead, spends most of his time modelling for pet food commercials, though he also scored a recent role in a horror film pretending to devour a corpse. Tank, a German shepherd, is in demand as a sniffer dog on shows like "NCIS" and "911" (his trainer, David Meyers, has a Screen Actors Guild card so that he can play the accompanying police officer). Two golden retrievers, Parker and Porter, are often cast as family pets. Two years ago they went to Mexico for a comedy movie called "El Roomie"; they were flown first-class and got their own trailer.

Domestic animals have been somewhat protected against digital competition. Audiences are more familiar with the real thing and thus quicker to spot a fake dog than a fake bear. Animal-rights protesters seem somewhat less bothered by their involvement, too. Yet even man's best friend is now losing work to digital doppelgangers. "The Call of the Wild", a Disney movie released in 2020, called in computer animators to create

Buck, the St Bernard-Scotch shepherd who co-stars alongside Harrison Ford. Audiences didn't much like the digital dog; for now, directors still prefer to cast the real thing. Nonetheless, "it was extremely disconcerting for us," says Ms McElhatton, who was relieved when the movie fizzled at the box office.

Could CGI replace the two-legged animals at the top of the acting food chain? Near Seattle, an unusual team of animal trainers has seen signs that it might. The trainers recently taught a lion cub to climb onto its father's head, before rolling off his back and onto the ground. Yet the lions in question do not live in a cage, but on a hard drive, and their training is not done with biscuits, but with biomechanical elastic-body solvers and quasi-static integrators.

The digital lion-tamers work for Unity, which creates virtual environments and characters for video games and has dabbled in movies (including 2022's sequel to "Avatar"). Creating believable animals is still easier than creating realistic humans, says Allan Poore, who moved to Unity after working as an animator at Disney's Pixar. "We stare at faces and people all day...so we're going to notice."

Eyes are hard to get right, and skin can look waxy without elaborate light-diffusion techniques. But creating digital humans is getting easier. The addition of AI to the animator's toolkit has sped things up, meaning that "rigging" a digital model of a human face (think the wires on a puppet) might take an hour or two, down from a month. "We've been on this journey a long time, and I think we're getting closer and closer," Mr Poore says. "I've seen some stuff [where] it's hard to tell the difference. And you'll see more of that."

Actors are already being "de-aged" for roles which might once have gone to young lookalikes. In "Indiana Jones and the Dial of Destiny", released in

June, the octogenarian Mr Ford was rejuvenated by half a century by animators who used AI to mine footage of the actor in his “Raiders of the Lost Ark” days. Robert DeNiro underwent a similar transformation in Netflix’s “The Irishman” (2019), as did Samuel L. Jackson in Disney’s “Captain Marvel”, released in the same year. Background actors, or extras, fret that they may soon not be needed at all.

What kind of work awaits human stars then? The animals offer a preview of the coming attractions. Some still give performances that are later digitally enhanced. Disney’s live-action remake of “Lady and the Tramp” (2019) mixes footage of real dogs with CGI shots, including animating their mouths to simulate talking (an effect that trainers used to achieve by feeding the dog something chewy before the cameras rolled). Real dogs acted in Warner Bros’ “Birds of Prey” (2020), only to be morphed into a hyena in post-production. American Humane explains that a herd of 100 CGI horses is likely to be modelled on ten real ones.

Others have moved away from feature films to focus on more humdrum work. Social-media influencers, prizing high-impact, low-budget stunts, have become regular employers of exotic animals. Tag the bear has gamely “wrestled” with Logan Paul, a YouTuber, and taken on humans in a hot-dog eating contest organised by Barstool Sports, a blokeish entertainment site. Live events are also fairly safe from AI interlopers. Tag was hired in 2021 to appear at campaign rallies alongside John Cox, a California Republican who called himself “the beast”. Even this kind of work is becoming scarce, however, amid animal-welfare concerns. Mr Martin is being sued by an animal-rights group over Tag’s appearance at the rallies.

| *Circle of life*

Many of Hollywood’s last animal-handlers are now near retirement. “When this generation of trainers kicks the bucket, I don’t know that you’re going to have hardly anything in America,” says Ms McElhatton.

Animal-rights advocates are delighted. PETA, a lobby group, advocates more use of CGI creatures, arguing that “creative people can tell compelling, emotional stories using special effects and without exploiting any real animals.” “I understand some of the motivations of animal-rights people. And they need to understand that we have more in common with them than we don’t,” says Mr Mui sadly. “I want what’s best for animals, but I don’t have an issue with animals working with people as long as it’s done correctly,” he says. But now, “it’s all fading away.”

At Luke’s ranch, a for-sale sign has gone up at the end of the long driveway. Mr Martin, 76, is planning to move to Oregon with his remaining animals. He believes that their absence from the screen will ultimately harm the cause of animal welfare, by removing the audience’s connection to real, living creatures. “These guys are ambassadors for the ones in the wild,” he says. Soon, Luke and Maasai will head north with him in their air-conditioned trailer. And then the only lions left in Hollywood will be digital. ■



好莱坞和AI

人工智能盯上了好莱坞最后几头狮子

因AI失业的第一批演员是四条腿的家伙们【深度】

卢克（Luke）在洛杉矶郊外山上宽敞的牧场里转悠，一副好莱坞大腕的趾高气昂的派头。经过六年成功的电影生涯后，他住在一户开放式山景寓所，配有一个大游泳池，工作人员会在有需要时送上牛排或冰沙。当他接到拍摄广告或出席有偿活动的电话时，会有司机把他送进城，他收取的报酬相当于普通演员一周的工资。卢克所到之处，吸睛水平难有匹敌。他的经纪人唯一的抱怨是，一有机会，他可能就试图把他的合作演员吃了。

身为一头重达500磅的非洲狮，卢克（如图）必须应对其他演员没有经历过的挑战。但最近，他和他的人类同事们开始共进退。2023年的一半时间里，美国的编剧和演员的罢工此起彼伏。他们与制片厂争执的原因之一是人工智能（AI）在影视制作中的应用。编剧们担心AI很快就会开始大量创作剧本，演员们则害怕随着技术让计算机生成图像（CGI）的质量越来越好，他们可能会被数字替身取代。

这对于大多数人类演员来说仍然只是个假设性的担忧，但对于四条腿的银幕明星来说已经成为现实。动物演员的工作正趋枯竭，因为计算机图形技术为在银幕上塑造动物形象提供了更简便（而且一些人认为更为人性化）的方法。随着AI使这些特效更加逼真和易于制作，在电视、广告和高端电影中，数字动物正在加速取代真实的动物。对动物演员的需求减少后，它们的主人和驯兽师正纷纷离开这个行当。卢克和他躺在附近围栏里打盹的同事马赛（Maasai）是好莱坞最后两头还在工作的狮子。

渲染腥牙血爪

自一只狮子出现在戈德温影业（Goldwyn Studios，后来成为米高梅的一部分）的商标上起，动物就成为了好莱坞演艺人才库中不可或缺的一部分。20世纪20年代，拯救华纳兄弟免于破产的明星是任丁丁（Rin Tin Tin），他是一只德国牧羊犬，曾出演过20多部影片，票房非常出色，制

片人戏称它为“能还贷的角儿”。从1950年代起，一年一度的形同奥斯卡的颁奖礼会向海豚飞宝（Flipper）等明星颁奖，一位名叫罗纳德·里根的演员主持了第一届典礼。1993年，《娱乐周刊》发布“娱乐圈最具影响力的非人类”排行榜，上榜的包括《欢乐一家亲》（Frasier）中的狗子演员穆斯（Moose，与他合作的人类演员身上涂满了肝酱，以吸引他用鼻子蹭他们）。

拥有适当技能的动物仍有机会名声大噪。狮子卢克的主人兼驯兽师史蒂夫·马丁（Steve Martin）从事这一行已有50多年，供应过的动物林林总总，从《猎鹿人》（The Deer Hunter）中的鹿，到一对名为爱丽丝（Alice）和库珀（Cooper）的臭鼬等。他最早为卢克争取到的重要角色之一是在一部关于哈里王子和梅根·马克尔的电视电影《皇家情缘》（A Royal Romance）中。卢克在片中饰演了博茨瓦纳的一头野生狮子，影片暗示这头狮子可能是戴安娜王妃转世。马丁的另一头狮子，已故的“少校”（Major），在米高梅公司90周年庆典上与神色紧张的史泰龙一同亮相，爪印被刻在了好莱坞的星光大道上。

在卢克和马赛旁边的围栏里，11岁大的泰格（Tag）笨拙地移步过来，舔了舔马丁向他问好。为了在派拉蒙影业于2018年上映的电影《行动时刻》（Action Point）中扮演一个角色，这只重达1000磅的熊接受了从啤酒罐里喝水的训练。“他甚至没有弄瘪过一个罐头。”马丁自豪地说。今年早些时候，泰格不得不在一部名为《灰熊之夜》（Night of the Grizzly，泰格是棕熊，但它可以扮灰熊）的独立电影里袭击睡袋里的一个假人。这场戏的训练花费了两周时间和大量饼干。和其他优秀的电影明星一样，泰格变得对饮食有些挑剔，他不碰熊在野外可能会吃的生鲑鱼，而选择沃尔玛超市里的熟鸡肉。

如此成功的动物表演生涯日益罕见。马丁曾经在他占地60英亩的牧场里饲养了100多只动物，配有15名驯兽师。现在，他的员工只剩下核心三人团，牧场里的大部分围栏都空了。其他企业也纷纷关闭或大幅削减饲养的动物数量。驯兽师也越来越少。位于洛杉矶周边的莫尔帕克学院（Moorpark College）自1974年以来通过其“奇珍动物训练管理”课程为好

莱坞提供驯兽师。该学院教师加里·穆伊（Gary Mui）估计，当他1995年从该课程毕业时，约有70%的同学进入了娱乐业。如今，只有一成左右的毕业生进入该行业。

行业萎缩的原因之一是公众对动物福利日益敏感。自动物首次出现在镜头前以来，动物福利一直都是好莱坞的热门话题。早期的电影制作人将动物视为一次性道具；西部片使用绊索让马匹摔倒，制造出中弹倒地的效果。1939年，牛仔电影《杰西·詹姆斯》（Jesse James）故意将一匹马赶下悬崖，掉进湖里淹死，引发了公众强烈不满。次年，慈善机构美国人道协会（American Humane Society）开始提供到今天大家都已很熟悉的“没有动物受到伤害”认证，证明影片的制作过程通过了其现场检查。

自《杰西·詹姆斯》时代以来，好莱坞对待动物的方式有了很大改善。但虐待动物的现象并未消失，引发丑闻的风险也让制片厂感到紧张。在三匹马死在片场后，HBO中途砍掉了其赛马题材剧集《幸运》（Luck）（收视率不佳可能是另一个因素；一位剧评人打趣说它们可能是被无聊的剧情闷死的）。目前正在制作中的《角斗士2》因使用猕猴和马而遭到抗议。如今许多驯兽师都不大愿意提起自己的工作。一位驯兽师说，动物权利活动人士曾经叫了一支特警队到他家。他（在一片震耳欲聋的动物叫声中）坚持说，出于安全考虑，他不能再透露他是否在这里饲养了动物。

对于谨慎的制片厂而言，真正可信的数字替身如今已成为真实动物的一种替代选项。多年来，电脑制作的动物只有在某些情况下看着令人信服。1993年，《侏罗纪公园》的特效令观众叹为观止，但它使用的更多是仿真恐龙而不是CGI恐龙。在那之后的多年里，计算机模型一直难以制作出逼真的毛发，而动物往往有很多毛。穆伊回忆说，CGI制作出来的毛茸动物看起来很奇怪，滑溜溜的“就像小熊软糖”。1998年，迪士尼的《无敌大猩猩》（Mighty Joe Young）上映，该片的主角是一只用动画和CGI制作的巨猿。穆伊看得垂头丧气。“当时我说，‘哦，这下我们的日子可不多了’。”他回忆道。这是动物的毛发头一回看起来对劲了。

随着效果越做越好，导演们也越来越依赖它们。迪士尼已经制作了一系列

经典动物动画的真人翻拍版，包括《奇幻森林》（The Jungle Book，2016年）和《小飞象》（Dumbo，2019年），其中人类角色由真人演员出演，动物主角则是在显示屏上制作出来的。在翻拍大片《狮子王》（The Lion King，2019年）中，从疣猪到角马的每一种动物都是电脑制作的。这样做的不只是迪士尼。环球影业去年2月推出的卖座喜剧恐怖片《可卡因熊》（Cocaine Bear）的主角就是由CGI制作的。泰格甚至连试镜的机会都没有。“过去有这种角色他们会给我们打电话，”马丁说，“那些家伙真把我们逼得没事干了。”

到目前为止，“奇珍品种”丢掉的工作最多。自2013年派拉蒙出品的《华尔街之狼》（The Wolf of Wall Street）之后，黑猩猩就再没出演过美国大片。据称最后一批大象也是在同一时期沉重出走好莱坞的。马丁说，制片厂越来越不愿意与大型猫科动物合作。“对于野生动物来说，基本上已经玩完了。”他总结道。

｜ 人类最佳化身

小型动物明星的驯兽员们想知道数字化趋势会走多远。距狮子卢克的牧场约一小时车程的制片厂动物服务公司（Studio Animal Services）的前院设有障碍训练场，里头有多种狗咬胶和苍蝇拍。公司所有者卡琳·麦克尔哈顿（Karin McElhatton）自20世纪70年代以来一直在好莱坞训练动物。不过，白色的北京鸭“流言”（Rumor）似乎相信自己才是这里真正的主人，他游完泳摇摇摆摆地进屋，在一台风扇前搔首弄姿，扬起一阵羽毛和绒毛。

“娱乐业想要使用的动物品类越来越窄。”麦克尔哈顿说。她曾经带着五只从小养大的松鼠飞往匈牙利拍摄一支健达巧克力广告，广告要求它们把一枚硬币拿到自动售货机上。如今这类工作几乎都是由计算机完成了，她解释说。

麦克尔哈顿的35只猫和25只狗仍然有活干。阿尔伯特（Albert）是一只安详的棕色虎斑猫，套着粉红色的牵绳，大部分时间都在为宠物食品广告做模特，不过最近还参演了一部恐怖电影，假装吞食一具尸体。坦克

（Tank）是一只德国牧羊犬，在《海军罪案调查处》（NCIS）和《911》等节目中扮演嗅探犬（他的训练师大卫·迈耶斯 [David Meyers] 拥有美国演员工会会员证，因此可以扮演随行警官）。两只金毛猎犬帕克（Parker）和波特（Porter）常扮演家庭宠物。两年前，他们去墨西哥参演喜剧电影《室友》（El Roomie），坐头等舱，还有自己的移动化妆拖车。

家畜在某种程度上免受数字竞争的影响。观众对家畜的真身更熟悉，因此假狗比假熊更容易看出来。动物权利抗议者对它们的参与也更宽容些。但即使是人类最好的朋友现在也在被数字分身取代。2020年上映的迪士尼电影《野性的呼唤》（The Call of the Wild）请电脑动画师制作了与哈里森·福特共同出演的圣伯纳-苏格兰牧羊犬巴克（Buck）。观众们不大喜欢这只数码狗。目前而言，导演们仍然更倾向于用动物真身。不过，“我们那次可是紧张死了，”麦克尔哈顿说。直到这部片子票房惨淡，她才松了一口气。

CGI能否取代处于表演食物链顶端的两足动物？在西雅图附近，一支不同寻常的驯兽师团队已经看到了这种可能性的迹象。最近，驯兽师教一只幼狮爬到它的父亲头上，然后从父亲的背上滚到地上。不过，这些狮子并不生活在笼子里，而是生活在硬盘上，它们的训练也不是用饼干完成的，而是用生物力学弹性体解算器和准静态积分器。

这些数字驯狮者为Unity工作，该公司为视频游戏创建虚拟环境和角色，还涉足电影（包括2022年的《阿凡达》续集）。在迪士尼的皮克斯担任动画师后加入Unity的艾伦·普尔（Allan Poore）表示，创造可信的动物仍然比创造逼真的人类更容易。“毕竟我们整天都盯着面孔和人看……我们会看出来的。”

眼睛就很难做好，而如果没有精致复杂的光漫射技术，皮肤看起来会像是蜡像。但创造数字人类正变得越来越容易。在AI加入动画师的工具包后，进展已经提速，“操纵”一个人脸数字模型（想想提线木偶）现在可能只需要一两个小时，而以前要一个月。“我们已经在这条路上走了很久，我认

为离目标越来越近了，”普尔说，“我已经见过一些真假难辨的东西。而你会看到更多这种东西。”

老演员们已经在被“减龄”，去扮演那些本来可能得找长得像他们的年轻人来演的角色。在6月上映的《夺宝奇兵：命运之盘》（Indiana Jones and the Dial of Destiny）中，动画师利用AI挖掘哈里森·福特在《夺宝奇兵》第一部时期的镜头，让已经八旬高龄的福特变回三十多岁。罗伯特·德尼罗在奈飞的《爱尔兰人》（The Irishman，2019年）中实现了类似的容颜转变，塞缪尔·杰克逊在同年上映的迪士尼的《惊奇队长》（Captain Marvel）中也是如此。背景演员（群演）担心自己可能很快就完全不被需要了。

那么，什么样的工作等待着人类明星呢？这些动物预告了即将到来的精彩节目。它们有些仍在表演，但后来经过了数字增强。迪士尼的真人版《小姐与流浪汉》（Lady and the Tramp，2019）将真狗的镜头与CGI镜头混剪，包括让狗的嘴巴模拟出讲话的效果（过去，训练师会在镜头启动前给狗喂一些有嚼劲的东西来达到这种效果）。真狗出演了华纳兄弟的《猛禽小队》（Birds of Prey，2020年），但在后期制作中变成了鬃狗。美国人道协会解释说，一群100匹的CGI马很可能是以10匹真马为原型制作出来的。

其他动物已经从参演电影长片转向更日常平淡的工作。社交媒体博主们推崇高冲击力、低预算的特技表演，已经成为了奇珍动物的常见雇主。棕熊泰格曾与YouTube博主洛根·保罗（Logan Paul）英勇“搏斗”，在男性体育娱乐网站Barstool Sports组织的吃热狗比赛中挑战人类。现场活动也不会受到AI的威胁。泰格在2021年受聘与自称“野兽”的加州共和党人约翰·考克斯（John Cox）一起出席竞选集会。但由于对动物福利的担忧，连这样的工作也变得稀缺。马丁因泰格参加了这次集会被动物权利组织告上了法庭。

| 生生不息

好莱坞最后一批驯兽师中的许多人如今已近退休。麦克尔哈顿说：“等这

一代驯兽师去世了，我不知道美国还会有什么动物演员。”

动物权益倡导者很高兴。游说团体PETA主张更多使用CGI制作的动物，认为“文艺创作者可以利用特效来讲述引人入胜的情感故事，而无需利用任何动物真身”。“我理解动物权益人士的某些动机。但他们要明白，我们和他们的共识要比分歧多。”穆伊伤感地说。“我希望为动物谋福利，但我并不反对动物与人合作，只要方式正确。”但现在，“一切都快没了。”

在卢克的牧场，长长的车道尽头竖起了一块写着待售的牌子。76岁的马丁计划带着他剩下的动物搬去俄勒冈州。他认为，它们从银幕上消失最终会损害动物福利事业，因为观众与真实动物的连结断了。“这些家伙是野生动物的形象大使。”他说。很快，卢克和马赛将乘坐带空调的拖车和他一起北上。然后，好莱坞就只剩下数字狮子了。■



Robotics

Delivery robots will transform Christmas

Santa's hi-tech little helpers

A SHOP ASSISTANT leaves a Co-op convenience store in Milton Keynes and opens the lid of a white box, about the size of a small suitcase, with a red flag on top and six wheels. After the assistant drops a bag of shopping inside and scans a bar code, the box trundles off. Travelling at a brisk walking pace along the footpath, it pauses at a road junction until two cars have passed before crossing safely. Neither pedestrians nor car drivers give it a second glance. Delivery robots like this have become part of the scenery since they started work in this town, some 80km north-west of London, in 2018.

“That’s when you know a new technology is successful,” says Ed Lovelock. “People don’t notice it any more.” Mr Lovelock is product manager for Starship Technologies, a Californian firm that has so far delivered more than 5m shopping orders and restaurant meals in Europe and America using its autonomous Starships.

In some places such deliveries arrive by air. “It soon becomes a normal part of your life,” says Keller Rinaudo Clifton, the boss of Zipline, a drone-delivery firm also based in California. Zipline began using drones to deliver blood and medical products in Rwanda in 2016. It is expanding into groceries and meals and now operates in other parts of Africa as well as America and Japan. In 2024 Zipline will begin deliveries to hospitals and clinics in the north of England for Britain’s National Health Service.

| *Where’s my bot?*

Like many new technologies, delivery bots have gone through something of a hype cycle. A decade ago many predicted they would soon be everywhere.

Amazon, for one, announced with great fanfare ambitious plans for its Prime Air drone-delivery service in 2013, but progress was slow and not much happened. That is changing, and even Amazon's drones finally look like they are about to take off.

A number of things have brought this about. Companies like Starship and Zipline began modestly in areas where regulators were more comfortable with robotic deliveries. Milton Keynes, for instance, is a new town with wide paths and cycleways for bots to drive along, and with few low-flying aircraft to worry about in the sky above Rwanda, drones can operate safely.

Having steadily gained solid operating experience, officialdom is becoming more relaxed about such services. What that means is, particularly at this time of year, instead of fleets of delivery vans with drivers hauling seasonal gifts and shopping to people's front doors, an increasing number of goods are arriving by robot.

Starship has gone on to launch services in ten British towns, including older places with narrower streets like Manchester, Leeds and Cambridge. It also makes deliveries on more than 50 university campuses in America. Nor is it alone. Serve Robotics, which is backed by Uber, a ride-sharing platform, began using "sidewalk robots" for restaurant deliveries in Los Angeles in 2022 and aims to deploy some 2,000 in other American cities.

Customers typically use an app to order, with the firms adding a small delivery fee. Depending on distance, this starts at 99 pence (\$1.20) in Milton Keynes. Around 100 Starships, each able to carry up to 10kg, serve a number of stores. They navigate along pre-mapped routes using satellite positioning. Sensors, including a dozen cameras and radar, create a "bubble of awareness" around the robot. On arrival, customers use their phone to unlock the robot's storage compartment and collect their shopping.

It helps that Starships have been made cutesy. Customers in Milton Keynes can choose a song, like “Happy Birthday” for the bot to play on arrival. Some are also decorated for festive occasions, such as “pumpkinbots” during Halloween or “reindeerbots” at Christmas. As a result, adds Mr Lovelock, residents are protective of them and few are tampered with. The bots emit a high-pitched screech if anyone tries to steal them or their contents.

The growing acceptance of delivery bots is helping the idea spread. A trial scheme using sidewalk robots in Helsinki, the Finnish capital, is due to be expanded in the spring of 2024. In November the South Korean government warned people “not to be surprised” by more of them appearing in the capital, Seoul, where the 7-Eleven convenience chain has been testing four-wheel models produced by Neubility, a startup backed by Samsung.

Much the same is happening with drones, although they are not yet dressing up and singing songs. America’s Federal Aviation Administration recently allowed some firms, including Zipline, to fly “beyond-visual-line-of-sight” (BVLOS). In America and many other countries drones are not allowed to be flown out of sight of their operators unless ground observers monitor them in case other aircraft are in the vicinity. This restricted how far drones could fly and drove up costs.

Advances in technology helped win these new freedoms. For BVLOS flights, new miniaturised sensing devices can be built into drones to detect and avoid other aircraft. Zipline’s system uses specially developed microphones which can pick up the sound of an approaching aircraft and determine its position, allowing the drone to take evasive action if necessary.

| *Drone highways*

In Britain a 165-mile (265km) superhighway for drones, connecting southern England with the Midlands, will start operating in 2024. It will

rely on a series of ground stations along the route to communicate with the drones to keep them apart and avoid any other aircraft.

The ability to fly BVLOS allows Zipline to offer similar services to its African operations. For these, the company uses a fixed-wing drone capable of a round trip of some 200km. Carrying up to 1.8kg, it is launched with a giant catapult and drops its delivery using a parachute.

The company is starting to work with a number of medical centres in America. In a recent deal with the Cleveland Clinic, it will deliver medicines directly to people's homes in locations throughout Ohio. For this Zipline will use a new type of hovering drone, able to make round trips of some 30km carrying up to 3.6kg. Instead of a parachute, this drone uses a load-carrying device called a "droid". After being lowered on a cable, the droid employs a small fan motor to manoeuvre, allowing it to set packages down in precise locations, such as the front steps of a home. This drone-plus-droid system will also be used to deliver groceries and meals.

Both sidewalk robots and drones still require some level of human supervision. Usually this involves people in a control centre monitoring them and intervening if necessary. For Starships, these interventions tend only to come when a bot stops and seeks confirmation that a manoeuvre it intends to undertake, like crossing a tricky road junction, is safe. Zipline's drones can be called back to base in the event of a problem, or ordered to stop flying immediately and deploy a parachute to land in an emergency. Such events, however, are "extraordinarily rare", says Mr Rinaudo Clifton.

As for Amazon, it began a limited drone-delivery service in two small areas of California and Texas in 2022. It has since developed a new drone, called the MK30, which it plans to put into service in America, Britain and Italy by the end of 2024. These will operate out of the company's delivery centres and also use a sense-and-avoid system for BVLOS flights. It is quieter than

the firm's existing model, can carry packages up to 2.2kg and will be able to fly in unsettled weather, including light rain.

Amazon is talking about delivering millions of packages by drone every year by the end of the decade. If the giant of online retailing can finally crack the technology, then automated delivery could spread almost everywhere. If not, there are already enough firms demonstrating that, at least in some areas, delivery bots using wheels, wings or rotors are coming your way. ■



机器人技术

送货机器人带来别样圣诞节

圣诞老人的高科技小助手

一名店员从米尔顿凯恩斯（Milton Keynes）的一家Co-op便利店走出来，打开一个白色箱子的盖子。这个箱子的大小和一个小行李箱差不多，上面插着一面小红旗，底下装着六个轮子。店员把一袋商品放进箱子、扫描完条形码，箱子就缓缓滑走了。它以比路人散步略快的速度沿着人行道滑行，在一个路口停下来，等两辆车经过后，才安全穿过路口。无论是过往行人还是司机都不会多看它一眼。自2018年以来，这样的送货机器人就开始穿梭在这个位于伦敦西北向约80公里处的小镇，成为镇上的一道风景。

“当人们对它熟视无睹的时候，”埃德·洛夫洛克（Ed Lovelock）表示，“你就知道一项新技术取得了成功。”洛夫洛克是加州公司Starship Technologies的产品经理。截至目前，该公司已经使用其自主移动机器人Starship为欧美的商店和餐馆完成了500多万单外送服务。

在有些地方，这些配送是从空中送达的。“它很快就会成为你日常生活的一部分。”同样位于加州的无人机送货公司Zipline的老板凯勒·里纳乌多·克利夫顿（Keller Rinaudo Cliffton）表示。2016年，Zipline开始在卢旺达使用无人机运送血液和医疗用品。它正在向食品杂货和餐饮领域扩张，现在除了在美国和日本，它也在非洲其他地区开展业务。2024年，Zipline将为英国国家医疗服务体系（NHS）提供服务，开始向英格兰北部的医院和诊所送货。

| 我的机器人在哪里？

和许多新技术一样，送货机器人也经历了某种程度上的技术成熟度曲线。十年前，许多人预测它们很快就会无处不在。例如，亚马逊在2013年大张旗鼓地宣布了其雄心勃勃的Prime Air无人机送货服务，但该计划后来进展缓慢，并未取得多少成就。现在情况正在改变，亚马逊的无人机似乎也终于要一飞冲天了。

一些因素促成了这些改变。Starship和Zipline等公司起步都较为谨慎，选择了监管机构对机器人送货较为包容的地区。例如，米尔顿凯恩斯是新城镇，这里有宽阔步道和自行车道可供机器人行驶；在卢旺达的上空几乎没有低空飞行的飞机可担心，无人机因而可以安全飞行。

在这类公司稳步积累了扎实的运营经验后，官员们开始放宽对它们的服务的限制。这意味着越来越多的货物正由机器人送达，而不是由货车司机把节日礼物和其他商品送到居民家门口，尤其是在每年的圣诞季。

Starship后续在英国的十个城镇推出了服务，包括曼彻斯特、利兹和剑桥等一些街道狭窄的较古老城镇。它还在美国50多所大学的校园里送货。Starship并非个例。2022年，由拼车平台优步（Uber）支持的Serve Robotics公司开始在洛杉矶使用“人行道送货机器人”为餐馆送外卖，并计划在美国其他城市部署约2000台。

顾客一般会通过应用下单，送货公司会加收少许送货费。在米尔顿凯恩斯，送货费根据距离远近而定，起步价为99便士（1.20美元）。米尔顿凯恩斯大约有100台Starship，每台最多可携带十公斤物品，为好几家商店送货。它们利用卫星定位沿着预先规划好的路线行进。包括十二个摄像头和雷达在内的传感器在机器人周围形成一个“感知气泡”。到达目的地后，顾客用手机解锁机器人的储物箱，取走自己购买的物品。

Starship萌萌的外型设计也是一个加分项。米尔顿凯恩斯的顾客可以选择一首歌曲（比如《生日快乐》），让机器人在到达时播放。逢年过节时，一些机器人还会被装饰成不同造型，比如万圣节的“南瓜机器人”或圣诞节的“驯鹿机器人”。因此，洛夫洛克补充道，居民很护着它们，很少有机器人被蓄意破坏。如果有人试图偷走它们或者它们运送的物品，这些机器人会发出刺耳的尖叫声。

人们对送货机器人不断接受度的提高有助于让这个创意传播开来。2024年春季，芬兰首都赫尔辛基将扩大一项使用人行道机器人的试验计划的范围。在韩国首都首尔，7-11连锁便利店已经在测试由三星支持的创业公司

Neubility生产的四轮电动送货机器人。对于首尔街头出现的越来越多的送货机器人，韩国政府在去年11月提醒民众“无需惊讶”。

送货无人机的情况大致相同，尽管它们还没有被装扮起来或是被安排唱歌。美国联邦航空管理局（FAA）不久前允许包括Zipline在内的一些公司进行“超视距”飞行。根据美国和许多其他国家的规定，无人机不准飞出操控员的视线，除非地面观察员能够监视它们，以防它们碰到附近的其他飞行器。这一规定限制了无人机的飞行距离，推高了成本。

技术上的进步帮助无人机争取到了新的自由度。执行超视距飞行的无人机可以内置新的微型传感设备以探测和避开其他飞行器。Zipline的系统使用了专门研发的麦克风，可以捕捉到其他飞行器靠近时发出的声音并确定其位置，从而让无人机在必要时采取规避行动。

| 无人机高速通道

在英国，一条连接英格兰南部和中部地区的165英里（265公里）长的无人机高速通道将于2024年开始运营。它将依靠沿途的一系列地面站与无人机建立通信，让无人机相互保持距离，同时避开其他所有飞行器。

因为具备了超视距飞行的能力，Zipline能够为其在非洲的业务提供类似的服务。Zipline使用的是一架单次能够往返飞行约200公里的固定翼无人机。它最大载重1.8公斤，通过一个巨大的弹射器起飞，并使用降落伞投放物品。

Zipline开始与美国的一些医疗中心合作。根据不久前与克利夫兰诊所（Cleveland Clinic）达成的协议，Zipline将把药品直接送到俄亥俄州各地的居民家中。为此，Zipline将使用一种新型悬停式无人机，单次能够往返飞行约30公里，最大载重3.6公斤。这款无人机使用的是一种叫作“机器人”的载货装置，而不是降落伞。“机器人”被缆绳放下后，会启动一个小型风扇马达来让自己移动，从而将包裹精准放在指定位置，比如房门口的台阶上。这种“无人机+机器人”的系统也将被用来运送食品杂货和餐食。

无论是人行道机器人还是无人机，都还需要一定程度的人类监督。通常是

由控制中心里的人员监控，并在必要时干预。对于Starship来说，一般只有当机器人停下来并试图确认自己打算采取的行动（比如穿过一个复杂的十字路口）是否安全时，才会进行干预。Zipline的无人机在遇到问题时可以被召回基地，或者在紧急情况下按指令立即停止飞行并使用降落伞着陆。不过，这种情况“极为罕见”，里纳乌多·克利夫顿表示。

至于亚马逊，它于2022年在加州和得克萨斯州的两小块区域开始了有限的无人机送货服务。此后，亚马逊开发了一种名为MK30的新型无人机，计划在2024年底前在美国、英国和意大利投入使用。这些无人机将从亚马逊的配送中心起飞，并且同样使用了“感知回避”系统来执行超视距飞行。它的噪音比亚马逊的现有机型小，最多可携带2.2公斤的包裹，并能在小雨等不稳定的天气条件下飞行。

亚马逊正在谈论在2030年前实现每年用无人机运送数百万个包裹。如果这家在线零售巨头最终能够攻克这项技术，那么自动化配送可能会遍布几乎世界各地。就算做不到这一点，也已经有足够多的公司证明，至少在某些地方，使用轮子、机翼或螺旋桨的各种送货机器人正在向我们走来。■



Xi-3PO

China's quest to become a robot superpower

As its population shrinks, China hopes machines can pick up the slack

CHINA'S FIRST attempt at building a humanoid robot did not hit the mark. The machine produced in 2000 by a team at the National University of Defence Technology looked like a walking toaster. It had googly eyes and cannon-like protuberances near its crotch. Called Xianxingzhe, or Forerunner, it was mocked in neighbouring Japan, which at the time boasted far sleeker robots. Japanese netizens described it as China's secret weapon—designed to make its enemies die of laughter.

China has stuck with it, though. In November the government published a plan calling for the mass production of humanoids by 2025. The country's love of robots goes beyond those that can walk and talk. Last year half of all the industrial robots installed worldwide were fitted in China, according to the International Federation of Robotics, an industry body. It is now the fifth most automated country in the world when measured by robots per worker. Motivated by pride and pressing demographic challenges, China is on a mission to become a robot superpower.

Many of the country's newly installed robots are mechanical arms that can be programmed to weld, drill or assemble components on a production line. But last year China also produced over 6m "service robots", which help humans with tasks apart from industrial automation. Such machines scoot around warehouses, moving boxes. Others clean hotels. At a restaurant in the southern city of Guangzhou meals are cooked and served by robots.

Some of this may seem gimmicky, but to the Communist Party led by Xi Jinping robots are serious business. Officials believe China fell behind and was humiliated by Western powers in the 19th century in part because it did

not embrace technological revolutions happening elsewhere. Now China aims to stay ahead of the game. Whereas officials once used steel production as a gauge of economic advancement, today they look at the number of robots installed, says Dan Wang of Hang Seng Bank.

China's impressive economic growth in recent decades was a result of three main factors: a soaring urban workforce, a big increase in the capital stock and rising productivity. Today, though, less new infrastructure is needed. And the working-age population, those between 15 and 64, is shrinking. It is projected to drop by over 20% by 2050. Earlier this year the government released a list of 100 occupations for which there is a shortage of labour. Manufacturing-related positions accounted for 41 of them. A surfeit of young and cheap workers once did these jobs; now wages are higher and workers less abundant.

As a result, Mr Xi has made boosting China's productivity a priority. The government sees robots playing a big part in this effort. For years it has pushed industry to go from being labour-intensive to robot-intensive. Provinces have spent billions of dollars helping manufacturers upgrade in this way. China's experience during the pandemic reinforced this mindset. Endless lockdowns caused factories to close and Western firms to reconsider their supply chains. When all of the controls were lifted in 2022, a wave of covid-19 again disrupted businesses as workers fell ill. With robots, health is not a concern.

Many of the challenges faced by factories apply to agriculture, too. The average Chinese farmer is in his or her 50s. Few young people want to take their place in the fields. Countries that face similar predicaments often import either their food or cheap labour. But China is paranoid about food security and uninterested in immigration. Robots could be the answer. Some aspects of agriculture, such as milking cows, can be automated fairly easily. Others are trickier, but appear possible on a small scale. The south-

western city of Chengdu has developed an unmanned vegetable farm which could, in theory, produce ten harvests a year.

In time, robots might replace ageing workers. They might also play a role in caring for them. China has far too few professionals looking after its 8.1m care-home residents. A plan from the National Health Commission, published in 2021, called for developing smart elderly care. Some of it is aspirational, such as providing frail people with electronic exoskeletons to aid their movements. But simpler robots could be used to help old folk bathe or stand up. China's tech giants are looking into the challenge. In 2022 iFlytek, a big artificial-intelligence firm, said it wanted to send robots into the homes of seniors to offer companionship and health management. Residents of a care home in Shanghai are kept happy by a robot that zips around singing revolutionary songs from their youth, according to local media.

What would make the government happy is if China's robotics industry became more self-sufficient. Local firms still rely on foreign companies for parts and know-how. China is fearful of being shut out of Western markets, for good reason. America has blocked Chinese firms from buying advanced semiconductors and the equipment used to make them (robots require chips, but usually not the most advanced kind). So the government has been trying to stimulate robotics research. In August the city of Beijing announced a 10bn-yuan (\$1.4bn) fund for robot development.

Such efforts are having some effect. Last year 36% of the industrial robots China installed were made at home, up from 25% in 2013. Shenzhen Inovance Technology, a big Chinese firm, builds robots that are used to make LED lights and mobile phones. It may be able to source all of the components it needs from Chinese companies within five years, says Zhu Xingming, its chairman.

For most Chinese robotics firms, though, self-sufficiency is still some way off. That is part of the reason why the government is pushing the development of humanoids. These may not be very practical or affordable in the near term. But officials hope the process of manufacturing them will create a domestic supply chain.

One thing the government does not have to worry about is much pushback against its plans. Surveys suggest most Chinese people think robots will create more jobs than they destroy. China, it seems, is a land of techno-optimists. It helps, of course, that independent labour unions are banned.





Xi-3PO

中国追求成为机器人超级大国

面对人口萎缩，中国希望机器人能填补空缺

中国打造人形机器人的第一次尝试并不理想。2000年，国防科技大学的一个团队开发了一台机器，看起来就像是会走路的烤面包机。它有圆溜溜的眼睛，胯部附近有炮筒一样的突起。这台名为“先行者”的机器人被当时机器人技术远远领先的邻国日本大加嘲笑。日本网民说它是中国的秘密武器——能让敌人笑死。

但中国坚持了下来。2023年11月，中国政府公布了一项计划，提出要在2025年实现大规模生产人形机器人。中国对机器人的热爱远不限于那些会走路说话的。据行业机构国际机器人联合会（International Federation of Robotics）的数据，2022年中国的工业机器人装机量占到了全球的50%。按平均每名工人配备的机器人数量计算，中国目前是全球自动化程度第五高的国家。受荣誉感的驱动，加上紧迫的人口挑战，中国正在努力成为机器人超级大国。

中国新安装的机器人有许多是经设置程序后可在生产线上焊接、钻孔或组装部件的机械臂。不过2022年中国还制造了600多万台“服务机器人”，辅助人类完成工业自动化以外的任务。这些机器人在仓库内穿行，搬运货箱。还有一些在酒店里打扫卫生。在南方城市广州的一家餐厅里，烹饪和传菜都由机器人完成。

这里面有些可能看起来只是营销噱头，但对习近平领导的共产党来说，机器人是件很严肃的事情。官员们认为，中国在19世纪落后于西方列强并遭受它们欺辱，一定程度上是因为没有接纳发生在其他地方的技术革命。现在，中国要力求在技术上保持领先。在过去，官员们用钢铁产量来衡量经济发展水平，如今他们看重的是机器人装机量，恒生银行的王丹指出。

中国近几十年来令人瞩目的经济增长归功于三大因素：城市劳动力激增，

资本存量大幅增加，以及生产率不断提升。但到了今天，对新基础设施的需求减少了。而15至64岁的劳动年龄人口日渐萎缩，预计到2050年将减少超过20%。2023年初，政府公布了一份清单，列出了“最缺工”的100个职业，其中与制造业相关的就有41个。曾经有大量年轻的廉价劳动力从事这些职业，而现在工资更高了，工人却不再充足。

因此，习已经把提高中国的生产率列为要务。政府认为机器人能在这方面发挥重要作用。多年来，政府一直在推动工业从劳动密集型向机器人密集型转型。多省投入数十亿美元计的资金帮助制造企业做这种升级。新冠疫情期间的经历更是强化了这一思路。无休止的封控导致工厂关闭，让西方企业重新考虑供应链部署。2022年所有管制解除后，一波疫情让员工纷纷病倒，再度打断了公司运作。有了机器人，就不会受制于员工的身体状态了。

工厂面临的许多挑战也是农业面对的难题。中国农民的平均年龄是50多岁。很少有年轻人愿意接手务农。陷于类似困境的国家通常会进口粮食或者引进廉价劳动力。但中国执着于保障粮食安全，也无意引进劳工。机器人可能是个出路。农业的某些工作要实现自动化并不难，比如挤奶，其他工作的自动化虽然比较棘手，但似乎也可以小规模实现。西南部城市成都开发了一个无人蔬菜农场，理论上一年可以收获十茬蔬菜。

假以时日，机器人也许能取代日渐年迈的人力，还可能在照顾他们方面发挥作用。中国入住养老院的老人达810万，而照护他们的专业人员远远还不够。国家卫健委于2021年发布的一项计划呼吁发展智慧养老服务。其中一些设想雄心勃勃，比如为体弱者提供电子外骨骼帮助其行动，但同时也可使用更简单的机器人帮助老人洗澡或站立。中国的科技巨头正迎向这一挑战。2022年，大型人工智能公司科大讯飞表示，希望把机器人送入老人家中，提供陪伴和健康管理服务。据上海媒体报道，在当地一家养老院，一台机器人会一边转悠一边唱老人们年轻时传唱的革命歌曲，把他们逗得很开心。

会让政府开心的是中国的机器人产业能变得更自给自足。本地企业仍依赖

外国公司提供零部件和专门技术。中国有充分理由担心被西方市场拒之门外。美国已禁止中国企业购买先进半导体和用于制造这些半导体的设备（机器人需要芯片，但通常不是最先进的芯片）。因此，中国政府一直努力推动机器人研究。8月，北京市宣布成立一项100亿元的基金用于机器人研发。

这些努力正初见成效。2022年中国安装的工业机器人中有36%是国产的，高于2013年的25%。大型企业深圳汇川技术制造的机器人用于生产LED灯和手机。公司董事长朱兴明表示，他们可能在五年内就能从中国企业采购到所需的全部零部件。

不过对于大多数的中国机器人公司而言，要达到自给自足仍有一段距离。这也是中国政府大力发展人形机器人的原因之一。短期内，这些机器人可能不太实用，价格也太高。但官员们希望在开发这些机器人的过程中能形成一条国内供应链。

政府不必担心其计划会遭到很多反对。调查显示，大多数中国人认为机器人创造的就业机会将多于它们会破坏掉的。由此看来，中国是一个技术乐观主义者的国度。当然了，这也得益于这里禁止成立独立工会。■



The economics of technology

A short history of tractors in English

What the tractor and the horse tell you about generative AI

IT WAS THE ChatGPT of its day. “Come and see the tractors”, entreated an article in the *Prairie Farmer* in 1915, advertising a trade show in Illinois showing off the new tech. “It will mark a new epoch in farming—the farmer’s liberation from sole dependence on the weary horse.” “Tractors are more economical than horses,” insisted an agricultural expert in a government report around the same time, “not only making farm work cheaper but easier.” The tech clearly impressed people, but it also scared them. One American observer, watching a tractor in England, said it “walked over the earth like some huge animal, puffing and snorting”. Tractors promised a revolution in American agriculture, an industry which in 1900 employed about a third of workers and produced about 15% of GDP.

Today many people expect another revolution, linked to developments in generative artificial intelligence (AI). Like then, the general public today view the technology with a mixture of awe and fear. Goldman Sachs, a bank, reckons generative AI could raise annual global GDP by 7% over ten years. Some economists now talk about “explosive growth”. Others say that before long, jobs will be eliminated in their millions. Yet the economic history of the tractor casts doubt over these predictions. Over the sweep of history the tractor has indeed had an immense impact on people’s lives. But it conquered the world with a whimper, not a bang.

Historians disagree about who invented the tractor. Some say it was Richard Trevithick, a British engineer, in 1812. Others credit John Froelich, working in South Dakota in the early 1890s. Still more point out that the word “tractor” was little used until the start of the 20th century; and that only then did people start seriously talking about the average farmer buying

one. At the time horses and mules pulled around an impressive array of farm implements, from ploughs to reapers.

The horses faced up to a bigger, more powerful beast. You can put yourself in the shoes of an early 20th-century horse by visiting Gene Jones's tractor museum in Millbrook, a small city in rural Alabama, which contains dozens of machines, including Farmalls and Fords, from the 20th century. The tractors are beautiful—and not just because Mr Jones has lovingly restored them, painting them in a variety of rich auburn-reds. They are also intimidating. Some weigh thousands of pounds. Others have cranks to start the engine which can break your arm if you don't know what you're doing.

With hindsight, it is clear that the tractor had profound impacts. It meant that a given quantity of farmland could feed more people. Tractor-owning farmers no longer needed to pasture horses, each of which required about three acres of cropland for feed each year. More intensive farming also had downsides. Some researchers have argued that tractors helped bring about the Dust Bowl of the 1930s. Their powerful ploughing techniques damaged the topsoil that had once prevented wind erosion.

The economic impact eventually became clear, too. The greater efficiency afforded by tractors allowed farmers to expand their operations, as they could manage more land with the same number of workers. Farms began to grow in size, with smaller family farms giving way to larger, mechanised operations. According to one estimate, by 1960 the average American farm was 58 acres (equivalent to the land occupied by ten big Walmarts today) larger than it would have been without tractors. The tractor also reduced the number of workers needed to produce food by about 2m, or 25% of farm employment in 1960. All these improvements added up. In a paper published in 2012 Richard Steckel and William White, two economists, argue that by the mid-1950s farm mechanisation had raised American GDP by about 8%.

And yet for much of the first half of the 20th century, tractor-induced changes did not feel very profound. This is because the tractor diffused across the American economy slower than one of Mr Jones's old Fords trying to cross a waterlogged field. In 1920, despite rave reviews in the *Prairie Farmer*, just 4% of American farms had a tractor (see chart). Even by 1940 only 23% had them. In the 1910s opportunistic businessmen had piled into the tractor-making business, hoping to make a quick buck (just as every second tech firm in Silicon Valley now describes itself as "AI-first"). Many had no customers and were forced to close.

The horse endured for a surprisingly long time. For much of the 1930s the total productive capacity of equine animals—quite literally, horsepower—across American farms still exceeded that of tractors. In 1945 a quarter of farms reported both draft animals and tractors. The slow diffusion of the tractor produced slow productivity gains. The data are spotty, but in the first half of the 20th century annual productivity growth in agriculture probably never exceeded 3%. That 8% GDP effect is real, but it made itself felt only over decades. Explosive growth? Hardly.

The tractor's plodding progress is one of the big puzzles of economic history. If they were so good, why did farmers not buy them more quickly? They were not Luddites who resisted new technologies on principle. True, anti-tractor lobby groups, such as the Horse Association of America, warned that buying one would land the farmer in unmanageable debt. But in the 1910s and 1920s many tractorless farmers did own cars, suggesting that they were willing to try new tech. In 1917 *Power Farming*, a journal, published letters from 15 farmers who used tractors. They were probably solicited, but these letters urged others to follow suit.

Three reasons explain why the triumph of the tractor took so long. First, early versions of the technology were less useful than people had originally believed, and needed to be improved. Second, adoption required changes

in labour markets, which took time. And third, farms needed to transform themselves.

Take capabilities first. The early tractors of the 1900s were behemoths. They were useful for ploughing, and a few other things, but not for cultivating fields of growing crops. Many early models had metal wheels, not tyres, so they got stuck in the mud. They were also costly. Between 1910 and 1940, however, the machines became both more versatile and smaller, making them suited to a wider range of tasks.

In 1927 John Deere released a power lift for its models. This meant that a farmer could pull a lever to raise an implement (such as a plough), rather than doing it manually. Rubber tyres came along in about 1933. For a long time the general-purpose tractor could not mechanise corn and cotton harvests, one reason why the area in which Mr Jones lives was one of the slowest to adopt tractors. But by the 1920s America had the corn-picker, followed by the mechanical cotton-picker after the second world war. By the end of the fighting, tractor prices had also fallen from their level in 1910, after adjusting for inflation, by about half.

Wages were the second factor. Horse technology was labour-intensive: horses require feeding, cleaning and medical care, even when they are not working. In the early 1930s, during the Depression, average real wages in agriculture fell. So for many farmers it became easier to hire someone to manage a horse—you could always fire them—than it was to splurge on a tractor. But by the second world war, labour shortages mounted, leading real wages to rise quickly. Suddenly, machines seemed like a better deal.

The third factor was corporate restructuring. Tractors worked best on big farms, where the farmer could spread out the expense of a huge upfront investment. As a result, enlarging the size of their holdings and buying a tractor were two sides of the same coin. In a survey in Illinois in 1916, for

instance, farmers who used tractors profitably also talked about increasing their acreage. But growing a farm takes time. A farmer looking to expand had to gather the necessary capital, and then negotiate the purchase with the owners.

The history of the tractor hints at how quickly generative AI may take over. At present most AI models still have metal wheels, not rubber tyres: they are insufficiently fast, powerful or reliable to be used in commercial settings. Over the past two years real wages have hardly grown as inflation has jumped, limiting companies' incentives to find alternatives to labour. And companies have not yet embraced the full-scale reorganisation of their businesses, and in-house data, necessary to make the most of AI models. No matter how good a new technology may be, society needs a long, long time to adjust. ■



技术经济学

英语拖拉机简史

从拖拉机和马的对峙看生成式人工智能来袭

它就是当年的ChatGPT。“来看看拖拉机吧！”1915年，《草原农场主》（Prairie Farmer）杂志上的一篇文章恳请道，它在为伊利诺伊州展示这项新技术的展销会做广告。“这将标志着农业的新纪元，让农场主从只能依靠疲倦的马匹中解放。”“拖拉机比马更经济，”一位农业专家在大约同一时间发布的一份政府报告中坚称，“它不仅让农业劳作的成本更低，也让农活更轻松。”这项技术显然让人们惊叹不已，但也让他们害怕。一位美国观察家在英国观摩拖拉机作业时说，它“喷着响鼻，像一头巨兽般在大地上横行”。拖拉机预示着美国农业的一场革命，该行业在1900年雇用了约三分之一的劳动力，创造了约15%的GDP。

如今，许多人预期另一场革命到来，这次是与生成式AI的发展相关。和当年一样，今天的公众对这项技术又敬又怕。高盛认为，生成式AI可能在十年内将全球年GDP提高7%。一些经济学家正大谈“爆炸性增长”。其他人则表示，用不了多久，千百万工作岗位将被淘汰。然而拖拉机的经济史让人对这些预测心生怀疑。纵观历史长河，拖拉机确实对人们的生活产生了巨大的影响。但它是悄无声息地征服了世界，而非轰轰烈烈地席卷而来。

历史学家对于谁发明了拖拉机存在分歧。有人说是英国工程师理查德·特里维希克（Richard Trevithick）在1812年发明的。另一些人认为是1890年代初在南达科他州工作的约翰·弗罗利希（John Froelich）。还有更多人指出，在20世纪初之前很少能看到“拖拉机”这个词。要等到进入20世纪后人们才开始认真讨论普通农场主购买拖拉机的事宜。那会儿，从犁到收割机等各种令人眼花缭乱的农具都是由马和骡子来拉动的。

马儿们遭遇了一种更高大威猛的巨兽。参观一下吉恩·琼斯（Gene Jones）位于阿拉巴马州乡村小城米尔布鲁克（Millbrook）的拖拉机博物馆，你就能体会到20世纪早期马儿们的感受了。这家博物馆内收藏了数十

台拖拉机，其中包括20世纪的Farmall系列和福特（Ford）拖拉机。它们都很漂亮，这一部分要归功于琼斯对它们的精心修复，还给它们刷上了深浅各异的赤褐色。它们也很吓人，有些重达数千磅，还有一些需要用摇动曲柄来启动发动机——要是你不知道怎么操作，可能会弄折了自己的胳膊。

事后看来，拖拉机显然产生了深远的影响。有了它，同样面积的农田就可以养活更多的人。有了拖拉机，农场主不再需要牧马，而饲养每匹马每年需要大约三英亩的耕地来种植草料。更集约化的农业也有其弊端。一些研究人员认为，拖拉机的应用是20世纪30年代沙尘碗（Dust Bowl）灾害事件发生的原因之一。它们强大的犁耕技术破坏了以往防止风蚀的表层土壤。

拖拉机的经济影响最终也变得清晰起来。拖拉机效率更高，让农场主能够用相同数量的雇工管理更多的土地，从而可以扩大经营。农场规模开始扩大，较小的家庭农场被规模更大的机械化农场取代。据一项估计，到1960年，美国农场的平均面积要比假如没有拖拉机的情况下大58英亩（相当于今天十家大型沃尔玛的占地）。拖拉机还让生产食物所需的工人减少了约200万，相当于1960年农场就业人数的25%。所有这些进步累积起来产生了巨大影响。在2012年发表的一篇论文中，经济学家理查德·斯特克尔（Richard Steckel）和威廉·怀特（William White）认为，到20世纪50年代中期，农业机械化让美国GDP提高了约8%。

然而，在20世纪上半叶的大部分时间里，拖拉机引发的变化并没有让人感觉非常深刻。这是因为拖拉机在美国经济中的普及速度比琼斯的老旧福特拖拉机穿越积水田地的速度还要慢。1920年，尽管《草原农场主》大加好评，仍只有4%的美国农场有拖拉机（见图表）。即使到了1940年也只有23%的农场有。在1910年代，投机商人纷纷涌入拖拉机制造业，希望能赚笔快钱（就像在如今的硅谷，每两家科技公司就有一家自称“以AI为先”）。许多厂家无人光顾，只能关门收场。

马儿坚持的时间之久出人意料。在20世纪30年代的大部分时间里，美国农

场上马类役畜的总生产力（可谓真正的“马力”）仍然大于拖拉机。1945年，四分之一的农场同时拥有役畜和拖拉机。拖拉机普及缓慢，导致生产率的提高同样缓慢。虽然缺乏完整数据，但可以知道在20世纪上半叶，农业生产力的年增长率可能从未高过3%。推动GDP提高8%的作用确实有，但要历经好几十年才感受得到。至于说推动爆发式增长？几乎没有。

拖拉机缓慢的普及速度是经济史上的一大谜题。如果拖拉机这么好，为什么农场主不赶紧买呢？他们并不是从原则上抵制新技术的卢德派。确实，美国马协会（Horse Association of America）等反拖拉机游说团体曾警告说，购买一辆拖拉机将使农场主陷入难以负担的债务。但在1910年代和1920年代，许多没有拖拉机的农场主却拥有汽车，表明他们是愿意尝试新技术的。1917年，《机械农业》（Power Farming）期刊发表了15位使用拖拉机的农场主的来信。虽说这些来信可能是应邀写的，但起到了敦促他人效仿的作用。

三个原因解释了为什么拖拉机的胜利花了这么长时间。首先，早期的拖拉机并没有人们最初以为的那么有用，它需要改进。其次，采用拖拉机需要改变劳动力市场，而这需要时间。第三，农场本身也需要改造。

先说说拖拉机的性能。1900年代的早期拖拉机都是些庞然大物。它们可用于开垦荒地和其他一些作业，但不适用于耕作已种植作物的田地。许多早期的机型都使用金属轮子，而不是轮胎，所以会陷在泥里。而且它们价格高昂。然而在1910年至1940年间，拖拉机变得功能更多样，体积也更小，能适用于更广泛的任务。

1927年，约翰·迪尔（John Deere）为其拖拉机设计了一个动力升降装置。这样农场主就可以拉动操作杆来拉起农具（例如犁），而无需手动操作。橡胶轮胎在1933年前后出现在拖拉机上。在很长一段时间里，通用拖拉机无法实现玉米和棉花收割的机械化，这便是琼斯居住的地区是采用拖拉机最慢的地区之一的一个原因。但到了20年代，美国有了玉米采摘机，第二次世界大战后又出现了机械采棉机。到战争结束时，拖拉机经通胀调整后的价格也比1910年的水平下降了约一半。

工资是第二个因素。用马从事农业生产要耗费很多劳动——马需要喂养、清洁和医护，即便是在它们不工作时。1930年代初经济大萧条期间，农业平均实际工资下降。因此，对于许多农场主来说，雇人管理马匹比花大钱买拖拉机更容易，雇工还可以随时解雇。但到了第二次世界大战时，劳动力变得日渐短缺，导致实际工资迅速上涨。突然间，用机器似乎更划算了。

第三个因素是农场重组。拖拉机在大型农场中效果最好，因为农场主可以摊薄巨额前期投资。因此，扩大农场规模和购买拖拉机变成了事情的一体两面。例如，在1916年伊利诺伊州的一项调查中，使用拖拉机获利的农场主也谈到了要增加农场面积。但扩大农场需要时间。想要扩大规模的农场主必须筹集所需的资金，接着还要与土地所有者协商购买事宜。

拖拉机的历史透露出生成式AI可能会以怎样的速度占据主导。目前，大多数AI模型采用的仍旧是“金属轮子”，而不是“橡胶轮胎”，它们的速度、动力或可靠性都还不足以应用于商业环境中。过去两年，随着通胀飙升，实际工资几乎没有增长，限制了企业寻找劳动力替代选择的积极性。而且企业尚未开启全面重组业务和内部数据，而这是充分利用AI模型所必需的。无论一项新技术可能有多么好，社会都需要很长很长的时间来调整适应。





Economic history

Is the age of Milton Friedman over?

Some may say so. But we are still living in it

Milton Friedman. By Jennifer Burns. Farrar, Straus and Giroux; 592 pages; \$35

IT IS VOGUISH to declare the ideas of Milton Friedman dead, whether you think they deserve damnation or eulogy. In America, prominent Democrats spit out his name contemptuously. The most influential American economist of the 20th century is routinely disparaged as a heartless fetishist of Ayn Randian capitalism, who evangelised corporate greed at home and authoritarianism abroad. Friedman is a special bugbear of President Joe Biden. While running for office in 2020, he declared that “Milton Friedman isn’t running the show anymore.”

Meanwhile, the current, populist standard-bearers of American conservatism—the political movement with which Friedman was identified throughout his life—agree, having turned their backs on fiscal discipline and open markets.

It might be tempting to buy into the thesis that Friedman’s ideas are passé and even to wish them good riddance. But that would be a mistake. Few thinkers are as important (and as grotesquely caricatured) as Friedman. His critiques of Keynesianism, his advocacy of the importance of central banks, his emphasis on the primacy of the monetary supply in explaining inflation and his prioritisation of real interest rates over nominal ones were once unorthodox. They are now mainstream.

A recent biography by Jennifer Burns, a professor at Stanford University, dispels fallacies. Because of Friedman’s long life (he was born in 1912 and

died in 2006) and prolific career involving the modern era's most important economic debates, Ms Burns's book functions as an intellectual guide to the entire 20th century, benefiting from nearly a decade of archival research.

The Friedman who emerges here is one of astonishing economic brilliance, establishing monetary policy as a field worthy of serious study. It is a portrait of a surprisingly heterodox economist, who was perhaps the last great political economist and thought deeply about the connection between political and economic freedom.

Friedman is best known for revolutionary ideas on the importance of money to the macroeconomy, which is now seen as blindingly obvious but once was not. With Anna Schwartz—his greatest intellectual partner other than his wife, Rose Director Friedman—he wrote “A Monetary History of the United States” (1963), which computed aggregate monetary supply to argue that the Federal Reserve had contributed to the Great Depression.

Ben Bernanke, the man who would lead the Fed through the global financial crisis of 2007-09, gave cheeky tribute to this argument in a speech at a gathering celebrating Friedman's 90th birthday: “Regarding the Great Depression, you're right, we did it. We're very sorry. But thanks to you, we won't do it again.”

By the 1980s Friedman was catapulted to global renown, claiming a Nobel prize, a column in Newsweek and even a popular TV series. He was a perpetual gadfly at the Fed. Were he alive today, he would probably jab at Jerome Powell for thinking that dramatic growth in the monetary supply would not manifest in higher inflation. (During his life, he sported a vanity licence plate with the formula of his quantity theory of money, $MV=PY$; the equals sign was drawn with the help of black tape, which resulted in several traffic tickets.)

He became a bogeyman of the left for a six-day trip to Chile to advise Augusto Pinochet, its dictator, though Ms Burns argues that while he “failed to appreciate the optics”, that “in truth, he played almost no role in policy design”. Other trips, to China and to countries east of the Iron Curtain, did not provoke so much conspiracism, outrage or damage to his reputation.

Although Ms Burns admires Friedman, her book is not a hagiography. She argues that his concept of freedom, the nominal core of his political philosophy, could be “woefully thin”. Friedman was vocally opposed to the Civil Rights Act of 1964, which outlawed racial discrimination, and “never revisited his position on civil rights”, she writes with disappointment.

Much as the three Abrahamic religions lay claim to one saviour, conservatives, libertarians and classical liberals all claim Friedman. But he defies easy categorisation. Unlike some libertarians, Friedman accepted the legitimacy of the state (though he fought against it and advocated eliminating some government departments). Unlike many conservatives, he deemed redistribution acceptable to alleviate poverty. Indeed, Friedman envisioned the school-voucher and health-care programmes still in effect in America, as well as the tax policies that top up working class wages—perhaps the country’s most important anti-poverty programme.

Despite consulting for Barry Goldwater, Ronald Reagan and Margaret Thatcher, Friedman considered himself a classical liberal. “Those of us who believe in liberalism...have a new faith to offer; it behoves us to make it clear to one and all what the faith is”, he wrote in 1951. He was critical of overly doctrinaire, laissez-faire philosophy that “assigned almost no role to the state other than the maintenance of order and the enforcement of contracts”.

Ms Burns insists on dubbing Friedman “the last conservative” because “the

synthesis Friedman represented—based in free-market economics, individual liberty and global co-operation—has cracked apart” in politics. Friedman may no longer be running the show, but he is still one of economics’ most influential acts. ■



经济史

弗里德曼的时代终结了吗？

也许有人这么认为。但我们仍生活在他的时代【《弗里德曼传》书评】

《弗里德曼传》，詹妮弗·伯恩斯著。Farrar, Straus and Giroux出版社，592页；35英镑。

无论你认为对米尔顿·弗里德曼（Milton Friedman）的思想是应该诅咒还是讴歌，宣称弗里德曼思想已死都很时髦。在美国，民主党要员提起他的名字时都语带轻蔑。这位20世纪最具影响力的美国经济学家经常被贬斥为安·兰德式资本主义的冷血信徒，在国内宣扬企业贪婪，在国外宣扬威权主义。弗里德曼是美国总统拜登的心头之患。在2020年竞选总统时，他宣称“米尔顿·弗里德曼已经不再是主角了”。

与此同时，美国保守主义（弗里德曼终其一生被视为这一政治运动的一员）当前的民粹主义旗手们也持相同的观点，他们已经背弃了财政纪律和开放市场。

也许人们会很容易听信弗里德曼的思想已经过时的观点，甚至庆幸终于从中解脱了。但这会是个错误。很少有思想家像弗里德曼一样重要（也很少像他那样被如此荒诞地歪曲丑化）。他批判凯恩斯主义、倡导央行的重要性、强调货币供应在解释通胀中的首要作用，以及优先考虑实际利率而非名义利率，这些观点一度都是非正统的。现在，它们已经成了主流。

斯坦福大学教授詹妮弗·伯恩斯（Jennifer Burns）最近出版的一本传记驳斥了种种谬误。由于弗里德曼的长寿（生于1912年，卒于2006年），以及学术生涯成果丰硕且参与了现代最重要的经济辩论，伯恩斯花了近十年研究档案文献写就的这本书可以充当整个20世纪的知识指南。

书中呈现的弗里德曼具有惊人的经济学才华，是他将货币政策确立为一个值得认真研究的领域。这本书描绘了一位有惊人非正统思想的经济学家，

也许是最后一位伟大的政治经济学家，对政治自由和经济自由之间的关联有深刻的思考。

弗里德曼最为人熟知的是关于货币对宏观经济的重要性的开创性思想，这一点在当今显而易见，但在当时却不然。他和除了妻子罗斯·戴瑞克特·弗里德曼（Rose Director Friedman）之外最重要的智力伙伴安娜·施瓦茨（Anna Schwartz）共同撰写了《美国货币史》（A Monetary History of the United States，1963年出版），通过计算货币供应总量来证明美联储对大萧条负有责任。

在庆祝弗里德曼90岁生日的聚会上，后来领导美联储渡过2007至2009年全球金融危机的本·伯南克（Ben Bernanke）在发言时顽皮地致敬了他的观点：“说到大萧条，你说得对，是我们干的。我们非常抱歉。但多亏了你，下次不会再犯了。”

到了1980年代，弗里德曼在全球名声鹊起，获得了诺贝尔奖，为《新闻周刊》撰写专栏，甚至还制作了一部热门电视系列片。他永远都在给美联储挑刺。如果他今天仍然在世，恐怕也会抨击鲍威尔认为大幅增加货币供应不会导致通胀上升的想法。（他一生都骄傲地挂着一张自选车牌，车牌号就是他的货币数量论公式 $MV=PY$ ，等号是用黑胶带贴出来的，还因此吃了几张交通罚单。）

他曾访问智利六天，为独裁者奥古斯托·皮诺切特（Augusto Pinochet）出谋划策，因而被左派视为妖魔。不过伯恩斯认为，尽管他“没有意识到这么做给外界的观感”，但“事实上，他在政策设计中几乎没有发挥任何作用”。他的其他出访，例如前往中国和铁幕以东的其他国家，并没有引起如此多的阴谋论、愤怒或对他声誉的贬损。

虽然伯恩斯钦佩弗里德曼，但她的书并不是一本歌功颂德之作。她认为，作为他政治哲学名义上的核心，弗里德曼的自由观可能“薄弱得可怜”。他曾公开反对1964年禁止种族歧视的《民权法案》，而且“从未重新审视过自己在民权问题上的立场”，她失望地写道。

正如三大亚伯拉罕宗教都宣称救世主在自己这边一样，保守主义者、自由意志主义者和古典自由主义者都将弗里德曼归入自己的阵营。但要给他归类并不容易。与一些自由意志主义者不同，弗里德曼接受国家的合法性（尽管他也与国家抗争并主张取消一些政府部门）。与许多保守主义者不同，他认为可以接受通过再分配来减轻贫困。事实上，弗里德曼设想的教育券和医疗保健计划仍然在美国实施，还有补贴工人阶级工资的税收政策——这也许是美国最重要的脱贫措施。

尽管曾为巴里·戈德华特（Barry Goldwater）、里根和撒切尔做过顾问，弗里德曼仍将自己视为一名古典自由主义者。他在1951年写道：“我们这些信奉自由主义的人.....有一种新的信仰要奉上；我们有责任向每个人阐明这种信仰是什么。”他批评过于教条的自由放任主义哲学，认为它“除了维持秩序和执行契约之外，几乎没有赋予国家任何作用”。

伯恩斯坚持将弗里德曼称为“最后的保守派”，因为“弗里德曼所代表的以自由市场经济、个人自由和全球合作为基础的综合理念在政治上已经分崩离析”。弗里德曼也许不再是主角，但他仍然是经济学舞台上最有影响力的角色之一。■



A dismal year for the dismal science

Economists had a dreadful 2023

Mistaken recession calls were just part of it

SPARE A THOUGHT for economists. Last Christmas they were an unusually pessimistic lot: the growth they expected in America over the next calendar year was the fourth-lowest in 55 years of fourth-quarter surveys. Many expected recession; The Economist added to the prognostications of doom and gloom. This year economists must swap figgy pudding for humble pie, because America has probably grown by an above-trend 3%—about the same as in boomy 2005. Adding to the impression of befuddlement, most analysts were caught out on December 13th by a doveish turn by the Federal Reserve, which sent them scrambling to rewrite their outlooks for the new year.

It is not just forecasters who have had a bad year. Economists who deal in sober empirical work have also had their conclusions challenged. Consider research on inequality. Perhaps the most famous economic studies of the past 20 years have been those by Thomas Piketty and his co-authors, who have found a rising gap between rich and poor. But in November a paper finding that after taxes and transfers American incomes are barely less equal than in the 1960s was accepted for publication by one of the discipline's top journals. Now Mr Piketty's faction is on the defensive, accusing its critics of "inequality denial".

Economists have long agreed that America would be richer if it allowed more homes to be built around popular cities. There is lots of evidence to that effect. But the best-known estimate of the costs of restricting construction has been called into question. Chang-Tai Hsieh of the University of Chicago and Enrico Moretti of the University of California, Berkeley, found that easing building rules in New York, San Francisco and

San Jose would have boosted American GDP in 2009 by 3.7%. Now Brian Greaney of the University of Washington claims that after correcting for mistakes the true estimated effect is just 0.02%. If builders disagreed as wildly about roof measurements, the house would collapse.

Think social mobility in America is lower than it was in the freewheeling 19th century, when young men could go West? Think again, according to research by Zachary Ward of Baylor University. He has updated estimates of intergenerational mobility between 1850 and 1940 to account for the fact that past studies tended to look only at white people, as well as correcting other measurement errors. It now looks as if there is more equality of opportunity today than in the past (albeit only because the past was worse than was thought).

A rise in suicides, overdoses and liver disease has reduced life expectancy for white Americans. Angus Deaton and Anne Case of Princeton University popularised the idea that these are “deaths of despair”, rooted in grimmer life prospects for those without college degrees. But economists have been losing faith in the idea that overdoses, which are probably the biggest killer of Americans aged 18-49, have much to do with changes in the labour market. New research has instead blamed the carnage on simple proximity to smuggled fentanyl, a powerful opioid.

Other findings are also looking shaky. The long decline in the prestige of the once-faddish field of behavioural economics, which studies irrationality, continued in 2023. In June Harvard Business School said it believed, after an investigation, that some of the results in four papers co-written by Francesca Gino, a behavioural scientist and PhD economist, were “invalid”, owing to “alterations of the data”. (Ms Gino, who has written a book about why it pays to break rules, is suing for defamation the university and the bloggers who exposed the alleged fiddling.)

What lessons should be drawn from economists' tumultuous year? One is that for all their intellectual discipline they are still human. Replicating existing studies and checking them for errors is crucial work.

Another lesson is that disdain for economic theory in favour of the supposed realism of empirical studies may have gone too far. After the global financial crisis of 2007-09, commentators heaped opprobrium on theorists' common assumption that people make rational predictions about the world; gibes about an unrealistic, utility-maximising Homo economicus helped raise the status of behavioural economics. Yet rational-expectations models allow for the possibility that inflation can fall rapidly without a recession—exactly the scenario that caught out forecasters in 2023.

A last lesson is that economists should cheer up. The research that has been called into question this year inspired much pessimism about the state of modern capitalism. But a dodged recession, flatter inequality trends and less despair would all be good news. Perhaps the dismal science should be a little less so. ■



【首文】郁闷科学的郁闷一年

经济学家经历了一个糟糕的2023年

对衰退的错误预测只是糟心事之一

体谅下经济学家的处境吧。2022年圣诞节时，这个群体异常悲观：他们对2023年美国增长的预计是55年来第四季度调查中的第四低。许多人预期会出现衰退；本刊也奉上了一些惨淡预测。到了2023年的圣诞节，经济学家们只能把圣诞布丁换成一盘尴尬的苦果，因为2023年美国的增长可能达到了3%，高于长期平均水平，大约与2005年的繁荣时期相当。再加上大多数分析师在12月13日被美联储的鸽派转向打了个措手不及，纷纷匆忙地改写自己对新一年的展望，更让人觉得这群人已经茫然无措。

不仅仅是做预测的人经历了糟糕的一年。从事严谨实证工作的经济学家们的结论也受到了挑战。看看关于不平等的研究。过去20年里最著名的经济学研究或许是由托马斯·皮凯蒂及其合著者所做的研究，他们发现富人与穷人之间的差距在扩大。但去年11月，一篇论文发现，经过税收和转移支付之后，美国的收入差距几乎与1960年代相当，该论文被一家顶级经济学期刊接受待发表。现在皮凯蒂一派摆出防御姿态，指责其批评者“否认不平等”。

经济学家长期以来一致认为，如果美国允许在热门城市的周围建造更多住房，美国会更加富裕。有很多证据支持这一点。但关于限制建筑的代价的最知名估计受到了质疑。芝加哥大学的谢长泰和加州大学伯克利分校的恩里科·莫雷蒂（Enrico Moretti）曾认为，放宽纽约、旧金山和圣何塞的建筑限制将会使2009年的美国GDP增长3.7%。现在，华盛顿大学的布赖恩·格里尼（Brian Greaney）声称，在纠正错误后，真实的影响估计仅为0.02%。如果建筑商们在屋顶测量上有这么大的分歧，那房子就得塌了。

你觉得美国的社会流动性低于自由奔放的19世纪（那时年轻人可以到西部去）？那你得再想想了——贝勒大学（Baylor University）的扎卡里·沃德（Zachary Ward）指出。他的研究更新了对1850年到1940年间代际流动性

的估计，考虑了过去的研究往往只关注白人这一问题，同时纠正了其他测量错误。现在看起来，如今的机会平等性要好于过去（尽管这只是因为过去比人们原本以为的更糟糕）。

自杀、药物过量和肝病的增加降低了美国白人的预期寿命。普林斯顿大学的安格斯·迪顿（Angus Deaton）和安妮·凯斯（Anne Case）在过去普及了一种观点：这些都属于“绝望之死”，其根源在于那些没有大学学位的人面对更加晦暗的生活前景。但经济学家开始不大相信药物过量——可能是18至49岁美国人的第一大杀手——与劳动力市场的变化有很大关系。新的研究将这类大量死亡归咎于仅仅是很容易到手的走私芬太尼，一种强效阿片类药物。

其他发现如今看起来也不大站得住脚了。研究非理性行为的行为经济学曾经风靡一时，之后声望持续下降，在2023年延续了这种趋势。哈佛商学院在6月表示，经调查认为，在行为科学家、经济学博士弗朗西斯卡·吉诺（Francesca Gino）与他人共同撰写的四篇论文中，部分结果由于“篡改数据”而“无效”。（曾著书解释为何违反规则有好处的吉诺正在控告哈佛以及曝光她涉嫌造假的博文作者诽谤。）

从经济学家动荡纷乱的一年里，应该吸取什么教训？有一点是，尽管经济学家富有智识自律，但他们终究是人。重复已有研究并检查其中的错误是至关重要的工作。

另一个教训是，蔑视经济理论、偏爱实证研究所谓的求真务实可能走过了头。在2007至2009年的全球金融危机之后，评论员对理论家认为人们会对世界做出理性预测的普遍假设大加指责；对不现实的、追求效用最大化的“理性经济人”的嘲弄帮助提升了行为经济学的地位。然而在理性预期模型中，通胀是有可能迅速下降却不引发衰退的——正是这种情景在2023年打了预测者的脸。

最后一个教训是经济学家应该振作起来。过去这一年受到质疑的这些研究激发了对现代资本主义状态的许多悲观情绪。而躲过了衰退、不平等趋势

走平，以及人们没那么绝望都应该是好消息。也许这门郁闷的科学应该变得稍微不那么郁闷些了。■



Free exchange

Where does the modern state come from?

Economists attempt to answer a profound political question

IT IS PART metaphor, part myth and part history. Thomas Hobbes thought life there was nasty, brutish and short. John Locke disagreed, proclaiming that it was where people first learnt how to own things. Jean-Jacques Rousseau described it as the place where people were born free, before they became ensnared in chains. Robert Nozick thought that people were so desperate to escape it, there was an inevitable result: the creation of a state.

Ideas about the “state of nature”—how people lived before politics organised itself into governments—have held the attention of philosophers for centuries. Discovering whether it played out as imagined was nigh-on impossible. And yet thinking about what people would do without a government helped answer profound questions. What are the limits of political power? Is the modern state something that citizens would freely choose?

Now, after all this theorising, three economists think they have some empirical answers. According to Robert Allen of New York University, Abu Dhabi, Leander Heldring of Northwestern University and Mattia Bertazzini of the University of Nottingham, the key to understanding the emergence of modern politics is not a metaphor, but the constantly shifting courses of ancient rivers in Iraq. The first states, they argue in a paper published in the *American Economic Review*, were glued together not as shelters from violence, as Hobbes believed, but by economics.

The banks of the Tigris and the Euphrates, Iraq’s two longest rivers, are home to some of the world’s oldest settlements. Mesopotamia, which 5,000 years ago refined the first known system of writing, earned the area the

reputation of “the cradle of civilisation”. The paths of these rivers shift, as floods and droughts cause their beds to flood. When a shift came, some ancient farmers were left without water for their crops.

Mr Allen and his co-authors investigate whether the timing of changes to a river’s course had anything to do with when the number and size of settlements grew. They do so by looking at the effect of the first recorded shift in 2,850BC. This presented farmers with something close to the choice imagined by philosophers when theorising about the state of nature. Those left behind by the river could revert to nomadism. Or they could band together to build irrigation systems to ferry water from distant rivers.

A philosophical question is therefore transformed into something akin to a laboratory experiment, only one set thousands of years ago and extending hundreds of miles across. Moreover, the results of the experiment are clear. A 5km-by-5km square in the basin left behind by a river was 14% more likely to have a settlement, marked by a public building such as a temple or marketplace, 150 years after the shift than in the 50 years before it. Each square was 12% more likely to have a built canal, a form of artificial irrigation that made farming far from rivers possible. Five new cities were created, and only three abandoned. Esnunna, one city along a new tributary of the river, became much bigger.

This, Mr Allen and his co-authors say, is evidence that that the first states were formed by farmers co-operating for economic reasons. A canal network would have been too large a cost for any to bear alone. But by spreading the cost, the construction was worth it for each. Such decisions were momentous. They represent some of the earliest examples of governments providing infrastructure in return for taxes, and thus the genesis of the earliest states.

The authors then divide centuries of thinking on the origins of states into

two camps. The first, which they say ranges from Daron Acemoglu, an influential economist at the Massachusetts Institute of Technology, to Karl Marx, supposes that states ultimately emerge from a process of social bargaining. The rich and high-status seize power for personal gain, and periodically dole out services, such as a road, school or police force, in order to keep populations on board. But if this had been the case in Mesopotamia then it would have been in the areas that a river shifted towards that settlements would have formed. After all, they developed richer and more fertile farmland, yielding a bigger tax take.

That Mesopotamian farmers seem to have chosen to band together as the river shifted away lends support to the second camp. Philosophers in this group, who include Locke and Rousseau, contend that governments emerged when people chose to co-ordinate themselves, swapping their freedom to do whatever they wanted for a state that mediates disputes and provides a degree of safety. Mr Allen and his co-authors analyse only Mesopotamian Iraq, but they argue that their results ought to apply more generally to other fledgling states. Governments, in other words, are chosen rather than foisted upon their citizens.

| *Meandering path*

This is quite the landgrab by economists, seizing terrain that is more commonly occupied by political theorists. The study is not flawless. Perhaps an unknown conquest explains the spread of settlements in the period under consideration. Maybe the authors are wrong and the pattern does not hold elsewhere. There were already six cities and many more settlements in the Mesopotamian Valley before its rivers really began to move, and some had existed for a thousand years. The authors insist that they are only interested in how new governments form, but there is a chance they have in fact captured older ones spreading.

The paper is nevertheless bold and valuable. Philosophers have sought for

centuries to explain why states emerge. Too little time has been spent considering whether economic factors might have been at play. Although transforming the state of nature into a specific time and place means losing some of its complexity, doing so opens the door to the sort of experiment that could only have been imagined by earlier philosophers. If Hobbes or Locke could have studied something approximating the state of nature about which they were theorising, they surely would have tried. ■



自由交流

现代国家从何而来？

经济学家试图回答一个深奥的政治问题

那种状态一部分是隐喻，一部分是神话，一部分是历史。托马斯·霍布斯认为那种状态下的生活恶劣、野蛮而又短暂。约翰·洛克不认同，他宣称正是在那种状态中人们第一次学会了拥有财产。让-雅克·卢梭称那种状态下的人们生而自由，直至被锁链束缚。罗伯特·诺齐克认为，人们如此迫切地想要逃离那种状态，而导致了不可避免的结果：国家被创造了出来。

几个世纪来，有关“自然状态”（state of nature）——也就是政治活动组织成政府之前人们的生活状态——究竟是怎么回事一直吸引了哲学家的关注。要想查明其状貌是否如人们想象的那样几乎是不可能的。然而，思考“假如没有政府，人们的生活会是什么样”有助于回答一些深刻的问题。政治权力的局限性在哪里？现代国家是公民会自愿选择的东西吗？

如今，三位经济学家经过如此种种理论分析，认为他们得出了一些实证答案。纽约大学阿布扎比分校的罗伯特·艾伦（Robert Allen）、西北大学的利安德·赫尔德林（Leander Heldring）和诺丁汉大学的马蒂亚·贝尔塔齐尼（Mattia Bertazzini）认为，理解现代政治何以出现的关键不是什么隐喻，而是伊拉克古代河流不断变化的河道。他们在《美国经济评论》（American Economic Review）上发表的一篇论文中提出，最早的国家并不是像霍布斯认为的那样是作为躲避暴力的庇护所而被组织起来，发挥粘合作用的其实是经济因素。

在伊拉克最长的两条河流底格里斯河和幼发拉底河的沿岸，世界上一些最古老的定居点曾分布于此。美索不达米亚于5000年前完善了第一个已知的文字体系，为该地区赢得了“文明的摇篮”的美誉。由于洪水和干旱导致河床被淹没，这些河流的路径发生了变化。一旦河流改道，一些古代农民就无法灌溉庄稼了。

艾伦和他的合著者调查了河道变迁的时间与定居点数量和规模发生增长的时间是否存在关联。他们的方法是研究有记录的第一次河流变道的影响，这次改道发生在公元前2850年。当时农民面临的选择与哲学家对自然状态进行理论分析时所想象的差不多。那些被改道的河流抛在身后的人们可以回归游牧生活。或者他们可以联合起来修建灌溉系统，从遥远的河流取水。

一个哲学问题就这样转化成了类似于实验室实验的东西，只不过实验时间是在数千年前，实验范围绵延数百英里。而且，实验的结果十分清晰。将河道变迁后留下的盆地划分为一个个5公里乘以5公里的方格，每个方格在河流改道150年后比改道前50年出现定居点（以拥有一个公共建筑为标志，如寺庙或市场）的可能性要高14%。每个方格修建运河的可能性也会高12%，这种人工灌溉形式使得在远离河流的地方发展农业成为可能。五个新城市被创建，只有三个被废弃。位于该河一条新支流沿岸的城市埃什努纳（Esnunna）规模大大扩张了。

艾伦及其合著者说，这证明最初的国家是由农民出于经济原因展开合作而形成的。运河网络的成本太高，任何人都无法独自承担。但分摊了成本后，这项建设对每个人来说都是划算的。这样的决定意义重大。它们代表了政府在征税后提供基础设施的一些最早的例子，也就代表着最早那批国家的起源。

作者随后将关于国家起源的几个世纪的思考分为两个阵营。他们说，从麻省理工学院颇具影响力的经济学家达龙·阿西莫格鲁（Daron Acemoglu）到卡尔·马克思都属于第一个阵营，这一派认为国家说到底是在社会层面的讨价还价过程中产生的。富人和地位高的人为了个人利益而夺取权力，并不时提供道路、学校或警力等服务，以换取民众的合作。但如果美索不达米亚是属于这种情况，那也应该发生在改道河流最新流经的地方所形成的定居点才对。毕竟，它们开垦出了更肥沃的农田，也就创造出了更多的税收。

当河流改道流走时，美索不达米亚的农民似乎选择了团结起来，这为第二

个阵营提供了支持。这一派的哲学家包括洛克和卢梭，他们认为，当人们选择互相协调、放弃为所欲为的自由而选择建立起一种能调解争端并提供一定程度安全保障的国家形态时，政府便出现了。艾伦和他的合著者只分析了伊拉克美索不达米亚，但他们认为他们的研究成果应该能更普遍地适用于其他新生国家。换句话说，政府是人们自发选择的，而不是强加给公民的。

| 河道蜿蜒

这着实是经济学家在抢地盘了，他们抢占了更常由政治理论家占据的领地。这项研究并非毫无瑕疵。也许某次未知的征服可以解释在研究所覆盖的时期内定居点的扩展。也许作者是错的，这种模式在其他地方并不成立。在其境内的河流真正开始改道之前，美索不达米亚的大河流域就已经有六座城市和多得多的定居点，有些已经存在了一千年。作者们坚称，他们只对新政府如何形成感兴趣，但他们实际上有可能捕捉到了那些更早形成的政府的扩展情况。

尽管如此，这篇论文还是大胆且有价值的。哲学家们花了几百年的时间解释国家为何出现。而花在考虑经济因素是否可能发挥了作用上的时间仍少之又少。尽管将自然状态具体化为一个特定的时间和地点会损失一些复杂性，但这样的操作为开展对早年的哲学家而言只能想想而已的那种实验打开了方便之门。如果霍布斯或洛克当初有办法研究一下跟自己推断的自然状态近似的東西，他们肯定乐于一试。■



Baby-making

How to entice Japanese couples to have babies

A few cities are bucking the country's low birth rate

KISHIKI NORIYO pulls up outside a house in Akashi, a city in western Japan, in a truck emblazoned with a heart logo and the slogan: “Diaper delivery: we also deliver kindness.” She steps out with two bags of nappies. Higuchi Miki, a young mother, appears at the front door with a baby on her hip. Ms Kishiki is on the front line of a ten-year push by Akashi to encourage its residents to have children. It includes delivering free baby food as well as nappies, free medical care and school lunches. The effort seems to be paying off. Akashi's population has increased for ten years in a row, to more than 300,000.

This makes the town exceptional. Japan's birth rate dipped below the replacement level of 2.1 children per woman in the mid-1970s and has been steadily declining ever since. In 2022 the total number of births dropped below 800,000 for the first time since records began in 1899. Of Japan's 1,800 municipalities, only around 200 have a rising population. According to Kishida Fumio, the prime minister, this has put the country on “the brink”.

Even in Akashi, which is an easy commute from the cities of Osaka and Kobe, most of the growth is from migration, not births. The town's birth rate is 1.65. Yet given that the national figure is 1.3, this represents success of a sort. Schools are closing across Japan for want of pupils; Akashi is short of school places.

Many of the obstacles to young Japanese forming families, from high education costs to inflexible family laws, can only be tackled with national policies. But Akashi shows how local communities can make a difference.

That starts with improving access to nurseries and day care. Smaller projects such as Ms Kishiki's, which assist parents of young children, also help.

The population of Nagareyama, a commuter town outside Tokyo, is also booming. Over the past decade it has grown by 24%, to 211,000. The opening of an express-train service to Tokyo in 2005 largely explains that. But Nagareyama's commitment to child care—the “utmost priority” of its local government—has also attracted young families. In 2007 the town launched a bus service that picks up children at train stations and takes them to day-care centres. Nagareyama has increased its number of nurseries from 17 to more than 100 in the past 15 years. “Our aim was to create an environment in which parents can continue to work while raising children,” says Izaki Yoshiharu, the town's mayor.

Lack of child care is endemic across Japan. The central government has made some improvements in this regard, reducing the number of children waiting for a nursery place by 90%. It has also introduced tax and other economic incentives to encourage people to reproduce. But, as scattered examples like Akashi and Nagareyama suggest, making a real difference requires a more fundamental shift.

Kato Hisakazu of Meiji University reckons Japan “needs to foster a culture that is generous to children”. Efforts to build more child-care facilities are often blocked by locals who worry about increased noise. When Soup Stock, a popular restaurant chain, started offering free food for babies last April, it encountered a fierce online backlash from people who objected to the prospect of sitting next to crying infants.

Tanaka Yumi, a mother of two in Nagareyama, says young Japanese parents are used to receiving a “cold look” from their unsympathetic neighbours. But the abundance of young families in the town and the supportive

policies of its local administration provide reassurance, she says. “I have many friends in Nagareyama who decided to have a second or a third.”

Akashi’s pro-child efforts are intended to drive the same cultural change. Morioka Kazumi of the town’s child-care department says the nappy deliveries are more about “alleviating loneliness” than the goods themselves. Ms Higuchi, the young mother, appreciates that. “It’s nice when someone checks on me,” she says. “It makes me feel I’m on the right track.” ■



造娃

如何说服日本夫妇生孩子

有几个城市正在对抗这个国家的低出生率

岸城乃理世（Kishiki Noriyo，音译）把车停在日本西部的明石市的一栋房子前，这是一辆绘有爱心标志的卡车，上面还印着一句口号：“送纸尿裤，也送温暖。”她走下车，拿着两袋纸尿裤。年轻的母亲樋口三希（Higuchi Miki，音译）到门口迎接，怀里抱着个宝宝。明石市十年来一直鼓励当地居民生孩子，岸城就在这项工作的第一线忙碌。该市的政策包括免费提供婴儿食品、纸尿裤、医疗保健和学校午餐。努力似乎得到了回报，明石的人口已经连续增长了十年，如今达到三十多万。

这让这个小城与众不同。日本的出生率在20世纪70年代中期降至人口更替水平（每位妇女生育2.1个孩子）以下，之后一直持续下降。2022年，出生人口自1899年有记录以来首次降至80万以下。在日本的1800个自治市中，只有200个左右的人口在增长。日本首相岸田文雄表示，这已经让日本站在了“悬崖边上”。

即便在明石市（从这里到大阪和神户的通勤都很方便），人口增长也主要来自移民，而不是本地出生。这里的生育率为1.65。不过考虑到全国的平均值是1.3，这仍代表着某种程度上的成功。因为生源不足，日本各地都有学校在关闭；明石市则是入学名额短缺。

从高昂的教育成本到僵化的家庭法，组建家庭的日本年轻人面临诸多障碍，其中许多只能通过国家政策来解决。但明石展示了地方社区能如何发挥作用。首先要做的就是提供更方便的托儿所和日托服务。类似岸城所从事的那种协助幼儿父母的小项目也能帮上忙。

在东京外围的通勤城镇流山市，人口也在迅速增长。过去的十年中，这里的人口增长了24%，达到了21.1万。这很大程度上要归功于2005年通往东京的特快列车开通。但流山对儿童保育的承诺——当地政府的“重中之重”

一一也吸引了年轻家庭。2007年，流山启动了一项公共汽车服务，从火车站接上孩子并将他们送往日托中心。在过去的15年里，流山市托儿所的数量已经从17个增加到了100多个。市长井崎义治表示：“我们的目标是创造一种环境，让父母在抚养孩子的同时能够继续工作。”

儿童保育匮乏的问题在日本普遍存在。中央政府在这方面取得了一些进步，将等待入托的儿童人数减少了90%。政府还出台了税收优惠和其他经济激励措施，鼓励人们生育。但正如明石和流山等零星例子所示，要想真正改变现状，需要一种更加根本性的转变。

明治大学的加藤久和认为，日本“要培养一种对儿童更包容的文化”。建造更多儿童保育设施的行动常常遭到本地居民的阻挠，担心会产生噪音。去年4月，当知名餐饮连锁店Soup Stock开始为婴儿提供免费食品时，遭到了一些网友的强烈反对，他们不想以后吃饭时旁边有婴儿哭闹。

居住在流山的田中佑美（Tanaka Yumi，音译）是两个孩子的母亲，她说日本的年轻父母习惯了邻居嫌幼儿太吵的“冷眼”，但流山有很多年轻家庭，加上有本地政府的支持政策，让他们感到安心。“我在流山有好多朋友都决定生二胎或第三胎。”

明石对育儿的支持意在推动同样的文化转变。该市儿童保育部门的森冈和美（Morioka Kazumi，音译）表示，送纸尿裤更多是为了“减轻孤独感”，而不是为了纸尿裤本身。年轻的母亲樋口很感激这一点。“有人来看我真好，”她说，“这让我觉得自己走在正确的路上。”■



From the ruins

Which economy did best in 2023?

Another unlikely triumph

ALMOST EVERYONE expected a global recession in 2023, as central bankers raised interest rates to cool inflation. The consensus was wrong. Global GDP has probably grown by 3%. Job markets have held up. Inflation is on the way down. Stockmarkets have risen by 20%.

But this aggregate performance conceals wide variation. The Economist has compiled data on five indicators—inflation, “inflation breadth”, GDP, jobs and stockmarket performance—for 35 mostly rich countries. We have ranked them according to how well they have done on these measures, creating an overall score. The table shows the rankings, and some surprising results.

Top of the charts, for the second year running, is Greece—a remarkable result for an economy that was until recently a byword for mismanagement. Aside from South Korea, many of the other standout performers are in the Americas. The United States comes third. Canada and Chile are not far behind. Meanwhile, lots of the sluggards are in northern Europe, including Britain, Germany, Sweden and, bringing up the rear, Finland.

Tackling rising prices was the big challenge in 2023. Our first measure looks at “core” inflation, which excludes volatile components, such as energy and food, and is a good indicator of underlying inflationary pressure. Japan and South Korea have kept a lid on prices. In Switzerland core prices rose by just 1.3% year on year. Elsewhere in Europe, though, many countries still face serious pressure. In Hungary core inflation is running at 11% year on year. Finland, which is heavily dependent on Russian energy supplies, is also

struggling.

In most countries inflation is becoming less entrenched—as measured by “inflation breadth”, a measure that calculates the share of items in the consumer-price basket where prices are rising by more than 2% year on year. Central bankers in places including Chile and South Korea increased interest rates aggressively in 2022, sooner than many of their peers across the rich world, and now appear to be reaping the benefits. In South Korea inflation breadth has fallen from 73% to 60%. Central bankers in America and Canada, where inflation breadth has dropped even more sharply, can take some credit, too.

However, in other places, the battle against inflation is not even close to being won. Take Australia. Inflation there remains firmly entrenched, with the price of close to 90% of the items in the average person’s shopping basket rising by more than 2% year on year. Worse, inflation breadth is not coming down either. France and Germany are also in trouble. And so is Spain, where inflation seems to be becoming more entrenched over time.

Our next two measures—growth in employment and GDP—hint at the extent to which the 35 economies are delivering for ordinary folk. Nowhere fared spectacularly well. Across the world productivity growth is weak, limiting potential increases in GDP. Already tight labour markets at the start of 2023 meant there was little room for improvement when it came to jobs.

Only a few countries, though, actually saw their GDP decline. Ireland was the worst performer, with a drop of 4.1% (take that with a pinch of salt: there are big problems with the measurement of Irish GDP). Estonia, another country whacked by the fallout of Russia’s invasion of Ukraine, did badly. Britain and Germany also underperformed. Germany is struggling with the consequences of the energy-price shock and rising competition from imported Chinese cars. Britain is still dealing with the aftermath of

Brexit—most economists expect the country to suffer from weak economic growth in the coming years.

America, by contrast, did well on both GDP and employment. It has benefited from record-high energy production as well as a generous fiscal stimulus implemented in 2020 and 2021. The world's largest economy may have pulled along other countries. Canada's employment has risen smartly. Israel, which counts America as its largest trading partner, comes fourth in the overall ranking, although its war with Hamas, which began in October, makes the outlook for 2024 deeply uncertain.

You might think that the American stockmarket, stuffed with firms poised to benefit from the revolution in artificial intelligence, would have done well. In fact, adjusted for inflation it is a middling performer. The Australian stockmarket, filled with commodities firms managing a comedown from high prices in 2022, underperformed. The Finnish stockmarket had a poor year, with the share price of Nokia, a national champion, continuing its long, slow decline. Japan's firms, by contrast, are experiencing something of a renaissance. For that, thank reforms to corporate governance, which finally seem to be bearing fruit. The country's stockmarket was one of the best performers in 2023, rising in real terms by nearly 20%.

But for glorious equity returns, look thousands of miles west—to Greece. There the real value of the stockmarket has increased by more than 40%. Investors have looked afresh at Greek companies as the government implements a series of pro-market reforms. Although the country is still a lot poorer than it was before its almighty bust in the early 2010s, the IMF, once Greece's nemesis, praised "the digital transformation of the economy" and "increasing market competition" in a recent statement. While underperforming Finns can console themselves this Christmas by drowning their sorrows alone in their underwear (or getting päntsdrunk, as

it is known locally), the rest of the world should raise a glass of ouzo to this most unlikely of champions. ■



从废墟中崛起

哪个经济体在2023年表现最好？

又一次意想不到的凯旋

由于各国央行加息以抑制通货膨胀，几乎所有人都预计2023年会出现全球经济衰退。这个共识是错误的。全球GDP可能增长了3%。就业市场保持坚挺。通胀正在下降。股市上涨了20%。

但这一整体表现掩盖了个体间的很大差异。《经济学人》根据五个指标——通胀、“通胀广度”、GDP、就业和股市表现——给35个以富裕经济体为主的国家编制了数据。我们根据它们在这些指标上的表现给它们排名，创建了一个综合得分。下表显示了排名，以及一些出人意料的结果。

希腊在这个排行榜上连续第二年蝉联榜首——这对于一个前些年还是管理不善的代名词的经济体来说是一个引人瞩目的成绩。除了韩国，其他排名前列的经济体大都位于美洲。美国排名第三。加拿大和智利与它相差不远。与此同时，许多表现疲软的国家位于北欧，包括英国、德国、瑞典，还有垫底的芬兰。

控制物价上涨是2023年的大挑战。我们关注的第一个指标是“核心”通胀，它不包括能源和食品等价格波动较大的项目，能很好地显示根本性的通胀压力。日本和韩国成功控制了物价。在瑞士，核心价格同比仅上涨了1.3%。然而在欧洲其他地方，许多国家仍然面临严重的通胀压力。在匈牙利，与一年前相比，核心通胀达到11%。严重依赖俄罗斯能源的芬兰也在艰难应对。

以“通胀广度”来衡量，在大多数国家，通胀正在变得不那么顽固。该指标计算了消费价格篮子中价格同比上涨超过2%的商品所占的份额。智利和韩国等国央行在2022年积极加息，动作比许多富裕国家的央行更快，现在似乎正在收获成果。在韩国，通胀广度从73%降至60%。美国和加拿大的央行官员成绩也不错，这两国的通胀广度降幅还要更大。

然而在其他一些地方，对抗通胀的战斗还远未接近胜利。比如澳大利亚。那里的通胀仍然顽固，普通人的购物篮中近90%的商品价格同比上涨超过2%。更糟糕的是，通胀广度也没能缩减下来。法国和德国也陷入了困境。西班牙也是如此，该国的通胀似乎变得越来越顽固。

接下来的两个指标是就业和GDP增长，它们显示了这35个经济体为普通人带来多少好处。没有哪个地方表现得特别出色。全球范围内生产率增长疲弱，制约了GDP的潜在增长。劳动力市场在2023年初就已经很紧张，意味着就业方面的提升空间很小。

不过只有少数几个国家实际上出现了GDP下降。爱尔兰表现最差，下降了4.1%（对此要持保留态度：爱尔兰GDP的测量存在很大问题）。另一个受俄罗斯入侵乌克兰影响的国家爱沙尼亚表现也很差。英国和德国同样表现不佳。德国正受困于能源价格冲击和中国进口汽车造成的竞争加剧。英国仍在应付脱欧的后果——大多数经济学家预计未来几年该国经济增长疲弱。

相比之下，美国在GDP和就业方面都表现良好。它受益于创纪录的能源产量以及2020年和2021年实施的慷慨财政刺激。这个世界上最大的经济体可能也拉动了其他国家的增长。加拿大的就业率大幅上升。以美国为最大贸易伙伴的以色列在总排名中位列第四，尽管该国与哈马斯于10月开始的战争让它在2024年的前景存在很大的不确定性。

你可能认为美国股市应该表现不错，因为它里头满是准备从人工智能革命中大赚一笔的公司。事实上，经过通胀调整后，它的表现只能算是中等水平。澳大利亚股市表现不佳，其中很多大宗商品公司正在应对2022年高价以后的跌落。芬兰股市度过了惨淡的一年，龙头企业诺基亚的股价延续了长期缓慢下滑的走势。相比之下，日本的公司可以说正在经历一场复兴。这要感谢企业治理方面的改革，它似乎终于开始见效。该国的股市是2023年表现最佳的股市之一，实际涨幅接近20%。

但说到亮眼的股本回报，还要看向西数千英里的希腊。在那里，股市的实

际价值增长超过40%。政府实施了一系列亲市场的改革，令投资者重新审视了希腊企业。尽管该国相比2010年代初经济大崩溃之前仍要穷得多，但希腊曾经的“报应女神”国际货币基金组织（IMF）最近在一份声明中赞扬了“该经济体的数字化转型”和“市场竞争加大”。当表现不佳的芬兰人在圣诞节时穿着内衣独自借酒消愁的时候（按当地的说法，就是 päntsdrunk[穿着内裤喝个大醉]），世界其他地方应该向希腊这个最意想不到的冠军敬上一杯茴香酒。 ■



Toko-Tok

Will TikTok's GoTo gambit save its Indonesian business?

How the video app is navigating around a digital shakedown

THE MORE the world's youngsters love TikTok's viral videos, the more their elected elders hate the app. They decry it for supposedly corroding young minds and, worse, for its links to China, home to its parent company, ByteDance. Many in America want to ban it. India already has. In October Indonesia, another big and promising market, shut down TikTok's fledgling but lucrative sideline of selling goods via its videos, by requiring social-media firms to obtain an e-commerce licence—with no guarantee of success.

Such obstacles have forced TikTok to act strategically, for instance by moving its global headquarters to Singapore and hiring a Singaporean chief executive, which has put distance between it and its Chinese parent. In another canny move, on December 11th it announced that it was paying \$840m for a 75% stake in Tokopedia, the e-commerce arm of GoTo, an Indonesian tech conglomerate. It has also pledged to invest \$1.5bn in the tie-up.

The deal is something of a shotgun marriage, but it benefits both sides. GoTo, which has struggled to turn a profit in recent years, will no longer need to subsidise its loss-making retail arm. TikTok, for its part, will be allowed to restart its e-commerce operations. Sales on TikTok's app will be fulfilled by Tokopedia's logistics network (though, like all e-merchants in Indonesia, it must now charge minimum prices for products made abroad).

TikTok and Tokopedia separately account for 10% and 28%, respectively, of Indonesia's fast-growing e-commerce market, according to Momentum Works, a data firm. Together, they are a powerhouse, matching the market

share of Shopee, hitherto the country's biggest online emporium (owned by Sea Group, a Singaporean technology conglomerate).

Most important, an intimate link with a domestic champion makes TikTok look less like a foreign interloper. If the firm can make its new partnership work in the world's fourth-most-populous country, it could use this as a model for expansion and consolidation in other countries where it is greeted with wariness, such as Malaysia and the Philippines.

It will be an uphill struggle, and not just because of challenges particular to TikTok. All over the world, the advocates of international openness in digital commerce are losing the battle for hearts and minds. Last year Sea halted its expansion to India in the face of regulatory pressure, after its popular mobile game, "Free Fire", was banned. Stringent new European rules on cloud computing, including requirements to store local users' data locally, are aimed squarely at the American tech giants.

Last month America, itself in an increasingly isolationist mood, dropped earlier demands to liberalise trade in digital goods and services as part of the Indo-Pacific Economic Framework, the already flimsy pact which President Joe Biden's administration has been negotiating with 13 Asian allies. To thrive amid rising protectionism—digital and otherwise—TikTok and its rivals will need to show plenty of delicate diplomatic footwork. ■



Toko-Tok

TikTok联姻GoTo能否拯救其印尼业务？

这个视频应用如何应对数字业监管震荡

全球年轻人越爱看TikTok上的爆红视频，他们国家掌权的长辈们就越憎恶这个应用。他们谴责它可能侵蚀年轻人的思想，更严重的是，还谴责它与中国关联，因为其母公司字节跳动来自中国。美国的许多政客想把它禁掉。印度已经这样做了。去年10月，另一个潜力大市场印尼规定社交媒体公司须获得许可（并不保证能成功获批）方可开启电子商务交易，从而叫停了TikTok新生但利润丰厚的视频带货业务。

这些障碍迫使TikTok采取战略行动，例如将其全球总部迁至新加坡，并聘请了一位新加坡籍的首席执行官，从而与中国母公司拉开距离。它还使出了另一个精明的招数，于12月11日宣布将支付8.4亿美元收购印尼科技企业集团GoTo旗下电商平台Tokopedia75%的股份。它还承诺将在这次合作中投资15亿美元。

这笔交易有点像是一场无奈的联姻，但对双方都有利。近年来一直难以盈利的GoTo将不再需要贴补亏损的零售业务。而TikTok将获准重新启动其电商业务。TikTok平台上的销售将由Tokopedia的物流网络履行（尽管与印尼的所有电商一样，它现在必须对国外制造的产品限定最低价格）。

根据数据公司Momentum Works的统计，在印尼快速增长的电商市场上，TikTok和Tokopedia分别占到10%和28%的份额。合在一起，它们是一支强大的力量，市场份额堪比目前印尼最大的在线商城虾皮购物（由新加坡科技企业集团冬海集团所有）。

最重要的是，与本土领军企业建立亲密联系使TikTok看起来不那么像是一个擅闯的外来者。如果该公司能够在全球人口第四多的国家中让这一新伙伴关系顺利推进，它就能以此为模板，在其他目前对它怀有戒心的国家扩张和巩固地位，比如马来西亚和菲律宾。

这将是一场艰苦的进军，不仅仅是因为TikTok特有的挑战。在全球各地，支持数字商务国际开放的人们都在输掉人心之战。去年，在其热门手机游戏“Free Fire”被禁后，冬海在监管压力之下暂停了向印度的扩张。欧洲对云计算出台了严厉的新规定，包括要求在本地存储本地用户数据，就是在直接针对美国的科技巨头。

美国自身的孤立主义氛围也日益浓厚。11月，它放弃了之前要求在《印太经济框架》（Indo-Pacific Economic Framework）中实现数字商品和服务贸易自由化的要求，拜登政府一直在与13个亚洲盟国谈判的这个协议本就已经脆弱不稳。想要在不断高涨的保护主义浪潮（无论是数字经济还是其他方面）中蓬勃发展，TikTok及其竞争对手将需要走出很多高难度的外交步伐。■



Bartleby

How to master the art of delegation

You can entrust decisions to subordinates without regretting it

DELEGATING WELL is the six-pack of management: widely desired and harder to achieve the older you get. In theory, handing appropriate decisions off to people lower down the corporate ladder means greater satisfaction all round. Bosses get more time to concentrate on the issues that really deserve their attention. Middle managers and workers enjoy a greater sense of autonomy. And the organisation benefits from faster decision-making on the part of people who are better informed about the matter at hand. In practice, however, delegation is a minefield.

Some bosses do not even try to delegate. They may mistrust people below them or crave control. Their career success may simply have persuaded them of their own genius. But there are kinder explanations, too. Startup founders are conditioned to do everything, at least until firms get to a certain size. Plenty of managers shoulder more work than they should in order to protect their teams from overload.

Other managers do delegate but they do so for the wrong reasons. Studies suggest that people are likely to hand off decisions when choices are hard, when the consequences affect others and when they want to avoid being blamed for a bad outcome. In a paper from 2016 by Mary Steffel of Northeastern University and her co-authors, volunteers were told that they had to book hotel rooms at a conference, either for their own use or for their boss, and asked them if they would like to reserve the rooms themselves or delegate the task to an office manager. When they were choosing for the boss and the hotels were ropery, people were more likely to pass the job to the hapless office manager.

A new study, by Victor Maas and Bei Shi of Amsterdam Business School, reaffirms this bleak picture of human motivation. It found that people were more likely to hand work off to subordinates when the performance targets for that particular task were demanding; they were much happier to keep hold of tasks with targets that were easier to attain. If a habitual micromanager unexpectedly asks you to take the lead on something, in other words, run for the hills.

The great mass of managers fall into a greyer area. They may be full of good intentions to leave decisions to others but still find it hard to do so. What if you put trust in your team members but then discover you violently dislike the choices they make? What if you want to hand over some decisions but you know that your own bosses will hold you personally responsible for them? These problems can easily result in “faux-tonomy”—a lip-service version of delegation in which managers do not actually leave their teams to get on with things or underlings use their freedom solely to guess what the boss would like.

One way to navigate such problems is to use an explicit decision-making framework that tries to make it clear who is on the hook for what. These frameworks are not perfect. Project managers often use something called the RACI model. Its first two letters sort those who are “responsible” from those who are “accountable”, a distinction which normal people may find “confusing” and “incomprehensible”. Other, clearer frameworks are available. They have punchy names like DACI, DARE and DICE: you might be choosing a cloud-computing vendor but you get to feel a little like you are in the special forces.

As well as working out who does what, it helps to have a way to parse what kinds of decision can be delegated and what not. Before Jeff Bezos started hanging out in spacesuits and doing laughable photoshoots in Vogue, he liked to articulate his management philosophy in annual letters to

Amazon's shareholders. In 2015 he made a useful distinction between type-1 decisions ("one-way doors") that are important and irreversible, and type-2 decisions ("two-way doors") that can be reversed if they do not pan out. Type-1 decisions warrant slow, deliberative processes; type-2 decisions should be taken quickly by smaller groups. Having a theory of decisions improves choices on what to delegate and reduces the chance of regrets.

Delegating well requires a lot of judgment, too. Delegation is not all-or-nothing. A detached boss can be as demotivating as a micromanager; you have to stay informed on decisions and, on occasion, override them. But checking in at the right cadence, and letting people proceed with decisions that you would not have made yourself, demands self-restraint and discipline. Just like those abs. ■



巴托比

如何掌握授权的艺术

你可以放心地让下属去做决策而不后悔

良好的授权就像保持六块腹肌：人人渴求，但随着年龄增长愈发难实现。理论上，将适当的决策交给下属能让公司里的各方皆大欢喜。老板们有更多时间专注于真正值得关注的问题。中层管理人员和员工享受更大的自主权。让那些对手头的事务进展更清楚的人更快地做出决策，整个组织都能从中受益。然而在实践中，授权是个雷区。

有些老板连试都不试一下。他们可能不信任下属，或者渴望掌控一切。他们在事业上的成功可能就是会让他们相信自己是天才。但也有更客气的解释。创业公司创始人习惯于亲力亲为，至少在公司达到一定规模之前是这样。为了不让团队不堪重负，许多管理者承担了额外的工作。

另一些管理者确实在授权，但出发点是错误的。研究表明，当难以抉择、后果影响他人，以及想避免为糟糕的结果担责时，人们更有可能把决策甩手给他人。东北大学（Northeastern University）的玛丽·斯特费尔

（Mary Steffel）及其合著者在2016年发表了一篇论文。这项研究中的志愿者被告知他们必须为一次会议预订酒店房间，有的是为自己订，有的是为他们的老板订，然后问他们是想自己预订房间还是将这件事交给办公室经理。结果发现，当他们是想要为老板选房间并且酒店条件糟糕时，他们更有可能把它推给倒霉的办公室经理去干。

阿姆斯特丹商学院（Amsterdam Business School）的维克多·马斯

（Victor Maas）和石贝所做的一项新研究再次证实了人类动机的这种阴暗面。该研究发现，当某项任务的绩效目标挑战较大时，人们更有可能把工作交给下属；而对于目标较易达成的任务，留给自己的意愿就高多了。换句话说，如果一个惯于微观管理的上司突然要求你去负责某件事情，那么最好赶紧躲开。

大多数管理者处于灰色地带。他们可能满怀好意地想授权别人做决定，但仍觉得这做起来很难。如果你信任团队成员，让他们去做决定，但后来发现自己极不喜欢他们的选择，那该怎么办？如果你想授权下属做一些决策，但又知道你自己的上司会把它们算在你的头上，那又该怎么办？这些问题很容易导致“假自主”——一种表面上的授权，即管理者实际上并没有让团队自己决定事情，或者下属拥有的自由仅够用来猜老板喜欢什么。

应对这些问题的一种方法是使用一个清楚明白的决策框架，尽量明确谁对什么事情负责。这些框架并不完美。项目管理者经常使用称为RACI模型的东西。它的前两个字母将“负责”的人与“负有责任”的人区分开来，这可能会让一般人感到“困惑”和“难以理解”。还有其他更清晰的框架。它们有响亮的名字，如DACI、DARE和DICE：你可能正在选择云计算供应商，但会感觉自己有点像在特种部队里。

除了弄清谁做什么之外，有一套区分哪些决策可以授权、哪些不可以的方法也会有帮助。在贝索斯开始穿上太空服、为《Vogue》杂志拍摄好笑的照片之前，他喜欢在每年给亚马逊股东的信中表达自己的管理理念。在2015年，他对重要且不可逆转的第一类决策（“单向门”）和可以在不奏效时撤销的第二类决策（“双向门”）做了有用的区分。第一类决策要审慎，可以做得慢一些；第二类决策应由较小的团队迅速做出。有了一套决策理论，可以在授权时做出更好的选择，减少后悔的机会。

良好的授权还需要做很多的判断。授权并非撒手不管。和微观管理者一样，冷漠的老板也可能会让人感到泄气；你必须保持对决策的了解，并在必要时出手干预。但是，以正确的节奏了解状况，并允许人们做出你自己不会做出的决策，这需要自我克制和纪律。就像保持腹肌那样。■



A surplus of anomalies

Is China understating its own export success?

The \$230bn puzzle at the heart of the country's trade figures

CHINA'S CURRENT-ACCOUNT surplus was once one of the most controversial statistics in economics. The figure, which peaked at almost 10% of GDP in 2007, measures the gap between China's earning and its spending, driven largely by its trade surplus and the income it receives from its foreign assets. For much of the past two decades, China's surpluses have left it open to the charge of mercantilism—of stealing jobs by unfairly boosting its exports. Some trading partners now worry about a similar shock if the country's output of electric vehicles grows too quickly.

But China's current-account surplus is now modest: \$312bn or 1.5% of GDP over the past year, according to the country's State Administration of Foreign Exchange (SAFE). That is below the 3% threshold that America's Treasury deems excessive.

Is the figure reliable? Some, such as Brad Setser of the Council on Foreign Relations and Matthew Klein, a financial commentator, believe that the official numbers are dramatically understated. China's true surplus, Mr Klein reckons, is now “about as large as it has ever been, relative to the size of the world economy”. They offer two arguments. First, China may be understating income from its foreign assets. Second, it may be understating exports.

According to SAFE, the income China earns on its stock of foreign assets plunged from mid-2021 to mid-2022. This seems odd given rising global interest rates. Mr Setser's alternative estimate, based on assumptions about China's assets, would add about \$200bn to the surplus.

China's goods surplus also appears smaller in SAFE's figures than it does in China's own customs data. The gap was \$230bn over the past year. "That is real money, even for China," says Mr Setser.

China might take some comfort from a bigger surplus. But it has an unsettling implication. What is happening to the additional dollars China is earning? Since they are not showing up on the books of China's central bank or its state-owned banks, they must be offset by a hidden capital outflow. Such outflows typically end up in a residual category of the ledger. Mr Setser believes this residual should be about 2% of GDP, not the official figure of near zero.

SAFE has a different explanation. It attributes the export gap largely to China's free-trade zones and similar enclaves. These lie inside China's territory but outside its official tariff border (see diagram). Goods leaving these enclaves for the rest of the world are counted as exports by customs but not by SAFE. Adam Wolfe of Absolute Strategy Research points out that these zones account for a growing share of China's exports. That may explain why the gap has emerged only in the past two years.

Mr Setser is unconvinced. If China's free-trade zones have enjoyed a dramatic export boom, it should produce ripples elsewhere. Wages earned by workers, for example, should appear as increased remittances. In fact, they have risen only a little. And as Mr Wolfe points out, even if the official current-account surplus is correctly calculated, it may be of little comfort to China's trading partners. After all, if the country's domestic demand remains weak, goods made in its free-trade zones may flood foreign markets. The rest of the world will count them, and experience them, as Chinese imports, even if SAFE does not count them as Chinese exports. ■



差异盈余

中国是否低报了它的出口成就？

中国贸易数据的核心是一个2300亿美元的谜团

中国的经常账户盈余曾经是经济学中最具争议的统计数据之一。这个数字衡量中国的收入和支出之间的差距，它在2007年达到峰值，几乎占到GDP的10%，这主要是受到中国的贸易顺差和从海外资产中获得的收入推动。在过去二十年的大部分时间里，中国的盈余让它被指责为重商主义——即通过不公平地促进出口来窃取就业机会。一些贸易伙伴现在担心，如果中国的电动汽车产量增长过快，可能会出现类似的冲击。

但是中国的经常项目盈余现在并不算高：按照国家外汇管理局的数据，去年中国的经常项目盈余为3120亿美元，占GDP的1.5%。这低于美国财政部认为过高的3%的门槛。

这个数字可信吗？有些人，比如美国外交关系协会（Council on Foreign Relations）的布拉德·塞瑟（Brad Setser）和金融评论员马修·克莱因（Matthew Klein），认为官方数据是大大低报了。克莱因认为，中国目前的真实盈余“相对于世界经济规模而言和过去任何时候都差不多大”。他们提出了两个论据。首先，中国可能算少了其海外资产的收入。其次，它对出口的统计可能打了折扣。

根据外汇局的数据，从2021年中到2022年中，中国从它的外国资产存量中获得的收入大幅下降。考虑到全球利率不断上升，这似乎有些奇怪。塞瑟根据对中国资产的假定做了另一种估算，按照他的算法，盈余要再多出约2000亿美元。

外汇局数据里中国的商品贸易顺差也小于中国海关的数据。过去一年这两个数字的差异达到2300亿美元。“即便对中国来说，这也是一大笔钱。”塞瑟表示。

盈余实则更大可能会让中国得到一些安慰。但这透露出的隐情让人不安。中国多赚的那些美元去了哪里？既然它们没有出现在中国央行或国有银行的账簿上，那么必定是被一种隐性的资本外流抵消了。这样的流出通常最终会入在分类账的一个剩余类别里。塞瑟认为这个剩余部分应该在GDP的2%左右，而不是官方数据中的接近于零。

外汇局对此有不同的解释。它把出口额上的差异主要归因于中国的自由贸易区和类似自贸区的飞地。这些区域位于中国境内，但在官方征收关税的边界之外（见图）。从这些飞地运往世界其他地方的货物在海关被算作出口，但在外汇局不算出口。Absolute Strategy Research的亚当·沃尔夫（Adam Wolfe）指出，这些自贸区在中国出口中所占的份额越来越大。这或许可以解释为什么数字差异只在过去两年才出现。

这没能让塞瑟全然信服。如果中国的自贸区出口非常繁荣，那应该会在其他地方产生连锁反应。例如，工人挣的工资应该表现为汇款增加。但实际上汇款只增长了一点点。而正如沃尔夫指出的那样，即使官方经常项目盈余的计算是正确的，可能也无法给中国的贸易伙伴带来多少安慰。毕竟，如果中国国内的需求持续疲软，其自贸区生产的商品可能会涌向国外市场。即使中国外汇局不把它们算作中国的出口，世界其他国家还是会把它们算作从中国的进口，并体验到它们的存在。■



Financial flows

How to sneak billions of dollars out of China

A new era of capital flight has begun

IT HAS BEEN a terrible year to be bullish on China. The CSI 300 index of Chinese stocks has dropped by 13% so far in 2023, to below the level reached during the last of the country's severe covid-19 lockdowns. Difficulties in the property market are prompting corporate defaults. The lacklustre outlook for economic growth, combined with the need to manage capricious autocratic leadership at home and uncertain relations with big trading partners, makes for a miserable financial climate.

This is also a recipe for enormous capital outflows. Foreign investors, who once had boundless enthusiasm for China, are rushing for the exits. So are numerous wealthy Chinese individuals. According to the Institute of International Finance, a think-tank, there have been cross-border outflows from the country's stocks and bonds for five consecutive quarters, the longest streak on record. Firms are getting itchy feet, too. In the third quarter of 2023 the net flow of foreign direct investment in China turned negative for the first time since the data began to be collected a quarter of a century ago. In part, this reflects investment by domestic manufacturers in overseas operations, which can lower labour costs and help skirt American tariffs. The size of the overall outflows is up for debate, but some believe up to \$500bn-worth is disguised in China's murky balance-of-payments data.

The last surge of capital out of China came in 2015-16. It was set off by a currency devaluation, which was itself sparked by a stockmarket collapse. By one estimate, as much as \$1trn escaped the country in 2015 alone. Back then, many countries welcomed Chinese capital with open arms. Now they are suspicious. New destinations for Chinese funds—both legitimate and illicit—are therefore being found.

Dodging China's capital controls is the first task for fretful investors. Some transfers are piecemeal: mainland residents can buy tradable insurance policies in Hong Kong, though they may legally spend only \$5,000 at a time. In the first nine months of the year, sales of insurance to mainland visitors hit HK\$47bn (\$6bn), some 30% more than in the same period in 2019. Other avenues are being closed off. In October China banned domestic brokers from facilitating overseas investment by local residents. For business owners, misinvoicing trade shipments, by overstating the value of goods being transacted, is one way to get money out of the country.

Many places are less inviting to Chinese investors than during the last era of capital flight. Dozens of American state legislatures have passed bills blocking foreign citizens residing overseas from buying land and property. Chinese buyers spent \$13.6bn on American property in the year to March, less than half the amount spent during the same period in 2016-17. In Canada, another once popular market, non-residents are now banned from buying real estate altogether. Golden visas in Europe, which offer residency rights in exchange for investment, are falling out of favour: schemes in Ireland, the Netherlands and Portugal are being tightened or abolished. Although Hong Kong remains a gateway through which Chinese capital can reach the rest of the world, its appeal as a bolthole for rich families aiming to shield their assets from the Chinese state has dimmed since the territory's political crackdown.

It is in this context that Singapore has taken on an increasingly important role. Its success in attracting Chinese cash owes a lot to its relative proximity, low taxes and large Mandarin-speaking population. Direct investment from Hong Kong and the Chinese mainland has risen by 59% since 2021, reaching 19.3bn Singapore dollars (\$14.4bn) in 2022. Suspicious gaps in the trade data between the two countries suggest greater unrecorded capital flight, too, note analysts at Goldman Sachs, a bank.

The number of family offices in Singapore rose from 400 in 2020 to 1,100 by the end of 2022, a trend driven by Chinese demand. There is little transparency about what assets ultra-rich investors hold through such vehicles, but Singapore's modest capital markets suggest that most money will eventually be invested abroad. Nevertheless, Chinese inflows have buoyed Singapore's banks, helping to lift profits at institutions like DBS and Overseas Chinese Banking Corporation. Other neutral locations are also benefiting from Chinese cash. Although golden visas are in decline elsewhere, issuance in Dubai rose by 52% in the first six months of 2023, compared with the same period in 2022, with lots of recipients thought to be Chinese.

Neutral countries are not the only beneficiaries. Inquiries about Japanese properties from clients in China and Hong Kong have roughly tripled in the past year, says Glass Wu of Japan Hana, an estate agency. The trend has been accelerated by a weak Japanese yen, which has fallen by a fifth in the past three years against the Chinese yuan. Around 70% of the buyers make viewings via video call, says Ms Wu, and buy without first visiting the property. Australia has also seen a surge in overseas demand for property, mostly from potential owner-occupiers, rather than investors as in previous waves, says Peter Li of Plus Agency, a local realtor. Data from Juwai IQI, a property firm, seem to confirm the trend. Since 2020 the median price of homes around the world receiving inquiries from Chinese buyers has risen from \$296,000 to \$728,000. Rather than buying smaller properties to let, buyers are opting for spacious ones in which they will actually live.

Chinese capital can cause problems. It has put pressure on Singapore's housing market, which is dominated by state provision and contains fewer than half a million private units. In April the state introduced an eye-watering 60% tax on all property purchases by foreigners to try to cool things down. The city's financial secrecy may also invite the wrong kinds of

activity. In August police raids resulted in the seizure of assets including cars, jewellery and luxury property, together worth around \$2bn, and the arrests of ten foreigners. The group had all been born in China, but most had acquired other citizenships through international investment schemes. In October the Singaporean government noted that at least one of the accused may have had links to a family office. Other countries in the region, such as Cambodia and Thailand, are wary of hosting elite Chinese citizens who may bring politics with them.

Although outflows from China are not yet on the vast scale of those seen during the panic of 2015-16, they might prove more enduring. Back then, a government-engineered credit boom in the property industry helped revive the economy's animal spirits. This time around, the Chinese government wants to allow the industry to cool. Without a sudden, unexpected recovery in the fortunes of the Chinese economy, the stream of capital looking for an exit is unlikely to slow. Investors and companies will continue to seek a wide variety of foreign assets—the ones, at least, they are still allowed to buy—prompting joy and headaches wherever they land. ■



资金流动

如何从中国润出千亿美元

资本出逃的新时代已经开始

过去这一年实在很难看好中国。2023年迄今为止，中国的沪深300指数已下跌了13%，至低于该国上一次因疫情实施严厉封锁时的水平。房地产市场的困境促发企业违约。经济增长前景低迷，再加上要应对国内反复无常的威权领导层，还有与主要贸易伙伴国不确定的关系，让金融环境十分严峻。

这些也造成了资本大量外流。曾经对中国充满无尽热情的外国投资者正在争相撤离。大量富裕的中国人也一样。根据智库国际金融研究所

（Institute of International Finance）的数据，中国的股票和债券已连续五个季度出现资金跨境流出，创下有记录以来最长的持续外流。企业也坐不住了。2023年第三季度，中国的外商直接投资净流量自二十多年前开始统计以来首次出现负值。在某种程度上，这是因为国内制造商纷纷在海外投资建厂，以求降低劳动力成本，并规避美国的关税。关于资金外流的整体规模尚不能确定，但一些人认为，中国模糊的国际收支数据掩盖了高达5000亿美元的资金流出。

中国上一次资本外流高峰发生在2015至2016年。那一次由货币贬值引发，而货币贬值又是缘于股市崩盘。据估计，仅2015年一年就有多达1万亿美元的资金流出中国。当时，许多国家敞开怀抱欢迎中国资本到来。而现在它们心存疑虑。因此，中国的资金——无论是否合法合规——正在找到新的目的地。

焦躁的投资者要办的第一个事项是规避中国的资本管制。有些人在蚂蚁搬家似地转移资金。大陆居民可以在香港购买可交易的保单，不过按规定单笔上限仅为5000美元。2023年前九个月，面向大陆游客的保险销售额达到470亿港元，比2019年同期增长约30%。其他渠道正在被关闭。10月，中国禁止国内经纪公司协助本国居民进行海外投资。对于企业主来说，将资

金转出国外的一种方式是在夸大交易货值，虚报贸易金额。

许多地方对中国投资者不像上一次资本外流时那样热情而散发吸引力。美国数十个州的立法机构已通过法案，禁止在海外居住的外国公民购买土地和房产。在截至2023年3月的一年时间里，中国买家在美国购买的房产总值为136亿美元，不到2016至2017年同期的一半。作为另一个曾经热门的市场，加拿大现在完全禁止非居民购买房地产。欧洲以居留权换投资的黄金签证正在失宠，爱尔兰、荷兰和葡萄牙正在收紧或废除此类投资居留计划。尽管香港仍然是中国资本进入世界其他地区的门户，但自政治管控以后，它作为富裕家庭保护资产免受中国政府染指的避难所的吸引力已经减弱。

正是在这种背景下，新加坡扮演了越来越重要的角色。它能够成功吸引到中国资金的主要原因是地理位置邻近、税率低，而且很多人会讲普通话。自2021年以来，来自香港和中国大陆的直接投资增长了59%，2022年达到193亿新加坡元（144亿美元）。高盛的分析师指出，两国贸易数据的可疑差异显示存在更大规模未被记录的资本外逃。

在中国需求的推动下，新加坡的家族办公室数量从2020年的400个增长到2022年底的1100个。至于超级富有的投资者通过此类工具持有着哪些资产，这方面的透明度很低，但新加坡规模不大的资本市场意味着大部分资金最终将投资于海外。尽管如此，中国资金的流入提振了新加坡的银行，推升了星展银行和华侨银行等银行的利润。其他中立国家也受益于中国资金。尽管黄金签证在其他地区的签发数量在下降，但迪拜的签发量在2023年前六个月相比2022年同期增加了52%，其中许多签发对象被认为是中国人。

受益的不止中立国家。房地产经纪公司日本华房地产的胡凯淇表示，过去一年里，中国大陆和香港客户对日本房产的咨询量增加了大约两倍。日元疲软加速了这一趋势，过去三年里日元兑人民币汇率下跌了五分之一。胡凯淇表示，大约70%的买家通过视频通话看房，并在没有先亲自看房的情况下购入。当地房地产中介Plus Agency的李铂表示，澳大利亚的房地产市

场也出现了海外需求激增的现象，主要是来自想要自住的业主，而不是像前几波热潮中那样来自投资者。房地产公司居外IQI（Juwai IQI）的数据似乎证实了这一趋势。自2020年以来，世界各地收到中国买家询问的房产的中位价格已从29.6万美元上涨到72.8万美元。买家不再购买较小的房产出租，而是选择宽敞的房产自住。

中国资本可能引发问题。它已经给新加坡的住房市场带来了压力，新加坡的住房要由政府供给，私人住宅不到50万套。为了给市场降温，政府在2023年4月开始对外国人购买的房产一律征收高达60%的税率。新加坡金融领域的保密政策也可能招致违规操作。8月，警方在突击搜查中查封了总价值约合20亿美元的汽车、珠宝和豪宅等资产，逮捕了十名外国人。这些人都出生在中国，但通过国际投资计划取得了他国国籍。10月，新加坡政府指出其中至少有一名被告可能与一个家族办公室有关联。柬埔寨和泰国等其他东南亚国家对接纳可能携带政治问题的中国精英公民态度谨慎。

尽管中国的资本外流还没有达到2015年至2016年的恐慌时期那么大的规模，但可能会比那会儿更持久。当时，政府推动的房地产业信贷繁荣帮助重振了经济的动物精神。而这一次，中国政府希望任该行业冷却下来。如果中国经济不发生出乎意料的突然复苏，寻求退出的资本流动不太可能会慢下来。投资者和公司将继续寻求各种外国资产，至少是仍然允许购买的那些资产。他们所到之处，必然是有人欢喜有人愁。■



Chaguan

China's cities compete for kids

Enlightened self-interest nudges rich places to woo rural families

AS A RULE, China's central planners do not say much about love. But look closely at recent plans from some reform-minded provinces—notably schemes that try to address a shrinking population—and appeals to hearts as well as minds leap from the page.

Take, for instance, a five-year plan to help rural migrants settle down in the cities of Zhejiang, a prosperous coastal province, and ideally to bring their young children with them. At first sight, Zhejiang's proposal, issued in July and covering 2023 to 2027, is dry stuff. One section explains how, in every city except the provincial capital, Hangzhou, recently arrived families can access places at city-funded schools and other public services. They qualify without buying a home or securing a local hukou (household registration). The hukou system has been used to regulate internal migration since Maoist times, when the Communist Party feared hungry peasants might crowd into cities. On the ground in Zhejiang the human import of these changes is well understood.

Chaguan travelled to Yiwu, a city of 1.9m in Zhejiang that is a trading hub for small commodities, supplying the world with pencils and parasols, shoelaces and shopping trolleys. He heard locals and migrants weigh the likely impact of relaxed residency rules on Yiwu's economy, on school waiting lists and on housing prices. Strikingly often, the same people then stopped talking about statistics and spoke of how the reforms make them feel.

Though Zhejiang stands out for reforming zeal, cities across China are being encouraged to hand out hukou papers more easily. Some are opening

public services to migrants who prefer to remain registered in their rural birthplaces. Both economics and demographics are driving change. Fertility rates are dropping fast and China's population declined in 2022 for the first time since the early 1960s. Natives of some of China's biggest and richest cities are proving indifferent to offers of baby-bonuses and other government incentives. Far-sighted provinces and cities are now focusing on a stock of young people who have already been born: China's 67m "left-behind children". That is the term for youngsters being raised by relatives or in boarding schools in villages, county towns or minor provincial cities, while one or both parents works as a migrant away from home.

Even some of China's biggest cities are anxious about maintaining their populations, says Lu Ming, an economist at Shanghai Jiaotong University and a prominent advocate of hukou reform. What is more, China is generating fewer of the factory jobs that can be filled by migrants straight from the countryside, and creating more service-sector jobs that require an understanding of city folk and their ways, notes Professor Lu. By way of example he cites jobs in nursing or housekeeping or as decorators, adding that workers raised and educated in cities are best placed to fill such vacancies. Cities have been offering hukous to university graduates and other skilled workers for years. Now, the contest is on for blue-collar families, the professor suggests.

Not every city has the means to compete. Yiwu, a wealthy place, has spent heavily on wooing young families this year. To help outsiders, the city closed 28 private schools that catered to migrant children, some of which charged as much as 20,000 yuan (\$2,811) a year. Others offered classes in shabby industrial premises. The city converted 24 into publicly funded schools, bringing 25,000 migrant children into the state sector. It built new primary schools, too, with one campus costing 224m yuan.

Migrant parents have mixed reactions. Yiwu's wide avenues are lined with

commercial complexes devoted to specific industries. Outside a centre for stationery merchants, your columnist found three men from the same rural corner of Hunan province. They eke out a living selling adhesive price labels from plastic crates balanced on electric scooters. One used to pay over 6,000 yuan a year to send his child to a local private school. The same school is now public and costs him a tenth of that. Yiwu “wants to hang on to more outsiders”, suggests that lucky father. A younger colleague will not be moving his 13-year-old daughter from Hunan to the city, however. “Of course, she’d prefer to live with her parents,” he admits. But he and his wife both work in Yiwu, often till midnight or later. “We don’t have time to take care of the child here,” says the label-seller, smoking as he waits for customers.

Inside the mall, a mother of one from elsewhere in Zhejiang sells children’s diaries and pens to buyers from around the world. The reforms leave her both grateful and sceptical. Migrants who rent homes and pay social-security contributions can now access city schools, even without a full hukou, she agrees. But they rarely land spots at Yiwu’s best schools. Homeowners and longstanding hukou-holders have a higher priority than newcomers who rent, she explains. In a nearby shop, a mother of two who moved to Yiwu years ago reports that she paid a hefty premium to live near a good school. She ventures that it would be “very unfair” on homebuyers if the newcomers could access the best schools.

| *A benign contest for growth*

Some migrants prefer a life in two places. Some keep a rural hukou to maintain their rights to village land. A woman from southern China may send her daughter back to her home province to take university-entrance exams in ten years’ time. Back home, the competition is less “ferocious” than in wealthy Zhejiang, she says.

In a playground near a new primary school, a retired migrant worker from

Hunan talks proudly of her grown children and the four grandchildren that she now helps to raise, each of whom has a hukou from Yiwu. A generation ago, her own children lived in her home village and she saw them twice a year. She supposes that her children missed her, she says, with a strained laugh. “But I don’t know and I would not ask.” China remains full of such sad tales. Self-interest now prompts cities and provinces to help more families stay together. Easing heartache will be one of their rewards. ■



茶馆

中国城市的抢娃大作战

开明的自利促使富裕地区想办法吸引农村家庭

中国的中央规划者一般很少谈“爱”。但仔细阅读一些具改革意识的省份近期出台的规划，尤其是那些试图应对人口减少的方案，会明显感受到字里行间不仅试图晓之以理，更试着动之以情。

以浙江省为例，这个富裕的沿海省份制定了一项为期五年的计划，旨在协助农业转移人口在该省各市安家落户，且最好他们年幼的子女也随迁。这份提案于7月发布，覆盖2023年至2027年，初看起来似乎索然无味。其中一个章节说明了除省会杭州以外，其他所有城市的新迁入家庭如何能获得公办学校入学名额和享受其他公共服务，而无需购房或获得当地户口。户籍制度自毛泽东时代起便被用来管理国家内部人口迁移，当时共产党担心饥饿的农民可能涌入城市。在浙江，民众对于目前这些变革在人口上的用意领会得非常清楚。

笔者走访了义乌。浙江这座190万人口的城市是一个小商品贸易中心，向全世界供应铅笔、遮阳伞、鞋带和购物车。笔者在那里听到本地人和外来工琢磨居住规定放宽会怎样影响义乌的经济、入学排队和房价。几无例外的是，本来说着数据的他们往往聊着聊着就开始述说起自己对这些改革的感受来。

尽管浙江的改革热情尤为突出，但全国各地的城市都受到敦促来放宽落户限制。一些城市正向更愿意保留农村出生地户籍的务工者开放公共服务。经济和人口结构变化都在推动变化。生育率迅速下降，2022年，中国人口自20世纪60年代初以来首次减少。一些中国最大、最富裕城市的居民对于生育奖励等政府激励措施反应冷淡。一些目光长远的省份和城市现在将关注的焦点放在了一个已经出生的年轻群体上，那就是中国6700万“留守儿童”。这些孩子的父母两人或之一远离家乡在外务工，孩子被留在乡村、县城或小城市里，由亲属抚养或上寄宿学校。

即便是中国最大的一些城市也在为保持人口规模而忧虑，上海交通大学经济学家、户口制度改革的知名倡导者陆铭表示。此外，他指出，中国可由直接从农村迁移而来的民工填补的工厂岗位在减少，而需要从业者懂得城里人及其生活方式的服务业岗位在增多。陆铭教授列举了护理、家政、装修这样的城市工作，并表示在城市长大和受教育的工人更适合填补这些职位空缺。多年来，城市一直向大学毕业生和其他技术工人提供户口。陆铭表示，如今争夺的焦点正转向蓝领家庭。

并非每个城市都有财力参与竞争。富裕的义乌今年投入了大量资金吸引年轻家庭。为帮助外来人口，该市关闭了28所专门面向农民工子女的民办学校，其中一些学费高达2万元一年。其他一些学校在破旧的工业场地授课。该市将其中的24所转为公办学校，将2.5万名农民工子女纳入公立教育体系。此外，义乌还新建小学，其中一个校园耗资2.24亿元。

农民工父母对此反应不一。义乌宽阔的大道两旁，聚集特定行业的商业综合体一字排开。在一个文具商场外，笔者发现了三名来自湖南省同一个村落的男子。他们以卖不干胶价签为生，“柜台”就是放在电瓶车上的塑料箱。其中一人过去每年花6000多元送孩子上义乌的民办学校。这所学校现在成了公办的，费用只有过去的十分之一。义乌“想留住更多外地人”，这位幸运的父亲表示。不过，旁边比他年轻的搭档却不准备将13岁的女儿从湖南接过来。“她当然更愿意和父母在一起。”他承认。但他和妻子两人都在义乌工作，经常会忙到半夜或更晚。“我们在这里没时间照顾孩子。”这位卖标签的父亲说着，一边抽烟一边等待顾客上前。

在商场里面，一名妇女向来自世界各地的买家销售儿童日记本和笔。她来自浙江其他地方，有一个孩子。对眼下这些改革，她既感激又怀疑。她承认，即使没有完整的户口，租房子并缴纳社保的农民工如今也能让孩子入读城市里的学校。但他们很少能够进义乌最好的学校。有房者和有常住户口的人比租房的新迁人口有优先权，她解释说。在旁边一个店铺里，一位迁居义乌多年的两个孩子的母亲称，她下了血本在一所好学校附近安了家。她提出，如果新来的人能进最好的学校，那对买了房的人就“非常不公平”。

一些外来务工者更倾向两地来回的生活。有些人保留农村户口以保持在农村的土地权益。一名来自中国南方的妇女可能会在十年后把女儿送回家乡省份参加高考。她说，在老家，竞争不像在富庶的浙江那么“激烈”。

在一所新建小学附近的操场上，一名来自湖南的退休农民工自豪地谈起她的成年子女和她现在帮忙带的四个孙辈，每个孩子都有义乌户口。二三十年前，她自己的孩子住在农村老家，她每年见他们两次。那会儿孩子们应该是想念自己的吧，她说，勉强地笑了一声。“但我不确定，也不会去问。”中国仍然有很多这样的悲伤故事。出于自身利益考虑，如今各省市正帮助更多的家庭团聚。减轻这样的内心伤痛将是它们收获的回报之一。





Future of chipmaking

Jensen Huang says Moore's law is dead. Not quite yet

3D components and exotic new materials can keep it going for a while longer

TWO YEARS shy of its 60th birthday, Moore's law has become a bit like Schrödinger's hypothetical cat—at once dead and alive. In 1965 Gordon Moore, one of the co-founders of Intel, observed that the number of transistors—a type of electronic component—that could be crammed onto a microchip was doubling every 12 months, a figure he later revised to every two years.

That observation became an aspiration that set the pace for the entire computing industry. Chips produced in 1971 could fit 200 transistors into one square millimetre. Today's most advanced chips cram 130m into the same space, and each operates tens of thousands of times more quickly to boot. If cars had improved at the same rate, modern ones would have top speeds in the tens of millions of miles per hour.

Moore knew full well that the process could not go on for ever. Each doubling is more difficult, and more expensive, than the last. In September 2022 Jensen Huang, the boss of Nvidia, a chipmaker, became the latest observer to call time, declaring that Moore's law was "dead". But not everyone agrees. Days later, Intel's chief Pat Gelsinger reported that Moore's maxim was, in fact, "alive and well".

Delegates to the International Electron Devices Meeting (IEDM), a chip-industry shindig held every year in San Francisco, were mostly on Mr Gelsinger's side. Researchers showed off several ideas dedicated to keeping Moore's law going, from exploiting the third dimension to sandwiching chips together and even moving beyond silicon, the material from which microchips have been made for the past half-century.

A transistor is to electricity what a tap is to water. Current flows from a transistor's source to its drain via a gate. When a voltage is applied to the gate, the current is on: a binary 1. With no voltage on the gate, the current stops: a binary 0. It is from these 1s and 0s that every computer program, from climate models and ChatGPT to Tinder and Grand Theft Auto, is built.

| *Small is beautiful*

For decades transistors were built as mostly flat structures, with the gate sitting atop a channel of silicon linking the source and drain. Making them smaller brought welcome side benefits. Smaller transistors could switch on and off more quickly, and required less power to do so, a phenomenon known as Dennard scaling.

By the mid-2000s, though, Dennard scaling was dead. As the distance between a transistor's source and drain shrinks, quantum effects cause the gate to begin to lose control of the channel, and electrons move through even when the transistor is meant to be off. That leakage wastes power and causes excess heat that cannot be easily disposed of. Faced with this "power wall", chip speeds stalled even as transistor counts kept rising (see chart).

In 2012 Intel began to build chips in three dimensions. It turned the flat conducting channel into a fin standing proud of the surface. That allowed the gate to wrap around the channel on three sides, helping it reassert control (see diagram). These transistors, called "finFETs", leak less current, switch a third faster and consume about half as much power as the previous generation. But there is a limit to making these fins thinner and taller, and chipmakers are now approaching it.

The next step is to turn the fins side on such that the gate surrounds them completely, giving it maximum control. Samsung, a South Korean electronics giant, is already using such transistors, called "nanosheets", in its newest products. Intel and TSMC, a Taiwanese chip foundry, are

expected to follow soon. By stacking multiple sheets and reducing their length, transistor sizes can drop by a further 30%.

Szuya Liao, a researcher at TSMC, compares going 3D to urban densification—replacing sprawling suburbs with packed skyscrapers. And it is not just transistors that are getting taller. Chips group transistors into logic gates, which carry out elementary logical operations. The simplest is the inverter, or “NOT” gate, which spits out a 0 when fed a 1 and vice versa. Logic gates are made by combining two different types of transistor, called n-type and p-type, which are produced by “doping” silicon with other chemicals to modify its electrical properties. An inverter requires one of each, usually placed side by side.

At IEDM Ms Liao and her colleagues showed off an inverter called a CFET built from transistors that are stacked on top of each other instead. That reduces the inverter’s footprint drastically, to roughly that of an individual transistor. TSMC says that going 3D frees up room to add insulating layers, which means the transistors inside the inverter leak less current, which wastes less energy and produces less heat.

The ultimate development in 3D chip-making is to stack entire chips atop one another. One big limitation to a modern processor’s performance is how fast it can receive data to crunch from memory chips elsewhere in the computer. Shuttling data around a machine uses a lot of energy, and can take tens of nanoseconds, or billionths of a second—a long time for a computer.

Julien Ryckaert, a researcher at Imec, a chip-research organisation in Belgium, explained how 3D stacking can help. Sandwiching memory chips between data-crunching ones drastically reduces both the time and energy necessary to get data to where it needs to be. In 2022 AMD, an American firm whose products are built by TSMC, introduced its “X3D” products,

which use 3D technology to stick a big blob of memory directly on top of a processor.

As with cities, though, density also means congestion. A microchip is a complicated electrical circuit that is built on a circular silicon wafer, starting from the bottom up. (Intel likens it to making a pizza.) First the transistors are made. These are topped with layers of metal wires that transport both electrical power and signals. Modern chips may have more than 15 layers of such wires.

As chips get denser, routing those power and data lines gets harder. Roundabout routes waste energy, and power lines can interfere with data ones. 3D logic gates, which pack yet more transistors into a given area, make things worse.

To untangle this mess, chipmakers are moving power lines below the transistors, an approach called “backside power delivery”. Transistors and data lines are built as before. Then the wafer is flipped and thick power lines are added to the bottom. Putting the power wires along the underside of the chip means fundamental changes to the way expensive chip factories operate. But shortening the length of the power lines means less wasted energy and cooler-running chips. It also frees up nearly a fifth of the area above the transistors, giving designers more room to squeeze in extra data lines. The end result is faster, more power efficient devices without tinkering with transistor sizes. Intel plans to use backside power in its chips from next year, though combining it with 3D transistors in full production is still a while away.

Even making use of an extra dimension has its limits. Once a transistor’s gate length approaches ten nanometres the channel it governs needs to be thinner than about four nanometres. At these tiny sizes—mere tens of atoms across—current leakage becomes much worse. Electrons slow down

because silicon's surface roughness hinders their movement, reducing the transistor's ability to switch on and off properly.

Some researchers are therefore investigating the idea of abandoning silicon, the material upon which the computer age has been built, for a new class of materials called transition metal dichalcogenides (TMDs). These can be made in sheets just three atoms thick. Many have electrical properties that mean they leak less current from even the tiniest of transistors.

Three TMDs in particular look promising: molybdenum disulphide, tungsten disulphide and tungsten diselenide. But while the industry has six decades of experience with silicon, TMDs are much less well understood. Engineers have already found that their ultra-thin profile makes it difficult to connect transistors made from them with a chip's metal layers. Consistent production is also tricky, particularly at the scales needed for reliable mass production. And the materials' chemical properties mean it is harder to dope them to produce n-type and p-type transistors.

| *The atomic age*

Those problems are probably not insurmountable. (Silicon suffered from doping problems of its own in the industry's early days.) At the IEDM, Intel was showing off an inverter built out of TMDs. But Eric Pop, an electrical engineer at Stanford University, thinks it will be a long while before they replace silicon in commercial products. For most applications, he says, silicon remains "good enough."

At some point, the day will arrive when no amount of clever technology can shrink transistors still further (it is hard to see, for instance, how one could be built with less than an atom's worth of stuff). As Moore himself warned in 2003, "no exponential is for ever." But, he told the assembled engineers,

“your job is delaying for ever”. Chipmakers have done an admirable job of that in the two decades since he spoke. And they have at least sketched out a path for the next two decades, too. ■



芯片制造的未来

黄仁勋说摩尔定律已死。其实还没有

3D元件和奇异新型材料可给它续会儿命

摩尔定律还差两年就要满60岁了，如今它已经变得有点像薛定谔的猫——既死又活。1965年，英特尔公司的联合创始人之一戈登·摩尔（Gordon Moore）提出，一块微芯片上可容纳的晶体管（一种电子元件）的数量每一年就会翻一番，后来他又将翻番的时间从一年改为两年。

摩尔的言论成了一种追求，为整个计算机行业设定了前进步调。1971年生产的芯片可以在一平方毫米中塞入200个晶体管。如今最先进的芯片可以在同样的面积上塞入1.3亿个晶体管，而且每个晶体管的运行速度也比当初快几万倍。如果汽车也以同样的速度进步，那么现如今汽车的最高时速可达到数千万英里。

摩尔很清楚这一进程不可能永远持续下去。每一次翻番都比上一次更困难、成本也更高。2022年9月，芯片制造商英伟达的老板黄仁勋成为最新一个唱衰摩尔定律的人，他宣称摩尔定律“已死”。但并非所有人都赞同他的观点。几天后，英特尔的CEO帕特·基辛格（Pat Gelsinger）表示，摩尔定律其实还“活得好好的”。

参与国际电子器件大会（IEDM）的代表大多站在基辛格一边。这一芯片行业的盛会每年在旧金山举行。研究人员在会上展示了若干让摩尔定律持续下去的创意，比如利用3D结构或把多个芯片堆叠起来，甚至不再使用硅这种过去半个世纪里用来制造微芯片的材料。

晶体管之于电流就像水龙头之于自来水一样。电流通过栅极从晶体管的源极流向漏极。当电压施加到栅极上时，电流接通——我们用二进制中的1来表示。当栅极上没有电压时，电流断开——用二进制中的0来表示。从气候模型、ChatGPT到手机交友应用Tinder、《侠盗猎车手》游戏，所有的计算机程序都由这些1和0构成。

几十年来，晶体管大多是平面结构，栅极位于连接源极和漏极的硅沟道上。制造更小的晶体管也带来了一些可喜的附带好处：晶体管越小，开关速度就越快，并且功耗也越低。这种现象被称为登纳德缩放定律。

然而到2000年代中期，登纳德缩放定律已经失效。随着晶体管源极和漏极之间距离的缩短，出现了量子效应，导致栅极开始无法控制沟道，并且即使晶体管处于关闭状态，电子也会隧穿。如此造成的漏电不仅浪费电能，还会产生难以散去的过多热量。因为这堵“功耗墙”，虽然芯片上的晶体管数量在持续增多，芯片速度却停滞不前（见图表）。

2012年，英特尔开始制造3D芯片。它把原来平面的电流通道变成了凸起于表面上的“鳍”。如此一来，栅极从三面包裹通道，帮助它增强了控制力（见图）。这些鳍式场效应晶体管（FinFET）漏电减少，开关速度提升三分之一，且功耗只有上一代晶体管的一半左右。但是这些鳍不可能无限变薄或变高，芯片制造商如今正在接近其极限。

下一步是翻转鳍，使栅极完全包裹住沟道，从而最大限度地控制沟道。韩国电子巨头三星已经在其最新产品中使用了这种叫作“纳米片”的晶体管。预计英特尔和芯片代工厂台积电也将很快跟进。通过把多个纳米片堆叠起来并缩短其长度，晶体管的尺寸可以进一步缩小30%。

台积电的研究人员廖思雅把芯片3D化比作提高城市密度——用密集的摩天大楼取代四处延伸的郊区。这不仅指晶体管在不断变高。芯片将晶体管分组组成逻辑门，这些逻辑门执行基本的逻辑运算。最简单的逻辑门是反相器，又称“非门”——如果输入为1，则其输出为0；反之亦然。逻辑门是由N型和P型两种不同类型的晶体管组成，这两种晶体管都是通过在硅中“掺杂”其他化学物质来改变其导电性能而制成的。一个反相器需要N型和P型晶体管各一个，通常并排放置。

在今年的IEDM上，廖思雅及其同事展示了一种名为互补场效应晶体管（CFET）的反相器，由晶体管相互堆叠而成。这大幅减少了反相器占用

的空间，差不多只需要一个晶体管的空间。台积电表示，芯片3D化可为增加绝缘层腾出空间，这样就可以减少反相器内部晶体管的漏电，从而降低能耗、减少发热。

研发3D芯片制造的终极目标是将整块芯片一个个堆叠起来，形成一个整体。现代处理器要从计算机其他位置的存储芯片接收所要处理的数据，接收速度是限制其性能的一大因素。计算机内部的数据传输需要消耗大量能量，并且可能需要几十纳秒（一纳秒等于十亿分之一秒）——这对计算机来说是很长的时间。

比利时微电子研究中心（Imec）的研究人员朱利安·瑞卡特（Julien Ryckaert）解释了3D堆叠技术如何可以帮助解决这个问题。将存储芯片夹在数据处理芯片之间，大大减少了将数据传输到指定位置所需的时间和能量。2022年，美国公司AMD（台积电为其代工）推出了它的“X3D”处理器，使用3D技术将一大片内存直接连接到处理器上面。

然而和城市一样，密集也意味着拥堵。微芯片是以圆形硅片为基片、自下而上构建起来的复杂电路。（英特尔将它比作做披萨。）首先要制造晶体管。它们的上端有多层用来传输电力和信号的金属线。现代芯片可能有15层以上这样的金属线。

随着芯片上的元件越来越密集，这些电源和数据线的布线变得越来越困难。线路迂回会浪费能量，而且电源线会对数据线造成干扰。3D的逻辑门因为在一定区域内塞入了更多的晶体管，布线就变得更难了。

为了解开这团“乱麻”，芯片制造商正在将电源线移至晶体管下方，这种技术被称为“背面供电”。晶体管和数据线的构建方式和以前一样。然后将晶圆片翻转过来，并在底部加上较粗的电源线。把电源线排布在芯片底部将从根本上改变造价高昂的芯片工厂的运作方式。但缩短电源线的长度意味着减少能耗，也能降低芯片运行时的温度。该技术还在晶体管上方腾出了近五分之一的面积，给设计人员留出了更多空间来塞进额外的数据线。该技术最终会制造出速度更快、能效更高的芯片，而不需要调整晶体管的尺

寸。英特尔计划从明年开始在其芯片中使用背面供电，不过把它与全面投产的3D晶体管结合起来还需要时日。

而即便是利用3D技术也有其上限。一旦晶体管的栅极长度接近10纳米，它所控制的沟道就需窄至大约在4纳米以下。如此微小的尺寸只够几十个原子通过，漏电因而会更加严重。由于硅片表面的粗糙度阻碍了电子的运动，电子的速度会变慢，也就会影响晶体管的正常开关。

因此，一些研究人员正在研究是否可以弃用硅这种让计算机时代得以建立的基础材料，转而使用一类名为过渡金属二硫属化物（TMD）的新材料。TMD可以制成只有三个原子厚的薄片。许多TMD具有良好的导电性能，即便制成最小的晶体管也能减少漏电。

三种尤其被看好的TMD材料分别是：二硫化钼、二硫化钨和二硒化钨。但是芯片制造行业与硅材料打了60年交道，对TMD的了解却要少得多。工程师们已经发现，由于TMD是一种超薄材料，用它们制造的晶体管很难与芯片的金属层连接起来。TMD也很难持续生产，尤其是要达到可靠的批量生产所需规模的话。而且TMD的化学特性决定了很难往它们掺杂别的物质来制造N型和P型晶体管。

｜ 原子时代

这些问题或许并非解决不了。（在行业发展初期，硅也曾遇到过掺杂上的问题。）在今年的IEDM上，英特尔展示了一款用TMD制造的反相器。但斯坦福大学的电气工程师埃里克·波普（Eric Pop）认为，要在商业产品中用TMD取代硅还需要相当长一段时间。他表示，在大多数应用场景下，硅仍然“足够好”。

总有一天，再巧妙的技术也无法进一步缩小晶体管的体积（例如，很难想象如何用不到一个原子大小的材料来制造晶体管）。正如摩尔本人在2003年警告的那样：“没有什么指数级增长能够永远持续。”但是，他又对当时与会的工程师们说：“你们的工作就是永远延后那一天的倒来。”自他讲这番话以来的二十年里，芯片制造商在延后上取得了令人钦佩的成绩。而且

他们至少也已蚀刻出了未来20年的发展线路。■



The wisdom of youth

Could newborn neurons reverse Alzheimer's?

Some scientists think so. Others doubt the cells even exist

ONE OF THE first signs of Alzheimer's disease is confusion. Most people can park their car in a different space every morning and find it again in the evening. Those with Alzheimer's find this type of problem much harder. Memories of things they do often, like eating or taking medication, become tangled in their minds.

The ability to distinguish between similar memories depends on a tiny strip of brain tissue called the dentate gyrus. Studies in mice have shown that the dentate gyrus is one of the few bits of the brain to generate new neurons even in adulthood. Those new neurons are thought to help keep similar memories distinct.

Whether something similar happens in humans is less clear. But a clutch of new results described recently at the Society for Neuroscience's conference in Washington, DC, suggest that it might. And if it does, then encouraging the process might offer a new treatment for Alzheimer's disease.

Until the 1960s scientists thought adult brains did not produce new neurons. Then evidence began to emerge of young neurons in the brains of adult rats and mice,—specifically in the olfactory bulb, which processes smell, and the dentate gyrus. These new neurons had developed from neural progenitor cells, a type of undifferentiated neuron akin to a stem cell, in a process scientists call neurogenesis.

And there seems to be a link, at least in mice, between these new neurons and Alzheimer's disease. Mice genetically engineered to have Alzheimer's-like symptoms also have fewer young neurons in their brains. Two studies

published in 2021 and 2022 showed that encouraging neurogenesis could improve memory in such animals. And a paper published in April this year found that boosting neurogenesis also caused other cells known as microglia to begin cleaning up tangles of protein, called amyloid-beta plaques, that are characteristic of Alzheimer's disease.

So far so promising—if you are a mouse. But studying neurogenesis in humans is tricky. MRI scanners cannot watch the growth of individual neurons. Scientists must take samples of brain tissue from cadavers and either stain them with chemicals that bind only to young neurons, or measure the genes that have been expressed within brain cells to look for the hallmarks of youth.

Dozens of such papers have been published. But for every one that has found evidence of neurogenesis, another has failed to do so. The pro-neurogenesis camp thinks the null results are down to poor-quality brain tissue or crude preservation techniques. The antis argue that either humans do not grow these neurons in the dentate gyrus, or if they do, there are too few of them to be useful.

The research presented in Washington strengthens the case for human neurogenesis. Maura Boldrini of Columbia University, Marí a Llorens-Martín of the University of Madrid, Orly Lazarov at the University of Illinois at Chicago and Hongjun Song of the University of Pennsylvania presented evidence of young neurons in the dentate gyruses of humans—though most of their findings have not yet been peer reviewed.

Three of these researchers also studied the brains of healthy older people or people with Alzheimer's disease. Their results suggested that the production of the supposed new neurons slows with age, and falls precipitously in Alzheimer's disease. Previous studies by two of the groups also found that Alzheimer's patients with more of these neurons had better

memories.

But while the new research strengthens the case for human neurogenesis, it is not yet definitive. One group of researchers from Yale University questioned whether the staining technique used in one of the studies was accidentally tagging other brain cells such as astrocytes. They are also concerned that the studies tend to find very few progenitor cells. “Where are all the mothers of these baby neurons?” asked Jon Arellano, one of the sceptics.

There are other wrinkles. Dr Song found a different set of genes expressed in the supposedly young human neurons from those seen in neurons from other animals. And the few young neurons that both Dr Song and Dr Lazarov found in the brains of Alzheimer’s patients looked very different from the same neurons in healthy brains. If the new cells are somehow defective, increasing their number may not help.

But although not all the scientists at the conference were convinced, some drug-makers appear to be. In April, Biomed Industries, a pharmaceutical firm based in California, said that results from an early clinical trial suggested that a new drug that the firm claims increases neurogenesis in mice improved memory in people with moderate Alzheimer’s. If subsequent trials prove to be equally encouraging, that could be further evidence that the neurogenesis theory of Alzheimer’s may indeed have something to it. ■



青春的智慧

新生神经元能逆转阿尔茨海默症吗？

有科学家认为可以。也有人怀疑这种细胞根本不存在【新知】

阿尔茨海默症的初期症状之一是思维混乱。大多数人可以每天早上把车停在不同地点，晚上又能找到。而阿尔茨海默症患者却很难做到。一些日常活动的记忆，比如吃饭或服药，会在他们的大脑中乱作一团。

区分相似记忆的能力取决于一小块称为齿状回的脑组织。对小鼠的研究表明，齿状回是大脑中少数几个即使在成年期也会生长出新神经元的部位之一。据信这些新神经元有助于区分相似的记忆。

在人身上是否也是如此还不太清楚。但近日神经科学学会（Society for Neuroscience）在华盛顿举行的会议上公布的一系列新研究结果表明，这是有可能的。如果确实如此，那么促进这一生长过程可能会为阿尔茨海默症带来新的治疗方法。

在1960年代以前，科学家一直认为成人脑不会产生新的神经元。后来有证据表明，成年大鼠和小鼠的大脑中会出现年轻的神经元，特别是在处理气味的嗅球以及齿状回中。这些新神经元是由神经祖细胞（一种类似于干细胞的未分化神经元）发育而来，科学家将这一过程称为神经发生。

至少在小鼠身上，这些新神经元和阿尔茨海默症之间似乎存在关联。经过基因改造而出现类似阿尔茨海默症状的小鼠，其大脑中新神经元的数量也较少。2021和2022年发表的两项研究表明，促进神经发生可以改善这些动物的记忆力。今年4月发表的一篇论文发现，促进神经发生还能使被称为小神经胶质的其他细胞开始清理蛋白质缠结，这些被称为 β -淀粉样斑块的缠结是阿尔茨海默症的症状表现。

这一切都很有希望——如果你是老鼠的话。但要研究人类的神经发生却很棘手。核磁共振扫描仪无法观察单个神经元的生长。科学家必须从尸体上

采集脑组织样本，要么用只与新生神经元结合的化学物质给它们染色，要么测量脑细胞内表达的基因来寻找年轻神经元的印记。

此类论文已发表了数十篇。但是，每有一篇论文找到神经发生的证据，就有另一篇没有找到。支持神经发生的阵营认为，这些无效结果是由于脑组织的质量太差或保存技术粗糙造成的。反方则认为，要么人类在齿状回中没有生长出这些神经元，要么就是即使生长了，也因为数量太少而没有作用。

在华盛顿会议上发表的研究进一步支持了人类神经发生的论证。哥伦比亚大学的莫拉·博尔德里尼（Maura Boldrini）、马德里大学的玛丽亚·洛伦斯-马丁（María Llorens-Martín）、伊利诺伊大学芝加哥分校的奥利·拉扎罗夫（Orly Lazarov）和宾夕法尼亚大学的宋红军展示了人类齿状回中存在新生神经元的证据——尽管他们的大部分发现尚未经过同行评议。

其中三位研究人员还研究了健康老年人或阿尔茨海默症患者的大脑。他们的研究表明，随着年龄的增长，这些所认为的新生神经元的生成速度会减慢，而在阿尔茨海默症患者身上更是急剧下降。其中两个团队之前的研究还发现，拥有更多这些神经元的阿尔茨海默患者的记忆力更好些。

但是，虽然新研究为人类神经发生提供了更多证据，却仍不足以下定论。耶鲁大学的研究团队质疑其中一项研究中使用的染色技术是否意外地标记了其他脑细胞，例如星形胶质细胞。他们也很关注这些研究往往只能发现极少量祖细胞的问题。“这些幼年神经元的所有母细胞在哪里呢？”怀疑者之一乔恩·阿雷利亚诺（Jon Arellano）问道。

还有其他疑惑。宋红军发现，在这些所认为的人类新生神经元中表达的基因与其他动物的神经元不同。此外，宋红军和拉扎罗夫都发现，阿尔茨海默症患者大脑中的少数新生神经元与健康大脑中的同类神经元看起来也有很大差异。如果这些新细胞存在某种缺陷，那么增加其数量可能也没什么好处。

但是，尽管不是所有与会的科学家都被说服了，一些制药商似乎已经信心

十足。今年4月，加州制药公司Biomed Industries表示，它声称能促进小鼠神经发生的一种新药在一项早期临床试验中改善了中度阿尔茨海默氏症患者的记忆力。如果后续的试验结果同样令人鼓舞，那将进一步证明，阿尔茨海默氏症的神经发生理论可能确有其价值。■



It does what it says on the tin

The Extremely Large Telescope will transform astronomy

It will be the world's biggest optical telescope by far—and a powerful time machine

IT IS THE colours of a sunset that inspire Joseph Anderson, an astronomer at the European Southern Observatory (ESO) in the high Atacama desert, in northern Chile. “They start off very blue and turquoise. And gradually, as it gets more purple, then we’re getting closer to observing the universe.” Once night falls the sky is dominated by the star-spangled curve of the Milky Way. If there were any extra left to give, more than two kilometres above sea level, your correspondent’s breath would have been taken away.

The Atacama is home to more than a dozen different astronomical observatories, and for good reason. It is far from the light pollution of civilisation. The air is thin and dry, which improves what astronomers call the “seeing”. And the desert averages 325 cloudless nights each year. Dr Anderson is standing on top of a mountain called Cerro Paranal, showing off the Very Large Telescope (VLT). The VLT is made up of four individual telescopes, each individually one of the largest in the world, alongside another four much smaller ones. It is Earth’s most productive astronomical facility, yielding more than one scientific paper each day. In 2004 it took the first picture of an extrasolar planet—one that orbits a star other than the Sun—and was the first instrument to track individual stars whipping around the enormous black hole at the centre of the Milky Way.

But it may not hold that title for much longer. An hour’s drive from the VLT, atop Cerro Armazones, a 3,046-metre peak, sits the half-finished bulk of the ELT, or Extremely Large Telescope. (ESO is a fan of quotidian names.) Like so many big projects, the ELT is behind schedule. But when it is finished—in 2028, on current plans, at a cost of €1.5bn (\$1.6bn)—it will be, by far, the biggest optical telescope in the known universe. The result, says Robert de

Rosa, an astronomer at ESO, will be “a step change in what we can do in terms of observational astronomy”.

Optical telescopes use a series of mirrors to capture light from space and redirect it to their various instruments. A bigger mirror can collect more light, which means it can both see dimmer things and resolve them in finer detail than a smaller one. The ELT’s main mirror will have a diameter of 39.3 metres, more than four times that of the VLT’s big telescopes (8.2 metres) and over three times that of the present record-holder, the 10.4-metre Gran Telescopio Canarias (GTC), in the Canary Islands. Since a telescope’s power depends on the area of its mirror, looking only at the diameter understates the difference. The GTC has a collecting area of around 75 square metres. The ELT will boast 978 square metres, a little smaller than four tennis courts (see diagram 1).

That size will be a boon for many branches of astronomy. The ELT will shed light on everything from the role of black holes in shaping the large-scale structure of the universe to how dark matter and dark energy affect the rate at which it is expanding, and even whether the supposed constants of physics really are constant over vast intergalactic distances.

It should also provide a big boost to the study of planets outside the solar system. These days, the existence of most exoplanets is inferred from the effects they have on the light from their parent stars. Taking pictures of them—so-called direct imaging—is rare. Of the roughly 5,500 known exoplanets, scientists have pictures of only around 1% of them.

| *Time and relative dimension in space*

The ELT’s enormous mirror will allow astronomers to separate the faint light of a planet from the overwhelming glare of its star from dozens of light-years away. The result should be a direct-imaging bonanza. And direct imaging will also help reveal the chemical composition of exoplanet

atmospheres, and whether any show signs of potential alien life.

And because telescopes are also time machines, the ELT will allow scientists more insight into what happened shortly after the universe began. Since the speed of light is finite, astronomers see distant objects not as they are today, but as they were when the light that arrives in their instruments first set out. Astronomers are keen to use the ELT to investigate how stars and galaxies formed when the universe was young. Early results from the James Webb Space Telescope, launched in 2021, have already turned up an array of stars and galaxies that seem too old to fit easily into existing theories of universal evolution. The ELT could help resolve that mystery.

Assuming, that is, that everything works. When your correspondent visited, the 80-metre-tall steel dome that will shelter the telescope was still being built. Each segment takes around 20 minutes to lift and slot into place; a further six hours are needed to tighten each of the 200 bolts. Work must finish before night, lest gusts of wind blow a panel loose. Once finished, the entire 5,500-tonne dome will be able to rotate so that the telescope can follow the stars as they move across the sky.

One of the few downsides of doing astronomy in Chile is that the country is prone to earthquakes. The telescope will therefore float atop a thin layer of oil. The oil, in turn, will sit atop hundreds of rubber shock absorbers, with the whole lot built on a 3-metre concrete foundation. That will isolate the dome both from earthquakes and any vibrations from the offices and laboratories next door.

The most impressive parts are the mirrors, of which the ELT will have five. Astronomical mirrors are precise, delicate things. Even the comparatively small mirrors of the big VLT telescopes are so heavy that, if not supported properly, they would shatter under their own weight. Engineers must lift

them with a special harness with 15 hooks when they need cleaning.

The ELT's main mirror is so big that it cannot be made as a single piece. Instead Schott, a German optics firm, will make 798 separate pieces that will act as a single mirror. Each is a slightly curved, 1.5-metre-wide hexagonal slice of high-tech glass ceramic that undergoes almost no thermal expansion. The segments are cast in Germany, polished in France, and then mated with supports produced in the Netherlands before being transported to Chile.

Each is checked to ensure it has survived the trip unscathed. Ricardo Parra, an ELT engineer, likens the process to ringing a bell. Vibrations are induced in the glass, and measurements made by accelerometers in strategic locations. The segments are finished by coating them with several further layers of chemicals, including a 100-nanometre layer of silver that provides the reflectivity. (A nanometre is a billionth of a metre.) That silver is protected from tarnishing by a layer of hard silicon nitride glass. Even so, the ESO thinks each segment will need re-coating every two years.

Getting all 798 segments to work together presents another set of difficulties. To produce a usable image each segment must be held in a precise position, with an accuracy of just tens of nanometres. Each is backed by a system of sensors and motors that can subtly deform the surface of the glass in order to correct for warping due to everything from small temperature variations to the changing angle of gravity as the mirror moves and tilts.

The primary mirror is just the first stop (see diagram 2). Light hitting it will be redirected towards a secondary and tertiary mirror, which are designed to correct various subtle optical defects. At around 4 metres across, each could be an impressive telescope main mirror in its own right.

The job of the fourth mirror is to counteract the vagaries of Earth's atmosphere. The reason stars appear to twinkle when seen from the ground is that the atmosphere is constantly churning. Frédéric Gonté, an instrumentation engineer at ESO, compares the effect to peering into water. "Try to see the ground of the swimming pool, you can see it is moving," he says. "The atmosphere is doing that to us."

Space telescopes avoid this problem by flying above the atmosphere. Ground-based ones can rely instead on a technology called adaptive optics. This involves deforming the surface of a mirror to cancel out the distortions imposed by the air. The technology is not unique to the ELT. Many modern telescopes sport it, including one of the VLT's big telescopes (it is being added to the other three). But the ELT's sheer size makes it more susceptible to atmospheric distortion than smaller telescopes. More than 5,000 actuators behind the ELT's fourth mirror will make tiny, rippling adjustments to its shape a thousand times each second. Without the adjustments, the ELT's images would be hopelessly blurred.

Working out exactly how the mirror must be deformed, millisecond by millisecond, requires the presence in the sky of something whose shape is known in advance. Comparing what the telescope actually sees with what it should see reveals the state of the atmosphere at that particular moment, allowing the system to counteract it. Often the object in question is a bright star near the object being studied. If no convenient star is available, though, astronomers can create an artificial one. "Laser guide stars" are made by firing four bright orange laser beams upwards so that they converge in a single point around 90 kilometres up, above the atmosphere's thickest layers. Because the system knows exactly what the ersatz star should look like, it can make whatever mirror-twisting adjustments are needed.

You might think that once the ELT is up and running, all other telescopes will be rendered obsolete. That is not really true, for even a machine such as

the ELT cannot do everything. The twin Keck telescopes in Hawaii, for example, once the world's largest, have mirrors that are a comparatively puny ten metres across. But they have the advantage of sitting on a substantially taller mountain, where the seeing is even better than it is in Chile. And the fact that there are two of them means they can serve twice as many astronomers at once.

The VLT, and other multi-mirror telescopes, can also use a technique called interferometry, a clever way of combining signals such that resolving power depends not on the size of individual mirrors, but on the distance between them. For the VLT that is more than 100 metres. On the other hand, that resolving power comes at the cost of a narrower field of view. The ELT is not competing with telescopes like the VLT, says Dr Gonté. "It's completing."

| *Ain't no replacement for displacement*

But when it comes to detecting the dimmest and most distant objects, there is no substitute for sheer light-gathering size. On that front the ELT looks like being the final word for the foreseeable future. A planned successor, the "Overwhelmingly Large Telescope", would have sported a 100-metre mirror. But it was shelved in the 2000s on grounds of complexity and cost. The Giant Magellan Telescope is currently being built several hundred kilometres south of the ELT on land owned by the Carnegie Institution for Science, an American non-profit, and is due to see its first light some time in the 2030s. It will combine seven big mirrors into one giant one with an effective diameter of 25.4 metres. Even so, it will have only around a third the light-gathering capacity of the ELT.

A consortium of scientists from America, Canada, India and Japan, meanwhile, has been trying to build a mega-telescope on Hawaii. The Thirty Meter Telescope would, as its name suggests, be a giant—though still smaller than the ELT. But it is unclear when, or even if, it will be finished.

Construction has been halted by arguments about Mauna Kea, the mountain on which it is to be built, which is seen as sacred by some. For the next several decades, it seems, anyone wanting access to the biggest telescope money can buy will have to make their way to northern Chile. ■



名副其实

极大望远镜将让天文学改观

它将是世界上遥遥领先的第一大光学望远镜，也是一台强大的时间机器【深度】

智利北部高海拔的阿塔卡马沙漠（Atacama）上日落降临，天空中变幻的色彩引领着欧洲南方天文台（European Southern Observatory，以下简称ESO）驻智利天文学家约瑟夫·安德森（Joseph Anderson）。“晚霞一开始是蓝绿交映，渐渐变得越来越紫，这时我们差不多可以开始观察宇宙了。”夜幕降临后，璀璨的银河横贯中天。海拔2000多米的此时此刻令笔者叹为观止。

在阿塔卡马沙漠有十多个不同的天文观测站，这是有充分理由的。这里远离人类文明的光污染。空气稀薄而干燥，可以提高天文学家所说的“视宁度”。阿塔卡马沙漠平均每年有325个夜晚晴空万里。安德森站在帕拉纳尔山（Cerro Paranal）山顶，向记者展示着“甚大望远镜”（Very Large Telescope，以下简称VLT）。VLT由四个独立的望远镜组成，每一个都是世界上最大的望远镜之一，旁边还有另外四个小得多的望远镜。VLT是地球上产出成果最多的天文设施，每天产出一篇以上的科学论文。2004年，它拍下了第一张太阳系外行星的照片（即一颗围绕太阳以外的恒星运行的行星），并且首次观测到围绕银河系中心巨大黑洞旋转的恒星。

但VLT可能没法保持世界最大望远镜的头衔太久了。在距离VLT一个小时车程、海拔3046米的阿玛索内斯山（Cerro Armazones）的山顶上，屹立着尚未完工的极大望远镜（Extremely Large Telescope，以下简称ELT）。

（ESO喜欢毫无新意的名字。）和太多大型项目一样，ELT的施工进度已经延误。但等建成后（按目前的计划将于2028年竣工，造价15亿欧元[16亿美元]），它将成为已知宇宙中遥遥领先的第一大光学望远镜。ESO的天文学家罗伯特·德·罗莎（Robert de Rosa）表示，这将使“观测天文学的能力向前迈进一大步”。

光学望远镜通过一组镜片收集来自太空的光，并将其投射到各种仪器上。

口径更大的镜面可以收集更多的光，意味着相比口径较小的镜面，它可以看到更暗的物体，成像也更清晰。ELT的主镜口径将达到39.3米，是VLT那几个大型望远镜（8.2米）的四倍多，也是加那利群岛（Canary Islands）上加那利大型望远镜（Gran Telescopio Canarias，以下简称GTC）的三倍多，口径10.4米的GTC是目前世界上最大的望远镜。由于望远镜的探测能力取决于其镜面面积，因此只看口径会低估它们之间的能力差异。GTC的镜面集光面积约为75平方米，而ELT将达到978平方米，略小于四个网球场的面积之和（见图1）。

这么大的面积对于天文学的许多分支来说都是福音。从黑洞在塑造宇宙大尺度结构中的作用，到暗物质和暗能量如何影响宇宙膨胀的速度，乃至我们所认为的物理常数放在广阔的星系际距离中是否真的是恒定的，ELT将帮助解答各种谜题。

它还将大大推动对太阳系外行星的研究。如今，大多数系外行星的存在都是根据它们对其母星发出的光的影响来推断的，很少能拍到它们本身的照片（所谓直接成像）。在大约5500颗已知系外行星中，科学家只有其中约1%的行星的照片。

| 时间和空间的相对维度

ELT的巨大镜面将使天文学家能够将数十光年之外的行星的微弱光芒与其恒星的强烈眩光区分开。这样就应该可以对系外行星大量直接成像。直接成像还将有助于揭示系外行星大气的化学成分，以及是否有任何行星存在外星生命的迹象。

由于望远镜也是时间机器，ELT将能让科学家更深入地了解宇宙刚形成后不久的情况。由于光速是有限的，天文学家看到的遥远物体并不是当天的样子，而是望远镜收集到的光线从这些星体发出时的样子。天文学家热切期盼着利用ELT来研究在宇宙年轻时恒星和星系是如何形成的。2021年发射的詹姆斯·韦伯太空望远镜（James Webb Space Telescope）的初期结果已经发现了一系列恒星和星系，它们都似乎非常古老，不太符合现有的宇宙演化理论。ELT可以帮助天文学家解开这个谜团。

这一切的前提是ELT能按计划竣工。在笔者采访时，用于保护望远镜的80米高钢制圆顶仍在建造中。每一块钢板需要约20分钟才能吊起并安装到位，还需要6小时一个个拧紧200个螺栓。每天的工作必须在夜晚之前完成，以免阵风将钢板吹松。完工后，这个5500吨重的圆顶将能够整体旋转，让望远镜得以追踪在天空中移动的恒星。

在智利建设天文台的少数缺点之一是该国容易发生地震。因此，望远镜将浮在一层薄薄的油膜之上，油膜之下放置了数百个橡胶减震器，再往下是3米高的混凝土基座。这将使圆顶免受地震以及隔壁办公区和实验室产生的任何振动的影响。

ELT最令人印象深刻的部分是五个反射镜。天文镜片精密易碎。即使是VLT的那些大型望远镜中相对较小的子镜也很重，如果支撑不当，就会在自重作用下破碎。需要清洁时，工程师必须用带有15个挂钩的特殊安全带将它们吊起。

ELT的主镜太大，无法做成一整张镜面。德国光学公司肖特（Schott）将制造798个独立子镜组成一面主镜。每面子镜都是对角线1.5米的六角形，有一点曲度，用几乎不会热膨胀的高科技玻璃陶瓷制成。这些子镜的镜坯在德国制作，在法国抛光，与荷兰生产的支架组装好后运往智利。

每一面子镜都会经过检查，以确保在运输途中完好无损。ELT的工程师里卡多·帕拉（Ricardo Parra）将这个过程比作敲钟。在玻璃中引起振动，用放置在关键位置的加速度计测量振动幅度。每一面子镜都会再涂上几层化学物质，其中包括提供反射能力的100纳米厚的银。（一纳米为十亿分之一米。）最后再加一层坚硬的氮化硅玻璃以防止银失去光泽。即便如此，ESO认为每面子镜每两年就需要重新做涂层。

要让全部798面子镜协同工作还带来了另一类困难。为了生成可用的图像，每面子镜所在的位置必须十分精确，精度公差仅为数十纳米。每面子镜都由一套传感器和电机支持，它们可以让玻璃表面微微变形，以纠正从微小的温度变化到主镜移动和倾斜时重力角度变化等各种原因造成的翘

曲。

主镜只是光线到达的第一站（见图2）。照射到主镜上的光线将被折射到第二块和第三块副镜上，它们的作用是纠正各种细微的光学缺陷。每块副镜的口径约4米，本身就可以充当一个较大型望远镜的主镜。

第四块副镜的作用是抵消地球大气层的干扰。之所以从地面上会看到星星在闪烁就是大气湍流的影响。ESO的仪表工程师弗雷德里克·冈特（Frédéric Gonté）将这种效果比作向水中凝望。“试着看看游泳池的池底，你会看到它在动。”他说，“大气层就给我们造成了这种幻象。”

空间望远镜通过在大气层上方飞行来避免这个问题。地面望远镜则可以依靠一种称为自适应光学技术，即通过让镜面变形以抵消大气造成的扭曲。该技术并非ELT独有。许多现代望远镜都有自适应光学系统，比如VLT的一个独立大型望远镜（其他三个望远镜也正在配备该系统）。但ELT非常庞大，比小型望远镜更容易受到大气湍流造成扭曲的影响。ELT的第四块副镜后面有5000多个促动器，每秒都会对其形状进行一千次联动式微调。如果不做这种调整，ELT的成像将会极其模糊。

要精确计算出每一毫秒间镜面要如何调整，需要天空中有某个形状预先已知的物体。将望远镜实际看到的这个物体的成像与应该看到的成像比较，就可以揭示这一时刻的大气状态，让系统能够抵消它的光学扭曲。通常，这样的物体是正在观测的物体附近一颗明亮的恒星。不过，如果附近没有恒星方便使用，天文学家可以创造一颗人造恒星。向天空发射四束明亮的橙色激光束，让它们在距离地面约90公里处汇聚到一个点上，就形成了“激光导星”，这个高度已经高过了大气层最稠密的部分。因为系统确切地知道这颗人造星应该是什么样子，所以它可以随时根据需要调整镜面的曲率。

你可能会认为，一旦ELT投入使用，所有其他望远镜就都过时了。但事实并非全然如此，因为即使是像ELT这样的仪器也无法完成所有任务。例如，夏威夷的那两台凯克望远镜（Keck）曾经是世界上最大的望远镜，其

镜面口径相对较小，只有十米。但它们的优势是所在的山峰要高得多，那里的视宁度甚至比智利还要好。而且有两台望远镜，就可以同时为两倍之多的天文学家提供服务。

VLT和其他多镜面望远镜还可以使用“干涉测量法”，这是一种组合信号的巧妙方法，让分辨率不取决于单个子镜的大小，而是取决于它们之间的距离。对于VLT而言，这就让它的组合等效口径超过了100米。另一方面，高分辨率是以视野变窄为代价的。冈特表示，ELT并不与VLT等望远镜竞争，“而是它们的补充。”

| 无可替代

但说到观测最暗和最远的物体，巨大尺寸的聚光镜面是无可替代的。在这方面，ELT在可预见的未来似乎将无与伦比。计划中的下一个更大的“绝大望远镜”（Overwhelmingly Large Telescope）口径将达到100米。但由于复杂度和成本原因，它的建造计划在2000年代搁置。在ELT以南数百公里处，巨型麦哲伦望远镜（Giant Magellan Telescope）目前正在美国非营利组织卡内基科学研究所（Carnegie Institution for Science）拥有的土地上建造，预计将在2030年代的某个时候收集到第一束光。它将把七面大尺寸子镜组合成一面有效口径为25.4米的巨大主镜。即便如此，它的聚光能力也只有ELT的三分之一左右。

与此同时，一个成员来自美国、加拿大、印度和日本的科学家联盟直力图在夏威夷建造一台巨型望远镜，取名三十米望远镜（Thirty Meter Telescope，以下简称TMT）。听名字就知道它的尺寸很大，但仍然比ELT小。不过目前还不清楚它何时能建成，甚至是否能建成。由于TMT选址在被一些人视为圣山的莫纳克亚山（Mauna Kea），相关争议已导致该项目暂停。看来在接下来的几十年里，想要使用花钱就能建成的最大的望远镜，就只能前往智利北部了。■



Baby Berkshire

How a Canadian company became the world's best acquirer of tech firms

Meet Constellation Software, tech's Berkshire Hathaway

FOR OLDER startups these are tough times. The weak recent stockmarket debuts of Arm, a British chipmaker, Instacart, a grocery-delivery group, and Klaviyo, a software firm, have dampened enthusiasm for initial public offerings. Venture capital (VC) has dried up. Data from PitchBook, a research firm, show that late-stage startups need almost three times as much money as is available to them. Many are putting themselves up for sale. Acquisitions of private firms valued at \$100m or more are at their highest since September 2022.

One happy buyer is Constellation Software. The Canadian firm's targets must have sales of at least \$5m and show consistent revenue and profit growth. A strong management team, preferably founder-led, is a plus. Though it has splurged on larger deals, the median value of firms it acquires is around \$3m. According to Royal Bank of Canada (RBC), since 2005 Constellation has spent \$8.7bn on more than 860 firms (see chart 1). In that time its revenue has grown by about 25% a year on average. This year it could exceed \$8bn. The company's market value is up by a big-tech-like 250% in the past five years, to \$50bn, outperforming the tech-heavy NASDAQ index (see chart 2). It is now Canada's second-largest tech firm after Shopify, an e-commerce platform.

Whether by fluke or design, Constellation's dealmaking success is based on principles that look strikingly similar to those of the world's heavyweight acquirer, Berkshire Hathaway. Like Warren Buffett, Berkshire's boss, and his right-hand man, Charlie Munger (who died on November 28th), the founder and president of Constellation, Mark Leonard, seeks out

businesses with a lasting competitive edge. In Constellation's universe, such a "moat" is enjoyed by software firms that specialise in building digital wares for unsexy industries from car dealerships and builders to spas. Tech giants shun these relatively piddling markets and smaller rivals lack the requisite know-how. The result is rich profits for the incumbents.

After a deal is done Constellation, much like Berkshire, runs the business with benevolent neglect. It does not integrate newly acquired companies or parachute in fresh managers. It is content to leave day-to-day operations to the existing leadership. It does not desperately try to squeeze out inefficiencies by centralising common business functions. Constellation believes that splitting a business weakens its bond with customers, notes Paul Treiber of RBC. Cash from the subsidiaries flows to the parent company, which uses it to buy new businesses. These in turn generate more cash, and so on.

To manage over 800 firms, Constellation is structured as a holding company with six large operating groups. Businesses in similar markets are grouped together. In 2021 Constellation floated Topicus, an operating entity that generated 14% of the firm's total revenue and is now valued at \$5.8bn. When any of the other five big operating units get large enough, they, too, may be listed. As with Topicus, Constellation would retain control of the board.

Like Berkshire but in contrast to private-equity or VC funds, Constellation has no exit clock ticking. It can thus be patient with investment decisions. Mr Leonard's annual letters to investors echo Mr Buffett's in describing the company as a "good perpetual owner". This marathon mentality shapes employee pay. Bonuses are tied to returns on invested capital rather than just revenue growth. Executives must invest three-quarters of their bonus in company stock, which they cannot sell for four years. This aligns management's incentives with those of shareholders.

Constellation's success reveals an important truth about mergers and acquisitions that would also be familiar to Mr Buffett: serial acquirers tend to outdo occasional dealmakers. Tobias Lundberg of McKinsey, a consultancy, calculates that regular buyers on average generate about two percentage points more in excess total returns to shareholders annually compared with irregular ones.

Mr Lundberg puts this edge down to practice. As with exercise, the more buying a company does, the better it gets. A few firms like Tyler Technologies from Texas and Roper Technologies from Florida are trying to emulate Constellation's workout regime of picking up niche software makers. None has so far come close to matching the Canadian company's muscle. ■



小伯克希尔

一家加拿大公司如何成为全球最佳科技公司收购者

来认识下星座软件，科技界的伯克希尔·哈撒韦

对于老牌创业公司来说，这是个艰难的时期。英国芯片制造商安谋（Arm）、杂货配送公司Instacart和软件公司Klaviyo近期挂牌上市的表现不佳，打击了市场对IPO的热情。风险投资（VC）资金已经枯竭。研究公司PitchBook的数据显示，处于后期阶段的创业公司所需资金几乎是可获得资金的三倍。许多公司正在寻求出售。被以1亿美元或更高的价格收购的私人公司数量达到了自2022年9月以来的最高峰。

其中一个心满意足的买家是“星座软件”（Constellation Software）。要成为这家加拿大公司的收购目标，销售额至少要达到500万美元，收入和利润也须显示持续增长。强大的管理团队（最好由创始人领导）是个加分项。尽管该公司在较大规模的交易上花费不菲，但所收购公司的中位数价值约为300万美元。根据加拿大皇家银行（RBC）的数据，自2005年以来，星座软件已斥资87亿美元收购了860多家公司（见图表1）。在此期间，其收入年均增长约25%。今年的收入可能超过80亿美元。在过去五年中，该公司市值以堪比大科技公司的势头猛增250%，达到500亿美元，超过了科技股主导的纳斯达克指数（见图表2）。它现在是加拿大第二大科技公司，仅次于电子商务平台Shopify。

不管是因为运气还是有意为之，星座软件的成功交易所遵循的一些原则看起来与全球重量级收购者伯克希尔·哈撒韦惊人地相似。与伯克希尔的老板沃伦·巴菲特和他的得力助手查理·芒格（于11月28日去世）一样，星座软件的创始人兼总裁马克·莱昂纳德（Mark Leonard）寻觅的也是具有持久竞争优势的企业。星座软件“宇宙”中的软件公司就拥有这样的“护城河”，这些公司专门为汽车经销商、建筑商和水疗中心等不那么光鲜的行业构建数字产品。科技巨头看不上这些相对较小的市场，而较小的竞争对手又缺乏所需的专业知识。结果就是这些既有公司获得了丰厚的利润。

一项交易达成后，星座软件也如伯克希尔一样，以“善意的忽略”来经营业务。它不会整合新收购的公司，也不会空降新的经理人。它放心地让现有领导层负责日常运营，也不会集中共同业务职能以竭力铲除低效。加拿大皇家银行的保罗·特雷伯（Paul Treiber）指出，星座软件认为拆分业务会削弱与客户的联系。子公司的现金流向母公司，母公司再用这些现金收购新企业，而新企业又会产生更多的现金，如此循环。

为了管理800多家公司，星座软件采用了一个控股公司下设六个大型运营集团的结构。在相似的市场里经营的业务被组合在一起。星座软件旗下的Topicus于2021年上市，该经营实体占公司总收入14%，目前估值为58亿美元。其余五大运营单位变得足够壮大时，可能也会上市。和对Topicus一样，星座软件将保留对董事会的控制权。

与伯克希尔类似、但与私募股权基金或风投基金不同的是，星座软件没有既定的退出时间。因此，它可以在投资决策上不急不躁。莱昂纳德在每年的致投资者信中将自己的公司描述为一个“优秀的长期持有者”，与巴菲特的说法如出一辙。这种从长计议的心态也体现在员工薪酬上。奖金不仅仅要看营收增长，还与投资资本回报挂钩。高管必须将四分之三的奖金投资于公司股票，四年内不得出售。这就使管理层的激励机制与股东的利益相一致了。

星座软件的成功揭示了一个关于并购的重要真理，巴菲特对此也不会陌生：连续收购者往往胜过偶尔的交易者。咨询公司麦肯锡的托比亚斯·隆德伯格（Tobias Lundberg）估算，与不常收购的公司相比，经常收购的公司平均每年为股东带来的超额总回报要高出约两个百分点。

隆德伯格将这种优势归结为熟能生巧。正如体育锻炼一样，一家公司收购的次数越多，就越得心应手。来自得克萨斯州的泰勒科技（Tyler Technologies）和来自佛罗里达州的儒博科技（Roper Technologies）等少数公司试图效仿星座软件的“健身”方案，收购利基软件制造商。然而，迄今没有一家公司的块头能与这家加拿大公司相媲美。■



An outside chance

How to succeed—and fail—as a foreign business in India

Why some companies are staying put while others up sticks

THE RECENT history of foreign business in India is littered with failures. Even as the country has tried to lure global businesses keen to diversify into a fast-growing emerging market and, amid rising geopolitical tensions, away from China, many multinational companies are throwing in the towel. Notable departures over the past couple of years include Abu Dhabi Commercial Bank; Ford, an American carmaker; Holcim, a Swiss cement giant; and Metro, a German retailer. Disney is negotiating the sale of all or part of its streaming business. On November 24th Berkshire Hathaway, a \$780bn American investment Goliath, offloaded its 2.5% stake in Paytm, an Indian payments processor.

These are only the latest companies to call it quits. Inbound foreign direct investment has been flat since 2018. Although nearly 11,000 foreign firms entered India between 2014 and 2021, a government report found that 2,783 had left or closed in that period—a dispiritingly high number for a supposedly fast-charging economy.

Some were probably put off by practical challenges, such as clogged roads, unbreathable air and patchy telecoms networks. Some no doubt balked at the legal obstacles to hiring workers, buying land or paying the right taxes. Some may simply have felt unwelcome; local bureaucrats and business leaders often see foreigners as a direct threat to domestic interests. Crucially, many fared less well than home-grown rivals. According to BCG, a consultancy, their gross operating margins average 12%, against 15% for Indian firms. When confronted by India's reality, as opposed to its potential, plenty of excited foreign chief executives quickly find themselves “disabused”, sighs a consulting boss.

Plenty, but not all. Dove soap, Knorr stock cubes and other consumer staples made by Hindustan Unilever, the Indian arm of a British giant, can be bought in 9m shops across the country. India's top car-seller is Maruti Suzuki, a joint venture with a Japanese firm, followed by Hyundai of South Korea. Honda of Japan may soon dethrone Hero, an Indian rival, as the bigger maker of two-wheelers. Indians snap up Samsung phones and use WhatsApp, part of Meta's social-media empire, to talk private and, increasingly, commercial business. They make half of all their digital payments via PhonePe, which is owned by Walmart, an American retailer.

Far from quitting, some foreign companies are doubling down on their Indian bets. Which businesses persevere—and why—helps understand what it takes to succeed in India as a foreign enterprise.

One group of corporate outsiders that can thrive in India are those whose business is aligned with the priorities of the Indian state, such as boosting export-oriented manufacturing. Apple has become the poster child of this approach, by moving some iPhone-making to contract manufacturers setting up shop in India. Vestas of Denmark and Senvion of Germany are producing wind turbines for sale abroad. Tesla is reportedly negotiating lower import tariffs on its electric cars in exchange for setting up an electric-car factory.

An indirect way to shore up India's economic ambitions is to help build the roads, ports and other infrastructure needed to get products from the factories to faraway markets. An investment manager at a big financial firm lists the Indian subsidiaries of engineering companies as good wagers on Indian growth. Over the past ten years ABB's Indian affiliate has generated annual total stockmarket returns of 21%, two and a half times those of its Swedish-Swiss parent. America's Honeywell averaged 11% globally but 28% for its Indian arm.

Another successful group are foreigners who make an effort to indigenise their Indian business. Some team up with well-connected locals. Google and Meta have invested billions of dollars in partnerships with Reliance Industries, India's biggest conglomerate, whose Jio telecoms unit brought mobile internet to 440m Indians. In August BlackRock, the world's biggest asset manager, returned to India in a joint venture with Reliance. Its earlier foray involving a smaller partner was discontinued in 2018. If this time works out, BlackRock will have succeeded where those trying to go it alone, such as Fidelity, had failed. SAIC Motor, a Chinese car firm, is reportedly looking to sell a large stake in MG Auto, a local subsidiary facing a pernicky tax exam, to JSW, India's steel champion.

Outsiders have other ways to make their business more Indian. Rather than run its Indian bank from its home in Singapore, DBS set up a local affiliate complete with an Indian board accountable to Indian regulators. Walmart strengthened its Indian presence by acquiring a controlling stake in Flipkart, a local e-commerce platform, in 2018. In July the American retailer increased its interest by buying the stakes held by two American tech-investment firms, Tiger Global and Accel.

One last important group is staying put—firms that are already big in India. Often, says the India head of a sovereign wealth fund, they flourish not by creating new markets but by replacing informal provision of existing goods and services. Many, similarly to ABB and Honeywell, earn better returns from their Indian subsidiaries, notes Nikhil Ojha of Bain (see chart). Some, like Hindustan Unilever or Maruti Suzuki, have been in the country for decades. Many Indians would consider them homegrown.

Some are not so well liked, at least at first. Since it entered India ten years ago, Amazon has faced limits on local acquisitions, restrictions on selling own-label products, rules on inventory size and accusations that it threatened millions of kirana corner shops. Rather than give in, the e-

emporium has stood firm. In June its boss, Andy Jassy, said it would invest an extra \$6.5bn in India by 2030, bringing its total spending in the country to \$26bn. It is expanding its e-commerce distribution network and building cloud-computing data centres. In November it launched FanCode, a channel on its Prime Video streaming service dedicated to sports including cricket, the national pastime.

This resolute approach appears to be paying off. Resistance to Amazon's Indian growth seems to be easing among government officials, who may have concluded that its logistical expertise is what India needs to connect its factories to the world. Billions of dollars in promised investments can't have hurt, either. ■



外来者突围

外企如何在印度成功——或失败

为什么有些公司扎下根来，有些在撤离

回顾不算久远的历史，外国企业在印度失败的案例比比皆是。一些寻求多元化的全球企业渴望进入快速增长的新兴市场，随着地缘紧张局势不断加剧，还希望撤离中国。就在印度想方设法吸引这些企业的同时，许多跨国公司正纷纷离开这里。过去几年，退出印度的知名外企有阿布扎比商业银行（Abu Dhabi Commercial Bank）、美国汽车制造商福特、瑞士水泥巨头豪瑞（Holcim），以及德国零售商麦德龙等。目前迪士尼正在就出售它在印度的全部或部分流媒体业务进行谈判。11月24日，市值7800亿美元的美国投资巨头伯克希尔·哈撒韦（Berkshire Hathaway）清仓了所持印度数字支付公司Paytm全部2.5%的股份。

这些还只是最近退出的公司。自2018年以来，印度的外国直接投资一直无甚起色。尽管2014年至2021年间有近1.1万家外企进入印度，但一份政府报告发现，同期撤离或关闭的外企多达2783家——对于一个被认为正在高速发展的经济体来说，这个数字高得令人沮丧。

有些公司对印度望而却步可能是因为一些客观存在的困难，比如道路堵塞、空气糟糕以及电信网络覆盖不全等。但毫无疑问，有些公司踟躇不前则是因为在雇用员工、购买土地或合理纳税方面遇到的法律障碍。有些可能就是感觉自己不受待见，因为地方官员和商界领袖常常视外国公司为对本土企业的直接威胁。关键是，许多外国公司发展得不如印度本土对手。根据波士顿咨询公司的数据，外国公司的平均毛营业利润率为12%，而印度公司为15%。当面对与印度透出的潜力反着来的现实，许多原本怀着兴奋之情的外企CEO“幡然醒悟”，一位咨询公司的老板叹道。

这样的公司有很多，但不是全部。英国巨头联合利华的子公司印度斯坦联合利华（Hindustan Unilever）生产的多芬香皂、家乐浓汤宝和其他日常消费品在印度各地900万家商店都有售。印度最大的汽车销售商马鲁蒂铃

木（Maruti Suzuki）是一家与日本合资的公司，第二大汽车销售商则是韩国的现代。日本的本田可能很快就会超过印度对手Hero，成为更大的摩托车制造商。印度人抢购三星手机，使用社交媒体帝国Meta旗下的WhatsApp聊私事，并越来越多地将它用于商务洽谈。他们一半的数字支付都是通过美国零售商沃尔玛拥有的PhonePe完成的。

一些外国公司非但没有退出，反而加倍在印度下注。哪些企业锲而不舍？又是出于什么原因？弄清这两个问题有助于了解外企在印度的成功要素。

首先，能在印度蓬勃发展的一类外国公司是那些自身业务与印度政府的发展重点相一致的企业，比如能够促进出口导向型制造业发展的企业。苹果便是一个典型，它将部分iPhone的制造转移到了在印度开设的代工厂。丹麦的维斯塔斯（Vestas）和德国的Senvion的印度工厂正在生产销往国外的风力涡轮机。据说特斯拉正以在印度建厂作为交换条件，就降低其电动汽车的进口关税与印度谈判。

外国企业帮助修建公路、港口和其他基础设施，从而将产品从工厂运往遥远的市场，也会间接助力印度成就其经济雄心。鉴于印度的经济增长，一家大型金融公司的投资经理把工程企业的印度子公司列为优质投资对象。在过去的十年里，ABB印度分公司的年股市投资总回报率达到21%，是其瑞典和瑞士合资母公司的2.5倍。美国公司霍尼韦尔的全球平均收益率为11%，而其印度子公司为28%。

还有一类外国公司之所以成功，是因为它们努力让自己在印度的业务本土化。一些公司与人脉甚广的本土企业合作。谷歌和Meta已投资数十亿美元，与印度最大的企业集团信实工业（Reliance Industries）建立合作关系，信实旗下电信公司Jio为4.4亿印度人提供移动互联网服务。今年8月，全球最大的资产管理公司贝莱德（BlackRock）重返印度，与信实成立了一家合资企业。贝莱德之前曾与一家较小的印度公司合作并于2018年终止了合作关系。如果此次合作进展顺利，贝莱德将在富达（Fidelity）等公司曾试图凭一己之力拿下却败下阵来的领域取得成功。据报道，中国汽车公司上汽集团正打算将其面临严苛税务审查的印度子公司MG Auto的大量

股份出售给印度钢铁龙头企业JSW。

外国公司还有其它办法让自己的业务更加印度化。星展银行没有将其印度分行的领导权放在新加坡本部，而是在印度设立了一家分支机构，建立印度董事会对印度的监管机构负责。2018年，沃尔玛通过收购印度本土电商平台Flipkart的控股权，巩固了在印度的根基。今年7月，沃尔玛又加大押注，收购了两家美国科技投资公司老虎环球（Tiger Global）和Accel所持有的Flipkart的股份。

最后一个重要的群体在印度稳扎稳打，它们就是那些已经在印度发展壮大的公司。一家主权财富基金的印度负责人表示，这些公司能够做大做强，往往不是因为开创了新市场，而是取代了既有的非正规商品和服务供应。其中许多与ABB和霍尼韦尔一样，其印度子公司的收益率高于母公司，贝恩的尼基尔·欧嘉（Nikhil Ojha）指出（见图表）。有些公司，比如印度斯坦联合利华以及马鲁蒂铃木等，已经在印度经营了几十年。许多印度人都愿意视它们为本土公司。

也有一些外国公司不大受待见，至少一开始是这样。亚马逊自十年前进入印度以来，一直面临各种障碍，比如限制其并购本土企业、销售自有品牌产品，规定其库存规模，以及指控其对街头巷尾数以百万的小卖部生存构成威胁等等。不过这家电子商务巨头没有退却，而是选择了坚守。今年6月，亚马逊CEO安迪·贾西（Andy Jassy）表示，在2030年前，亚马逊将在印度追加65亿美元的投资，使其在印度的总投资达到260亿美元。它正在扩大其电子商务配送网络，并建立多个云计算数据中心。11月，亚马逊在其流媒体服务Prime Video上推出了FanCode频道，专门播放有印度“国球”之称的板球等体育节目。

这种坚持不懈的做法看上去奏效了。印度政府官员似乎正在放松对亚马逊在印度扩张的抵制。他们可能得出了结论，认为亚马逊在物流上的专长正好契合了印度将其工厂与世界连接起来的需要。况且，亚马逊承诺的数十亿美元投资也不会有什么坏处。■



Bartleby

How not to motivate your employees

Douglas McGregor's prescient writing on management and motivation

HERE ARE some handy rules of thumb. Anyone who calls themselves a thought leader is to be avoided. A man who does not wear socks cannot be trusted. And a company that holds an employee-appreciation day does not appreciate its employees.

It is not just that the message sent by acknowledging staff for one out of 260-odd working days is a bit of a giveaway (there isn't a love-your-spouse day or a national don't-be-a-total-bastard week for the same reason). It is also that the ideas are usually so tragically unappreciative. You have worked hard all year so you get a slice of cold pizza or a rock stamped with the words "You rock"?

This approach reveals more about the beliefs of the relevant bosses than it does anything about what actually motivates people at work. In a book published in 1960, called "The Human Side of Enterprise", Douglas McGregor, a professor at MIT Sloan School of Management, divided managers' assumptions about workers into two categories. He called them theory X and theory Y.

McGregor, who died in 1964, was a product of his time. The vignettes in the book feature men with names like Tom and Harry. But his ideas remain useful.

Theory X managers believe that people have a natural aversion to work; their job is to try and get the slackers to put in some effort. That requires the exercise of authority and control. It relies heavily on the idea of giving and withholding rewards to motivate people. Perks and pizza fit into this

picture but pay is critical to theory X; work is the price to be paid for wages.

Theory Y, the one McGregor himself subscribed to, is based on a much more optimistic view of humans. It assumes that people want to work hard and that managers do not need to be directive if employees are committed to the goals of the company. It holds that pay can be demoralising if it is too low or unfair, but that once people earn enough to take care of their basic needs, other sources of motivation matter more. In this, McGregor was a follower of Abraham Maslow, a psychologist whose hierarchy of needs moves from having enough to eat and feeling safe up to higher-order concepts like belonging, self-esteem and purpose.

Theory X is not dead. It lives on in low-wage industries where workers must follow rules to the letter and in high-wage ones where pay motivates people long after they can feed themselves. It surfaces in the fears of managers that working from home is a golden excuse for people to do nothing. It shows up in the behaviour of employees who phone in and bosses who bully and berate.

Nevertheless, theory Y is in the ascendant. You cannot move for research showing that if people think what they do matters, they work harder. A meta-analysis of such research, conducted by Cassondra Batz-Barbarich of Lake Forest College and Louis Tay of Purdue University, found that doing meaningful work is strongly correlated with levels of employee engagement, job satisfaction and commitment. Trust is increasingly seen as an important ingredient of successful firms; a recent report by the Institute for Corporate Productivity found that high-performing organisations were more likely to be marked by high levels of trust.

Firms of all kinds are asking themselves Y. Companies in prosaic industries are trying to concoct purpose statements that give people a reason to come into work that goes beyond paying the rent. The appeal of autonomy and

responsibility permeates the management philosophy not just of creative firms like Netflix but also of lean manufacturers that encourage employees to solve problems on their own initiative. Some retailers have raised wages in the theory Y belief that reducing workers' financial insecurity will improve employee retention and organisational performance.

McGregor himself wrote that the purpose of his book was not to get people to choose sides but to get managers to make their assumptions explicit. On this score he is less successful. It is still possible to run financially viable firms in accordance with theory X. It is impossible to admit it. ■



巴托比

如何不激励你的员工

道格拉斯·麦格雷戈关于管理和激励的著作很有先见之明

这里有一些简单易用的经验法则。对任何自称思想领袖的人都敬而远之。不穿袜子的人不可信。还有，设置员工赞赏日的公司并不真的赞赏自己的员工。

一年有260多个工作日，只拿出其中一天予以员工认可，这传递出的信息本就有点不对劲（同样的道理，世界上可没有“爱配偶日”，也没有全国性的“别做彻头彻尾的王八蛋周”）。更何况，那些用来表达赏识的点子往往漫不经心到了悲催的地步。你一年到头辛勤工作，就是为了一片凉掉的披萨或者一块印着“你‘石’在棒”几个大字的石头？

这种方法更多地揭示了那些老板们想当然的见解，而非真正激励员工努力工作的因素。麻省理工学院斯隆管理学院（MIT Sloan School of Management）教授道格拉斯·麦格雷戈（Douglas McGregor）在1960年出版的《企业的人性面》（The Human Side of Enterprise）一书中，将管理者对员工的臆断分为两类，分别称之为X理论和Y理论。

1964年去世的麦格雷戈是他那个时代的产物。书中小花絮的出场角色都叫汤姆和哈利这样的名字。但他的理念至今仍然有用。

X理论管理者认为人生来就厌恶工作，他们的任务就是设法让懒鬼们付出些努力。这就需要行使权威和控制。X理论严重依赖给予或不给予奖励来激励人们。福利和披萨属于这种情况，但在X理论中最关键的还是薪酬：工作就是获得工资的代价。

麦格雷戈本人赞同的Y理论是基于一种对人类乐观得多的看法。它假设人们愿意努力工作，而如果员工致力于实现公司目标，就无需管理者发号施令。该理论认为，如果薪酬过低或不公平，就可能会打击士气，但一旦人

们的收入足以满足他们的基本需求，其他动力来源就更为重要了。在这一点上，麦格雷戈是亚伯拉罕·马斯洛（Abraham Maslow）的追随者，在这位心理学家提出的需求层次中，底层是能吃饱饭和有安全感，再往上便是更高层次的概念，如归属感、自尊和使命感。

X理论并没有消亡。它依旧存活在工人必须严格遵守规章制度的低薪行业，以及薪水在早就能满足温饱之后仍在激励人们的高薪行业。每当管理者担心居家办公成了人们摸鱼的万能借口，或是员工敷衍了事、老板霸凌责骂员工时，都是X理论在浮现真容。

然而，Y理论日益占得上风。数不胜数的研究表明，如果人们认为自己的工作很重要，他们就会更加努力地工作。森林湖学院（Lake Forest College）的卡桑德拉·巴茨-巴尔巴里奇（Cassandra Batz-Barbarich）和普渡大学的路易斯·泰伊（Louis Tay）对这类研究的综合分析发现，做有意义的工作与员工敬业度、工作满意度和忠诚度密切相关。信任越来越被视为企业成功的重要因素。企业生产率研究所（Institute for Corporate Productivity）最近的一份报告发现，高绩效的组织更有可能拥有高水平的信任度。

各行各业的公司都在自问如何让Y理论为己所用。一些平淡乏味的行业里的公司煞有介事地编写使命声明，想给人们一个除了赚房租之外的去上班的理由。自主性和责任心的感召力不仅渗透到像奈飞（Netflix）这样的创意公司的管理哲学中，在鼓励员工主动解决问题的精益制造商那里也是如此。一些零售商提高了工资，因为Y理论促使他们相信减少员工的财务不安全感会提高员工留任率和组织绩效。

麦格雷戈本人写道，他写这本书的目的不是让人们选边站，而是要让管理者坦率阐明自己对员工的假定。就这一点来说，他不太成功。遵照X理论把公司经营得财务状况良好仍然是可能的，但要承认这一点是绝无可能的。■



Bartleby

How to manage teams in a world designed for individuals

If collaboration matters so much, why don't firms do more to promote it?

THERE IS NO “i” in team. But there is one in “autopilot”. Despite the growing importance of teamwork in organisations, the processes used to manage employees have carried on much as before. Bosses may wax lyrical about collaboration, but the way they reward, review and recruit has not caught up.

People in organisations have always worked in concert with others. But the emphasis on teams is growing, for a variety of reasons. Technology has made the sharing of ideas and information easier, while hybrid working has made it more vital. (There's a reason it's not called Microsoft Silos.) The software industry has spread the gospel of teams—agile, scrums, OKRs and all the rest of it—into all kinds of places.

Teams, it turns out, are better at solving complex problems, according to a recent paper by Abdullah Almaatouq of the MIT Sloan School of Management. Research also suggests that people have a greater attachment to their work group than to their organisation; you're less likely to go for lunch with a logo.

Knowledge is also accumulating as to what makes teams tick. Project Aristotle, a famous bit of research by Google into the characteristics of its best-performing teams, identified “psychological safety”—comfort to speak one's mind—as the most important ingredient, alongside things like dependability, role clarity and meaningful work. Different teams excel at different things. Analysis by Lingfei Wu of the University of Chicago and his co-authors found a correlation between team size and types of scientific research: larger teams develop existing ideas and smaller ones

disrupt the field with new ones.

But a greater emphasis on, and understanding of, teams does not generally translate into matching management practices. Recruitment processes focus on the achievements of the individual rather than the collectives they have been in. Performance management is still largely a one-player sport. Reviews are usually based on individual targets, as are bonuses. Metrics are often confined to concrete outputs rather than softer team-based measures, such as how trusted people are. It doesn't help that many bosses have little idea what their teams really do. Soroco, a software firm, and academics at Harvard Business School and the Wharton School of the University of Pennsylvania asked managers to describe the processes that they thought took up most of their teams' time. On average they did not know or could not recall 60% of what their team members did, making them more like high-functioning goldfish than bosses.

There are good reasons for much of this. People move jobs and get promoted one by one, not as battalions. Rewarding people on the basis of team performance can lead to unfairness: free-riders might get too much recognition or hard workers might be penalised for someone else not pulling their weight. It's difficult to quantify team contributions. When teams are made up of people from different departments—or form for limited periods—managers find it harder to know what their direct reports are up to.

But these problems are not insurmountable. When hiring people, it is possible to assess traits that make for good group members: scoring well on a test that asks participants to determine what people are feeling from a snapshot of their eyes is correlated with being a good team player, for example. Peer reviews can give a good sense of how people are seen within teams.

The worry that team-based bonuses may encourage free-riding also seems to be overblown. A recent study by Anders Frederiksen of Aarhus University and his co-authors looked at the impact of introducing group-based incentives at a manufacturing firm, and found it sparked a big leap in performance. That jump was not just because the scheme incentivised existing workers to be more efficient, but also because it attracted more productive new hires.

Employees are individuals; managers should never forget that. But if teams are where a lot of the magic happens, bosses should have better ways to get the most out of them. Working out what they do all day might be a good place to start. ■



巴托比

如何在为个体设计的系统中管理团队

如果合作如此重要，为什么企业不采取更多措施促进合作呢？

“Team”（团队）一词中没有“i”（我）这个字母，但在“autopilot”（自动惯性模式）中却有。尽管团队合作在组织中日益重要，但管理员工的流程基本还是老一套。谈到合作，老板们可能口若悬河，但在奖励、考评和招聘上却没有相应的行动。

处于组织中的人从来都在与其他人协同工作。但对团队的强调越来越多，这有多方面原因。技术让想法和信息共享变得更加容易，而混合工作则让这种共享变得更加重要。（微软的会议软件叫Teams而不是Silos[“孤岛”]是有原因的。）软件行业已经将敏捷、敏捷开发框架scrum、OKR（目标与关键成果法）以及其他种种团队合作的信条散播到各个角落。

麻省理工学院斯隆管理学院（MIT Sloan School of Management）的阿卜杜拉·阿尔马图克（Abdullah Almaatouq）最近发表的一篇论文表明，事实证明，团队更擅长解决复杂的问题。还有研究表明，人们对所在的工作团队比对整个企业组织更有感情——你总不大可能和公司标识去吃午餐。

关于哪些因素让团队有效运作的了解也在不断积累。谷歌著名的亚里士多德项目（Project Aristotle）研究了公司表现最佳的团队的特征，认为“心理安全”（能否放心说出自己的想法）是最重要的因素，此外还有团队成员可靠、角色明确和工作有意义等。不同的团队擅长不同的任务。芝加哥大学的吴令飞及其合著者的分析发现，团队规模和科研的类型之间存在相关性。较大的团队发展某一领域内的现有想法，较小的团队用新想法颠覆某个领域。

然而，对团队的重视加强和理解加深通常不会转化为相应的管理实践。招聘流程主要看的是个人已取得的成就，而不是他们过去所在的集体如何。绩效管理在很大程度上仍然只看个人表现。评价通常基于个人目标，奖金

也是如此。衡量标准通常仅基于实际产出，而不是更软性的基于团队的衡量标准，例如人们的受信赖度如何。更糟糕的是，许多老板根本不知道他们的团队到底在做什么。软件公司Soroco以及哈佛商学院和宾夕法尼亚大学沃顿商学院的学者请主管们说出哪些流程最占用手下团队的时间。平均而言，他们不知道或记不起团队成员60%的工作内容是什么，这让他们更像是高功能忘事佬，而不是老板。

这其中大部分情况都是有充分理由的。调动和升迁都是个人行为而非团队行动。根据团队绩效奖励员工可能会导致不公平：“白嫖怪”可能会得到过度的奖励，努力工作的人可能会因为其他人没有尽职尽责而承担后果。量化团队贡献很难。当团队的成员来自不同部门，或者团队只是临时组建时，管理者就更难知道他们的直接下属在做什么。

但这些问题并非无法克服。在招聘时是有可能评估候选人是否具有成为优秀团队成员的特质的。例如，有一项测试要求参与者根据对眼睛的快照来判断人的情绪，能在这个测试中取得良好成绩的就可能是优秀的团队合作者。同事评议可以很好地反映个体在团队中的形象。

至于说根据团队表现来发放奖金可能会导致有人坐享其成，这种担忧似乎也被夸大了。奥胡斯大学（Aarhus University）的安德斯·弗雷德里克森（Anders Frederiksen）和合著者最近调查了在一家制造企业引入基于团队的激励措施的影响，发现这种措施引发了绩效的巨大飞跃。出现这种飞跃不仅是因为这样的措施激励了现有员工提高效率，还因为吸引来了生产率更高的新员工。

员工们都是一个一个的人，管理者永远不应该忘记这一点。但如果团队能促成众多奇迹发生，老板就应想出更好的方法来充分利用团队。弄清楚团队一整天在忙什么可能是一个不错的起点。■



Bartleby

Why Monday is the most misunderstood day

What's wrong with the start of the workweek?

WHEN THE Boomtown Rats, an Irish band, released “I Don’t Like Mondays” in 1979, the song became an instant hit. The inspiration behind it was the Cleveland Elementary School shooting in San Diego that year. The 16-year-old perpetrator listed “not liking Mondays” as her main reason for firing 36 shots, killing two adults and injuring eight children and a police officer. This is not, though, why the song resonated with millions of people around the world; most of them are in all likelihood unaware of its tragic origins. What many do recognise all too well is the difficulty of summoning the energy to get out of bed on Monday mornings in order to face the week ahead.

Many bosses argue that starting off the week in person in the office creates good energy. Plenty of employees beg to differ. A paper published in 2021 by the Journal of Applied Psychology, found that people tend to be more ill-mannered on Mondays, and grow more courteous as the week unfolds.

A paper from 2015 by Yun Tae Hwang and Amy Kang published in the Medical Journal of Australia goes so far as to diagnose a new condition, Mondayitis. The authors define it as “a systemic illness with a non-specific constellation of symptoms including fatigue, lethargy or asthenia, dysthymia, irritability, light-headedness, photophobia, dry mouth, myalgia and headache in the absence of another focal or systemic illness”.

These symptoms typically appear on the first working day after a period off work, which could be a weekend or a longer holiday. They can lead sufferers to call in sick, decide to work from home or, if they do show up in the office, come across as detached and unavailable. So much for good

energy.

Mondayitis appears to be contagious, infecting other days of the week. Some Americans now complain of “Sunday scaries”, when pre-Monday dread sets in as the weekend draws to a close. Both conditions can be aggravated by a weekend hangover, a looming deadline or painful memories (double science in secondary school first thing in the morning?). They are likely to be particularly acute among the nearly half of American workers who, according to a poll from 2022 conducted by UKG, an HR-software company, hate their jobs.

Still, the sudden shift from non-work to work affects everyone, not just those who despise what they do for a living. The covid-19 pandemic has led many people to re-evaluate their work-life balance. A barrister in London who spends weekends working on cases likes to ease into the formal workweek with an elegant breakfast at The Delaunay and lunch in Inner Temple Hall. A broader movement is promoting the idea of a four-day workweek, one permutation of which would make Monday part of the weekend (though this may lead to an epidemic of Tuesdayitis instead). Less ambitiously, and more realistically, a social-media campaign for “bare-minimum Mondays” argues for a gentle start to the week.

All this reflects a deep human instinct towards self-indulgence and procrastination; there is a reason why “Thank God it’s Monday” does not feature on many bumper stickers or T-shirts. Still, on that first day of the week employees do not have to be mired in apathy, weariness and desire that things were otherwise. As Robert Frost counselled in his poem, “A Servant to Servants”, “the best way out is always through.”

The preceding 60 hours or so were probably spent with people who have nothing to do with your job. You may have prepared—or merely enjoyed—a more elaborate meal than an al desko sandwich. You may have gone for a

walk in the park or simply lounged in bed. Either way, you almost certainly cleared your head. Unless you capped the weekend off by going on a bender, this means that the following morning could be your most productive time of the week.

For one banker, Monday is the day to cross items off their to-do list. Your columnist, a guest Bartleby, feels crisp and invigorated on Monday mornings (which is when the editorial meetings take place at The Economist, planning and discussing the coming week's issue). The first shower, coffee and commute after the weekend do not have to feel like a hike with a rucksack full of stones. They can instead be imbued with a renewed sense of purpose and, as such, act as a tonic. It is on Friday afternoons when Bartleby feels depleted and cannot wait to go home—until Monday morning, when revived and spirited, she is ready to do it all over again. ■



巴托比

为什么星期一受误解最深

工作周的第一天有什么不好？

爱尔兰乐队“新城之鼠”（Boomtown Rats）在1979年推出了单曲《我不喜欢星期一》（I Don't Like Mondays），这首歌迅速爆红。歌曲的灵感来自当年发生在美国加州圣地亚哥市的克利夫兰小学（Cleveland Elementary School）的枪击事件。16岁的罪犯称，“不喜欢星期一”是她连开36枪，导致两名成年人死亡、八名儿童和一名警察受伤的主要原因。当然，全世界千百万人对这首歌深有感触并不是因为枪击案，他们大部分人十有八九都不知道这首歌源自一场悲剧。但很多人对于在星期一早鼓起勇气起床去开始一周工作的艰难都太清楚不过了。

不少老板认为，员工到办公室开启新的一周会带来正能量。很多员工不这么看。2021年在《应用心理学杂志》（Journal of Applied Psychology）上发表的一篇论文发现，人们在周一往往更粗鲁无礼，但随着一周往后推移，他们会越来越彬彬有礼。

黄润泰（Yun Tae Hwang，音译）和艾米·姜（Amy Kang，音译）2015年在《澳大利亚医学杂志》（Medical Journal of Australia）上发表的一篇论文甚至诊断出一种新型疾病——星期一综合征。作者将其定义为“在没有其他局灶性或全身性疾病的情况下出现的一种具有非特异性症状的全身性疾病，症状包括疲劳、嗜睡或无力、精神不振、易怒、头晕、畏光、口干、肌痛和头痛”。

这些症状通常出现在结束一段休息后的第一个工作日，这段休息可能是周末或更长的假期。患者可能因此请病假、决定居家工作，或是即便人在办公室，也是一副爱理不理、生人勿近的样子。正能量什么的就算了吧。

星期一综合征似乎还会传染，蔓延到一周中的其他日子。如今有些美国人抱怨起了“星期天恐惧”，当周末接近尾声时，即将面临周一的恐惧就来

了。周末宿醉、某个最后期限将近或是痛苦的回忆（中学时周一早上要连上两节科学课？）都会让这两种病情加重。人力资源软件公司UKG从2022年开始的一项民意调查显示在美国有近一半的劳动者讨厌自己的工作，这些人的星期一综合征和星期天恐惧症很可能尤其严重。

不过，从非工作状态突然切换到工作状态会影响到每个人，不仅是那些讨厌自己手头活计的人。新冠疫情让很多人重新评估自己工作与生活的平衡。伦敦一位周末也要处理案子的大律师喜欢在德罗涅饭店（The Delaunay）享用一顿优雅的早餐，然后在内殿律师学院大堂（Inner Temple Hall）享用午餐，让自己轻松缓和地进入正式的工作周。越来越多人在推动每周四天工作制，其中一种安排是把星期一算成周末（不过这可能导致“星期二综合征”蔓延开来）。在社交媒体上发起的“最低强度星期一”（bare-minimum Mondays）的运动没这么激进，而是更加现实，主张温和地开启新的一周。

所有这些都反映了人类自我放纵和拖延的深层本能；难怪保险杠车贴或T恤上永远不可能写着“感谢上帝，今天周一”。尽管如此，在一周的第一天，员工们也无需陷入冷漠和倦怠之中不可自拔，或是幻想着能有另一种现实。正如罗伯特·弗罗斯特（Robert Frost）在他的诗《仆人们的仆人》（A Servant to Servants）中提出的忠告：“最好的出路永远都是走下去。”

之前的60个小时你可能是和跟工作无关的人一起度过的。也许你精心准备了一——或仅仅是享用了一——一顿美食，怎么样也比坐在办公桌前啃三明治强。也许你去了公园散步，或者就是懒洋洋地躺在床上。不管怎样，你几乎一定是头脑清明，神清气爽了。所以接下来的周一上午应该是你一周效率最高的时候，除非你周末净忙着花天酒地了。

对银行家来说，星期一是从待办事项清单上划掉条目的日子。作为本专栏的特邀撰稿人，笔者在星期一早上也是精力充沛（《经济学人》编辑部会在这时开会，计划和讨论这一周的选题）。不必非得把周末过后的第一次起床淋浴、第一杯咖啡和第一趟通勤搞得像是背着一大包石头在徒步一

样。相反，它们可以被注入一种重燃的使命感而帮助你振奋精神。每到星期五下午，笔者就会感到精疲力竭，迫不及待地想回家，直到星期一早上，她才恢复过来，精神抖擞，准备好投入新一周的工作。■



The learning power of PISA

Covid-19 was a disaster for the world's schoolchildren

The costs of wasting brainpower are huge

EVERY THREE years for the past two decades analysts at the OECD, a club of mostly rich countries, have asked pupils in dozens of places to take tests in reading, maths and science, the better to compare the quality of their schools. No one was expecting the latest round of exams, sat a year late in 2022 after years of pandemic-induced disruption, to bring good news. But the results, released on December 5th, are still a blow. An average teenager in the rich world is found to have fallen about six months behind in reading and nine months behind in maths, compared with peers who sat similar tests in 2018. In several rich countries 15-year-olds are performing at levels that back then would have been expected of learners a full year younger.

These findings are all the gloomier because of the discouraging trends that preceded them. Years of international testing suggest that, when the pandemic struck, typical teenagers in the rich world were no more numerate than those schooled some 20 years earlier. In reading and science, average scores have been drifting down for a decade, according to the OECD's yardstick, even though spending has been going up. So there are good reasons to think that grades in the latest exams (often known as the PISA tests) might have slipped even without the turmoil of covid-19.

The sombre school report should rally governments to accomplish two tasks. The first is to renew pandemic "catch-up" programmes, for which energy and funding is beginning to flag even though the job is far from complete. Data released in July by a big test-provider suggest that in the most recent academic year many pupils in America made no faster progress than was normal before the pandemic. This month's PISA results suggest

that America's scores may have fallen back a bit less than in lots of other places—but that means nothing to the millions of youngsters who are nonetheless approaching the end of their school days with yawning gaps in their skills.

A priority of any revamped catch-up schemes should be to bring down absenteeism. In both America and Britain 20-30% of pupils miss at least one lesson in ten, and often many more. This is roughly double the rate before the pandemic. As for pupils who are regularly coming to class, schools could be offering them more lessons than usual. Providing more learning time—in holidays, at weekends and after school—is perhaps the simplest way of getting youngsters back up to speed. But in many places extra hours have been given only a minimal role in catch-up plans; they are expensive because teachers would have to be paid more, or more teachers hired. And the children are not keen.

Governments' second task is to turn around the disheartening long-term trends. International tests offer clues about what works and what does not. Cutting class sizes is often a waste of money; having high-quality teachers matters more. Education budgets could be better focused. Across rich countries, disadvantaged pupils put up with less qualified staff and make do with fewer books. Changing much of this means taking on powerful lobbies, including teachers' unions and wealthy parents. In theory the crisis offers a big opportunity to make such reforms.

All the more reason to regret that politicians are focusing their energies elsewhere. Britain's government has painted its pupils' performance in the PISA tests as a triumph (like America it has drifted up the league tables, but only because its scores collapsed a smidgeon less than the average). The Labour Party, which will probably come to power next year, plans to get tougher on private schools by making them pay tax; they cost the government nothing and get excellent results, but taxing them will

probably force some parents to increase the burden on the public sector. In America, meanwhile, the past few years have seen much energy wasted on fiery but mostly fruitless battles about the teaching of history, gender and race. Neverending disruptions during the pandemic were bad for learning. Schoolchildren must not be let down once again. ■



【首文】PISA的启示

新冠肺炎是全球学童的灾难

智力浪费代价巨大

在过去二十年里，主要由发达国家组成的经合组织（OECD）的分析师每三年就对几十个地方的学生开展阅读、数学和科学测试，以便更好地比较他们学校的教学质量。由于过去几年里疫情造成的干扰，最新一轮测试在推迟一年后于2022年举行。没人指望它会带来惊喜，但12月5日公布的结果仍是当头一棒。与2018年参加类似测试的同龄人相比，发达国家青少年的阅读能力平均落后了约六个月，数学落后九个月。在几个发达国家，15岁青少年的成绩只达到以前比他们整整小一岁的学生的水平。

在此之前的趋势本就不乐观，这次的结果因而愈发令人气馁。纵观多年的国际测试结果可以发现，疫情来袭时，发达国家一般青少年的算数能力还比不上20来年前的学生。尽管支出一直在增加，但根据经合组织的衡量标准，阅读和科学的平均分数十年来却持续下滑。因此有充分理由认为，即使没有新冠疫情的扰乱，这一次的测试（通常称为PISA测试）成绩也可能会下降。

这份黯淡的成绩单应该促使政府行动起来完成两项任务。首先是继续疫情“追赶”计划，尽管这项工作远未完成，但投入的精力和资金都已开始减退。一家大型考试机构7月发布的数据显示，在最近一个学年里，美国许多学生的进步速度未超过疫情前的正常水平。本月的PISA结果显示，美国分数下滑的程度比其他许多地方略低，但这对数百万青少年来说毫无意义，因为他们仍将带着巨大的技能缺口结束学业。

无论怎样重振追赶计划，降低缺勤率都应该是首要任务。在美国和英国，20%至30%的学生至少缺课十分之一，常常还远多于此。这大约是疫情前的两倍。对于那些正常上课的学生，学校可以给他们提供比平时更多的课程。延长学习时间——在假期、周末和课后——也许是让孩子们赶上进度的最简单方法。但在许多地方，额外加课在追赶计划中扮演的角色非常有

限，因为这得向教师支付更多薪资或者雇用更多教师，成本高昂。再者孩子们也不愿意。

政府的第二项任务是扭转令人沮丧的长期趋势。从国际测试中可以看出哪些做法有效、哪些无效。减少班级人数往往是浪费金钱；拥有高素质的教师更加重要。教育预算可以做到更加有的放矢。在发达国家，弱势群体的学生只能忍受更差的师资和更少的书籍。要真正改变这种状况，就必须与包括教师工会和富裕家长在内的强大游说集团抗争。从理论上讲，这场危机是进行此类改革的大好机会。

更让人感到遗憾的是政客把精力都放在了别处。英国政府将其学生的PISA测试表现形容为一场胜利（与美国一样，英国的排名有所上升，但只不过是因为其分数下滑的幅度略小于平均水平而已）。明年可能上台执政的工党计划对私立学校采取更强硬的立场，要求它们缴税；私立学校不需要政府花钱，而且教学成果优异，但对其征税可能会迫使部分家长转向公立学校而增加公共负担。与此同时，过去几年美国将大量精力浪费在关于历史、性别和种族的教学的激烈但基本无果的争论上。疫情期间无休止的干扰影响了学习。学童们不能再一次被辜负。■



Bartleby

Generative AI generates tricky choices for managers

Transformational technologies can be very trying

THE REMARKABLE capabilities of generative artificial intelligence (AI) are clear the moment you try it. But remarkableness is also a problem for managers. Working out what to do with a new technology is harder when it can affect so many activities; when its adoption depends not just on the abilities of machines but also on pesky humans; and when it has some surprising flaws.

Study after study rams home the potential of large language models (LLMs), which power AIs like ChatGPT, to improve all manner of things. LLMs can save time, by generating meeting summaries, analysing data or drafting press releases. They can sharpen up customer service. They cannot put up IKEA bookshelves—but nor can humans.

AI can even boost innovation. Karan Girotra of Cornell University and his co-authors compared the idea-generating abilities of the latest version of ChatGPT with those of students at an elite university. A lone human can come up with about five ideas in 15 minutes; arm the human with the AI and the number goes up to 200. Crucially, the quality of these ideas is better, at least judged by purchase-intent surveys for new product concepts. Such possibilities can paralyse bosses; when you can do everything, it's easy to do nothing.

LLMs' ease of use also has pluses and minuses. On the plus side, more applications for generative AI can be found if more people are trying it. Familiarity with LLMs will make people better at using them. Reid Hoffman, a serial AI investor, has a simple bit of advice: start playing with it. If you asked ChatGPT to write a haiku a year ago and have not touched it

since, you have more to do.

Familiarity may also counter the human instinct to be wary of automation. A paper by Siliang Tong of Nanyang Technological University and his co-authors that was published in 2021, before generative AI was all the rage, captured this suspicion neatly. It showed that AI-generated feedback improved employee performance more than feedback from human managers. However, disclosing that the feedback came from a machine had the opposite effect: it undermined trust, stoked fears of job insecurity and hurt performance. Exposure to LLMs could soothe concerns.

Or not. Complicating things are flaws in the technology. The Cambridge Dictionary has named “hallucinate” as its word of the year, in tribute to the tendency of LLMs to spew out false information. The models are evolving rapidly and ought to get better on this score, at least. But some problems are baked in, according to a new paper by R. Thomas McCoy of Princeton University and his co-authors.

Because off-the-shelf models are trained on internet data to predict the next word in an answer on a probabilistic basis, they can be tripped up by surprising things. Get GPT-4, the LLM behind ChatGPT, to multiply a number by $9/5$ and add 32, and it does well; ask it to multiply the same number by $7/5$ and add 31, and it does considerably less well. The difference is explained by the fact that the first calculation is how you convert Celsius to Fahrenheit, and therefore common on the internet; the second is rare and so does not feature much in the training data. Such pitfalls will exist in proprietary models, too.

On top of all this is a practical problem: it is hard for firms to keep track of employees' use of AI. Confidential data might be uploaded and potentially leak out in a subsequent conversation. Earlier this year Samsung, an electronics giant, clamped down on usage of ChatGPT by employees after

engineers reportedly shared source code with the chatbot.

This combination of superpowers, simplicity and stumbles is a messy one for bosses to navigate. But it points to a few rules of thumb. Be targeted. Some consultants like to talk about the “lighthouse approach”—picking a contained project that has signalling value to the rest of the organisation. Rather than banning the use of LLMs, have guidelines on what information can be put into them. Be on top of how the tech works: this is not like driving a car and not caring what is under the hood. Above all, use it yourself. Generative AI may feel magical. But it is hard work to get right. ■



巴托比

生成式人工智能给管理者出了难题

变革性技术可能很难应付

生成式人工智能（AI）的非凡能力，你一试就明白。但对于管理者来说，能力非凡也是个问题。当一项新技术可以影响众多活动，而且采用该技术并不仅仅取决于机器的能力，也取决于麻烦的人类，况且该技术还有些出人意的缺陷时，要弄清楚该如何应对它的难度就更大了。

一项又一项的研究充分表明，ChatGPT等AI背后的大语言模型（LLM）具有改善各种事务的潜力。LLM能够生成会议纪要、分析数据或起草新闻稿，从而节省时间。它们能够提升客户服务。它们不能组装宜家的书架——但人类也一样不行。

AI甚至可以促进创新。康奈尔大学的卡兰·吉罗特拉（Karan Girotra）及合著者比较了最新版ChatGPT和一所名牌大学的学生们的创意能力。一个人单枪匹马可以在15分钟内想出大约五个创意，配备上一个AI后可以想出200个。关键是这些创意的质量还要更高，至少从新产品概念的购买意向调查来看是这样。这样巨大的可能性反而可能让老板们手足无措：如果你什么都能做，最后很容易什么都没做。

LLM的易用性也是有利有弊。有利的一面是，越多人尝试使用生成式AI，就越能发现它的更多用处。越熟悉LLM，就越懂得如何善用它们。投资了一系列AI项目的里德·霍夫曼（Reid Hoffman）给出了一条简单的建议：先用起来。如果你一年前让ChatGPT写了一首俳句，之后就再没碰过它，那么就该多用用了。

熟悉感也可能对抗人类对自动化的本能的警惕。南洋理工大学的佟思亮及合著者于2021年生成式AI尚未风行之时发表的一篇论文精准地捕获了这种疑惧。该研究表明，AI生成的反馈比人类管理者的反馈更能提高员工的绩效。然而，披露这些反馈来自机器却会产生相反的效果：它破坏了信任，

引发了饭碗不保的恐惧，损害了绩效。多接触LLM有可能缓解这些担忧。

但也未必。这项技术的缺陷让事情变得更复杂。剑桥词典将“hallucinate”（幻觉）选为年度热词，它描述的就是LLM胡说八道的倾向。这些模型目前迅速演进，在这方面应该至少会有所改进。但普林斯顿大学的托马斯·麦考伊（R. Thomas McCoy）及合著者新发表的论文显示，有些问题是根深蒂固的。

现有的模型是用互联网数据训练的，在作答时是根据概率来预测下一个单词，因此可能会被意想不到的问题难倒。ChatGPT背后的LLM是GPT-4，让它把一个数乘以1.8再加上32，它算得很准；让它把同样这个数字乘以1.4再加上31，表现就差多了。造成这种差异的原因是，第一种计算是将摄氏度换算为华氏度的方法，因此在互联网上很常见；第二种计算比较罕见，因此在训练数据中很少出现。闭源模型也会存在这样的缺陷。

除此之外，还有一个现实问题：公司很难跟踪员工使用AI的情况。机密数据可能会被上传，并可能在随后的对话中泄露出去。今年早些时候，电子巨头三星禁止员工使用ChatGPT，因为据称有三星工程师向这个聊天机器人分享了源代码。

能力超凡、使用简单、可能出错，这样的混乱组合让老板难以驾驭。但这也指向了一些经验法则。要有针对性。一些咨询顾问爱谈论“灯塔方法”——选择一个对组织其他部分有指导意义的受控项目。与其禁用LLM，不如制定指引，明确哪些信息可以输入LLM。要了解这项工作的工作原理：它不像开车，不用关心引擎盖下面是什么。最重要的是，要亲自去使用它。生成式AI可能让人感觉神奇，要把它用好却得下苦功夫。■



Crystal balls

A Google AI has discovered 2.2m materials unknown to science

Zillions of possible crystals exist. AI can help catalogue them

CRYSTALS CAN do all sorts of things, some more useful than others. They can separate the gullible from their money in New Age healing shops. But they can also serve as the light-harvesting layer in a solar panel, catalyse industrial reactions to make things like ammonia and nitric acid, and form the silicon used in microchips. That diversity arises from the fact that “crystal” refers to a huge family of compounds, united only by having an atomic structure made of repeating units—the 3D equivalent of tessellating tiles.

Just how huge is highlighted by a paper published in *Nature* by Google DeepMind, an artificial-intelligence company. Scientists know of about 48,000 different crystals, each with a different chemical recipe. DeepMind has created a machine-learning tool called GNoME (Graph Networks for Materials Exploration) that can use existing libraries of chemical structures to predict new ones. It came up with 2.2m crystal structures, each new to science.

To check the machine’s predictions, DeepMind collaborated on a second paper, also published in *Nature*, with researchers at the University of California, Berkeley. They chose 58 of the predicted compounds and were able to synthesise 41 of them in a little over two weeks. The team at DeepMind say more than 700 other crystals have been produced by other groups since they began preparing their paper.

To help any other laboratories keen to investigate the computer’s bounty, the firm has made public a subset of what they think should be the 381,000 most stable structures. Among them are many thousands of crystals with

structures potentially amenable to superconductivity, in which electrical currents flow with zero resistance, and several hundred potential conductors of lithium ions that could find a use in batteries. In both cases DeepMind's work has increased the total number of candidate materials known to researchers tens of times over.

Aron Walsh, a materials scientist at Imperial College London who was not involved in the research, says DeepMind's work is impressive. But "this is the start of the exploration rather than the end," he says, noting that the machine has only scratched the surface of what might be possible. In a recent paper of his own he tried to calculate how many stable crystals incorporating four chemical elements (so-called quaternaries) might be potentially manufacturable. He wound up with a conservative estimate of 32trn. For its part, GNoME looked only at crystals that form under relatively low temperatures and pressures. And crystals are only one subset of a universe of materials that includes everything from amorphous solids such as glass through to gases, gels and liquids.

Whether any of DeepMind's 2.2m new crystals will be useful remains to be seen. Even if they do not, the techniques used to make the predictions could be valuable. Besides suggesting new crystals, AI may also shed light on as-yet-unknown rules that govern how they form.

Ekin Dogus Cubuk at DeepMind highlights one such finding. Previously, he says, crystals made from six elements, called senaries, were thought to be vanishingly rare. But DeepMind's AI found around 3,200 in its sample of 381,000 stable compounds. A better understanding of how crystals form, and what sorts are possible, might also save scientists curious to test how the 2.2m new materials behave from the tedious task of synthesising each one of them by hand. ■



水晶球

谷歌的人工智能发现了220万种科学界未知的材料

有无数种可能的晶体存在。AI可以帮忙罗列和编目

晶体有各种各样的用途，其中一些比另一些用处更大。摆在新时代疗愈店里的那些能让轻信的人乖乖掏出钞票。但它们也可以用作太阳能电池板的光收集层，催化工业反应以制造氨和硝酸等物质，还可以制成用于微芯片的硅。用途如此多样是因为“晶体”指的是一个庞大的化合物家族，它们仅有的共同点是原子结构都由重复的单元组成——相当于三维的瓷砖拼接。

这个家族的成员数量之庞大，在谷歌的人工智能公司DeepMind于《自然》上发表的一篇文章中可见一斑。科学家们已知的晶体大约有48,000种，每种化学成分都不相同。DeepMind开发了一个名为材料探索图谱网络（Graph Networks for Materials Exploration，以下简称GNoME）的机器学习工具，可以运用现有的化学结构库预测新的化学结构。它预测出了220万个晶体结构，每一个在科学上都是全新的。

为了验证这个机器的预测，DeepMind与加州大学伯克利分校的研究人员合作，在《自然》上发表了第二篇论文。他们从所预测出的化合物中选择了58种，并在两周多一点的时间内就成功合成了其中41种。DeepMind的团队表示，自他们开始准备论文以来，其他研究团队已经制造出700多种其他晶体。

为了辅助其他任何有兴趣的实验室探究这一机器学习的丰硕成果，DeepMind公开了38.1万个他们认为最稳定的结构。其中包括成千上万种可能具有超导结构的晶体，电流在其中能以零电阻流动，还有数百种可能用于电池的锂离子导体。在这两个方向上，DeepMind的工作均让研究人员已知的候选材料总数增加了数十倍。

没有参与这项研究的伦敦帝国理工学院的材料科学家阿隆·沃尔什（Aron Walsh）表示，DeepMind的研究令人惊叹。但他说“这只是探索的开始，

而不是终点”，指出这台机器只是触及了所有可能性的皮毛。在他自己最近的一篇论文中，他尝试算出有多少种含有四种化学元素（所谓的四元化合物）的稳定晶体可能被制造出来。他最后得出的保守估计是32万亿种。但GNoME只观察在相对较低的温度和压力下形成的晶体。而晶体只是物质宇宙的一个子集，这个宇宙包括无定形固体（如玻璃）、气体、凝胶和液体等各种形态。

DeepMind的220万个新晶体中有没有哪个会有实际用途还有待观察。即使没有，这种用于预测的方法也可能有重要价值。除了提示新的晶体之外，AI还可能揭示有关晶体形成的尚未破解的规则。

DeepMind的伊金·多乌什·楚布克（Ekin Dogus Cubuk）特别指出了这方面的一个发现。他说，以前人们认为由六种元素组成的六元化合物的晶体非常罕见。但DeepMind的AI在这38.1万种稳定化合物的样本中就发现了大约3200种。如果能更好地了解晶体是如何形成的，以及可能形成什么类型的晶体，那些想对这220万种新材料的性能一探究竟的科学家们也许就不用费力逐一合成它们了。■



Green shoots

In a first, COP28 targets the root cause of climate change

Now to turn diplomacy into action

AS ACTIVISTS AND diplomats first assembled in Dubai for COP28, the UN's climate summit, a fortnight ago, the chances of significant progress seemed slim. War had returned to the Middle East and the geopolitical order was fragmenting. The choice of the summit's host country—the United Arab Emirates, one of the world's leading petrostates—and its chairman, Sultan al-Jaber, the head of its national oil company, threatened to turn the event into a giant exercise in greenwashing.

Instead, COP28 defied the pessimists. For the first time the world has agreed to move away from the coal, oil and natural gas that are the principal causes of global warming. The 198 parties to the UN Framework Convention on Climate Change agreed on a text that called for a transition away from fossil fuels “in energy systems, in a just, orderly and equitable manner”.

Some will be disappointed at the compromises made. The Europeans had hoped to agree to “phase out” fossil fuels entirely, to which fossil-fuel producers refused to sign up. Small island countries say their voices were not heard. The deal states that only “unabated” coal power will be phased down, leaving the option of the dirtiest fuel continuing to be burnt as long as its emissions are captured at source. Nonetheless, the document is an important, and realistic, step forward.

The call to phase out fossil fuels was both politically naive and economically unfeasible. COP operates by consensus, meaning that the big petrostates had a veto on any deal. Moreover, fossil fuels are likely to remain part of the energy mix for decades to come. Even optimistic forecasts suggest a substantial role for oil and gas, balanced by

technologies that remove their greenhouse-gas emissions, in scenarios for the world to achieve net zero by 2050. Although clean energy has made vast strides, it is unlikely to displace fossil fuels fully by then.

Climate diplomacy also proved to be more potent than the pessimists had expected. Mr al-Jaber proved keener to ensure a negotiating success for his country than to distort the process to favour its economic interests. An early pledge from 50 oil companies, including Mr al-Jaber's firm, to reduce their emissions of methane, a potent greenhouse gas, suggests that there were some benefits to an oilman running the show.

An agreement between America and China ahead of the summit helped lay the groundwork. It meant that the two largest polluters and geopolitical rivals together pressed for restoring some language on fossil fuels into the deal, which helped steer recalcitrant petrostates towards agreement. Even the choice of the venue for next year's summit—Baku—was a symbol of harmony. Armenia lent its support for Azerbaijan's bid as the two warring neighbours inch towards peace.

Yet a global agreement is only one small step. A far bigger and harder one will be to translate words on a page into action in the real world. The deal sends a signal to oil companies, especially in rich countries, that they may find it harder to do business, for example because of legal challenges to exploration licences. But reducing reliance on fossil fuels will ultimately depend on making them uncompetitive. A combination of carbon prices and well-targeted subsidies for clean technologies can do so in the rich world.

Poorer countries will need help. The summit largely sidestepped this thorny issue. Developing countries with fossil-fuel reserves argued that it was unfair to expect them to forgo one of their few revenue streams without being given aid to do so. According to the Energy Transition

Commission, a think-tank, getting rid of coal power early will require the rich world to make available around \$25bn-50bn a year in grants and other concessional finance to poor countries over the rest of this decade, to retire coal assets early.

This provides the backdrop for a fierce battle. Projects in poor countries are much costlier than those in rich ones, because the private sector demands a premium to compensate for the associated risk. But rich countries will try to limit their financial obligations to the developing world. Bridging the gap, far more than diplomatic backslapping in Dubai, will determine whether the beginning of the end for the fossil-fuel era has come. ■



【首文】绿芽萌发

COP28瞄准气候变化的根本成因，这是第一次

现在，把外交转化为行动吧

两周前，气候活动人士和外交官们最初齐聚迪拜参加联合国气候大会COP28时，取得显著进展的机会似乎显得很渺茫。中东再次爆发战争，地缘秩序分崩离析。峰会主办国阿联酋是全球的主要产油国之一，峰会主席苏丹·贾比尔（Sultan al-Jaber）是该国国家石油公司的负责人，这使得此次会议有可能演变成一场大型漂绿行动。

然而，COP28打破了悲观者的预期。世界各国首次同意摆脱煤炭、石油和天然气这些导致全球变暖的主要成因。联合国气候变化框架公约的198个缔约方达成了一项协议，其中呼吁“以公正、有序、公平的方式减少能源系统”对化石燃料的依赖。

一些人会对这当中所做的妥协感到失望。欧洲人本希望达成“逐步淘汰”化石燃料的协议，但化石燃料生产国拒绝签署。小岛国表示它们的声音未被听到。协议规定只是将逐步淘汰“未经消减技术处理”的煤电，这意味着这种最脏的燃料仍可能继续燃烧，只要其排放在源头被捕获即可。尽管如此，这份文件仍是迈出了重要而务实的一步。

逐步淘汰化石燃料的呼吁在政治上很天真，在经济上也不可行。COP通过达成共识来运作，这意味着大型产油国对任何协议都有否决权。而且，化石燃料在未来几十年内很可能仍是能源组合的一部分。即使乐观的预测也显示，在实现2050年全球净零排放的情境中，在经减排技术处理后，石油和天然气仍将发挥实质性作用。尽管清洁能源取得了巨大的进展，但到那时它仍不太可能完全取代化石燃料。

气候外交也比悲观者的预期更有成效。事实证明，贾比尔更愿意为他的国家争取一次谈判成功，而不是为其经济利益而扭曲谈判。包括贾比尔的公司在内，有50家石油公司在之前承诺减少排放强效温室气体甲烷，这表明

由一位石油专业人士主持会议确实带来了一些好处。

在此次峰会前，中美两国达成的协议帮助奠定了基础。这意味着全球最大的两个污染国和地缘竞争对手共同推动了在协议中重新加入一些关于化石燃料的内容，帮助引导了顽固的产油国同意协议。甚至明年峰会的举办地巴库（Baku）也是和谐的象征。亚美尼亚支持阿塞拜疆申办峰会，这两个交战邻国正逐渐走向和平。

然而，达成一项全球协议只是迈出了一小步。远为重大和艰巨的一步将是把纸面上的言辞转化为现实世界里的行动。该协议向石油公司发出信号，特别是富裕国家的石油公司，预示它们可能会发现经营变得更加困难，例如获得勘探许可要面对法律挑战。但要减少对化石燃料的依赖，最终就得要让它们失去竞争力。在富裕国家，同步实施碳定价和对清洁技术的精准补贴可以实现这一点。

贫穷国家将需要帮助。峰会在很大程度上回避了这个棘手的问题。拥有化石燃料储量的发展中国家认为，不给予援助就期望它们在收入来源本就不多的情况下放弃其中一项是不公平的。据智库能源转型委员会（Energy Transition Commission）称，如果要尽早淘汰煤电，富裕国家就要在2030年前每年向贫穷国家提供250亿至500亿美元左右的拨款和其他优惠融资，以让煤炭资产提前退役。

这为一场激烈的斗争提供了背景。贫穷国家的项目成本要远高于富裕国家，因为私营部门会要求溢价来弥补相关风险。但富裕国家将力求限制它们对发展中国家的财务责任。弥合这道鸿沟将决定是否能够开启化石燃料时代的终篇，远重要过在迪拜外交场面上的握手寒暄。■



The southern strategy

Why Chinese companies are flocking to Mexico

The country offers a back door to the United States

CHINESE INVESTMENTS have been pouring into Mexico lately. Last month alone brought two notable ones. The government of Nuevo León, a northern state bordering the United States, announced that China's Lingong Machinery Group, which makes diggers and other construction equipment, would build a factory that it estimates will generate \$5bn dollars in investment. The same day Trina Solar, a solar-panel manufacturer, said it would invest up to \$1bn in the state. Both companies and their corporate compatriots can now find a home away from home at Hofusan, a Chinese-Mexican industrial park in Nuevo León.

Chinese companies' heightened interest in Mexico dates to 2018 when Donald Trump, America's president at the time, launched a trade war that included raising tariffs on imports from China. His successor, Joe Biden, has kept the tariffs in place. Mr Biden's own America-first policies, such as the Inflation Reduction Act, are encouraging companies to consider "nearshoring" in North America, in large part to thwart China. The pandemic and the snarl-ups in supply chains it caused also pushed manufacturers to move closer to the American market. And setting up in Mexico has begun to look cheaper, as wages and other costs in China rise.

Mexico has tried to lure Chinese money before. The Mexico-China Chamber of Commerce and Technology organised events in 2008 to encourage the flow of capital but they were unsuccessful, says the chamber's César Fragoz; back then China had no need to use Mexico as a way into America, which had yet to turn its back on Chinese companies. "The irony is that the first to react positively to an explicit policy against China are Chinese firms," says Enrique Dussel Peters of the Centre for Chinese-Mexican Studies at UNAM,

a university in Mexico City.

China gets a back door into America because Mexico is part of a free-trade agreement with the United States and Canada. Depending on what components they use, Chinese companies based in Mexico cannot enjoy all the benefits of the trading bloc, whose rules dictate what percentage of a product must originate in North America. But, Mr Dussel Peters notes, the average American tariff on imports from Mexico in 2021 was 0.2%, far lower than on those from China.

Accurate statistics are hard to come by but, according to some estimates, Chinese foreign direct investment in Mexico increased from a total of \$500m in 2000-04 to \$2.5bn in 2022 alone. That is below a peak of nearly \$6bn in 2016, but more than twice the figure in 2018—and rising (see chart). The nature of these investments differs from how China spends its money in the rest of Latin America. In countries such as Brazil and Chile most Chinese investments are in raw materials or infrastructure, often courtesy of Chinese state-backed companies. In Mexico, Chinese investment is in services and manufacturing, including of electronics, cars and home appliances.

In the 1990s and 2000s Mexican exports to America lost out to Chinese competition. Now Chinese investments are helping Mexico's exporters. In September Mexico overtook China for the first time since the early 2000s to become the leading exporter of goods to the United States. Net trade with China generated 6.8m jobs in Latin America between 1995 and 2021, compared with 6.7m for the region's exchange with the United States. Chinese investors are also less particular about environmental and human rights. And they have learned to deal with the challenges of working in Mexico, such as insecurity and poor infrastructure.

A growing Chinese presence in Mexico could backfire if it raises tensions

with the United States. Most Chinese manufacturing and assembly in Mexico seems to be aimed at exports, observes Mr Dussel Peters—especially to America. This is alarming some lawmakers across the border. In a recent letter to Katherine Tai, the US Trade Representative, four members of Congress warned of Chinese carmakers in Mexico trying to take “advantage of preferential access to the US market through our free-trade agreements and circumvent any [China-specific] tariffs”. If China is too successful in skirting tariffs it may find its back door as well as the front entrance slammed shut. ■



南方策略

中国企业为何涌向墨西哥

该国为通往美国开了个后门

近来中国投资大量涌入墨西哥。仅10月就有两起值得注意的事件。在墨西哥北部与美国接壤的新莱昂州（Nuevo León），州政府宣布，生产挖掘机和其他建筑设备的中国临工重机将在该州建设一座工厂，预计将带来50亿美元的投资。同一天，太阳能电池板制造商天合光能表示将在该州投资多达10亿美元。现在，这两家公司及其他中国企业都可以在新莱昂州的中墨合作的华富山工业园（Hofusan）安家落户。

中国企业对墨西哥兴趣大增可以追溯到2018年，当时的美国总统特朗普发起了贸易战，措施包括提高对中国进口产品的关税。他的继任者拜登维持了加征的关税。拜登自己提出的《通胀削减法案》等美国优先政策正在鼓励美国企业考虑在北美展开“近岸外包”，很大程度上是为了挫败中国。疫情及其造成的供应链混乱也促使制造商向美国市场靠拢。随着中国的工资和其他成本不断上涨，在墨西哥设点开始显得更便宜了。

墨西哥以前尝试过吸引中国资金。墨西哥中国商业科技商会（Mexico-China Chamber of Commerce and Technology）的塞萨尔·弗拉格兹（César Fragoz）表示，该商会在2008年组织了一些活动鼓励中国资本流入，但没有收到成效。当时美国还没有背对中国企业，中国不需要通过墨西哥进入美国。墨西哥城的墨西哥国立自治大学中墨研究中心（Centre for Chinese-Mexican Studies at UNAM）的恩里克·杜塞尔·彼得斯（Enrique Dussel Peters）表示：“吊诡的是，最先对明确针对中国的政策做出积极反应的是中国的企业。”

中国能在墨西哥找到进入美国的后门是因为墨西哥与美国和加拿大签有自由贸易协定。位于墨西哥的中国公司无法享受该自贸区的所有好处，具体要看它们所使用零部件的来源而定，因为根据北美自由贸易区的规定，产品的零部件必须有一定比例来自北美。但杜塞尔·彼得斯指出，2021年美

国从墨西哥进口产品的平均关税为0.2%，远低于从中国进口产品的关税。

虽然很难获得准确的统计数据，但据一些估计，中国对墨西哥的外国直接投资从2000年至2004年间的总计5亿美元上升至2022年的25亿美元。尽管这一数字低于2016年近60亿美元的峰值，但却是2018年的两倍多，而且还在不断上升（见图表）。这些投资的性质不同于中国在拉丁美洲其他地区的投资。在巴西和智利等国，中国的大部分投资都集中在原材料或基础设施方面，通常是靠中国国有企业的支持。在墨西哥，中国的投资则集中在服务业和制造业，包括电子、汽车和家用电器。

在1990年代和2000年代，墨西哥对美国的出口不敌中国。现在，中国的投资正在帮助墨西哥的出口商。9月，墨西哥自2000年代初以来首次超越中国，成为对美第一大商品出口国。1995年至2021年间，与中国的净贸易为拉丁美洲创造了680万个就业岗位，而该地区与美国的贸易创造了670万个就业岗位。中国投资者对环境和人权也没那么多讲究。他们还学会了应对在墨西哥经营的各种挑战，例如不安全和基础设施薄弱等。

如果中国在墨西哥势力日增加剧了它与美国的紧张关系，结果就可能适得其反。杜塞尔·彼得斯表示，大多数中国在墨西哥的制造和组装似乎都是为了出口，尤其是出口到美国。这令一些美国的立法者感到不安。在最近致美国贸易代表戴琪的一封信中，四名国会议员警告说，在墨西哥的中国汽车制造商试图“通过我们的自由贸易协定获得进入美国市场的优惠待遇，并规避所有（针对中国的）关税”。如果中国在规避关税上做得过于成功，可能会发现这扇后门也会和前门一样砰然关闭。■



STIK shift

How economists have underestimated Chinese consumption

The surprising relevance of state-subsidised spicy cucumber

“CONSUMPTION IS THE sole end and purpose of all production,” Adam Smith pointed out. But his “perfectly self-evident” maxim has never held much sway in China. Earlier this year the country’s statisticians revealed that household consumption accounted for only 37% of China’s GDP in 2022, its lowest level since 2014.

Although removing covid-19 controls should have helped lift that figure a bit, tweaks to Chinese data could lift it rather more. China’s headline statistics may understate household income and consumption. Look closer, and both appear higher than reported—and both have risen faster.

For almost two decades, Chinese policymakers have sought to “rebalance” the economy from exports and investment towards spending on more immediate gratifications. “We will work to restore and expand consumption...and increase personal income through multiple channels,” the finance ministry declared in this year’s budget, for example. Yet progress has been slow. In recent years, the IMF has graded China’s efforts on a colour-coded “rebalancing scorecard”. The latest card, published in February, was mostly red.

Advocates of rebalancing typically identify two problems. First, Chinese households save a lot of their income; second, their income is too small a slice of the national cake. The second problem features prominently in the arguments of Michael Pettis, an influential professor at Peking University. In the West, he has noted, household income typically represents 70-80% of GDP. In China, by contrast, it is only 55%. Rebalancing, he has argued, will necessarily involve shifting wealth and therefore power to ordinary

people.

Indeed, some observers now wonder whether Xi Jinping, China's leader, has soured on the goal altogether. For him, the end and purpose of Chinese production is not limited to consumption—it also includes ambitions such as making China a resilient power, less dependent on “chokehold” technologies that are dominated by the West. As a young man, he was “repulsed by the all-encompassing commercialisation of Chinese society”, according to the leaked account of a professor who knew him in the 1970s and 1980s.

But although Mr Xi is no fervent champion of rebalancing, his scorecard may be better than commonly thought. Economists have long believed that China's figures understate household earning and spending. Surveys probably fail to capture the unreported “grey” income of the wealthy. And the national accounts probably still underestimate the implicit “rent” that homeowners pay themselves when they live in property they own.

Less well known are the struggles of China's statisticians to account for goods and services that governments provide to individuals at little or no cost. These transfers include education and health care, not least reimbursements for medicines. They also encompass cultural amenities and subsidised food. Zhu Hongshen of the University of Virginia has highlighted community canteens, often housed in state-owned buildings but operated by private contractors, which provide tasty dishes, such as oyster mushroom or spicy cucumber, at heavily discounted prices.

According to international standards, these goodies should appear in the official statistics as “social transfers in kind” (sometimes abbreviated to STIK). They can then be added to household income and consumption to provide a fuller “adjusted” picture. “In principle, social transfers should be included in a complete definition of income,” argued an international team

of experts known as the Canberra Group in 2001, although they recognised it is not straightforward to do in practice.

China in particular has struggled. In the past, it has not reported them cleanly or separately, shovelling them into other parts of the national accounts, including government consumption. If these transfers are ignored, then the disposable income of China's households was only 62% of national income in 2020 (and as low as 56% in 2010). This seems strikingly low, as Mr Pettis has argued. But that is partly because of everything it leaves out. If social transfers in kind are also stripped out of the disposable income of other countries, their numbers look more like China's. The figure for the euro area would be less than 64% in 2020 (see chart 1). By this measure, a dozen European countries had a smaller income share than China.

Fortunately, China's statisticians can now do better. In the past few years, they have begun publishing figures for social transfers in kind in their annual statistical yearbooks, Mr Zhu has pointed out. These amounted to 6.8trn yuan (\$1trn, or almost 7% of national income) in 2020, larger, as a share of GDP, than America's. That has enabled China's National Bureau of Statistics to publish an "adjusted" figure for disposable income that makes international comparisons with OECD countries easier.

Adding these social transfers in kind raises China's share of household income to 69% of national income, placing it near the bottom of the pack, but not at the very bottom. Moreover, since they have grown faster than the economy over the past decade, they make Mr Xi's rebalancing record more promising. Household consumption, including these transfers, increased from 39% of GDP in 2010 to 45% in 2019 before the pandemic struck (see chart 2).

Such revisions do make government consumption look weaker. And

China's social transfers in kind, as a share of national income, are still not high compared with the OECD average. There is thus scope to raise them. If Mr Xi objects to the commercialisation of Chinese society, the state could instead provide more of the things that he thinks his citizens should be consuming. That would be a way for Mr Xi to rebalance towards consumption without reconciling himself to consumerism. ■



实物社会转移带来的改变

经济学家如何低估了中国的消费

政府补贴的炆黄瓜大有乾坤

“消费是所有生产的唯一归宿和目的。”亚当·斯密指出。但他这句“完全不证自明”的格言在中国却从未产生过太大影响。今年早些时候，中国的统计学家透露，2022年中国的居民消费仅占GDP的37%，为2014年以来的最低水平。

尽管取消新冠疫情控制措施应该稍微提高了这一比例，对中国的数据做些微调却可能大幅提高它。中国公布的核心统计数据可能少算了居民收入和消费。仔细观察，会发现这两项都高于公布数据，而且增速也都更快。

近20年来，中国的政策制定者一直寻求经济“再平衡”——从出口和投资转向更注重即时满足的消费。例如，财政部在今年的预算草案中宣布“要促进恢复和扩大消费……多渠道增加居民收入。”但进展缓慢。近年来，国际货币基金组织用不同颜色标记的“再平衡计分卡”对中国的成果进行评分。今年2月最新发布的计分卡大部分显示为红色。

经济再平衡的支持者通常会指出两个问题。其一是中国居民将很大一部分收入存了起来；其二是他们的收入只占了国民收入大蛋糕中太小的一块。在颇有影响力的北京大学教授迈克尔·佩蒂斯（Michael Pettis）的论述中，第二个问题成为重要的论据。他指出，在西方，居民收入通常占GDP的70%至80%。而在中国，这一比例仅为55%。他认为，经济再平衡必然涉及将财富、继而将权力转移到老百姓手里。

事实上，一些观察人士如今猜测中国领导人习近平是否已经对这一目标彻底失去了兴趣。对他来说，中国生产的归宿和目的并不局限于消费——还包括一些雄心壮志，比如让中国成为韧性强的大国、减少对西方主导的“卡脖子”技术的依赖。根据一份揭秘文件，一位在上世纪七、八十年代就认识习的教授回忆，他年轻时就“反感中国社会铺天盖地的商业化”。

但是，尽管习不是经济再平衡的热切支持者，他的再平衡记分卡得分可能比一般认为的要好。经济学家长期以来都认为，中国的数据少算了居民收入和支出。各项调查可能没有捕捉到富人未申报的“灰色”收入。此外，国民经济账户可能还低估了居住在自有房产中的房主支付给自己的隐性“租金”。

不那么广为人知的是，中国统计人员在核算时很难将政府向个人提供的低成本或免费的商品和服务纳入其中。这些转移支付包括教育和医疗保健支出，尤其是药品报销。它们还包括文化便利设施和受补贴的食品等。弗吉尼亚大学的朱洪申特别提到了社区食堂——它们通常设在公家建筑内，但由私人承包商经营，以非常优惠的价格提供平菇、炆黄瓜等美味菜肴。

按照国际标准，这些福利应该以“实物社会转移”（有时缩写为STIK）的形式出现在官方统计数据中。然后再将它们计入居民收入和消费，就能得到一幅更为全面的“调整后”图景。“原则上，完整的收入定义应该包括社会转移支付。”一个名为堪培拉小组（Canberra Group）的国际专家团队在2001年提出，尽管他们也承认在实际操作中要做到这一点并不容易。

而中国在这方面尤其吃力。过去，中国没有清晰或单独地公布这些数据，而是将它们纳入政府消费等国民经济账户的其他部分。如果忽略这些转移支付，那么2020年中国居民的可支配收入仅占国民收入的62%（2010年则低至56%）。正如佩蒂斯所认为的那样，这一比例看起来低得惊人。但这一一定程度上是由它遗漏的各种因素造成的。如果从其他国家的可支配收入中同样剔除实物社会转移，它们的比例看起来和中国也差不多。比如欧元区2020年的这一比例就会低于64%（见图表1）。按照这一标准，欧洲有十来个国家的居民可支配收入占国民收入的比例低于中国。

所幸如今中国的统计人员可以做得比以前更好了。朱洪申指出，过去几年，他们已经开始在每年的统计年鉴中公布实物社会转移的数据。这部分在2020年达到6.8万亿元人民币（接近国民收入的7%），占GDP的比重超过了美国。这让中国国家统计局能够公布一个“调整后”可支配收入数据，更易于与经合组织成员国进行国际间比较。

如果加上这些实物社会转移，中国居民收入占国民收入的比例将提高到69%，尽管这一数字落后于大部分经合组织成员国，但还不至于垫底。此外，在过去十年里它们的增速快于经济增速，这让习的经济再平衡得分显现出更乐观的前景。把这些实物社会转移包括在内，居民消费占GDP的比例从2010年的39%上升到2019年新冠疫情暴发前的45%（见图表2）。

这样的修正确实让政府消费看起来更疲软了。而中国的实物社会转移占国民收入的比例相比经合组织的平均水平仍然不高。因此还有提升的空间。如果习反对中国社会的商业化，政府可以转而提供更多他认为国民应该消费的东西。这将是习实现朝向消费的再平衡却不向消费主义妥协的一个办法。 ■



Mad man v mad men

Elon Musk's X is especially vulnerable to an ad boycott

The perils of telling advertisers to clear off

FOR SOMEONE who despises the advertising industry, Elon Musk has a way with viral slogans. At a New York Times event on November 29th the world's richest man was asked how he felt about firms pulling ads from X, the social network he bought last year when it was known as Twitter. "If somebody's going to try to blackmail me," he replied, "go fuck yourself." The "GFY" approach, as he dubbed it, may come naturally to billionaires. But it is bold for a company that last year made 90% or so of its revenue from ads. Those that have pulled ads from X include Apple and Disney, whose presence Mr Musk previously cited as evidence that X was a safe space for brands.

Advertisers are worried about unsavoury content on the platform. Since Mr Musk fired 80% of X's staff, including many moderators, more bile seems to be leaking through the filters. Last month Media Matters for America, a watchdog, reported that ads for brands such as IBM had appeared alongside posts praising Adolf Hitler (X disputes this and is suing Media Matters).

Social networks are freer than mainstream media to tell advertisers to get lost. Whereas a typical TV network in America gets most of its ad revenue from fewer than 100 big clients, social networks can have millions of small ones. A year ago the largest, Facebook, was getting 45% of its domestic sales from its 100 biggest advertisers, reckons Sensor Tower, a research firm; a boycott against it in 2020 by more than 600 firms, including giants like Unilever and Starbucks, had little effect on sales. But X lacks Facebook's sophisticated ad-targeting apparatus, and relies on campaigns by big brands. In October 2022, when Mr Musk bought Twitter, its 100 top clients accounted for 70% of American ad sales.

Half of them have since left X, Sensor Tower says. On December 1st Walmart said it had gone, owing to its ads' poor results on X. The impact has been severe. In September Mr Musk said that X's American ad business was down by 60%. Advertisers in other regions may be less bothered by the culture wars that Mr Musk is fighting. But X is unusually reliant on America. Whereas Meta, Facebook's parent company, makes most of its money abroad, 56% of Twitter's revenue came from America before Mr Musk bought it. Even before GFY, Insider Intelligence, another research firm, expected X's worldwide ad sales to fall by more than half this year (see chart).

Mr Musk's fans insist being rude to air-kissing admen and "woke" brands delights X's everyman users. X still has nearly five times as many as Threads, a newish rival from Meta. Yet Sensor Tower reports that the X app is being downloaded less often than a year ago, and estimates that it has lost 15% of monthly users.

Some observers put this down to a purge of bots and fake users. Still, X must monetise the users it has in new ways to make up for the declining ad dollars. One idea is X Premium, which offers extra features and fewer ads for between \$3 and \$16 a month. So far there seem to be few takers: Sensor Tower estimates that X has sold \$60m-worth of subscriptions in the past year, equivalent to 1% of pre-Musk annual ad sales. Mr Musk has talked of turning X into an "everything app", handling payments, calls and more. But even optimists concede this would take years.

Until then, the aim is to replace the departing big advertisers with an army of little ones. X is said to be working on its ad technology for smaller firms, eyeing a Facebook-like long tail of clients. There is no time to lose. Further drops in ad sales could necessitate a bail-out from investors, or from Mr Musk himself. X's employees have their work cut out to attract advertisers faster than their boss repels them. ■



科技狂人对阵广告狂人

马斯克的X公司尤其易受广告商抵制的冲击

让广告主滚蛋的风险

马斯克看不上广告业，对病毒式口号的运用倒是自有一套。在11月29日《纽约时报》举办的一次活动上，有人问这位全球首富对各家公司从他去年收购的社交网络X（当时还叫推特）撤下广告作何感想。“如果有人想以此要挟我，”他回答道，“去他妈的吧。”他口中这种“去他妈”的态度对于亿万富翁来说可能是再自然不过的。但对于一家去年90%左右的收入来自广告的公司而言，就很大胆了。从X上撤下广告的公司包括苹果和迪士尼，而马斯克先前曾以它们的存在为依据，说明X对品牌来说是个安全的空间。

广告主对该平台上的不良内容感到担忧。自从马斯克解雇了X 80%的员工后（其中包括许多审查员），似乎有更多的恶意言论逃过了筛查。上个月，监督组织美国媒体事务（Media Matters for America）报告称，IBM等品牌的广告出现在赞美希特勒的帖子旁边（X对报告所述提出异议并将该组织告上法庭）。

相比主流媒体，社交网络更能随意地叫广告主滚蛋。美国一个普通电视网络的大部分广告收入来自不到100个大客户，而社交网络则可能有数百万个小客户。据研究公司Sensor Tower估计，一年前，最大的社交网络Facebook有45%的国内销售来自其最大的100家广告客户；2020年，包括联合利华和星巴克等巨头在内的600多家公司对它发起抵制，对广告销售几乎没有影响。但是X缺乏Facebook那种先进的广告定向系统，并且依赖大品牌的推广活动。2022年10月马斯克收购推特时，其100个最大客户占到美国广告收入的70%。

据Sensor Tower称，自那以后其中一半的客户已经离开了X。12月1日，沃尔玛表示已经离开，原因是在X上投放的广告效果不佳。影响已经很严重。9月，马斯克表示X在美国的广告业务下降了60%。其他地区的广告主

可能不那么在意马斯克开打的文化战。但X异常依赖美国市场。Facebook的母公司Meta的大部分收入来自海外，而在被马斯克收购之前，推特的56%的收入来自美国。即便在“去他妈”事件之前，另一家研究公司Insider Intelligence也预计今年X的全球广告收入将减少一半以上（见图表）。

马斯克的拥趸坚持认为，冒犯惺惺作态的广告人和倒向“觉醒文化”的品牌让X的普通人用户群体拍手称快。相比于Meta推出的新竞争对手Threads，X仍然拥有近五倍的用户。然而Sensor Tower的报告显示X应用的下载量较一年前有所减少，并估计它失去了15%的月活跃用户。

一些观察人士将这归因于对僵尸虚假账号的清理。即便如此，X必须以新的方式利用现有用户创造收入，以此弥补广告收入的下降。其中一个想法是推出X Premium，每月付费3到16美元可以得到额外功能和刷到更少的广告。到目前为止，似乎没有太多人愿意接受这种模式：Sensor Tower估计，X在过去一年内售出了6000万美元的订阅服务，相当于马斯克收购之前年广告收入的1%。马斯克曾谈到将X打造成一个“全能应用”，能处理支付、通话等等。但即使是乐观派也承认这还得等上好几年。

在那之前，目标是用一大批小广告主取代离开的大广告主。据说X正在为小型企业开发广告技术，像Facebook那样瞄准长尾客户。时间紧迫。如果广告销售进一步下滑，可能就需要投资者或马斯克本人出手援助。X的员工们得拼劲全力，赶在被他们的老板赶走之前吸引来广告主。■



The 5% question

Will China leave behind its economic woes in 2024?

Xi Jinping must decide whether to set an ambitious growth target

AFTER THE global financial crisis of 2007-09, economists quickly understood that the world economy would never be the same again. Although it would get past the disaster, it would recover to a “new normal”, rather than the pre-crisis status quo. A few years later the phrase was also adopted by China’s leaders. They used it to describe the country’s shift away from breakneck growth, cheap labour and monstrous trade surpluses. These changes represented a necessary evolution in China’s economy, they argued, which should be accepted, not resisted too strenuously.

After China’s long campaign against covid-19 and its disappointing reopening this year, the sentiment is popping up again. China’s growth prospects seem “structurally” weaker—one reason why Moody’s, a rating agency, said this week that it might have to cut the country’s credit rating in the medium term. Several economists have declared a new normal in China’s unruly property market. Some commentators hope for a new equilibrium in China’s relations with America following the recent meeting between the two countries’ leaders. In September Cai Fang of the Chinese Academy of Social Sciences identified a “new” new normal, brought about by a mixture of China’s shrinking population, greying consumers and picky employers.

Calibrating the new normal is a matter of some urgency. China’s leaders will soon gather in Beijing for the Communist Party’s Central Economic Work Conference. Their deliberations will help set a growth target for 2024, which will be announced in March. Most forecasters expect China’s economy to grow by less than 5%. Moody’s forecasts 4%. Officials must thus decide how strenuously to resist this slowdown.

If they think it represents a new equilibrium, they may accept it and lower their growth target accordingly. If they think China has room to grow faster, they may stick with the 5% target they set for 2023. Meeting such a goal will be more difficult in 2024 than it was this year, because the economy will not benefit from another reopening boost. However, an ambitious target could also serve a purpose, underlining the government's commitment to growth, and reassuring investors that more fiscal help is on its way if required.

It is impossible to think about how the economy will grow without first considering how China's property slump will end. Although most economists agree that the market "cannot return to its past glory", as Liu Yuanchun of the Shanghai University of Finance and Economics has put it, there is less agreement on how inglorious its future must be. In the past, sales were buoyed by speculative demand for flats from buyers who assumed they would rise in price. In the future, the market will have to cater chiefly to fundamental demand from buyers who want a new or better home.

How much fundamental demand remains? China now enjoys a living area of 42 square metres per person, according to the census of 2020; an amount comparable to many European countries. On the face of it, this suggests that the market is already saturated. But the European figures typically count only the useable area of a property, as Rosealea Yao of Gavekal Dragonomics, a research firm, has pointed out. The Chinese number, on the other hand, refers to everything that is built, including common areas shared by several households.

Ms Yao has estimated that China might eventually reach a living space per person of about 45-50 square metres when common areas are included. The country's property sales might therefore have room to grow from their depressed levels of 2023, even if they never return to the glories of earlier

years. Ms Yao believes that sales needed to fall by about 25% from their levels in 2019. Yet in recent months the drop has been closer to 40%.

Property developers could also benefit from the government's new efforts to renovate "urban villages". As China's cities have expanded, they have encompassed towns and villages that were once classified as rural—the cities move to the people not the other way around. This "in-situ urbanisation" accounted for about 55% of the 175m rural folk who became city-dwellers over the ten years from 2011 to 2020, according to Golden Credit Rating International, a Chinese rating agency. By some estimates, the government's "urban villages" project could span as many as 40m people in 35 cities over the next few years.

China's property slump has also revealed the need for a "new normal" in the country's fiscal arrangements. The downturn has hurt land sales, cutting off a vital source of revenue for local governments. That has made it more difficult for them to sustain the debts of the enterprises they own and the "financing vehicles" they sponsor. These contingent liabilities are "crystallising", as Moody's puts it.

The central government would like to prevent an outright default on any of the publicly traded bonds issued by local-government financing vehicles. But it is also keen to avoid a broader bail-out, which would encourage reckless lending to such vehicles in the future. Although any assistance that the central government grudgingly provides will weaken the public finances, a refusal to help could prove fiscally expensive, too, if defaults undermine confidence in the state-owned financial system. For now, the relationship between China's central government, its local governments and local-government financing vehicles remains a work in progress.

Whatever happens, property seems destined to shrink in the medium term. What will take its place? Officials have begun to talk about the "new three",

a trio of industries including electric cars, lithium-ion batteries and renewable energy, especially wind and solar power. But despite their dynamism, such industries are relatively small, accounting for 3.5% of China's GDP, according to Maggie Wei of Goldman Sachs, a bank. In contrast, property still accounts for almost 23% of GDP, once its connections to upstream suppliers, consumer demand and local-government finances are taken into account. Even if the "new three" together were to expand by 20% a year, they cannot add as much to growth in the next few years as the property downturn will subtract from it (see chart 1).

| *Under the hammer*

The new three as a group are also not as labour-intensive as property, which generates a useful mixture of blue-collar jobs (builders) and white-collar careers (estate agents and bankers). A period of transition from one set of industries to another can make jobs and career paths less predictable. Mr Cai worries that this labour-market uncertainty will inhibit spending by Chinese consumers, who will anyway become more conservative as they age.

During erratic pandemic lockdowns, consumer confidence collapsed and household saving jumped (see chart 2). Many commentators believe that the experience has left lasting scars. Consumers still say they are gloomy in surveys. Yet they seem less stingy in the shops. Their spending is now growing faster than their incomes. They have, for example, snapped up Huawei's new Mate 60 smartphone, with its surprisingly fast Chinese chips.

One question, then, is whether China's new normal will feature a permanently higher saving rate. Some economists fear that further declines in house prices will inhibit consumption by damaging people's wealth. On the other hand, if people no longer feel obliged to save for ever-more

expensive flats, then they might spend more on consumer items. Hui Shan of Goldman Sachs argues that retail sales, excluding cars and “moving-in items”, such as furniture, are, if anything, negatively correlated with house prices. When homes become cheaper, retail sales grow a little faster. She believes the saving rate will continue to edge down, albeit gradually.

What do these shifts add up to for the economy as a whole? The consensus forecast for Chinese growth next year is of about 4.5%. China’s policymakers might accept this as the new normal for the economy, just as they accepted the slowdown after 2012. But should they?

According to economic textbooks, policymakers can tell when an economy is surpassing its speed limit when it starts to overheat. The traditional sign of overheating is inflation. By that measure, China can grow faster than its present pace. Consumer prices fell in the year to October. And the GDP deflator, a broad measure of prices, is forecast to decline this year (see chart 3), raising the spectre of deflation.

Another potential sign of overheating is excessive lending. The Bank for International Settlements, a club of central bankers, calculates a country’s “credit gap”, which compares the stock of credit to companies and households with its trend. From 2012 to 2018 and again in mid-2020, China’s credit gap surpassed the safe threshold of 10% of GDP. Yet the gap has since disappeared. China’s problem now is not excessive credit supply to companies and households. It is weak loan demand.

Therefore neither test suggests that China’s economy is growing too fast. And growing too slowly poses its own dangers. If China’s policymakers do not do more to lift demand, they might fail to dispel deflation, which will erode the profitability of companies, increase the burden of debt and entrench the gloominess of consumers. After the global financial crisis, many economies “muddled along with subpar growth”, as Christine

Lagarde, then head of the IMF, put it. They resigned themselves to a “new normal”, only to instead lapse into a “new mediocre”. China could find itself making the same mistake. ■



5%问题

中国能在2024年摆脱经济困境吗？

习必须决定是否设定一个高增长目标【深度】

在2007年至2009年的全球金融危机过后，经济学家们很快就意识到，世界经济将再无法回到过去。尽管它会渡过难关，但只会恢复到一种“新常态”，而非危机前的状态。几年后，中国领导人也采用了这个词，用它描述中国从飞速增长、廉价劳动力和巨额贸易顺差的状态的转变。他们认为，这些变化代表了中国经济的必然演进过程，应该接受它而非竭力抵抗。

经历了长时间的新冠疫情管控后，中国今年重启经济，但表现令人失望，让这种论调再度浮现。中国的增长前景似乎呈现“结构性”疲软，这也是评级机构穆迪近期表示可能不得不下调中国中期信用评级的原因之一。多位经济学家宣称中国难以管控的房地产市场步入了新常态。一些评论人士希望，在中美两国领导人近期会晤后，两国关系能找到一个新的平衡。9月，中国社会科学院的蔡昉指出，中国人口减少、消费人群老龄化、雇主变得挑剔，这些因素的混合带来了一种“新”新常态。

因应新常态做调整成了当务之急。中国领导人很快将在北京召开中共中央经济工作会议。他们的商议将帮助制定2024年的经济增长目标，该目标将于明年3月公布。多数人预测中国经济增长将低于5%。穆迪的预测为4%。因此，官员们必须决定要花多大的力气抵抗这种经济减速。

如果他们认定这是一种新的平衡，也许就会接受现状并相应调低增长目标。假如他们认为中国经济仍有加快增长的空间，则可能沿用对2023年设定的5%的目标。要在2024年实现这样的目标将比在今年更困难，因为经济不会再一次因重启受到提振。不过把目标定高一点也可能有用处，能突显政府求增长的决心，并使投资者相信在必要时政府会提供更多财政支援。

要思考中国经济的增长前景，就不能不先讨论中国的房地产业将如何走出低迷。尽管大多数经济学家都认同上海财经大学校长刘元春所说的中国房地产市场“不能重返过去的辉煌”，但至于未来会多黯淡，看法就没那么一致了。过去，预期房价会上涨的购房者的投机性需求推高了销售。而未来，市场将只能主要满足购买首套房或者改善型住房的基本需求。

这样的基本需求还有多少？2020年的人口普查显示，中国当前人均居住面积为42平方米，与许多欧洲国家相当。表面上看，这表明市场已经饱和。但正如研究公司龙洲经讯（Gavekal Dragonomics）的咬丽蕾所指出的，欧洲的数字通常只计算房屋使用面积。但中国的数字是建筑面积，包括了多户分摊的公共区域面积。

据咬丽蕾估计，中国含公摊面积的人均居住面积最终可能达到45至50平方米左右。因此，中国的房地产销售即使永远无法重返过去的辉煌，却可能仍有机会在2023年的低迷水平上实现增长。她认为销售额会跌至比2019年低约25%。但最近几个月的降幅已接近40%。

房地产开发商也可以从政府新启动的“城中村”改造中获益。随着中国城市的扩张，以往被归为农村的乡镇和村庄已被城市包围——是城市走向人们，而不是反过来。据中国评级机构东方金诚的数据，在2011年到2020年的十年间，1.75亿农村人口变为城镇居民，其中约55%属于这样的“就地城镇化”。一些估计显示，未来几年，中国政府的“城中村”改造项目将覆盖35个城市的4000万人口。

中国房地产的低迷也揭示出中国财政措施需要进入一个“新常态”。经济放缓影响卖地，切断了地方政府一个至关重要的收入来源。这使它们更难承受下属企业和它们发起的地方“融资平台”的债务压力。正如穆迪指出，这些或有负债正在“明晰化”。

中央政府想阻止由地方政府融资平台发行的任何公开交易的债券发生直接违约。但它也很希望避免更广泛的救助，因为这会助长日后对这些融资平台轻率放贷。尽管中央政府勉为其难地提供的任何援助都会削弱公共财

政，但如果违约会削弱对国有金融体系的信心，拒施援手也可能带来昂贵的财政代价。目前看来，中央政府、地方政府和地方政府融资平台之间的关系仍在梳理中。

无论如何，房地产部门在中期似乎注定要萎缩。哪些行业能接替它？官员们已经开始谈论“新三样”——电动汽车、锂电池和可再生能源（尤其是风能和太阳能）这三大产业。但高盛的魏美琪指出，尽管势头喜人，但这些产业的规模相对较小，仅占中国GDP的3.5%。相比之下，算上与之关联的上游供应商、消费需求和地方政府财政，房地产仍占到GDP的近23%。即使“新三样”一起以每年20%的速度扩张，在未来几年对经济的拉动也无法弥补房地产衰退对经济的拖累（见图表1）。

| 待价而沽

整体而言，“新三样”的劳动密集程度也不如房地产，后者带来了既包含蓝领工作（建筑工人）又创造白领岗位（房地产经纪和银行员工）的有益组合。从一组行业转到另一组行业的过渡期会使工作和职业发展变得不那么明朗。蔡昉担心，劳动力市场的这种不确定性将抑制中国消费者的支出，他们本来也将随着年龄增长变得更为保守。

在反复无常的疫情封控期，消费者信心崩溃，居民储蓄猛增（见图表2）。许多评论人士认为，这一经历留下了持久的创伤。消费者在接受调查时仍在表达沮丧悲观的情绪。但是他们在商店里购物时似乎又没那么“手紧”。目前居民消费增速高于收入增速。一个例证是他们争相抢购华为搭载了速度出人意料的国产芯片的新款智能手机Mate 60。

那么一个问题是，中国新常态的一个特点会不会是储蓄率长期走高。有经济学家担心房价进一步下跌会令人们财富受损，进而抑制消费。而另一方面，如果人们发觉不必再为购买越来越贵的房子而存钱，他们在消费品上的花销就可能提高。高盛的闪辉认为，如果说零售（不包括汽车，以及家具等“家装用品”）与房价真有什么关联，那也是负相关。房价下降，零售增长会略为加快。她认为储蓄率将继续下降，尽管是逐步下降。

所有这些变化对整体经济有何影响？人们普遍预测明年中国的经济增速在4.5%左右。中国的政策制定者可能接受它为经济的新常态，就像他们接受了2012年后经济放缓的现实一样。但这次他们应该接受吗？

按经济学教科书的说法，在经济刚开始过热时，政策制定者就能判断出经济是否超过速度限制。经济过热的传统标志是通货膨胀。以此标准衡量，中国经济的增速还可以比目前水平更快一些。在截至10月的一年里，消费价格下降。预计GDP平减指数这一衡量物价的宽泛指标今年也将下降（见图表3），引发通缩之忧。

经济过热的另一个潜在迹象是过度放贷。央行组织国际清算银行（BIS）计算一个国家的“信贷缺口”，即比较企业和居民的信贷存量与其长期趋势的偏离度。从2012年到2018年，以及在2020年中期，中国的信贷缺口超过了占GDP10%的安全阈值。但之后这个“缺口”就消失了。中国现在的问题不是企业和居民信贷供应过多，而是贷款需求疲软。

因此，这两个检验指标都没有显示目前中国经济增长过快。而增长过慢会有它自己的问题。假如中国的政策制定者不采取更多措施提振需求，通缩可能将无法避免，进而削弱企业的盈利能力，加重债务负担，加深消费者的悲观情绪。正如国际货币基金组织（IMF）前总裁克里斯蒂娜·拉加德（Christine Lagarde）所说，全球金融危机爆发后，许多经济体“在低于应有水平的增长中混日子”。它们甘愿接受“新常态”，结果却堕入了“新平庸”。中国也可能发现自己在犯同样的错误。■



Free exchange

How to save China's economy

Lessons from the last stimulus for the next one

EARLIER THIS year a Chinese publisher released a translation of “In Defence of Public Debt”, a book by Barry Eichengreen of the University of California, Berkeley, and several others. Reaching deep into history, the book seeks to restore balance to the debate on government borrowing by emphasising its neglected benefits. Mr Eichengreen argues that indebted countries can get into trouble when they turn to fiscal restraint too soon, neglect growth or succumb to deflation, which only makes debt harder to service. The arrival of the translated edition was timely. Many economists believe the Chinese government’s fiscal caution this year has contributed to disappointing growth and the danger of falling prices.

Thankfully, China’s government has now begun to loosen the purse strings. It has taken the rare step of revising its budget-deficit target from 3% of GDP to 3.8%. It has allowed provinces to issue “refinancing bonds”, which will help them repay some of the more expensive debt owed by affiliated infrastructure firms known as local-government financing vehicles. Financial regulators have urged banks to meet the “reasonable” financing needs of the less rickety property developers, without discriminating against private ones. Officials also talk more often about “three major projects”: affordable housing; leisure facilities that can also help China cope with disasters and emergencies; and efforts to renovate “urban villages”, or formerly rural enclaves.

But these steps by themselves will not be enough. Houze Song of MacroPolo, a think-tank, worries that the “stimulus is not big enough to reflate the economy”. The government seems to fear an excessive response more than it fears an inadequate one. Many in China view public debt as

suspect despite the arguments in its favour. Even defenders of public borrowing are careful not to appear too strident. The Chinese edition of Mr Eichengreen's book is not called "In Defence of Public Debt". It carries the more anodyne title "Global Public Debt: Experience, Crisis, Response".

What explains the government's fiscal reticence? It may be ideology. But it may also be recent history. Fifteen years ago this month, China's government announced a fiscal stimulus worth about 4trn yuan (or \$590bn) in response to the global financial crisis. Financial regulators also gave their blessing to local governments to sidestep restrictions on their borrowing by setting up financing vehicles that could issue bonds and borrow from banks. Local governments responded with "frenzied enthusiasm", as Christine Wong of the University of Melbourne put it. With the extra borrowing, the initial 4trn yuan ballooned into 9.5trn yuan (or 27% of 2009 GDP) spread over 27 months.

The frenzy successfully revived growth. But in the years since, stimulus has acquired a stigma in China. Chinese officials have repeatedly warned of the dangers of a similar "flood-like" response to economic slowdowns. The lending spree has been accused of privileging state-owned enterprises, crowding out manufacturing investment, and impeding spending on industrial R&D.

Drawing on confidential loan data from 19 banks, Lin William Cong, now of Cornell University, and co-authors have shown that the increased supply of credit in 2009 and 2010 favoured state-owned enterprises over private firms. And among private firms, it favoured those making less productive use of their capital. The authors guess that in a crisis, banks prefer to lend to companies that enjoy the backing of local governments, whether they be state-owned enterprises or well connected but inefficient private firms. Jianyong Fan of Fudan University and co-authors argue that spending on R&D by industrial firms was squeezed by higher capital costs in parts of the

country where local governments borrowed most heavily. These localities were often led by newly promoted party secretaries who were eager to shine.

It is easy to read these studies and conclude that the 2008 stimulus was a mistake. But the flaws of that response do not mean that it was worse than nothing. The paper by Mr Cong, for example, does not show that the increased supply of credit hurt borrowing by private firms, merely that it benefited them less than it helped state-owned firms. The study of R&D by Mr Fan and his colleagues also controls for each locality's growth rate. That means that if the stimulus boosted growth, and growth boosted R&D, this beneficial effect will be stripped out of their results.

Since the stimulus amounted to a "flood" of lending and investment, it would be surprising if private firms were parched of credit. Indeed, lending to them grew briskly in 2009 and 2010, show figures compiled by Nicholas Lardy of the Peterson Institute for International Economics, a think-tank. Investment by private manufacturers was also strong. Instead stimulus spending crowded out China's accumulation of foreign assets, including the American Treasury bonds bought by its central bank, argues Zheng Song of the Chinese University of Hong Kong, co-author of another influential paper on China's fiscal expansion.

| *Stimulus check*

Looser financial limits on local governments nonetheless cast a "long shadow", as Mr Song's paper put it. Their financing vehicles continued to borrow long after the crisis. Some of the debts these vehicles have accumulated now look impossible for local governments to repay, adding to the gloom hanging over China's economy. Like many economists, Mr Song believes the next stimulus should adopt different fiscal machinery, providing handouts to households. Mainland China could, for example, copy the electronic consumption vouchers distributed in Hong Kong,

which are forfeited if they are not spent within a few months.

Fifteen years on, the side-effects of China's 2008 lending spree are an argument for better stimulus, not zero stimulus. Public borrowing to rescue an economy can leave a difficult financial legacy, as Mr Eichengreen's book points out. But that is different from saying that "not borrowing would have been better". ■



自由交流

如何挽救中国经济

上一次刺激计划为下一次提供的经验教训

今年早些时候，中国的一家出版社出版了《In Defence of Public Debt》一书的中文译本。该书由加州大学伯克利分校的巴里·艾兴格林（Barry Eichengreen）和其他几位作者合著。它深入历史，试图通过强调政府借贷被忽视的好处来让相关辩论重回平衡。艾兴格林认为，背负高额债务的国家如果过早采取财政紧缩措施、忽视增长或接受通缩，可能就会陷入麻烦，结果只会更难偿还债务。其中文版的出版恰逢其时。许多经济学家认为，中国政府今年的财政政策过于谨慎，导致增长令人失望和通缩的危险。

幸好中国政府现在已经开始松开钱袋子。它罕有地将预算赤字目标从GDP的3%修订为3.8%，允许各省发行“再融资债券”，这将帮助它们偿还一部分由名为地方政府融资平台的附属基础设施投资公司欠下的成本更高的债务。金融监管机构敦促银行满足那些状况尚可的房地产企业的“合理”融资需求，不歧视私营开发商。官员也更经常谈论“三大工程”：保障性住房、“平急两用”设施，以及“城中村”改造。

但仅仅这些措施本身是不够的。智库MacroPolo的宋厚泽担心“刺激措施不足以重振经济”。政府似乎更担心刺激过度而非不足。尽管有支持公务债务的理据，但许多中国人仍然对它持怀疑态度。即使是为政府借债辩护的人也小心翼翼，不敢表现得过于激进。艾兴格林那本书的中文版没有按英文标题直译为《捍卫公共债务》，而变成了更温和的《全球公共债务：经验、危机与应对》。

该如何解释政府在财政上的审慎态度？原因也许出在意识形态上，但也可能是并不久远的历史所致。十五年前的11月，为应对全球金融危机，中国政府宣布了约4万亿元的财政刺激计划。金融监管机构还允许地方政府通过设立融资平台规避借贷限制，这些平台可以发行债券并从银行借款。正

如墨尔本大学的黄佩华所说，地方政府积极响应，“热情高涨”。在27个月内，加上这些额外的借贷，最初的4万亿元刺激规模膨胀到了9.5万亿（占2009年GDP的27%）。

这一轮信贷狂潮成功地恢复了经济增长。但在之后的那些年里，刺激措施在中国背上了污名。中国官员一再警告，对经济放缓采取类似的“大水漫灌”式措施存在风险。这轮放贷潮被指特别偏向国企、挤压了制造业投资，阻碍了工业研发支出。

现就职于康奈尔大学的丛林及其合著者此前根据19家银行的机密贷款数据指出，2009年和2010年增加的信贷供应更偏向国企而非私企。而在私企中，更多信贷流向了那些资本利用效率较低的企业。几位作者猜测，在危机中，银行更愿意向享有地方政府支持的企业提供贷款，无论是国企还是有人脉但效率低的私企。复旦大学的范剑勇和合著者认为，在地方政府借贷最多的地区，工业企业的研发支出因资本成本上升受到挤压。这些地方政府的领导者往往是急于出政绩的新晋党委书记。

看完这些研究很容易得出结论，认为2008年的刺激计划是一个错误。但刺激计划有缺陷并不意味着还不如不刺激。例如，丛林的论文并没有显示信贷供应的增加妨碍了私企借贷，只是表明相对于国企，私企从中受益更少。范剑勇和他的同事在对研发的研究中也控制了各地增长率的影响。这意味着，如果刺激措施促进了增长，而增长又促进了研发，那么这种有益影响会被从研究结果中剥除。

既然刺激措施达到了贷款和投资“大水漫灌”的水平，这种情况下如果私企还严重缺乏信贷就有些奇怪了。而事实上，智库彼得森国际经济研究所（Peterson Institute for International Economics）的尼古拉斯·拉迪（Nicholas Lardy）编制的数据显示，2009年和2010年向私企提供的贷款增长迅速。私营制造企业的投资也很强劲。香港中文大学的宋铮与人合著了另一篇关于中国财政扩张的有影响力的论文，他认为刺激性支出反而挤出了中国积累的外国资产，包括央行购买的美国国债数额。

｜ 刺激补贴

尽管如此，正如宋铮的论文所言，对地方政府放松财政限制还是投下了“长长的阴影”。在危机过去很久以后，地方政府融资平台仍在继续借贷。地方政府如今看起来无法偿还这些平台积累的部分债务，加重了中国经济的阴霾。与许多经济学家一样，宋铮认为，下一次刺激措施应该采用不同的财政机制，转而向家庭发放补贴。例如，中国大陆可以复刻香港发行电子消费券的做法，如果在几个月内的期限内没有使用，电子消费券就会自动失效。

十五年过去了，中国2008年信贷热潮的副作用提供的前车之鉴是要采取更好的刺激措施，而不是不采取刺激措施。正如艾兴格林的书所指出的那样，以公共借贷拯救经济可能会遗留财政金融难题。但这并不等同于说“当初不借钱才更好”。■



The Economist Film

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经济学人视频

人造子宫是未来趋势吗？

这项技术是艺术、设计、生物和工程的交汇点，良好的模型是成功的关键。



The World Ahead 2024

Travellers face another year of disruption in 2024

Demand is recovering faster than supply, which means delays and higher prices

NOBODY ENJOYS starting or ending a hard-earned holiday by wasting hours in an airport waiting for a flight. Alas, that is what many travellers will face in 2024.

People have recovered their appetite for whizzing around the world. The UN World Tourism Organisation estimates the global number of travellers will be at 95% of pre-pandemic levels in 2023, up from 63% in 2022, driven by a post-pandemic “revenge tourism” boom. Business travel is also rebounding faster than expected: the Global Business Travel Association now anticipates a return to pre-pandemic levels of business-travel spending in 2024, rather than its previous estimate of 2026.

For the airline industry, however, restoring capacity has not been straightforward. Reversing the mass lay-offs triggered by the pandemic is taking time. With demand for flights outstripping supply, prices have risen faster than inflation, padding airlines’ profits. But operations are buckling under the pressure. In America, the share of flights delayed continues to rise.

Flying will not be the only pain point for travellers in 2024. Cities around the world are cracking down on short-term rentals like those accessed through Airbnb. A new law that came into effect in New York in September requires hosts to register with the city and be present during a guest’s stay. Airbnb calls the law a “de facto ban”. Berlin, Paris and Rome have also implemented restrictions, and others including Vienna will follow suit in 2024. Municipal governments hope these curbs will ease pressure on rents and house prices for residents. For travellers, the result is less choice and

higher prices.

China could yet throw out a wild card. The World Travel and Tourism Council, a trade group, forecasts that Chinese outbound travel-and-tourism spending will reach roughly nine-tenths of 2019 levels in 2024, up from half in 2023. But a flagging Chinese economy could derail that recovery. That would be bad for businesses counting on Chinese demand. For other tourists, however, it might mean a less crowded return to globetrotting.

THOMAS LEE-DEVLIN, Global business correspondent, The Economist ■



世界展望2024

旅行者面临又一个混乱的年份

需求恢复快于供应，导致延误和涨价

没人喜欢以在机场苦等航班来开始或结束一个来之不易的假期。可惜，这将是许多旅行者在2024年的遭遇。

人们已经恢复了在世界各地跑来跑去的兴致。联合国世界旅游组织（UN World Tourism Organisation）估计，在疫情后“报复性旅游”热潮的推动下，2023年全球游客数量将恢复到疫情前水平的95%，高于2022年的63%。商务旅行的反弹速度也快于预期：全球商务旅行协会（Global Business Travel Association）目前预计商务旅行支出将在2024年恢复到疫情前水平，而不是之前估计的2026年。

然而，对于航空业来说，恢复运力没有那么简单。扭转疫情引发的大规模裁员仍需要时间。由于航班供不应求，机票涨价速度已快过通胀，增加了航空公司的利润。但它们的运营难以承受压力。在美国，航班延误的比例持续上升。

旅行者在2024年碰到的麻烦不只在飞行上。世界各地的城市都在打击爱彼迎（Airbnb）等短租民宿。纽约9月生效的一项新法律要求房东向市政府登记，并且在客人入住期间留在出租屋内。爱彼迎称该法律为“事实上的禁令”。柏林、巴黎和罗马也实施了限制措施，维也纳等其他城市也将在2024年效仿。市政府希望这些限制措施能够缓解其居民在房租和房价上的压力。对于旅行者来说，结果是选择更少、价格更高。

中国可能增加事态的不确定性。行业组织世界旅行和旅游理事会（World Travel and Tourism Council）预测，2024年，中国出境旅行和旅游支出将达到2019年水平的约90%，而2023年为2019年的一半。但疲软的中国经济可能会拖累这一复苏。这对于那些依赖中国需求的企业来说不是个好消息。而对于其他游客来说，这可能意味着他们重新踏上环球之旅没那么

拥挤了。

《经济学人》全球商业记者托马斯·李-德弗林■



The World Ahead 2024

New medical treatments will use genetic scissors, and other clever tricks

From sickle-cell disease to glaucoma, these are the drugs to look out for

NEW MEDICINES to treat sickle-cell disease and beta thalassaemia, two genetic blood disorders, will make headlines in 2024. Most notable of these is the first CRISPR-gene-edited drug, which made its historic arrival in late 2023. Gene editing uses molecular scissors to edit DNA. It is a more precise form of modification than gene therapy, an older technology that uses a viral vector to inject a working gene into a cell. Gene editing has moved astonishingly quickly through drug pipelines—much faster than gene therapies, which have been slow and difficult to develop.

For sickle-cell disease, the gene-edited therapy, exa-cel, developed by Crispr Therapeutics and Vertex, is likely to be approved just ahead of a gene-therapy drug from Bluebird Bio, lovo-cel. In both cases, stem cells are first extracted from a patient's body. They are then either edited (exa-cel) or transfected with the viral vector (lovo-cel), and returned to the body, where they correct the genetic defect. The effects are said to last a lifetime.

But these drugs will cost more than \$2m per patient. Even in America some patients will struggle to get hold of them. In poorer countries, where most patients with sickle-cell disease live, they will be impossible to obtain.

The great flexibility of the gene-editing technology, and its ability to target non-genetic diseases, means it has a particularly bright future. The coming year will see progress in efforts by Crispr Therapeutics and Caribou Biosciences to develop off-the-shelf cell products that can treat cancer and other diseases.

The workhorse of the immune system, the T-cell, can be gathered from donors and reprogrammed, via gene editing, to fight cancer without triggering an immune rejection by the patient's body. This approach means that powerful CAR-T treatments no longer have to be manufactured individually, and expensively, for each patient.

Crispr Therapeutics is developing similar technology to create replacement insulin-producing cells in the pancreas. There are also efforts to develop “in vivo” gene editing, to allow gene-editing treatments to be delivered into the body by packaging them in lipid nanoparticles.

Gene-editing technology is advancing in other ways, too. Verve Therapeutics is focusing on cardiovascular disease using a more precise approach to gene editing known as “base editing”, which can change a single base in the genome without damaging the DNA molecule itself. Look for news of its early-stage work, on a treatment to lower cholesterol levels. Meanwhile another treatment, EBT-101 from Excision, which aims to use gene editing to eliminate HIV infection from the body, will complete enrolment of patients for its first phase-1 trial in 2024.

Other coming highlights in the year ahead include a hotly anticipated decision on a new antibiotic for urinary-tract infections, many of which are resistant to existing antibiotics; two “pentavalent” meningococcal vaccines that protect against a wide range of serotypes of meningitis; and an innovative “microinvasive” eye implant that continuously releases minuscule amounts of a drug for glaucoma, an eye disease. It promises to deliver far better results than eye drops, which patients often forget to apply regularly. Yet another exciting new treatment to keep an eye on, you might say, in the coming year.

NATASHA LODER, Health editor, The Economist ■



世界展望2024

新疗法将使用基因剪刀和其他妙招

从镰状细胞病到青光眼，这些是值得留意的药物

治疗镰状细胞病和 β 地中海贫血这两种遗传性血液疾病的新药将在2024年登上新闻头条。其中最引人注目的是首款CRISPR基因编辑药物，它于2023年底历史性地问世了。基因编辑使用分子剪刀编辑DNA，比起使用病毒载体将治疗基因注入细胞的旧技术基因疗法，这种修饰形式更为精确。用基因编辑制造新药的进展快得惊人——相比研发缓慢又困难的基因疗法要快得多。

在镰状细胞病上，由Crispr Therapeutics和Vertex研发的基因编辑药物exa-cel很可能会比Bluebird Bio的基因疗法lovo-cel先一步获批。两种疗法都先从患者体内提取干细胞，然后编辑它们（exa-cel）或用病毒载体转染（lovo-cel），然后回输到患者体内，纠正遗传缺陷。据称疗效持续一生。

但这些药物的花费超过每名患者200万美元。即使在美国，一些患者也很难买到它们。而在大多数镰状细胞病患者居住的较贫穷国家根本无处可寻。

基因编辑技术具有巨大的灵活性，并且能以非遗传性疾病为标靶，这使得它显现出特别光明的前景。明年，Crispr Therapeutics和Caribou Biosciences将在开发可治疗癌症和其他疾病的开架细胞治疗产品方面取得进展。

免疫系统的主力军T细胞可以从捐赠者那里收集到，并通过基因编辑重编程以对抗癌症，而不会引发患者身体的免疫排斥。有了这种方法后，强大的CAR-T细胞疗法就不再需要以高昂的成本为每名患者定制实施了。

Crispr Therapeutics正在研发类似的技术来制造胰腺中生成胰岛素的胰腺

细胞的移植细胞。人们也在致力开发“体内”基因编辑，把基因编辑药物包装在脂质纳米粒中递送入体内。

基因编辑技术也在其他方面取得进展。Verve Therapeutics正在使用一种名为“碱基编辑”的更精确的基因编辑法来对抗心血管疾病，这种方法可以改变基因组中的单个碱基而不损坏DNA分子本身。用它来降低胆固醇水平的前期研究很快会有结果。与此同时，来自Excision的另一种疗法EBT-101旨在利用基因编辑消除体内的艾滋病毒感染，将于2024年完成首次1期试验的患者入组。

未来一年的其他亮点包括：一种治疗尿路感染的新抗生素将迎来备受期待的审评决定，这类感染中有许多对现有抗生素耐药；两种“五价”脑膜炎球菌疫苗，可预防多种血清型脑膜炎；还有一种创新的“微创”眼部植入物，能持续释放微量的青光眼药物。它的疗效有望远好过滴眼液，因为患者常常会忘记定期使用滴眼液——你可能会说，这是来年又一个值得我们拭目以待的新疗法。

《经济学人》医疗编辑娜塔夏·洛德 ■



The World Ahead 2024

Self-driving cars are slowly moving forward

Having kept riders waiting for years, they are finally arriving

A HIGH-PERFORMANCE sensor is not needed to detect the list of missed targets for the widespread adoption of self-driving cars. General Motors once promised autonomous vehicles (AVs) in abundance by 2019. Ford and Lyft, a ride-hailing firm, had reckoned 2021 was more plausible. For a decade, Elon Musk has loudly proclaimed that fully autonomous Teslas were a year away at most. Taking a nap behind the wheel on a tediously long drive remains a distant dream. But broad adoption of AVs will inch closer in 2024.

In the coming year robotaxis will spread beyond test zones and powerful self-driving features will become available to more motorists. The pursuit of autonomy has split into three camps: firms working on fully autonomous robotaxis; carmakers focused on various forms of driver assistance; and Tesla, which does its own thing.

Hailing robotaxis will become more commonplace. Waymo (owned by Alphabet) and Cruise (GM's AV arm), have long been testing vehicles. They have been charging for rides in San Francisco around the clock, with no need for safety drivers (though Cruise's licence was suspended in October after an accident involving a pedestrian).

In 2024 such vehicles, already operating in Austin, Los Angeles and Phoenix, as well as AVs from Amazon's Zoox, may pop up in other American cities including Atlanta, Miami and Seattle. In China, Baidu, a tech giant, and Pony.ai, also both with small operations in Beijing and other cities, have similar expansion plans—in Baidu's case to 65 cities by 2025.

Establishing a robotaxi business requires years of investment, and the prospects remain uncertain. Many carmakers think a faster route to profit is to add self-driving tech to ordinary cars. Some already have “level 2” systems that can steer, brake and change lanes. But Mercedes-Benz is leading the way with Drive Pilot, a “level 3” system that does not require constant supervision. Already available in Germany, it will become available in several American states in 2024, as a \$2,500-a-year subscription option in some of the firm’s fanciest models. Crucially, Mercedes assumes full legal liability when Drive Pilot is on. Other carmakers are not far behind: Ford, Stellantis and others are likely to launch similar “level 3” systems in 2024.

And that leaves Tesla. Despite much hype, its self-driving system is “level 2”, requiring constant supervision and hands on the steering wheel. Mr Musk claims the next version, likely to be made available in 2024, provides a far higher level of autonomy. Perhaps it will. One way or another, the driverless journey is creeping ever closer.

SIMON WRIGHT, Industry editor, The Economist ■



世界展望2024

自动驾驶汽车正在缓慢前行

在让乘客等待多年之后，它们终于要来了

用不着高精度传感器就可以看到自动驾驶汽车在通往普及的路上曾有多少目标没能达成。通用汽车公司曾承诺在2019年之前大量普及自动驾驶汽车。福特汽车和网约车公司Lyft则认为2021年更现实些。十年来，马斯克一直大声宣称，完全自动驾驶的特斯拉汽车最多还需要一年时间就将问世。在乏味的长途驾驶中，坐在方向盘前打个盹仍然是一个遥不可及的梦想。但在2024年，自动驾驶汽车的广泛应用将又向我们靠近一点点。

在未来的一年里，自动驾驶出租车将超越测试区，更多的驾驶者将享受到强大的自动驾驶功能。对自动驾驶的追求分为三个阵营：致力于开发完全自动驾驶出租车的公司；专注于各种形式的驾驶辅助功能的汽车制造商；以及独辟蹊径的特斯拉。

呼叫自动驾驶出租车将变得更加普遍。Waymo（Alphabet旗下公司）和Cruise（通用汽车的自动驾驶部门）早已开始测试车辆。它们在旧金山昼夜不停地收取乘车费用，不需要安全驾驶员（不过Cruise在10月份发生一起涉及行人的事故后被吊销了许可）。

2024年，已在奥斯汀、洛杉矶和凤凰城运营的此类车辆以及亚马逊Zoox公司的无人车可能会出现在亚特兰大、迈阿密和西雅图等其他美国城市。在中国，科技巨头百度和小马智行（Pony.ai）都在北京和其他城市有小规模运营，也有类似的扩张计划——百度的计划是到2025年扩张到65个城市。

建立自动驾驶出租车业务需要多年投资，前景仍不明朗。许多汽车制造商认为，为一般车辆添加自动驾驶技术是更快实现盈利的途径。一些汽车制造商已经拥有“2级”系统，可以转向、刹车和变道。但梅赛德斯-奔驰率先推出了驾驶领航（Drive Pilot），这是一种无需持续监控的“3级”系统。该系统已在德国投入使用，并将于2024年铺开到美国的几个州，为该公司最

豪华的一些车型提供每年2500美元的订户选项。最重要的是，梅赛德斯将在驾驶领航功能开启时承担全部法律责任。其他汽车制造商也不甘落后：福特、斯特兰蒂斯和其他公司也很可能在2024年推出类似的“3级”系统。

剩下的就是特斯拉了。尽管大肆炒作，但特斯拉的自动驾驶系统仍属于“2级”，需要持续的监督和手握方向盘。马斯克声称，可能在2024年推出的下一个版本的自动驾驶水平要高得多。也许会吧。无论如何，无人驾驶之旅正在悄然接近。

《经济学人》产业编辑西蒙·赖特 ■



The World Ahead 2024

EVs are poised to make China the world's biggest car exporter

Its lead in battery-making is crucial

COMBUSTION ENGINES in motor vehicles account for about 15% of carbon-dioxide emissions each year. Eliminating them requires the electrification of transport, which in turn requires batteries in unprecedented quantities. In 2024 the outlines of a new global battery-production infrastructure will come into focus in China, Europe and America—a network of factories capable of churning out batteries in sufficient amounts to store the energy required to propel the global fleet of vehicles.

The majority of battery factories, existing and planned, are in China. Many in Europe are being built by Chinese firms. Benchmark Mineral Intelligence, a firm of analysts, says that China will have 69% of global battery-production capacity by 2030, down from 78% in 2022, but still sufficient to make enough batteries for 90m cars every year. Europe and America, in contrast, are each forecast to have around 14% of global capacity by 2030, enough for 19m vehicles each.

China holds this lead in part because its government has been supporting electric-vehicle (EV) manufacturing and adoption for longer. Tax breaks for EV purchases began in the early 2010s, and by 2022 the Chinese government had poured around \$30bn into supporting the market through consumer incentives alone; EV manufacturers received further support through local governments. These subsidies created competition between many new EV companies. Most have now gone bust, leaving winners such as BYD and CATL in a strong position. China's pre-existing strengths in the electronics supply chain also gave EV manufacturers a boost. By 2010 there were already more than 100m electric bikes in China, thanks to government bans of petrol-powered motorcycles in city centres.

Europe and America have only recently started to catch up. In America the Inflation Reduction Act (IRA), passed in 2022, provides tax breaks for EV buyers, but only if the car contains no parts from China or Russia. The IRA also offers battery-makers a tax credit which covers about one-third of the cost of production. All told, Benchmark calculates that American automakers will receive \$140bn in subsidies over the next decade. In early 2023 the European Union proposed a similar measure, the Green Deal Industrial Plan, which opened the way for member-states to offer subsidies of their own, as well as providing some funding.

Thanks to these stimulus efforts, it now looks as though both Europe and America will have sufficient battery-production capacity to cover domestic demand for EVs by 2030. China is set to have three times more battery capacity than it needs to service its home market. As 2024 begins, China is poised to become the world's largest car exporter for the first time. And no matter how much money Europe and America spend trying to catch up, China's battery dominance will last for the foreseeable future.

HAL HODSON, Special projects writer, The Economist ■



世界展望2024

电动汽车将使中国成为全球最大的汽车出口国

它在电池制造方面的领先地位至关重要

机动车中的内燃机每年导致了约15%的二氧化碳排放。要淘汰内燃机，就必须实现交通电气化，而这又需要数量空前的电池。2024年，一个新的全球电池生产基础设施的轮廓将在中国、欧洲和美国显现出来——这个工厂网络能够生产出足够多的电池来储存驱动全球汽车所需的能量。

大多数现有和规划的电池工厂都位于中国。欧洲的许多工厂都是由中国公司建造的。分析机构基准矿物情报（Benchmark Mineral Intelligence）称，到2030年，中国将拥有全球电池生产能力的69%，低于2022年的78%，但仍满足每年生产9000万辆汽车所需的电池。相比之下，预计到2030年，欧洲和美国的产能将各占全球产能的14%左右，分别足够装配1900万辆汽车。

中国之所以领先，部分原因是中国政府支持电动汽车制造和落地的时间更长。中国政府从2010年代初就开始实行电动汽车购置税减免，到2022年，仅通过消费者激励措施就投入了约300亿美元支持电动汽车市场；电动汽车制造商还通过地方政府获得了进一步支持。这些补贴造成了许多新兴电动汽车公司之间的竞争。现在，大多数此类公司都已倒闭，而比亚迪和宁德时代等赢家则占据了强势地位。中国原有的电子产品供应链优势也为电动汽车制造商助推了一把。由于政府禁止在市中心使用汽油动力摩托车，到2010年，中国的电动自行车保有量已超过1亿辆。

欧洲和美国最近才开始迎头赶上。在美国，2022年通过的《通货膨胀削减法案》（IRA）为电动汽车购买者提供税收减免，但前提是汽车不含来自中国或俄罗斯的零部件。IRA还为电池制造商提供税收减免，减免额约为生产成本的三分之一。根据基准矿物情报的计算，未来十年美国汽车制造商将获得1400亿美元的补贴。2023年初，欧盟提出了一项类似的措施，即《绿色交易工业计划》，为成员国自行提供补贴和部分资金开辟了道路。

得益于这些刺激措施，现在看来，到2030年，欧洲和美国的电池生产能力将足以满足国内对电动汽车的需求。中国的电池产能将是其国内市场需求的三倍。到2024年，中国就将首次成为世界上最大的汽车出口国。而无论欧洲和美国花多少钱试图赶上，在可预见的未来，中国在电池方面的主导地位都将持续下去。

《经济学人》特别项目撰稿人哈尔·霍德森 ■



The World Ahead in 2024

The fight to control the headset market will intensify

They are the next big tech platform

THE MOST eagerly awaited gadget of 2024 is Apple's Vision Pro, a sleek headset that can transport users to the middle of a "Star Wars" battlefield, or simply project the world's biggest Excel spreadsheet into their office. The magic goggles combine virtual reality (VR) with "mixed reality", using front-mounted cameras to show the user a live video-feed of the outside world, onto which computer graphics can be superimposed. The device is controlled with eye movements and hand gestures. Apple calls it the most ambitious product it has ever made. At \$3,499 its price is ambitious, too.

Apple will be jostling for consumers' attention with various rivals. Chief among them is Meta, formerly known as Facebook, which had a big hit with its Quest 2 headset during covid-19 lockdowns, when the metaverse was briefly more enjoyable than real life. It launched an upgraded Quest 3 late in 2023, offering mixed reality. The Quest 3 is more basic than Apple's device, but at \$499 will outsell it. Fancier models will follow.

Google may re-enter the headset race. A decade ago it launched camera-toting smart specs called Google Glass, which flopped. Plans for high-tech glasses called Iris seem to have gone the same way. Its latest gambit is a partnership with Samsung, a South Korean giant, and Qualcomm, an American chipmaker. The three are working on a mixed-reality project which may produce a headset.

Smaller firms are creating their own niches. Valve, an American video-game company, makes VR headsets for gamers, as does Pico, a Chinese-owned VR firm. Pico's parent company, Bytedance, also owns TikTok, an app that has aroused suspicion in America—a situation that might make it

hard to sell a device that tracks your eyeballs.

Don't expect any headset to take the world by storm just yet. Worldwide sales of video headgear will grow by a third in 2024, but will still total only 18m units, forecasts Omdia, a market-research company. (Smartphone sales will exceed 1bn.) Apple's Vision Pro will probably sell fewer than 200,000 units, because of supply constraints on components, as well as the price tag. It "will be a hit with developers in 2024 and then consumers in 2025", predicts Dan Ives of Wedbush Securities, an investment company.

The thing to watch in 2024 is what those developers find to do with the device. Smartphones took off only after the launch of apps that turned internet-connected phones from novelties into vital everyday tools.

Headsets, used mostly for gaming, still lack compelling use cases for most people. But as programmers begin to play around with the Vision Pro, that could change. In the months ahead, tech-watchers will have their eyes on Apple's new gadget—and it will have its four internal cameras looking right back at them.

TOM WAINWRIGHT, Technology and media editor, The Economist ■



世界展望2024

头显市场争霸战将愈演愈烈

它们是下一个大技术平台

2024年最受期待的电子产品是苹果的Vision Pro。这款时尚的头显可将用户带至“星球大战”战场的中心，或将世界上最大的Excel电子表格投影到他们的办公室里。这款神奇的眼镜把虚拟现实（VR）与“混合现实”结合起来，使用前置摄像头向用户展示外部世界的实时视频，并可在其上叠加计算机图形。该设备用眼球移动和手势控制。苹果说它是该公司史上最宏伟大胆的产品——它3499美元的定价也是。

苹果将与各种竞争对手争夺消费者的注意力。首当其冲的是Meta（原Facebook），该公司在疫情封锁期间推出的Quest 2头显大受欢迎，当时元宇宙一度变得比现实生活还有趣。它于2023年末推出升级版Quest 3，提供混合现实功能。Quest 3比苹果的设备更基础，但因售价仅499美元，销量会更大。之后还会推出更高级的版本。

谷歌可能会重新加入头显竞赛。十年前，它推出了名为谷歌眼镜的带摄像头的智能眼镜，但以失败告终。名为Iris的高科技眼镜计划似乎再度折戟。它的最新招数是与韩国巨头三星和美国芯片制造商高通合作。三家公司正在开发一个混合现实项目，可能会带来一款头显。

较小的公司正在创造自己的利基市场。美国视频游戏公司Valve为游戏玩家生产VR耳机，中国的VR公司Pico也一样。Pico的母公司字节跳动还拥有TikTok，这款应用在美国引发质疑，这种局面可能会导致Pico很难销售一款追踪眼球的设备。

目前还不要期待哪款头显能够席卷全球。市场研究公司Omdia预测，在2024年，视频头戴设备的全球销量将增长三分之一，但总量将仍仅为1800万套。（智能手机销量将超过10亿部。）苹果的Vision Pro由于零部件供应限制以及价格高昂，销售量可能不会超过20万部。投资公司韦德布什证

券（Wedbush Securities）的丹·艾夫斯（Dan Ives）预测，它“将在2024年大受开发者的欢迎，然后在2025年走向消费者”。

2024年值得关注的事情是那些开发人员发现可以拿Vision Pro干什么。智能手机真正风靡世界要等到各种应用出现之后，这些应用把联网的手机从一件新奇玩意变成了不可或缺的日常工具。头显目前主要用于游戏，仍缺乏让大多数人感觉不可或缺的用例。但如果程序员开始捣弄Vision Pro了，情况可能就会有变化。未来几个月里，科技观察者将把目光投向苹果的新设备——而它的四个内置摄像头也会径直回望他们。

《经济学人》技术和媒体编辑汤姆·维恩莱特 ■



The World Ahead 2024

Semiconductors will remain central to America's tech rivalry with China

Expect America to step up global enforcement of its sanctions on chips and chipmaking gear

AS SOON AS the Huawei Mate 60 Pro handset went on sale on August 29th, technologists raced to smash it open and see how it worked. The Chinese telecoms-equipment maker had somehow succeeded in creating a new 5G smartphone—something few thought it could accomplish. Huawei had been forced to give up making such devices in 2020 after American sanctions blocked it from buying advanced semiconductors or the equipment needed to make them. Sales of Huawei smartphones, which at one stage even outsold Apple's iPhones globally, collapsed. Yet as they sifted through the innards of the Mate 60 Pro, engineers discovered a Chinese-made chip that seemed to show that American sanctions had been overcome by indigenous innovation.

This chip, the Kirin 9000S, was manufactured by SMIC, the leading Chinese chipmaker, and its appearance was a deeply symbolic moment. China's tech war with America began in earnest in 2019 when Donald Trump's administration banned the sale of high-end chips to Huawei. In 2022 President Joe Biden built on the framework of those sanctions to introduce a blanket ban on the sales of advanced semiconductors to all companies in China. Since then leaders in Beijing have retaliated by banning the sales of some chips made by Micron, an American firm, to Chinese companies, on security grounds. They also began restricting exports of gallium and germanium, two rare metals needed to make state-of-the-art chips.

Huawei's new phone, and the chip that powers it, are thus seen in China as signalling a paradigm shift. "People can see from this that American

sanctions cannot stop China's technological progress," read an editorial on September 12th in the People's Daily, a government mouthpiece. Photos on local social media showed children bowing in front of Huawei advertisements in Shenzhen. In America, the Mate 60 Pro was used as evidence both to argue that sanctions on China were failing and should be abandoned and to argue that they should be tightened. In fact, it highlights just how difficult it will be for Huawei and other Chinese firms to make new breakthroughs in 2024 and beyond.

The performance of the Mate 60 Pro is on a par with Samsung's Galaxy S20, a handset released in 2020 and powered by a chip manufactured by TSMC of Taiwan, the world's leading chipmaker. Being three years behind may not sound like a lot, but SMIC is using a previous generation of lithography machines, based on a technology called DUV, to etch its chips.

Industry observers reckon that the Kirin 9000S represents the limit of DUV technology. TSMC's superior chips are made using more advanced EUV technology. And that is off-limits to SMIC and other Chinese chipmakers because EUV machines are made only by ASML, a Dutch company, and are covered by American sanctions.

Impressive as it is, in short, the Kirin 9000S probably marks the boundary of what China can achieve without EUV technology, which it will have to develop on its own. That is likely to take many years—and TSMC will continue to race ahead in the meantime. The Mate 60 Pro is not the decisive blow in the tech war that it seemed. And other aspects of the phone's innards signal the direction the tech war will take in 2024.

The handsets were found to contain memory chips made by SK Hynix, a South Korean firm. It says it has not done business with Huawei in years. But Chinese companies have found clever workarounds to get their hands on chips via underground markets. For this reason, America is likely to step

up global enforcement of its sanctions. The Biden administration has already dragged allies such as Japan, the Netherlands and South Korea into the fight, to the displeasure of companies in those countries. In 2024 it may expand that group, perhaps in places such as the Middle East, where Chinese firms are rumoured to be buying chips.

That may hamper Chinese firms' ability to create new high-tech products, from smartphones to the specialised systems needed to train artificial-intelligence models. But it will also sap the patience that America's friends have for its tech war.

DON WEINLAND, China business and finance editor, The Economist, Shanghai ■



世界展望2024

半导体仍将是美国与中国科技竞争的核心

预计美国将在全球范围内加大对芯片和芯片制造设备的制裁力度

华为Mate 60 Pro手机在8月29日甫一上市，技术专家们就争先恐后地把它大卸八块，看看它是如何工作的。这家中国电信设备制造商以某种方式成功打造了一款全新的5G智能手机——很少有人觉得它能做到这一点。在美国的制裁阻止了华为购买先进半导体或制造设备后，华为被迫于2020年放弃制造此类手机。华为智能手机的销量一度在全球范围内超过了苹果的iPhone手机，在这以后一蹶不振。然而，当工程师们仔细检查Mate 60 Pro的内部结构时，却发现了一个中国制造的芯片，似乎表明美国的制裁已被本土创新所克服。

这款名为麒麟9000S的芯片由中国领先的芯片制造商中芯国际制造，它的出现是一个具有深刻象征意义的时刻。中美科技战于2019年正式打响，当时特朗普政府禁止向华为出售高端芯片。2022年，总统拜登在这些制裁框架的基础上全面禁止向中国所有公司销售先进半导体。此后，北京领导人以安全为由，禁止了美国公司美光向中国公司销售它生产的部分芯片作为报复。中国还开始限制镓和锗这两种制造最先进芯片所需的稀有金属的出口。

因此，华为的新手机及其芯片在中国被视为模式转变的标志。政府喉舌《人民日报》9月12日的社论写道：“人们从中看到，美国制裁无法阻止中国技术进步。”当地社交媒体上的照片显示，深圳的孩子们在华为广告前鞠躬。在美国，Mate 60 Pro既被用来证明对华制裁失败因而应该放弃制裁，也被用来论证应该加强制裁。而事实上，它凸显了华为和其他中国企业在2024年及以后取得新突破的难度。

Mate 60 Pro的性能与三星Galaxy S20相当，后者于2020年发布，采用世界领先的芯片制造商台积电生产的芯片。落后三年听起来也许并不多，但中芯国际使用的是上一代基于深紫外（DUV）技术的光刻机来蚀刻芯片。

行业观察家认为，麒麟9000S代表了DUV技术的极限。台积电的高级芯片采用的是更先进的极紫外（EUV）技术。中芯国际和其他中国芯片制造商无法采用这种技术，因为EUV机器只能由荷兰公司阿斯麦（ASML）制造，而且受美国制裁的限制。

简而言之，尽管麒麟9000S令人印象深刻，但可能也标志着中国在没有EUV技术的情况下所能达到的极限，而EUV技术必须由中国自主研发。这可能需要很多年的时间——而在此期间走在前头的台积电也不会停止脚步。Mate 60 Pro并不像先前看起来的那样是技术大战中的决定性一击。这款手机内核的其他方面预示着2024年科技大战的走向。

人们发现这些手机含有韩国公司SK海力士生产的内存芯片。海力士自称已多年未与华为开展业务。但中国公司找到了巧妙的变通办法，通过地下市场获得了芯片。因此，美国很可能在全球范围内加大制裁力度。拜登政府已经把日本、荷兰和韩国等盟国拖入了这场斗争，令这些国家的公司感到不满。2024年，美国可能会扩大制裁的适用范围，也许会扩大到中东等地，据传中国企业正在中东购买芯片。

这可能会阻碍中国企业创造新的高科技产品的能力——从智能手机到训练人工智能模型所需的专用系统。但这也会消耗美国盟友对其科技战的耐心。

《经济学人》驻上海中国商业与金融编辑唐·维兰德 ■



The World Ahead 2024

Generative AI will go mainstream in 2024

Data-savvy firms will benefit first

WHEN NEW technologies emerge they benefit different groups at different times. Generative artificial intelligence (AI) first helped software developers, who could use GitHub Copilot, a code-writing AI assistant, from 2021. The next year came other tools, such as ChatGPT and DALL-E 2, which let all manner of consumers instantly produce words and pictures.

In 2023 tech giants gained, as investors grew more excited about the prospects of generative AI. An equally weighted share-price index of Alphabet, Amazon, Apple, Meta, Microsoft and Nvidia grew by nearly 80% (see chart). Tech firms benefited because they supply either the AI models themselves, or the infrastructure that powers and delivers them.

In 2024 the big beneficiaries will be companies outside the technology sector, as they adopt AI in earnest with the aim of cutting costs and boosting productivity. There are three reasons to expect enterprise adoption to take off.

First, large companies spent much of 2023 experimenting with generative AI. Plenty of firms are using it to write the first drafts of documents, from legal contracts to marketing material. JPMorgan Chase, a bank, used the technology to analyse Federal Reserve meetings to try to glean insights for its trading desk.

As the experimental phase winds down, firms are planning to deploy generative AI on a larger scale. That could mean using it to summarise recordings of meetings or supercharging research and development. A survey by KPMG, an audit firm, found that four-fifths of firms said they

planned to increase their investment in it by over 50% by the middle of 2024.

Second, more AI products will hit the market. In late 2023 Microsoft rolled out an AI chatbot to assist users of its productivity software, such as Word and Excel. It launched the same thing for its Windows operating system. Google will follow suit, injecting AI into Google Docs and Sheets. Startups will pile in, too. In 2023 venture-capital investors poured over \$36bn into generative AI, more than twice as much as in 2022.

The third reason is talent. AI gurus are still in high demand. PredictLeads, a research firm, says about two-thirds of S&P 500 firms have posted job adverts mentioning AI. For those companies, 5% of adverts now mention the technology, up from an average of 2.5% over the past three years. But the market is easing. A survey by McKinsey, a consultancy, found that in 2023 firms said it was getting easier to hire for AI-related roles.

Which firms will be the early adopters? Smaller ones will probably take the lead. That is what happened in previous waves of technology such as smartphones and the cloud. Tiddlers are usually more nimble and see technology as a way to gain an edge over bigger fish.

Among larger companies, data-centric firms, like those in health care and financial services, will be able to move fastest. That is because poor data management is a big risk for deploying AI. Managers worry about valuable data leaking out through AI tools. Firms without solid data management may have to reorganise their systems before it is feasible to deploy generative AI. Using the technology can feel like science fiction, but getting it to work safely is a much more humdrum affair.

GUY SCRIVEN, US technology editor, The Economist ■



世界展望2024

生成式人工智能将在2024年成为主流

精通数据的企业将首先受益

当新技术出现时，它们会在不同时间使不同群体受益。生成式AI（Generative AI）首先帮到了软件开发人员——他们从2021年起就可以使用能编写代码的AI助手GitHub Copilot。第二年出现了其他工具，如ChatGPT和DALL-E 2，它们可以让各种各样的消费者即刻生成文字和图片。

2023年，随着投资者对生成式AI的前景愈感兴奋，科技巨头获益了。Alphabet、亚马逊、苹果、Meta、微软和英伟达的同等权重股价指数增长了近80%（见图表）。科技公司会受益，是因为它们要么供应了这类AI模型本身，要么提供了驱动和支持这些模型的基础设施。

在2024年，最大的受益者将是科技行业以外的公司，它们会认真采用AI以期降低成本并提高生产率。预期企业会开始大量采用该技术的理由有三。

首先，大公司在2023年已经花了很多时间在试用生成式AI。许多公司现在用它生成从法律合同到营销材料的文本初稿。摩根大通使用该技术分析美联储会议内容，尝试为其交易部门收集信息。

随着实验阶段逐步结束，企业正计划更大规模地部署生成式AI。这可能意味着用它来总结会议录音或加强研发。毕马威会计师事务所（KPMG）的一项调查发现，五分之四的公司表示计划到2024年中期将这方面投资增加50%以上。

其次，更多的AI产品将上市。2023年末，微软推出了一款AI聊天机器人来辅助其生产力软件（如Word和Excel）用户。它也为Windows操作系统推出了同样的产品。谷歌也将效仿，将AI嵌入谷歌文档和表格中。创业公司也将蜂拥挤入。2023年，风险资本投资者向生成式AI投入超过360亿美

元，是2022年的两倍多。

第三个原因是人才。对AI专家的需求仍然很大。研究公司PredictLeads表示，标准普尔500强公司中，约三分之二的公司发布了提及AI的招聘广告。而就这些公司而言，它们的广告目前有5%提到该技术，高于过去三年的平均2.5%。但这个吃紧的人才市场正在放松。咨询公司麦肯锡的一项调查发现，在2023年，企业表示招聘AI相关职位变得容易了些。

哪些公司将成为早期采用者？较小的公司可能会跑在前面。这就是在智能手机和计算云等之前的技术浪潮中发生的情况。小鱼小虾通常更加灵活，并将技术视为获得相对于大鱼的优势的一个途径。

在较大的公司中，那些以数据为中心的公司（如医疗和金融服务公司）将能够采取最快的行动。这是因为数据管理不善是部署AI的一大风险。企业主管们担心有价值的数据会通过AI工具泄露出去。缺乏可靠的数据管理的公司可能必须首先重组其系统，然后才能切实部署生成式AI。使用这项技术可能让人感觉身处科幻世界，但让它安全地工作却是一项乏味得多的事务。

《经济学人》美国技术编辑盖伊·斯克瑞文 ■



The World Ahead 2024

AI will transform every aspect of Hollywood storytelling

But it will also cause more friction

REUNIONS OFFER a chance to reflect on how much has changed. One will happen during the coming year in Hollywood when “Here” premieres, bringing together the actors, director and writer behind “Forrest Gump” 40 years later for a new, unrelated film. Set in a single room over decades, “Here” is very much a film of the here and now. The stars, Tom Hanks and Robin Wright, will be “de-aged” using new AI tools, rendering them more youthful in some scenes and enabling the film-makers to see the transformation in real time while shooting.

Generative AI now means images can be produced in seconds. Songs can be created in the style of singers dead or alive. More than 3,000 books on Amazon name ChatGPT as the author or co-author, lending new meaning to the term “ghostwriter”.

It is still early days, but 2024 will be a preview of what is to come. Three things are worth watching. The first is how AI will be used to tell new types of stories, as storytelling becomes more personalised and interactive. Films will change and so will gaming, an industry where people can choose their own adventures more easily than moviegoers can. The amount of entertainment available will also balloon.

Like the arrival of the internet, which led to an explosion of “user-generated content” being posted to social media and YouTube, generative AI will contribute to reams of videos and other material proliferating online. Some predict that as much as 90% of online content will be AI-generated by 2025. Curation and good search tools will be vital, and there will be debates about whether, and how, to label AI-generated content.

No one is quite sure how the nature of storytelling will change, but it is sure to. David Thomson, a film historian, compares generative AI to the advent of sound. When movies were no longer silent, it altered the way plot points were rendered and how deeply viewers could connect with characters. Cristóbal Valenzuela, who runs a company called RunwayML, which offers AI-enhanced software tools to creative types, says AI is more like a “new kind of camera”, offering a fresh “opportunity to reimagine what stories are like”. Both are right.

The Hollywood writers’ strike shone a spotlight on the question of whether AI would start producing scripts. For now, studios have agreed to concessions and will not bypass writers’ rooms to employ ChatGPT instead. It will probably be a few years before a full-length blockbuster is produced entirely by AI.

Instead, the second big development to watch is how AI will be used as a time-saving tool. Generative AI will automate and simplify complex tasks like dubbing, film-editing, special effects and background design. For a glimpse of the future, watch “Everything Everywhere All at Once”, which won the Academy Award for Best Picture in 2023. It featured a scene that used a “rotoscoping” tool offered by RunwayML to edit out the green-screen background and make a talking rock more believable. It compressed into hours what might have otherwise taken days of video-editing.

The third thing to watch for is more dramatic clashes between creators (otherwise known as copyright-owners) and those who run AI platforms. The coming year is likely to bring a deluge of lawsuits from authors, musicians, actors and artists about how their words, music and images have been used to train AI systems without consent or payment. Perhaps they can agree on some sort of licensing arrangement, in which AI companies start paying copyright-holders for content to train their models. But that will not happen without an intense legal brawl.

AI presents bigger questions about the future of stories and the nature of collective storytelling. For example, will generative AI simply imitate previous hits, resulting in more derivative blockbuster films and copycat interpretations of pop songs that lack depth, rather than original stories and art forms? And as entertainment becomes more personalised, will there still be stories that become part of humanity's collective consciousness and move large numbers of people, who can talk about them together?

As creators grapple with AI's rise, they will channel their anxieties about technology into their work. Look out for more "Terminator"-style clashes between man and machine. Life imitates art—and art life.

ALEXANDRA SUICH BASS, Culture editor, The Economist ■



世界展望2024

人工智能将改变好莱坞叙事的方方面面

但也会造成更多的摩擦

重聚提供了一个机会，让人们反思发生了多大的变化。明年好莱坞的一次机会是《这里》（Here）的首映，《阿甘正传》的演员、导演和编剧在40年后将齐聚一堂，打造一部不相关的新电影。《这里》的故事发生在一个房间里，时间跨度长达数十年，基本上就是一部“此时此地”的电影。主演汤姆·汉克斯和罗宾·怀特将使用新的人工智能（AI）工具来“减龄”，使他们在某些场景中变得更加年轻，并让电影制作人能够在拍摄过程中实时看到容颜转变。

现在，生成式AI意味着可以在几秒钟内生成图像。歌曲可以按照已故或在世歌手的风格来创作。亚马逊上有超过3000本书将ChatGPT列为作者或共同作者，这为“捉刀人”或“影子写手”一词赋予了新的含义。

现在也许还为时过早，但2024年将是未来的预演。有三件事值得关注。首先是如何利用AI讲述新型故事，因为讲故事会变得更加个性化和互动化。电影会改变，游戏也会改变——在游戏里，人们比电影观众更容易选择自己的冒险经历。可提供的娱乐的数量也将激增。

就像互联网的来到导致社交媒体和YouTube上发布的“用户生成内容”激增一样，生成式AI也将促使视频和其他资料在网上激增。有人预测，到2025年，多达90%的网络内容将由AI生成。内容管理和良好的搜索工具将至关重要，而关于是否以及如何标记AI生成内容的问题也将引起争论。

没有人确切知道叙事的性质会发生怎样的变化，但它肯定会变化。电影历史学家大卫·汤姆森（David Thomson）将生成式AI比作有声电影的出现。当电影不再无声时，它改变了情节转折点的表现方式，也改变了观众与角色的共情深度。克里斯托巴尔·巴伦苏埃拉（Cristóbal Valenzuela）经营的RunwayML公司为创意人士提供AI增强软件工具。他表示AI更像是

一种“新型摄影机”，提供了全新的“重新想象故事的机会”。这两位说的都是对的。

好莱坞编剧的罢工让AI是否会开始制作剧本成为人们关注的焦点。目前，电影公司已同意做出让步，不会绕过编剧室而改用ChatGPT。要完全由AI制作一部长篇大片，可能还需要几年的时间。

真正应关注的第二个重大发展是如何将AI用作节省时间的工具。生成式AI将自动化和简化配音、剪辑、特效和背景设计等复杂任务。要想一窥未来，请看看2023年获得奥斯卡最佳影片奖的《瞬息全宇宙》吧。其中有一个场景使用了RunwayML提供的“动态遮罩”工具来剪掉绿幕背景，让一块会说话的石头更加真实可信。它将原本可能需要数天时间的视频剪辑压缩到几个小时。

第三件值得关注的事，是创作者（也称版权所有者）与AI平台运营者之间的冲突变得更激烈。未来一年，作家、音乐家、演员和艺术家很可能会提起大量诉讼，控告他们的文字、音乐和图像在未经同意或未支付报酬的情况下被用于训练AI系统。也许他们可以达成某种许可安排，让AI公司开始向版权所有者就用于训练模型的内容付费。但是，不经过激烈的法律斗争，这种情况是不会发生的。

AI也带来了关于故事的未来和集体叙事的性质的更大问题。例如，生成式AI会不会只是简单地模仿以前的热门作品，从而产生更多缺乏深度的衍生大片和山寨版流行歌曲，而不是原创故事和艺术形式？当娱乐变得更加个性化时，是否还会有故事成为人类集体意识的一部分，感动大批人，成为他们共同的谈资？

随着创作者努力应付AI的崛起，他们会把对技术的焦虑输出到他们的作品中。等着看更多的人类与机器之间发生“终结者”式冲突的故事吧。生活模仿艺术——艺术也模仿生活。

《经济学人》文化编辑亚历山德拉·苏伊奇·巴斯 ■



The World Ahead 2024

AI models will become smaller and faster

They will improve in plenty of other ways, too

INTEREST IN artificial intelligence (AI) reached fever pitch in 2023. In the six months after OpenAI's launch in November 2022 of ChatGPT, the internet's most famed and effective chatbot, the topic "artificial intelligence" nearly quadrupled in popularity on Google's search engine. By August 2023, one third of respondents to the latest McKinsey Global Survey said their organisations were using generative AI in at least one capacity.

How will the technology develop in 2024? There are three main dimensions on which researchers are improving AI models: size, data and applications.

Start with size. For the past few years, the accepted dogma of AI research has been that bigger means better. Although computers have got smaller even as they have become more powerful, that is not true of large language models (LLMs), the size of which is measured in billions or trillions of "parameters". According to SemiAnalysis, a research firm, GPT-4, the LLM which powers the deluxe version of ChatGPT, required more than 16,000 specialised GPU chips and took multiple weeks to train, at a cost of more than \$100m. According to Nvidia, a chipmaker, inference costs—getting the trained models to respond to users' queries—now exceed training costs when deploying an LLM at any reasonable scale.

As AI models transition to being commercial commodities there is a growing focus on maintaining performance while making them smaller and faster. One way to do so is to train a smaller model using more training data. For instance, "Chinchilla", an LLM developed in 2022 by Google DeepMind, outperforms OpenAI's GPT-3, despite being a quarter of the size (it was trained on four times the data). Another approach is to reduce the

numerical precision of the parameters that a model comprises. A team at the University of Washington has shown that it is possible to squeeze a model the size of Chinchilla onto one GPU chip, without a marked dip in performance. Small models, crucially, are much less expensive to run later on. Some can even run on a laptop or smartphone.

Next, data. AI models are prediction machines that become more effective when they are trained on more data. But focus is also shifting from “how much” to “how good”. This is especially relevant because it is getting harder to find more training data: an analysis in 2022 suggested that stocks of new, high-quality text might dry up in the next few years. Using the outputs of the models to train future models may lead to less capable models—so the adoption of LLMs makes the internet less valuable as a source of training data. But quantity isn’t everything. Figuring out the right mix of training data is still much more of an art than a science. And models are increasingly being trained on combinations of data types, including natural language, computer code, images and even videos, which gives them new capabilities.

What new applications might emerge? There is some “overhang” when it comes to AI, meaning that it has advanced more quickly than people have been able to take advantage of it. Showing what is possible has turned into figuring out what is practical. The most consequential advances will not be in the quality of the models themselves, but in learning how to use them more effectively.

At present, there are three main ways to use models. The first, “prompt engineering”, takes them as they are and feeds them specific prompts. This method involves crafting input phrases or questions to guide the model to produce desired outputs. The second is to “fine-tune” a model to improve its performance at a specific task. This involves giving a pre-existing model an extra round of training using a narrow dataset tailored to that task. For

instance, an LLM could be fine-tuned using papers from medical journals to make it better at answering health-related questions. The third approach is to embed LLMs in a larger, more powerful architecture. An LLM is like an engine, and to make use of it for a particular application, you need to build the car around it.

One example of this is “retrieval augmented generation”, a technique that combines an LLM with extra software and a database of knowledge on a particular topic to make it less likely to spit out falsehoods. When asked a question, the system first searches through its database. If it finds something relevant, it then passes the question, along with the factual information, to the LLM, requesting that the answer be generated from the information supplied. Providing sources in this way means users can be more confident of the accuracy of responses. It also allows the LLM to be personalised, like Google’s NotebookLM, which lets users supply their own databases of knowledge.

Amid all the focus on AI’s commercial potential, the hunt for artificial general intelligence continues. LLMs and other forms of generative AI may be a piece in the puzzle, or a step on the way, but they are probably not the final answer. As Chris Manning of Stanford University puts it: there is “no reason to believe...that this is the ultimate neural architecture, and we will never find anything better.”

ABBY BERTICS, Science correspondent, The Economist ■



世界展望2024

AI模型将变得更小更快

它们也会在其他许多方面取得进步

在2023年，人们对人工智能（AI）的兴趣近乎白热化。在OpenAI于2022年11月推出互联网上最有名、效果最好的聊天机器人ChatGPT后的六个月里，“人工智能”话题在谷歌搜索引擎上的流行度几乎翻了两番。到2023年8月，麦肯锡最近一次全球调查的受访者中有三分之一表示，他们所在的机构在至少一种职能中使用生成式AI。

在2024年，这项技术将如何发展？研究人员正从三大维度改进AI模型：规模、数据和应用。

先看规模。过去几年里，AI研究中公认的信条是“大即好”。计算机在变得更强大的同时尺寸变小了，但大型语言模型（LLM）却不是这样，这种模型的大小以几十亿或几万亿个“参数”论。据研究公司SemiAnalysis称，ChatGPT豪华版背后的LLM GPT-4需要用到超过16,000个专用GPU芯片，花费好几周训练，成本超过1亿美元。据芯片制造商英伟达（Nvidia）称，如今，当以任何尚够用的规模部署LLM时，推理成本（让经过训练的模型响应用户查询的成本）都超过了训练成本。

随着AI模型转变为商业化日用品，人们越来越关注如何能把它们变得更小、更快而不折损性能。一种方法是用更多的训练数据来训练更小的模型。例如，谷歌DeepMind于2022年开发的LLM“龙猫”（Chinchilla）的性能优于OpenAI的GPT-3，尽管其大小仅为GPT-3的四分之一（它接受了四倍的数据训练）。另一种方法是降低模型包含的参数的数值精度。华盛顿大学的一个团队已经证明，有可能把“龙猫”大小的模型压缩到一个GPU芯片上，性能却不会明显下降。至关重要的是，小模型在日后运行时的成本要低得多。有些甚至可以在一台笔记本电脑或一部智能手机上运行。

然后是数据。AI模型这种预测机器接受的训练数据越多效果越好。但焦点

也在从“多少”转向“多好”。这一点尤其重要，因为找到更多训练数据变得越来越难：2022年的一项分析表明，新的高质量文本库存可能会在未来几年内耗尽。使用模型的输出来训练未来模型可能会生成能力较差的模型，因此LLM的普遍采用使得互联网作为训练数据源的价值降低。但数量不代表一切。找出训练数据的正确组合仍然更像一门艺术而非科学。而模型正在越来越多地接受各种类型数据的组合的训练，它们包括自然语言、计算机代码、图像，甚至视频，这赋予了它们新的能力。

可能出现哪些新应用？AI存在“能力过剩”的问题，即它的发展速度快过人们能够利用它的速度。人们的注意力已经从展示它们的可能性转向弄清楚什么是实际可行的。最重要的进步将不在于模型本身的质量，而在于学习如何更有效地利用它们。

目前，使用模型的方式主要有三种。首先是“提示工程”，也就是按它们本来的用处，向它们输入特定的提示。需要精心设计输入的短语或问题来引导模型生成所需的输出。第二种是“微调”模型以提高其在特定任务中的性能。这涉及使用针对该任务定制的狭窄数据集，对已存在的模型进行一轮额外训练。例如，可以使用医学期刊中的论文微调一个LLM，使其能更好地回答健康相关问题。第三种是将LLM嵌入到更大、更强的架构中。LLM就如同一台发动机，而要让它在特定的应用中发挥作用，就需要围绕它构建汽车。

这方面的一个例子是“检索增强生成”，这是一种将LLM与额外的软件和特定主题知识数据库相结合的方法，以降低其给出错误回答的概率。当被提问时，该系统首先搜索其数据库。如果发现了相关的内容，就将问题连同这些事实信息一起传递给LLM，要求它根据所提供的信息来生成答案。以这种方式提供信息源意味着用户可以对答案的准确性更有信心。它也让LLM可以被个性化定制，就像谷歌的NotebookLM让用户可以提供自己的知识数据库。

在人们聚焦于AI的商业潜力之际，对通用人工智能的探索也在继续。LLM和其他形式的生成式AI可能是拼图中的一块，或前进中的一步，而可能不

是最终的答案。正如斯坦福大学的克里斯·曼宁（Chris Manning）所说：“没有理由相信.....这就是终极的神经架构，而我们永远找不到更好的了。”

《经济学人》科学记者艾比·伯提斯 ■



The World Ahead 2024

Metrics to keep an eye on in 2024, from solar cells to superhero movies

Some are merely fun—while others are potentially world-changing

SOMETIMES THE best way to follow a trend is to plot it on a chart. Here is a selection of noteworthy metrics that are worth keeping an eye on in 2024, from solar-cell technology to superhero movies. Some are merely fun—while others are potentially world-changing.

| *Will the cost of launching things into orbit fall further?*

The cost of launching things into space has plunged over the past decade, a direct consequence of the development of reusable rockets by SpaceX, the rocket-launch company founded by Elon Musk. Its Falcon 9 rocket has a reusable booster stage, which can send a payload on its way to orbit and then return to Earth, touching down either on land or on a drone ship. Not throwing away the booster, which costs tens of millions of dollars, but instead reusing it up to 15 times, has slashed launch costs, and SpaceX now carries more to orbit than the rest of the world combined. But launch costs could soon fall even further, if two new rockets make successful flights in 2024. The first is SpaceX's Starship, the largest rocket ever built, which is fully reusable and can carry as much as 150 tonnes into orbit, ten times more than Falcon 9. But keep an eye, too, on Neutron, a new reusable rocket from Rocket Lab, a rival startup. It aims to be competitive on a cost-per-kilogram basis with the Falcon 9, but for smaller payloads. To open up new opportunities in space, what goes up must come down—in price.

| *Is enthusiasm for AI chatbots in decline?*

ChatGPT attracted 100m users within two months of its launch in November 2022, but user visits peaked in mid-2023 and have since levelled off. This may indicate flagging enthusiasm for chatbots in general. Or it

may just signal that users have become more discerning, and have switched to other chatbots that are better suited to particular tasks. Another possibility is that the mid-year decline is the result of school holidays: watch to see if the numbers tick up again in late 2023.

| *Will perovskite solar cells take off?*

Most photovoltaic cells are made of silicon, and convert sunlight to electricity with an efficiency of about 23%. Perovskite cells, which use other elements in a particular crystal structure, cost more but offer higher efficiency: over 25%, and over 30% when combined in a “tandem” cell with silicon. So the extra expense can be worth it, particularly in situations where space is tight. Firms in America, Britain, South Korea and Sweden aim to start selling perovskite cells in 2024.

| *When will renewables overtake coal?*

Renewable supplies of energy, such as solar and wind power, will soon overtake coal-fired power stations to become the world’s largest single source of electricity, according to the International Energy Agency (IEA). But when? Having previously said it would be in 2025, the IEA now thinks it could happen in 2024, “as a result of the accelerated pace of renewable capacity additions” and “the plateauing of electricity generation from coal”. Adoption of renewables in Europe has been accelerated by the war in Ukraine: EU countries added 41 gigawatts (GW) of solar capacity in 2022, and are expected to add more than 50GW in 2023. China added 107GW of solar capacity in 2022, roughly equivalent to all existing capacity in America, and is expected to have added two Americas’ worth of solar capacity in 2023. Meanwhile, use of coal for generation rose by 1.7% in 2022, as high natural-gas prices prompted gas-to-coal switching. But use of coal in Europe and America in 2023 and 2024 is predicted to drop sharply, more than offsetting a slight increase in Asia.

| *Will superhero films make a comeback?*

Superheroes may have met their match—at the box-office, that is. In 2023 superhero films were overshadowed by “Barbie”, whose plastic heroine battled the patriarchy with frequent wardrobe changes, rather than superhuman powers, and “Oppenheimer”, a biopic of an non-super (but very clever) human. Much speculation ensued about whether the appetite for endless superhero flicks from Marvel, and its imitators, had cooled. The scene is thus set for a showdown in 2024, when superhero releases include “Captain America: Brave New World”, “Deadpool 3” and two Spider-Man spin-offs, “El Muerto” and “Madame Web”. They face off against “Mickey 17”, Bong Joon Ho’s follow-up to “Parasite”; “Challengers”, Luca Guadagnino’s tennis drama; “It Ends with Us”, based on Colleen Hoover’s book; and “Gladiator 2”, Ridley Scott’s follow-up to his epic of 2000. Let battle commence.

| *Will your cup of coffee get more expensive?*

Consumption of coffee is now outstripping production, according to the International Coffee Organisation. The gap could widen in 2024: extreme weather in Brazil in late 2023 may reduce harvests of arabica beans, while El Niño threatens to depress yields of robusta beans in Indonesia. Coffee producers may need to consider cultivation in new areas as the planet warms, and encourage coffee-drinkers to embrace a third species, called liberica, which is more heat-tolerant.

| *Will wild polio be eradicated?*

2024 could be the first year without wild polio. Pakistan and Afghanistan are the last countries where the disease is endemic. Cases have dwindled (the chart shows the number of cases, not thousands or millions) and are limited to small geographical areas. Eradication programmes have a good chance of eliminating the wild virus in the coming months. The focus is shifting towards eliminating a new form of the disease, vaccine-derived

polio, which is on the rise.

| *Will robotaxis turn the corner?*

After much hype five years ago, plans for self-driving robotaxis were delayed and scaled back, as ironing out the bugs from the technology proved harder than expected. But they have since made quiet progress, with the distance between “disengagements” (mistakes requiring intervention by a safety driver) ticking up across the industry, and commercial roll-outs in more cities. More will follow in 2024. But Americans’ trust in self-driving cars fell for the second year running in 2023, according to a survey by J.D. Power. People who have ridden in one, however, were more positive. The question for 2024 is: can robotaxis get better more quickly than perceptions of them get worse?

| *Will quantum computing become useful?*

A race is under way to harness the spooky, counter-intuitive laws of quantum physics to build a new kind of computer. For some tasks a quantum computer could outperform any non-quantum machine that could ever be built, blazing through calculations in cryptography, chemistry and finance. But when will a useful machine arrive?

One measure of a quantum computer’s capability is its number of quantum bits, or qubits. But existing machines, which implement qubits in various different ways, all have a fatal flaw: the delicate quantum states on which they depend “decohere” after a fraction of a second.

A better measure may be so-called “quantum volume” (QV), which depends on the “width” of a computer (its number of qubits) and its “depth” (the number of operations they can perform before decohering). A computer with 14 qubits that is able to execute 14 operations is said to have a QV of 2 to the power of 14, or 16,384.

The maximum QV achieved is rising steadily, but the volume needed to perform useful operations, not just small-scale tests, remains unclear. IBM, a leader in the field, has set itself a QV target of 2 to the power of 100. Like artificial intelligence, which disappointed for decades before its sudden, spectacular success, quantum computing is likely to go from useless to ubiquitous very quickly—just as soon as researchers figure out how to turn up the volume.

| *Will the number of coups continue to rise?*

Coups are back, and in sub-Saharan Africa in particular, after a lull in the 2010s. You can walk from the Red Sea to the Atlantic entirely within countries that have had coups in the past three years. Of 18 attempted coups since 2021, nine have succeeded. Coups tend to occur for one of two reasons: either a collapse of security, as in Niger and Mali, where generals claimed to be restoring order; or when an unpopular leader outstays his welcome, as in Gabon.

Instability in the Sahel shows no sign of abating, so further coups are possible. But where? Analysts at BMI, a research firm, reckon South Sudan is at most risk, followed by the Central African Republic, much of which is no longer under government control. SBM Intelligence, a Nigerian firm, reckons the chances are highest in the Democratic Republic of Congo. And keep an eye on Equatorial Guinea, which is ruled by Africa's longest-standing leader, Teodoro Obiang Nguema Mbasogo, now 81 years old. A succession crisis could trigger a coup.

| *When will China take the lead in car exports?*

The switch to electric vehicles (EVs) has reshaped the car industry. In many ways, EVs have more in common with smartphones on wheels than they do with combustion-engine vehicles; they contain fewer moving parts and are mechanically much less complex. Incumbent manufacturers, which excel at building engines and gearboxes, have lost their competitive advantage.

Chinese manufacturers spotted an opening—and have charged into it.

Some time in 2024 China will overtake Germany and Japan to become the world's largest car exporter, driven by demand for EVs. Admittedly, Chinese car exports include a lot of vehicles made by Tesla, an American firm, in its Chinese factory. But Tesla, the world's biggest maker of EVs, will be overtaken by BYD, a Chinese firm, which will sell more vehicles, both within China and globally.

Compiled and written by GILEAD AMIT, RACHEL LLOYD, JONATHAN ROSENTHAL, TOM STANDAGE, PRATIBHA THAKER and CHRISTOPHER WILSON, The Economist ■



世界展望2024

2024年值得关注的指标，从太阳能电池到超级英雄电影

有些只是好玩，而另一些则有可能改变世界

有时，跟踪趋势的最好方法是将其绘制在图表上。以下是2024年一系列值得关注的指标，从太阳能电池技术到超级英雄电影等等。有些只是好玩，而另一些则有可能改变世界。

| 将物体送入轨道的成本会进一步下降吗？

在过去十年中，将物体发射到太空的成本大幅下降，这是马斯克创立的火箭发射公司SpaceX开发可重复使用火箭的直接结果。它的“猎鹰9号”火箭有一个可重复使用的助推器级，它可以在进入轨道的途中将有效载荷送入轨道，然后返回地球并在陆地或无人机船上着陆。这种做法没有扔掉耗资数千万美元的助推器，而是重复使用多达15次，从而降低了发射成本。如今SpaceX送入轨道的物体比世界其他地区的总和还要多。但是，如果两枚新火箭在2024年成功发射，发射成本可能很快就会进一步下降。第一个是SpaceX的“星舰”，这是有史以来最大的火箭，它可完全重复使用，能携带多达150吨的重量进入轨道，是“猎鹰9号”的十倍。但也要关注“中子号”（Neutron），这是来自竞争对手创业公司火箭实验室（Rocket Lab）的新型可重复使用火箭。它的目标是每千克成本能与“猎鹰9号”竞争，但有效载荷较小。要在太空中开辟新的机会，必须有去有回、有起有落——说的是价格。

| 对人工智能聊天机器人的热情是否在减退？

ChatGPT在2022年11月推出后的两个月内吸引了1亿用户，但用户访问量在2023年年中达到顶峰，此后趋于平稳。这可能表明对聊天机器人的热情总体上正在减弱。或者它可能只是表明用户变得更加挑剔，并已转向其他更适合特定任务的聊天机器人。另一种可能性是，年中的下降是学校假期的结果：看看这些数字是否会在2023年底再次上升吧。

｜钙钛矿太阳能电池会起飞吗？

大多数光伏电池由硅制成，将太阳光转化为电能的效率约为23%。钙钛矿电池在特定的晶体结构中使用其他元素，成本更高，但效率更高：超过25%；当与硅结合制成“串联”电池时，效率超过30%。所以额外的成本或许是值得的，尤其是在空间紧张的情况下。美国、英国、韩国和瑞典的公司计划在2024年开始销售钙钛矿电池。

｜可再生能源发电何时会超过煤炭？

根据国际能源署（IEA）的数据，太阳能和风能等可再生能源将很快超越燃煤发电站，成为世界上最大的电力来源。但这会在什么时候发生呢？国际能源署此前曾说它将在2025年发生，但现在认为，“由于可再生能源新增速度加快”和“煤炭发电进入平台期”，这有可能在2024年发生。乌克兰战争加速了欧洲可再生能源的采用：欧盟国家在2022年增加了41吉瓦的太阳能装机容量，预计2023年将增加超过50吉瓦。中国在2022年增加了107吉瓦的太阳能装机容量，大致相当于美国现有的全部装机容量，预计在2023年将增加两个美国的太阳能装机容量。与此同时，2022年煤炭发电使用量增长了1.7%，原因是天然气价格高企促使天然气转煤。但预计2023年和2024年欧洲和美国的煤炭使用量将大幅下降，远远抵消亚洲的轻微增长。

｜超级英雄电影会卷土重来吗？

超级英雄可能遇到了对手了——说的是在票房上。2023年，超级英雄电影的风头被《芭比娃娃》和《奥本海默》盖过，前者的塑料娃娃女主角用频繁更换的服装而不是超能力与父权作斗争，后者是一部非超级（但非常聪明的）人类的传记片。业界纷纷猜测，观众对漫威及其模仿者无休止的超级英雄电影的胃口是否已经减退。2024年看来将上演一场大对决，届时上映的超级英雄电影将包括《美国队长：美丽新世界》、《死侍3》和两部蜘蛛侠衍生作品《亡灵》（El Muerto）和《蜘蛛夫人》（Madame Web）。它们面对的是奉俊昊的《寄生虫》续集《米奇17》；卢卡·瓜达尼诺（Luca Guadagnino）的网球题材正剧《挑战者》；改编自科琳·胡佛（Colleen Hoover）小说的《以我们结束》（It Ends with Us）；以及雷

德利·斯科特（Ridley Scott）2000年史诗的续集《角斗士2》。让战斗开始吧。

| 你的咖啡会变得更贵吗？

根据国际咖啡组织的数据，咖啡的消费量现在超过了产量。这一缺口在2024年可能会扩大：2023年底巴西的极端天气可能会减少阿拉比卡咖啡豆的收成，而厄尔尼诺现象可能会压低印度尼西亚的罗布斯塔咖啡豆的产量。随着地球变暖，咖啡生产商可能需要考虑在新的地区种植咖啡，并鼓励咖啡饮用者接受第三个更为耐热的品种“大果咖啡”（liberica）。

| 野生脊髓灰质炎会被根除吗？

2024年可能是没有野生脊髓灰质炎的第一年。巴基斯坦和阿富汗是最后两个流行这种病的国家。病例数有所减少（上图显示了病例数，而单位不是千或百万），并且仅限于较小的地理区域。根除计划很有可能在未来几个月内消灭野生脊灰病毒。重点正在转向消除这种疾病的一个新形式，即疫苗衍生脊髓灰质炎，其发病数正在上升。

| 无人驾驶出租车会有转机吗？

五年前，无人驾驶出租车的计划被炒得沸沸扬扬，但由于消除技术缺陷的难度超出预期，该计划被推迟和缩减。但自那以后，技术悄然取得了进展，发生“干预”（需要安全驾驶员做出干预的错误）的行驶里程间距普遍拉大，商业推广也打入更多城市，2024年还会有新的进展。但根据君迪（J.D. Power）的调查，美国人对无人车的信任度在2023年连续第二年下降。不过，那些已经乘坐过无人车的人群的态度更为积极。2024年的问题是：无人出租车进步的速度是否能快过人们对其看法恶化的速度？

| 量子计算会派上用场吗？

一场利用量子物理那诡异而反直觉的定律来制造新型计算机的竞赛正在上演。在某些任务中，量子计算机的性能可能会超过任何非量子计算机，在密码学、化学和金融领域的计算中大显身手。但是，一台实用的机器何时才能出现呢？

衡量量子计算机能力的一个指标是其量子比特（quantum bits或qubits）的数量。但是，现有的机器以各种不同的方式实现量子比特，都有一个致命的缺陷：它们所依赖的微妙的量子态会在几分之一秒后“退相干”。

更好的衡量标准可能是所谓的“量子体积”（QV），它取决于计算机的“宽度”（量子比特数）和“深度”（它们在退相干之前可以执行的操作数）。一台具有14个量子比特且能够执行14次操作的计算机的QV为2的14次方，即16,384。

已实现的最大QV值正在稳步上升，但执行有用操作（而不仅仅是小规模测试）所需的体积仍不明确。该领域的领军企业IBM已将自己的QV目标设定为2的100次方。就像人工智能在突然取得辉煌成功之前令人失望了几十年一样，量子计算很可能会很快从无用变为无处不在——只要研究人员弄清楚如何提高量子体积。

｜ 政变的数量会继续上升吗？

在经历了2010年代的平静之后，尤其是在撒哈拉以南的非洲，政变卷土重来。过去三年里发生过政变的国家可以完全从红海连接到大西洋。自2021年以来，18次尝试的政变中有9次获得成功。政变的发生往往有两个原因：一是安全局势崩溃，如尼日尔和马里，将军们声称要恢复秩序；二是不受欢迎的领导人难以为继，如加蓬。

萨赫勒地区的不稳定没有缓解的迹象，因此有可能发生更多政变。但会发生在哪里呢？研究公司BMI的分析师认为，南苏丹的风险最大，其次是中非共和国，因为该国大部分地区已不再受政府控制。尼日利亚公司SBM Intelligence认为刚果民主共和国的风险最高。还要关注赤道几内亚，它由现年81岁的特奥多罗·奥比昂·恩圭马·姆巴索戈统治，他是非洲在位时间最长的领导人。继任危机可能引发政变。

｜ 中国何时成为最大的汽车出口国？

向电动汽车（EV）的转变重塑了汽车行业。在许多方面，电动汽车更像车轮上的智能手机而不是内燃机汽车；它们包含的运动部件更少，机械复杂

程度也低得多。擅长制造发动机和变速箱的现有制造商已经失去了竞争优势。中国制造商发现了这一商机并蜂拥而入。

在电动汽车需求的推动下，中国将在2024年的某个时候超过德国和日本，成为世界上最大的汽车出口国。诚然，中国的汽车出口包括美国的特斯拉公司在其中国工厂生产的大量汽车。但全球最大的电动汽车制造商特斯拉将被中国公司比亚迪超越，后者将在中国和全球都售出更多汽车。

由《经济学人》的吉利德·阿米特、雷切尔·劳埃德、乔纳森·罗森塔、汤姆·斯坦迪奇、普拉蒂巴·塔克和克里斯托弗·威尔逊编写 ■



The World Ahead 2024

Demand for “green” metals will redraw the global mining map

The energy transition will mint new fortunes in surprising places

A NET-ZERO GLOBAL economy, if it materialises, will not just be carbon-neutral. It will also consume far fewer raw materials. Going from here to there, however, will require a heap of them. In the next few decades, supplying them will create new fortunes.

A planet moving towards a cleaner energy system will still need dirty fuel. And even when oil consumption peaks, countries that can produce high-quality crude at low cost will be strengthened rather than weakened, as their market share and pricing power rise in tandem. Gulf giants such as Saudi Arabia and the UAE will be obvious beneficiaries. Less on the radar is tiny Guyana, where recent discoveries—enough for it to extract 1.2m barrels a day, or 1.1% of global supply, by 2028—could allow it to produce more oil per person than any country in the world.

Appetite for natural gas, a cleaner alternative to coal in fossil-fuel-fired power plants, may last longer still. As Europe has weaned itself off Russian gas, America, Australia and Qatar, which are cranking up output of the fuel in liquefied form, will pocket the proceeds. But so may Argentina. And African countries, meanwhile, could see their share of the global gas market double by 2050.

More durable riches may be earned through exporting the billions of tonnes of metal the planet needs to build new, low-carbon infrastructure. Chile and Peru already supply much of the world’s copper; their vast remaining reserves will be tapped as the roll-out of everything green, from wires to wind turbines, boosts demand for the red metal. Declining copper content of ores in ageing mines is raising costs, however, and pushing

miners to riskier frontiers. Barrick Gold, a Canadian firm, wants to invest \$7bn in a copper mega-project in the volatile borderlands between Pakistan and Iran.

The Democratic Republic of Congo is already well known as the world's biggest source of cobalt, used in electric-car batteries. Less well known is the fact that cobalt is a by-product of the extraction of other minerals. In recent years that has allowed Indonesia, the largest exporter of nickel, another battery metal, to become a big and growing supplier of cobalt as well. The world's fourth-largest producer of nickel, by the way, is New Caledonia, a French territory of 300,000 people in the Pacific that holds 7% of global reserves.

When it comes to lithium, the king of battery metals, Latin America, Australia and China look like the obvious champions (Latin America alone hosts 60% of known resources). But they may face unexpected competition. In March, Iran said it had discovered what may be the world's second-largest deposit. Atlantic Lithium, an Australian firm, is developing Ghana's first lithium mine. And in September a huge deposit was found in America, on the Nevada-Oregon border. Demand for "green" metals will redraw the global mining map in ways that are hard to predict.

MATTHIEU FAVAS, Commodities editor, The Economist ■



世界展望2024

对“绿色”金属的需求将重新绘制全球矿业版图

能源转型将在令人意想不到的地方创造新的财富

如果全球净零经济成为现实，那么它将不仅仅是碳中和的。它消耗的原材料也将大幅减少。然而，实现这一目标将需要很多原材料。在接下来的几十年里，供应它们将创造新的财富。

迈向清洁能源系统的地球仍然需要肮脏的燃料。即使石油消费达到顶峰，能够以低成本生产优质原油的国家也会增强实力而不是削弱，因为它们的市场份额和定价能力会同步上升。沙特阿拉伯和阿联酋等海湾大国将是明显的受益者。不太受关注的是小国圭亚那，该国最近的发现足以使其到2028年每天开采120万桶石油，占全球供应量的1.1%，这可能使其人均石油产量超过世界上任何国家。

天然气是化石燃料发电厂中煤炭的更清洁替代品，人们对天然气的需求可能会持续更长时间。随着欧洲逐渐摆脱对俄罗斯天然气的依赖，正在提高液化天然气产量的美国、澳大利亚和卡塔尔将把收益收入囊中。但阿根廷也可能如此。与此同时，到2050年，非洲国家在全球天然气市场的份额可能会翻一番。

地球建设新的低碳基础设施需要数十亿吨金属，出口这类金属或许可以赚取更持久的财富。智利和秘鲁已经供应了世界上大部分的铜；随着从电线到风力涡轮机等所有绿色产品的推出，对这种红色金属的需求将会提升，两国剩余的巨大储量将被利用起来。然而，老化的矿山中矿石的铜含量下降，这会提高成本，并将矿工推向风险更高的地域。加拿大公司巴里克黄金（Barrick Gold）公司希望投资70亿美元，在巴基斯坦和伊朗之间动荡的边境地区建设一个大型铜项目。

至于电动汽车电池中所用的钴，众所周知，刚果民主共和国是世界上最大的产地。不太为人所知的是，钴是提取其他矿物的副产品。近年来，这使

得印度尼西亚这个最大的镍（另一种电池金属）出口国也成为了一个不断增长的大型钴供应国。顺便说一句，世界第四大镍生产国是新喀里多尼亚，这是一个位于太平洋的法国海外领地，有30万人口，拥有全球储量的7%。

说到电池金属之王锂，拉丁美洲、澳大利亚和中国看起来是明显的领导者（仅拉丁美洲就拥有60%的已知资源）。但它们可能会面临意想不到的竞争。今年3月，伊朗表示已发现可能是世界第二大矿床。澳大利亚公司大西洋锂业（Atlantic Lithium）正在开发加纳的第一个锂矿。9月，美国在内华达州和俄勒冈州的交界处发现了巨大的矿床。对“绿色”金属的需求将以难以预测的方式重新绘制全球采矿版图。

《经济学人》大宗商品编辑马蒂尤·法瓦斯 ■



The World Ahead 2024

Global average temperatures may pass a threshold in 2024

El Niño won't help

WHEN WILL the annual global average temperature rise by more than 1.5°C above pre-industrial levels for the first time? There have been individual days when the global average temperature has exceeded that threshold, but so far no single year has, on average, been that hot overall. This may change in 2024, when the steady, century-long rise in temperatures driven by greenhouse-gas emissions syncs with a natural cyclical warming pattern for the first time in nearly a decade.

Meteorological agencies collect temperature data from across the globe and throughout the year to determine the annual average global surface temperature. That number, published each January, has been rising since early in the 20th century, but not systematically. The line zigzags (see chart). This is because global warming, driven by greenhouse gases, is happening at the same time as natural variations in the global climate system, which cause some years to be hotter or colder than others.

The largest such hot-and-cold cycle is the El Niño Southern Oscillation (ENSO), a pattern that begins in and above the waters of the equatorial Pacific and affects the weather in the tropics and beyond. ENSO alternates between three states: La Niña, neutral and El Niño. The two extremes are typically cooler (La Niña) and hotter (El Niño) than average; both bring enhanced probabilities of wild weather extremes.

From mid-2020 to early 2023, ENSO was in a La Niña pattern. As well as exacerbating some remarkable weather events, including record-breaking floods in Pakistan in 2022, this unusually long La Niña temporarily depressed global average temperatures, masking some of the warming

caused by industrial emissions. There will be no such reprieve in 2024. In June 2023, ENSO flipped into a much-anticipated El Niño state, which will add to global warming. And this El Niño is forecast to be a strong one, bringing a greater likelihood of extremes.

The last such event was in 2015-16. It brought record-breaking global temperatures in 2016, an annual record that still stands. There are two possibilities. El Niño is an end-of year phenomenon that starts in the later days of the boreal summer and peaks at Christmas and the new year (it was named after Baby Jesus by Peruvian fishermen who noticed the way its warmer Pacific temperatures chased anchovies into deeper, cooler waters). Typically, the year after an El Niño is the record-breaker. But the boreal summer of 2023 brought serious climate fevers in both the oceans and the atmosphere. Starting in July, daily temperatures rose to new heights. As a result, when all the data are in and published in January, it may turn out that 2023 was the hottest year ever. If it was not, then 2024 almost certainly will be.

So will either year's average exceed the Paris threshold? The Paris agreement talks of a rise in temperatures "above pre-industrial". Naturally, when the threshold is passed depends on what is used as the pre-industrial average (temperatures are now measured with a precision that is not available from the proxies used to estimate averages before the steam engine). So some predict it will happen in 2024, others that it could take one more El Niño cycle.

Paris signatories will, however, have a little longer before the overshoot of 1.5°C will technically have been reached. The deal refers to a vaguely defined long-term average, taken over several years. So there will be a few more ups and downs before that average exceeds the threshold. Not many, though—climate models suggest the game will be up in the 2030s.

CATHERINE BRAHIC, Environment editor, The Economist ■



世界展望2024

全球平均气温可能在2024年突破阈值

厄尔尼诺的叠加效应

全球年平均气温何时将首次较工业化前水平上升超过 1.5°C ？全球平均气温曾有个别日子超过了这一阈值，但到目前为止，平均而言还没有哪一年整体如此炎热。这在2024年可能会改变，届时温室气体排放导致的持续了一个世纪的气温稳定攀升将在近十年来首次与自然周期性变暖模式同步。

气象机构收集来自全球各地的全年温度数据以确定全球年平均表面温度。这个在每年1月发布的数字自上世纪初以来不断上升，但并不是系统有序的。这条线呈锯齿状（见图表）。这是因为由温室气体驱动的全球变暖与全球气候系统的自然变化同时发生，导致某些年份比其他年份更热或更冷。

此类冷热循环中，最大的一个是厄尔尼诺南方涛动（ENSO），这一模式始于赤道太平洋水域及其上方，影响热带地区及其他地区的天气。ENSO在三种状态之间交替：拉尼娜、中性状态和厄尔尼诺。两个极端状态通常比平均水平更冷（拉尼娜）和更热（厄尔尼诺），都会增加发生极端天气的概率。

从2020年中到2023年初，ENSO处于拉尼娜状态。这次异常漫长的拉尼娜现象加剧了一些重大天气事件，包括2022年巴基斯坦破纪录的洪水，还暂时降低了全球平均气温，掩盖了工业排放造成的部分变暖现象。2024年不会有这样的缓和效应了。2023年6月，ENSO已转变为姗姗来迟的厄尔尼诺状态，这将加剧全球变暖。而预计这次厄尔尼诺将很强烈，出现极端事件的可能性会更大。

上一次厄尔尼诺是在2015到2016年间，它使得全球气温在2016年创下历史新高，这一年度纪录保持至今。现在有两种可能性。厄尔尼诺是一种在年底时出现的现象，它始于北半球夏季的后期，在圣诞节和新年达到顶峰

（最初秘鲁的渔民以婴儿耶稣为其命名，他们注意到太平洋变暖的水温驱动凤尾鱼游向更深更冷的水域）。通常情况下，在厄尔尼诺发生后的翌年气温会打破纪录。但2023年的北半球夏季给海洋和大气都带来了严重的“高烧”。从7月开始，每日气温不断攀升新高。因此，当所有数据汇整并在2014年1月份发布时，可能会揭示2023年是有史以来最热的一年。如果不是的话，那么2024年几乎肯定会是了。

那么这两年的平均气温会超过巴黎门槛吗？巴黎协议讨论的气温上升是“高于工业化前水平”。何时超过阈值自然要取决于拿什么作为工业化前的平均值（现在测量温度的精度是蒸汽机问世前用于估计平均值的指标所无法达到的）。因此，一些人预测这将在2024年发生，另一些人预测可能需要再经历一轮厄尔尼诺周期。

不过，在严格达到超过1.5度的阈值之前，留给巴黎协议签署国的时间还要略多一点。该协议所指是一个模糊定义的长期均值，跨越数年。因此，在这个平均值超过阈值之前还会有几回起伏波动。不过也不会太多——气候模型显示这将在2030年代到头。

《经济学人》环境编辑凯瑟琳·布拉希克 ■



The World Ahead 2024

Three commodities could take off in 2024

Markets have adjusted to the war in Ukraine

FOR MUCH of 2023 commodity markets were treading water. Russia's invasion of Ukraine, on top of supply-chain snarls from covid-19, had sent raw-material prices soaring in 2022. But a subdued economic outlook turned a busy market boring. Some excitement returned in late 2023, as oil prices perked up. But worries about demand kept indices on the floor.

In 2024 supply problems, together with resurgent demand, could cause three markets to take off. The first is crude oil. Most analysts reckon that new supply will combine with slow economic growth to cause a gradual decline in price, from more than \$90 in September 2023 to \$80 a barrel or less during 2024. But that could prompt Saudi Arabia, the world's biggest producer, to announce deeper output reductions than the 1m barrel-per-day cut—equivalent to 1% of global demand—it adopted in July. Iran's production may also be dented by sanctions or shipping problems. That could set the stage for a squeeze when economic growth returns.

Some metal markets also look vulnerable. Those for cobalt and lithium, two green metals on everyone's radar in 2022, look well supplied. Instead watch copper, prices for which fell during 2023 because of low Chinese growth. The hottest of all metal markets could be the ultra-niche one for uranium. The search for steady sources of low-carbon power and the war in Ukraine have made governments hungrier for atomic energy just as coups and conflicts have disrupted uranium production. Prices for the metal, already at their highest for a decade, could rise further as market deficits remain.

The third area to watch is the market for grain. Russia's invasion of Ukraine did not jolt the market for long: wheat prices, at \$12 a bushel in March 2022,

hit \$5 in autumn 2023. But Ukraine, the world's fifth-biggest exporter of the grain, now exports 35% less. Bumper crops from Russia have made up the difference, but bad weather and escalating tensions could jeopardise that. Stocks at large exporters have been falling for years. Buffers against shocks are slim.

MATTHIEU FAVAS, Commodities editor, The Economist ■



世界展望2024

三种大宗商品可能在2024年起飞

市场已适应了乌克兰战争

在2023年的大部分时间里，大宗商品市场都停滞不前。新冠疫情造成的供应链混乱再加上俄罗斯入侵乌克兰，导致2022年原材料价格飙升。但低迷的经济前景又让繁忙的市场变得平淡。2023年末，随着油价上涨，一些兴奋情绪再次出现。但对需求的担忧使指数仍处于低位。

到了2024年，供应问题加上需求复苏可能会导致三个市场腾飞。首先是原油。大多数分析师认为，新的供应加上经济增长的缓慢会导致价格逐渐下降，从2023年9月的每桶90美元以上，降至2024年的每桶80美元或更低。但这可能会促使全球最大生产国沙特阿拉伯宣布比7月份实施的每日减产100万桶（相当于全球需求的1%）更大幅度的减产。伊朗的生产也可能因制裁或运输问题而受到影响。当经济恢复增长时，这可能会为轧空奠定基础。

一些金属市场看起来也很脆弱。钴和锂这两种在2022年受到所有人关注的绿色金属看起来供应充足。应该更关注铜。由于中国经济增长缓慢，2023年铜价下跌。所有金属市场中最热门的可能是铀的超利基市场。寻找稳定的低碳能源来源，加上乌克兰战争，使各国政府对核能更加渴望，而与此同时政变和冲突扰乱了铀生产。由于市场缺口依然存在，铀价已经达到十年来的最高水平，可能会进一步上涨。

第三个值得关注的领域是粮食市场。俄罗斯入侵乌克兰并没有对市场造成长期冲击：小麦价格在2022年3月为每蒲式耳12美元，到2023年秋季降到每蒲式耳5美元。但世界第五大谷物出口国乌克兰目前的出口量减少了35%。俄罗斯的丰收弥补了这一缺口，但恶劣的天气和不断升级的紧张局势可能会危及这一点。大型出口商的库存多年来一直在下降。抵御冲击的缓冲带很薄。

《经济学人》大宗商品编辑马蒂尤·法瓦斯■



The World Ahead 2024

The fight over remote working will heat up in 2024

And reality will set in for landlords

WHEN COVID-19 forced office workers to toil from their spare rooms and kitchen tables, it triggered the biggest shift in professional life for decades. And, as with any big shift, the consequences are still working their way through corporate hierarchies and the financial system. In 2024 reality will start to set in, for workers, bosses and landlords.

Managers and their employees do not quite see eye to eye on the vexed question of where work should be done. According to a survey by WFH Research, a group of academics, full-time workers with at least a secondary education in America, Britain and Canada work, on average, a day and a half a week from home. And, on average, they want to double their time doing so. Employers, however, have different ideas. Everyone from Goldman Sachs, a Wall Street giant, to Zoom, of video-calling fame, is asking its reluctant workers to show up to the office more often.

No one is expecting, or even looking for, a return to five days a week. The most likely outcome is that bosses and workers meet in the middle, with a little less work done remotely than employees would prefer. But a lot depends on whether rising interest rates eventually weaken the economy. If unemployment starts rising and workers are no longer in short supply, bosses will drive a harder bargain.

The shift to remote work has so far had a curiously muted effect on the commercial-property industry. Offices are certainly less busy than they used to be: according to Kastle, a firm that operates swipe-in systems for offices, occupancy in America is roughly half what it was before the pandemic. Yet the long duration of office leases means that vacancy rates,

though rising, have been relatively low. Goldman Sachs reckons that 12% of leases will come up for renewal in 2024, more than twice as many as in 2023.

The bank reckons that remote working could contribute to an extra 46m square feet (4.3m square metres) of office space lying vacant in America—equivalent to all the floor space built in 2022. Whereas swish offices that comply with tightening environmental standards will stay in high demand, the offices most likely to stay empty are in older buildings.

None of this is welcome news for landlords. Their refinancing costs have gone up as well, as interest rates have risen. In America most commercial-property loans are owed to smaller lenders, which are especially under strain after the collapse of Silicon Valley Bank in March 2023. And financing costs for less desirable office space are likely to be higher still. The yields on commercial mortgage-backed securities, for instance, are higher for low-quality offices than they are for “prime” properties.

Expect to see more of these buildings being sold at a discount, so that they can be refurbished or demolished. Those that have sufficient light and the right plumbing may be turned into homes. Though this is unlikely to be financially viable for most unwanted offices, the number of conversions in places like London and New York is growing. In Manhattan, 25 Water Street, which used to house a newspaper and a bank, is being converted into a residential block with 1,300 flats, a spa, a swimming pool—and a co-working space. The pandemic may be over, but in 2024 the remote-work revolution will continue to change how and where people work and play.

RACHANA SHANBHOGUE, Business affairs editor, The Economist ■



世界展望2024

远程工作之争将在2024年升温

现实将摆在房东面前

新冠肺炎迫使办公室员工在自家的空房间和厨房餐桌上辛勤工作，引发了职场生活几十年来最大的转变。而且，和任何重大转变一样，其影响仍在通过公司等级制度和财务体系慢慢渗透。在2024年，对于员工、老板，还有房东来说，谜底将开始揭开。

在应该在哪里完成工作这个棘手的问题上，管理者和员工的看法并不很一致。学者研究团队WFH Research的一项调查显示，美国、英国和加拿大至少受过中学教育的全职工作者平均每周在家工作一天半。平均而言，他们希望把这一时长增加一倍。雇主们却有不同的想法。从华尔街巨头高盛到视频通话巨子Zoom，各行各业的公司都在要求它们不情不愿的员工更频繁地出现在办公室里。

没人预期或哪怕寻求回归到每周去公司五天的状态。最有可能的结果是老板和员工各退一步，而最终以远程方式完成的工作会比员工所希望的略少一些。但事情在很大程度上将取决于利率上升最终是否会削弱经济。如果失业率开始上升，员工不再短缺，那么老板们在这场谈判中就会变得更强势。

到目前为止，向远程工作的转变对商业地产的影响却出奇微弱。办公室肯定没有以前那么拥挤了：据运营办公室刷卡系统的Kastle的说法，美国的办公室占用率约是疫情前的一半。但是，由于写字楼的租赁期限长，空置率虽有所上升，仍处于相对较低水平。高盛估计，2024年将有12%的租约需要续签，是2023年的两倍多。

高盛认为，远程工作可能导致美国额外空置4600万平方英尺（430万平方米）的办公空间，相当于2022年建成的建筑面积总和。对遵循更严格环保标准的豪华办公室的需求将维持高位，位于更老旧的建筑中的办公室则最

有可能长久空置。

这一切对房东来说都不是好消息。随着利率上升，他们的再融资成本也上升了。在美国，大多数商业地产贷款都借自较小的银行，这类贷款机构在2023年3月硅谷银行倒闭后处境尤其艰难。而那些不太理想的办公空间的融资成本可能还会更高。例如，低质量写字楼的商业抵押贷款支持证券的收益率高于“优质”物业的收益率。

可以预期将有更多此类大楼会折价出售，以便被翻新或拆除。那些拥有充足的光线和恰当的管道的商业大楼可以改造成住宅。尽管对于大多数闲置的办公室来说，这在财务上不大可行，但伦敦和纽约等地的改造项目正在增加。在曼哈顿，水街25号曾有一家报纸和一家银行，现在正被改建为一个有1300套公寓、水疗中心、游泳池和联合办公空间的住宅区。疫情可能已经结束，但在2024年，远程工作革命将继续改变人们工作和娱乐的方式和地点。

《经济学人》商业编辑拉查纳·尚伯格 ■



The World Ahead 2024

Don't count on a soft landing for the world economy

Inflation has fallen, but vulnerabilities remain

FOR SOME time the world economy has seemed to defy gravity. Despite the fastest tightening of monetary policy since the 1980s, America's economic growth probably accelerated in 2023. Europe has mostly weaned itself off Russian gas without economic catastrophe. Global inflation has fallen without big surges in unemployment, in part because labour markets have so far cooled mainly by shedding job vacancies not jobs themselves. As the year ends, optimists who predicted a "soft landing" are taking victory laps.

Yet the world economy will remain fragile in 2024. Though inflation will be lower, it will remain too high. Economic policy still faces an excruciating balancing act. And even if America continues to dodge a recession, the rest of the world looks vulnerable.

Inflation's recent fall has been a relief to central bankers. But in big, rich economies it is unlikely to continue declining all the way to their 2% targets unless a recession strikes. For one thing, labour markets still look too hot and nominal wage growth too high. For another, economies will have to contend with the effects of more expensive oil. Just when it seemed as if the supply shocks of the pandemic era and Russia's invasion of Ukraine had dissipated, with supply chains unclogged and economies rebalanced, a barrel of oil has risen in price by about a third since the summer, thanks to production cuts in Saudi Arabia and elsewhere. A price fall was halted by Hamas's attack on Israel. The resulting pricier petrol could raise fears of a "second wave" of inflation.

The major central banks will probably not raise interest rates further, instead treating any oil-driven inflation rebound as temporary. But, fearful

of premature declarations of victory, they will not be keen to cut rates, either. On recent evidence America's economy can withstand tight money, even if big companies refinancing debts and households who have run down their pandemic-era savings are beginning to feel squeezed. But high interest rates may be tipping the already-wobbly euro-zone economy into recession, and fear of inflation could stop its policymakers from cutting rates in response.

Even the robustness of America's economy comes with a big asterisk: it is being supported by extraordinary levels of government borrowing. At the time of writing the federal government's deficit is running at an annual rate of over 7% of GDP. Debate rages about whether interest rates have entered a "higher-for-longer" regime. The answer depends on whether the borrowing binge continues. It probably will: Congress will not confront it in a presidential-election year. And the first order of business for the next occupant of the White House will be renewing Donald Trump's 2018 tax cuts, many of which expire in 2025 and which even Democrats will be reluctant to let lapse in full.

Economies without freely borrowing governments look more vulnerable. As well as the likely recession in Europe, the world economy is suffering from China's growth slowdown. Whether China rebounds and escapes "Japanification" will depend on the degree to which the government continues to open the stimulus taps. But the recent deterioration of China's economic policymaking—in everything from ending zero-covid to the technology crackdown—suggests it would be unwise to expect a well-calibrated stimulus. And China faces fiscal constraints owing to the indebtedness of its local governments.

All the while, the gradual worsening of geopolitical tensions between America and China, and the global tide of protectionism, are throwing sand in the gears of trade. The number of protectionist measures in place is up

from about 9,000 a decade ago to around 35,000 today, according to Global Trade Alert, a charity. Although some economies in Asia benefit from the relocation of supply chains outside China, the duplication of investment and loss of the gains from specialisation are weighing on the global economy's potential growth. Even winners, such as fast-growing India, show a worrying drift towards homeland economics.

Poor countries that are not in a position to benefit from the redistribution of investment are suffering from high indebtedness, low growth and a strong dollar. In 2024 the IMF will continue to struggle to work out how to provide debt relief to countries that are heavily in debt to China and other lenders who do not subscribe to traditional principles for debt restructuring. And if America's deficits continue to propel its economy while global growth disappoints, expect the dollar to rise still further, exacerbating their woes.

The possibility of Mr Trump's re-election to the White House brings the potential for all of these trends to be magnified. A second Trump term would probably mean even deeper tax cuts—and hence bigger deficits—and a further escalation of the trade war. As in 2016, stockmarkets might rally if Mr Trump wins in November, but it would be no good-news story. By the end of 2024 it might feel less as though the global economy has landed softly, and more like the start of another wild ride.

HENRY CURR, Economics editor, The Economist ■



世界展望2024

不要指望世界经济软着陆

通胀已下降，但脆弱性还在

一段时间以来，世界经济似乎违反了地心引力。尽管实行了自上世纪80年代以来最快的货币紧缩，但在整个2023年美国的经济增长很可能是加速的。欧洲基本上已经摆脱了对俄罗斯天然气的依赖而没有发生经济灾难。全球通胀率下降，但失业率并未大幅上升，部分原因是到目前为止劳动力市场的降温主要是职位空缺减少而不是职位本身减少。随着2023年走到末尾，预测“软着陆”的乐观主义者正在取得胜利。

但世界经济在2024年仍将是脆弱的。尽管通胀会下降，但仍会维持在过高的水平。经济政策要兼顾各方依然叫人非常头痛。而即使美国能继续躲过经济衰退，世界其他地区看起来也很脆弱。

近期通胀下降让各国央行官员松了口气。但对于大型富裕经济体而言，除非发生经济衰退，否则通胀不太可能继续一路下滑至2%的目标。一方面，劳动力市场看起来仍然过热，名义工资增长过高。另一方面，经济将不得不应对石油价格上涨的影响。正当全球疫情和俄罗斯入侵乌克兰带来的供应冲击似乎已经消散、供应链重新畅通、经济体完成再平衡之际，沙特阿拉伯等地减产使得每桶石油价格自夏季以来已经上涨了约三分之一。 Hamas袭击以色列又打断了油价下跌之路。由此导致的更昂贵的油价可能引发对“第二波”通胀的担忧。

全球各主要央行可能不会进一步加息，而会将石油驱动的通胀反弹视为暂时波动。但它们也担心宣布胜利过早，所以也不会急着降息。近期证据表明，即使大公司要为债务再融资，而家庭在耗尽了疫情期间储蓄后开始感到压力，美国经济还是能够承受住货币紧缩的冲击。但高利率可能会让本已摇摇欲坠的欧元区经济陷入衰退，而对通胀的担忧可能会阻止其政策制定者用降息来应对。

就连美国经济的强韧也带有一个大大的注脚：它是由极高水平的政府借债支持的。在作者撰写本文时，美国联邦政府的赤字年增长率已超过GDP的7%。关于利率是否已进入“长期高企”状态的争论十分激烈。答案取决于政府这种大举借债是否会继续。很可能是会的，因为国会不会在总统选举年挑战这种做法。下一任白宫主人的首要任务将是延续特朗普2018年的减税政策，其中有许多将于2025年到期，而即使民主党人也不愿让它们完全失效。

那些政府没法随心所欲借贷的经济体看起来就更脆弱了。除了欧洲很可能出现衰退外，世界经济也受到中国增长放缓的影响。中国经济能否反弹并摆脱“日本化”将取决于其政府继续打开刺激水龙头的程度。但从近年中国经济决策变糟（从结束新冠清零到打压科技行业，等等）来看，期望它出台精准的刺激措施是不明智的。而由于地方政府负债累累，中国也面对财政约束。

与此同时，中美地缘紧张局势逐渐恶化，全球保护主义浪潮不断涌现，正让贸易的齿轮运转不灵。根据慈善机构“全球贸易警报”（Global Trade Alert）的数据，已实施的保护主义措施数量从十年前的约9000项增加到如今的约35,000项。尽管亚洲一些经济体受益于供应链转移出中国，重复投资和失去分工合作带来的收益正在严重拖累全球经济增长潜力。即使是像快速增长的印度这样的赢家也显现出滑向本土经济的不祥势头。

没有机会从投资再分配中受益的贫穷国家正在遭受高负债、低增长和强势美元的困扰。2024年，国际货币基金组织会继续绞尽脑汁，要琢磨出如何向一些国家提供债务减免，它们对中国和其他拒绝遵循传统债务重组原则的债权人负债累累。如果美国的赤字继续推动其经济增长，而同时全球经济增长令人失望，那么可以预期美元将进一步升值，从而加剧它们的困境。

特朗普再度当选的可能性加大了所有上述趋势的可能性。特朗普的第二个任期可能会出台更大幅度的减税——从而导致更大的赤字——以及贸易战的进一步升级。与2016年时一样，如果特朗普在11月获胜，股市可能会上

涨，但这并不会是什么好消息。到了2024年底，世界经济看起来可能不再像是软着陆，而更像是另一场疯狂之旅的开始。

《经济学人》经济编辑亨利·柯尔 ■



There's no place like home

The likelihood of living on Mars soon is as remote as Pluto

Even if tech geeks do not want to hear that

A City on Mars. By Kelly Weinersmith and Zach Weinersmith. Penguin Press; 448 pages; \$32. Particular Books; £25

SOME CONVERTS are zealous. Some are reluctant. Kelly and Zach Weinersmith are definitely in the second camp. Both, as they constantly remind the reader, are space geeks. But they are also rationalists (who happen to be married). They began writing their new book in the expectation that off-Earth settlements would soon be on the cards. Their rational appraisal, having finished it, is the opposite. Those, such as Elon Musk, who aspire to make *Homo sapiens* a two-planet species by colonising Mars or somewhere else, are, they conclude, deluding themselves.

That opinion is not popular in the circles in which they move. But they argue their case cogently, contrasting the escapist fantasies of would-be planetary homesteaders with practicality. How, for example, would people feed themselves? Mars's surface is covered with toxic perchlorates, making the planet's "soil" hard to farm; the Moon's has little carbon, life's essential ingredient. Will space-dwellers be able to have babies? Both conception and birth may prove tricky in low gravity.

Will there be a land grab for the few lunar mountain tops that enjoy perpetual sunshine and the equally rare crater bottoms that never see it (and so might harbour the precious resource of frozen water)? Who will control the air supply? (For a fictional take on how this can go wrong, watch "Total Recall".) What will the currency be? Space-shuttle astronauts in the 1990s favoured packets of taco sauce.

Then there is the question of why anyone would want to go in the first place. Escaping an environmentally damaged Earth or even simply having an insurance policy against the chance of nuclear annihilation or an asteroid strike may sound attractive. But Mars is actually far more horrid than any fate likely to be awaiting humanity's home planet—even, probably, the aftermath of a nuclear exchange. And the Moon is worse even than that.

Space may appeal to Mr Musk as a retirement destination (“I’d like to die on Mars, just not on impact” is a saying often attributed to him). But nursing homes for the hyper-rich are a niche market, not the sort of enterprise on which new countries are usually founded. As to the one proper business space-colonisation enthusiasts propose that has a chance of becoming real—the mining of asteroids for precious metals—this would mean pushing space rocks around in ways that might make an asteroid strike more rather than less likely.

And there are even bigger difficulties than these. One is that, however much people might aspire to leave Earth’s cares behind and start afresh elsewhere, they cannot. Any successful space settlement will carry inescapable historical baggage, and will, at least to start with, be simply an extension of terrestrial geopolitics. The other difficulty is that people themselves are the problem, and they will continue to be a problem even if they are born and raised in other parts of the solar system.

The Weinersmiths are reluctant to rule out the settlement of space for ever. But they argue that if it is to be done, it should not be piecemeal, in the way now planned. Humanity should instead wait a century or two, garner knowledge, develop technology and accumulate sufficient resources to pull it off properly—and then quickly build a large, planned outpost in a sort of “big bang”. Good luck with that. Patience has never been humanity’s strong suit (it certainly does not seem to be Mr Musk’s). Neither has long-term

planning. ■



金窝银窝，不如地球

很快搬去火星的可能性渺如冥王星

即便技术极客们听不得这个【《火星上的城市》书评】

《火星上的城市》，凯莉·维纳史密斯和扎克·维纳史密斯著。企鹅出版社；448页，32美元。Particular Books出版社；25英镑

改变信仰的人有些很狂热，有些则不大情愿。凯莉·维纳史密斯（Kelly Weinersmith）和扎克·维纳史密斯（Zach Weinersmith）肯定属于后者。正如他们不断提醒读者的那样，两人都是太空极客。但他们也是理性主义者（碰巧结婚了）。怀着对人类可能很快将能在地球之外定居的期许，他们开始写新书。写完后，他们的理性评估所得出的结论却恰恰相反。他们认为，那些像马斯克一样渴望通过殖民火星或其他地方而让智人成为双星球物种的人，是在自欺欺人。

这种观点在他们所混迹的圈子里并不讨喜。但他们拿未来星际开拓者逃避现实的幻想比对实际情形，做了清晰有力的论述。例如，人们如何养活自己？火星表面覆盖着有毒的高氯酸盐，因此火星的“土壤”很难耕种；月球上几乎没有碳，而碳是生命的基本成分。太空居民能生孩子吗？在低重力环境下，受孕和分娩可能都会很难。

人们会不会争夺地盘，去抢那几个永浴阳光的月球山顶，还有同样罕见的永远暗无天日的陨石坑底（因此可能蕴藏着宝贵的冰冻水资源）？谁将控制空气供应？（想要了解事态能发展到多严重，可以看看电影《全面回忆》[Total Recall]。）用什么做货币？上世纪90年代，航天飞机上的宇航员最喜欢用的是墨西哥卷饼的酱料包。

接下来的问题是，为什么会有人想去呢？逃离环境被破坏的地球，或者甚至就只是为了加个保险，在核毁灭或是小行星撞击地球时有地方可以躲避，这听上去可能都很吸引人。但其实，相比人类家园未来可能面临的任何命运——即便是核战争，火星都可怕得多。而月球只会更糟糕。

马斯克对太空感兴趣，他可能把那里当做退休后的去处（“我想要死在火星上，不过不是在降落时摔死”这句话通常被认为是他说的）。但是，为超级富豪准备养老院是个利基市场，而不是那种能创建新国家的壮举。至于太空殖民狂热者提出的一项有可能成为现实的正经业务——在小行星上开采贵金属——则意味着摆弄干扰太空岩石，或许会增加而不是减少小行星撞击地球的可能性。

还有比这些更大的困难。一是无论人们多么渴望把地球上的烦恼抛在脑后，在其他地方重新开始，他们都做不到。任何成功的太空移民都会背负甩不掉的历史包袱，而且，至少在一开始，会仅仅是地球上的地缘格局的延伸。另一个困难是，人类本身就是问题所在，就算在太阳系的其他地方出生、长大，他们也依然会成为问题。

维纳史密斯夫妇不愿永久排除在太空移民的可能性。但他们认为，要做到这一点，不应该像现在计划的这样零敲碎打。相反，人类应该等上一两个世纪，储备知识、发展技术、积累足够的资源来恰当实现这一目标，然后在某个“大爆炸”时刻到来时迅速按计划建立一个大型前哨站。希望能有好运。耐心从来都不是人类的强项（当然也不是马斯克的强项）。长期规划也不是。■



Reasons to be cheerful

What will artificial intelligence mean for your pay?

A dispatch from industries on the front line of economic transformation

AROUND A DECADE ago Carl Benedikt Frey and Michael Osborne, two economists, published a paper that went viral. It argued that 47% of American jobs were at risk of automation. A deluge of research followed, which suggested the poorest and least-educated workers were most vulnerable to the coming revolution. Such fears have intensified as artificial-intelligence (AI) capabilities have leapt ahead. On November 2nd, speaking after Britain's AI summit, Elon Musk predicted: "There will come a point where no job is needed."

Yet at the same time, economists have become more optimistic. Recent studies have found that fewer workers are exposed to automation than Messrs Frey and Osborne supposed (see chart 1). In 2019 Michael Webb, then of Stanford University, showed that AI patents are more targeted at skilled jobs than those for software and robots. New AI seems better at coding and creativity than anything in the physical world, suggesting low-skilled jobs may be insulated. In March Shakked Noy and Whitney Zhang, both of the Massachusetts Institute of Technology (MIT), published an experiment showing that ChatGPT boosted the productivity when writing of lower-ability workers more than that of higher-ability workers.

Although AI is still in its infancy, some industries have been eager adopters. A close look at three of these—translation, customer service and sales—is broadly supportive of the optimistic shift among economists, though not without complications. In translation, perhaps the first industry to be heavily affected by language modelling, workers have become copy editors, tidying a first draft undertaken by AI, which eases the path of newbies into the industry. In customer service, AI has helped raise

the performance of stragglers. But in sales, top performers use the tech to find leads and take notes, pulling away from their peers. Will AI boost the incomes of superstars more than those of stragglers, much as the internet revolution did? Or will it be a “great equaliser”, raising the incomes of the worst off but not those of high flyers? The answer may depend on the type of employment in question.

| *Roll the dice*

Roland Hall has been translating board games and marketing material from French to English for 27 years. He recalls that even in the 1990s software was used to render specific words from one language to another. Today the tools are more advanced, meaning the types of job available have split in two. One type includes texts where fluency is less important. An example might be a several-thousand-page manual for an aircraft, says Mr Hall, where readers simply need to know “what part to look for” and “do you turn it left or right”. The other type includes literary translations, where the finest details matter.

The first type has been most affected by AI. Many workers now edit translations that have gone through a machine similar to that underlying Google’s translation service. They are paid at a steep discount per word, but more work is available. Lucia Ratikova, a Slovakian who specialises in construction and legal translations, reckons that such work now makes up more than half of listings on job sites, up from a tenth a few years ago. A larger pool of businesses, many eager to expand into global markets, are taking advantage of the drop in price.

If machines are able to do what humans do more cheaply, employers will turn to computers. But as prices fall, overall demand for a service may rise, and possibly by enough to offset the increased use of machines. There is no law to determine which effect will dominate. So far in America the number of translators has grown, yet their real wages have fallen slightly (see chart

2)—probably because the profession now requires rather less skill.

Customer service offers more difficult terrain for AI. Firms have been trying to automate it for years. Thus far they have mostly just annoyed customers. Who doesn't try to game the chatbot in order to speak to an actual human? The American Customer Satisfaction Index has been falling since 2018, and workers also appear fed up. Turnover in American "contact centres" hit a record high of 38% last year.

But there may be consolation: the workforce is becoming more welcoming to the low-skilled. Erik Brynjolfsson of Stanford, as well as Danielle Li and Lindsey Raymond of MIT, studied the roll-out of an AI assistant to more than 5,000 customer-support agents earlier this year. The assistant offered real-time suggestions to workers. This lifted the productivity of the least-skilled agents by 35%, while the most-skilled ones saw little change.

It would be reasonable to assume that the impact on salespeople would be fairly similar to the one on customer-service workers. But that is not the case. Marc Bernstein of Balto, a firm that creates AI software for both sales teams and call centres, notes that "style points" (ie, charisma and the ability to develop a relationship) matter much more in sales than in customer service, where the important thing is getting the right answer quickly.

AI might even create sales superstars. Skylar Werneth has been in the industry for eight years and is now at Nooks, a startup that automates sales. Software analyses his calls, identifying which tactics work best. It also helps him call many people at once. Most customers do not pick up; dialling in parallel ensures Mr Werneth is talking more and listening to dial-tones less. He reckons the tools Nooks offers makes him three times more productive, earning him a solid amount more than before.

What does this mean for labour markets? Sales representatives are given

bonuses based on the number of clients they bring in over a threshold. When productivity grows across a firm, bosses tend to raise the threshold. Because not everyone is able to meet it, low performers are pushed out of the workforce, since demand for products does not grow in parallel with sales performance, as would be necessary to justify retaining them. The result is a shrinking set of highly productive salespeople. At least, given high turnover in the industry, the shift to this state of affairs might mean hiring fewer people, not mass firings.

| *AI caramba*

If AI eventually becomes superhuman, as many attendees at Britain's recent summit believed possible, all bets are off. Even if AI advances in a less epochal fashion, labour markets will see profound change. A study by Xiang Hui and Oren Reshef of Washington University in St Louis and Luofeng Zhou of New York University, published in August, found that earnings for writing, proofreading and copy-editing on Upwork, a freelancing platform, fell by 5% after ChatGPT was launched last November, compared with roles less affected by AI. A survey of 400 call-centre managers by Balto found that the share using at least some AI grew from 59% in April to 90% by October. Mr Bernstein thinks that although "today AI is not capable of replacing a human [in call centres]...in ten years, quite possibly five, it will be there."

The flipside of AI disruption is new jobs elsewhere. Modelling in 2019 by Daron Acemoglu of MIT and Pascual Restrepo of Boston University suggests that the impact of automation is worst for workers when productivity gains are small. Such "so-so" automation creates little surplus wealth to increase the demand for workers in other parts of the economy. Our investigation of industries at the front line of AI change suggests that the new tech has a shot at leading to much greater efficiency. The picture on inequality remains murkier. Better to be a superstar than a straggler, then, even if only

to be safe. ■



乐观的理由

人工智能会如何影响你的薪酬？

来自经济转型前线产业的最新战报【深度】

大约十年前，经济学家卡尔·本尼迪克特·弗雷（Carl Benedikt Frey）和迈克尔·奥斯本（Michael Osborne）发表的一篇论文迅速流传开来。文中指出，美国有47%的工作岗位有被自动化取代的风险。之后大量研究涌现，称最贫穷和受教育程度最低的工人最易受到即将到来的这股变革的冲击。随着人工智能（AI）的突飞猛进，这种担忧愈演愈烈。11月2日，马斯克出席英国的AI峰会后预言道：“终有一天人们不再需要工作。”

但与此同时，经济学家们变得更乐观了。近期的研究发现，受自动化威胁的工人比例比弗雷和奥斯本推测的要少（见图表1）。2019年，当时任教于斯坦福大学的迈克尔·韦伯（Michael Webb）指出，相比软件和机器人专利，AI专利更多是针对高技能工作。新型AI似乎更擅长编程和创意而非在实体世界中劳作，表明低技能工作也许不受影响。今年3月，麻省理工学院的沙克德·诺伊（Shakked Noy）和惠特尼·张（Whitney Zhang）发表的一项实验结果表明，ChatGPT在写作任务上对能力较低的员工的帮助更甚于能力较高的员工，结果是提升了整体生产率。

尽管AI仍处于起步阶段，一些行业已迫不及待地率先采用它。仔细观察其中的三个行业——翻译、客服和销售，大体上可以明白经济学家为何态度转向乐观，即使其中也不乏复杂情况。翻译可能是首当其冲严重受语言建模影响的行业，译员已转变为文案编辑，整理润色AI生成的初稿，方便了新手入行。在客服领域，AI帮助落后者提升了表现。但在销售领域，顶级销售人员会利用这项技术寻找销售机会并做笔记，从而拉开与同事的业绩差距。AI会否像互联网革命那样，更多提升了明星员工而非落后员工的收入？还是说AI会成为一个“大平衡器”，提高底层而非精英的收入？答案可能取决于所涉及的职业类型。

罗兰·霍尔（Roland Hall）从事桌游和营销资料的法译英翻译已有27年。他回忆道，早在上世纪90年代人们已经在利用软件来翻译某些单词。现在，这类工具变得更先进，让市场上的翻译任务被分成了两类。一类是不太讲究表达流畅的文本翻译。几千页的飞机操作手册可能算一例，霍尔说，其读者只需要知道“该找到哪个部件”和“是要往左扭还是往右扭”就好。另一类包括文学翻译等，最细微之处事关紧要。

前一类翻译受AI的影响最大。现在，许多译员编辑的译文都是由类似谷歌翻译服务的机器生成的。他们的每字翻译单价大大降低，但市面上的翻译任务也更多了。专事建筑和法律类翻译的斯洛伐克译员露西娅·拉蒂科娃（Lucia Ratikova）估计，现在这类工作在招聘网站上的占比过半，而几年前只占十分之一。越来越多的企业——其中有许多迫切想拓展全球市场——正在利用翻译价格下降的好处。

如果机器能够以更低的成本完成人类的工作，雇主就会转而采用计算机。但随着价格下降，对某项服务的总需求有可能上升，而且升幅可能足以抵消扩大机器应用的影响。没有什么法则可拿来判断哪种效应会占主导。目前而言，在美国，翻译队伍更壮大了，但他们的实际工资略有下降（见图表2），可能是因为现在翻译行业对技能的要求有所降低。

AI在进军客服领域时阻力更大。多年来，企业一直在试图将客服工作自动化。但到现在为止它们大多时候只是惹恼了客户。谁没试过戏弄聊天机器人只为能与真人客服对话？自2018年以来，美国客户满意度指数一直在下降，而从业者似乎也心生厌倦。去年，美国的“客服中心”员工流失率创下了38%的历史新高。

但也许仍有值得欣慰之处：这个劳动力队伍正变得更能接纳低技能员工。今年早前，斯坦福大学的埃里克·布林约尔松（Erik Brynjolfsson）联同麻省理工学院的丹妮尔·李（Danielle Li）和林赛·雷蒙德（Lindsey Raymond）研究了5000多名客服代表使用一个AI助手的情况。该AI助手向客服人员提供实时建议，使水平垫底的客服的工作效率提高了35%，而最

熟练的客服的效率变化不大。

人们有理由猜想AI对销售人员的影响和对客服人员的影响差不多。但事实并非如此。Balto公司同时为销售团队和呼叫中心开发AI软件，该公司的马克·伯恩斯坦（Marc Bernstein）指出，在销售领域，“风格分”（即人格魅力和发展关系的能力）要重要得多，在客服岗位上则不然，这里更重要的事是迅速给出正确答案。

AI甚至可能造就销售明星。斯凯拉·韦尔内斯（Skylar Werneth）做销售已有八年，如今在专事销售自动化的创业公司Nooks任职。软件会分析他的电话通话，辨别哪些策略最有效。软件还能帮助他同时给很多人打电话。大多数客户不会接电话，同时拨打可以确保韦尔内斯能多和客户通话，少听拨号音。他认为，Nooks提供的工具使自己的工作效率提高至原来的三倍，收入也就大大增加。

这对劳动力市场意味着什么？销售代表的奖金是按他们在一定基数之上成交的客户计算的。当整个公司的生产率提高时，老板往往会提高这个基数。由于并非所有销售人员都能达到这个基数，业绩差的就会被挤走，毕竟对产品的需求并不会随销售业绩的上升而增加，而需求增加是留下他们的必要条件。结果只会留下为数越来越少的高生产率销售人员。考虑到销售领域员工的高流动率，向这种状态的转变就算不会导致大量销售人员被解雇，至少也可能让招聘人数减少。

| AI哟我去

假如AI的能力最终超越人类——近期英国峰会上的许多与会者认为这是可能的——那一切都不好说了。而即使AI的进军没有那么颠覆时代，劳动力市场也将上演深刻变化。圣路易斯华盛顿大学（Washington University in St Louis）的回翔和奥伦·雷舍夫（Oren Reshef）以及纽约大学的周罗峰（音译，Luofeng Zhou）今年8月发表的一项研究发现，去年11月ChatGPT推出后，在自由职业者平台Upwork上，相比受AI影响较小的工作，写作、校对和文案编辑这些工作的收入下降了5%。Balto对400名呼叫中心经理的调查发现，或多或少运用了AI的人数比例从4月的59%增加到10月的

90%。伯恩斯坦认为，尽管“今天AI还无法取代（呼叫中心）的人类客服.....但十年后，也很可能是五年后，AI就能做到这一点”。

AI颠覆劳动力市场的另一面是在其他领域创造新的就业机会。麻省理工学院的达龙·阿西莫格鲁（Daron Acemoglu）和波士顿大学的帕斯夸尔·雷斯特雷波（Pascual Restrepo）在2019年的建模表明，当自动化对生产率提升不大时，对工人的冲击最严重。这种“一般般”的自动化创造的剩余财富很少，不足以增加经济中其他领域对工人的需求。我们对处于AI变革前沿的行业所做的调查表明，这一新技术有可能大大提升效率。它对不平等的影响则依然更不明朗。所以安全起见，最好还是争当明星，而不要沦为掉队者。■



The big climate question

Will China save the planet or destroy it?

The country's carbon emissions will soon peak. Then comes the hard part

THOUGH HE LAY dying of brain cancer, Tu Changwang had one last thing to say. The respected Chinese meteorologist had noticed that the climate was warming. So in 1961 he warned in the People's Daily, a Communist Party mouthpiece, that this might alter the conditions that sustain life. Yet he saw the warming as part of a cycle in solar activity that would probably go into reverse at some point. Tu did not suspect that the burning of fossil fuels was pumping carbon dioxide into the atmosphere and causing the climate to change. In that issue of the People's Daily, a few pages before his paper, there was a photo of grinning coalminers. China was rushing to industrialise with the aim of catching up economically with the West.

Today China is an industrial powerhouse, home to over a quarter of the world's manufacturing—more than America and Germany combined. But its progress has come at a cost in terms of emissions. Over the past three decades China has released more carbon dioxide into the atmosphere, in total, than any other country (see chart 1). It now emits over a quarter of the world's greenhouse gases each year, according to Rhodium Group, an American research firm. That is about twice as much as America, which comes second (though on a per-person basis America is still worse).

Much, then, depends on China if the world is to keep global warming since the Industrial Revolution well below 2°C, as governments pledged at the UN's annual climate summit in Paris in 2015. This year's summit (called COP28) began on November 30th in Dubai. China has both good and bad news for those attending.

On the positive side, China's emissions will soon stop rising. Some analysts

think they will top out this year. There is little doubt that the peak will come before 2030, which is the goal China has set for itself. It is building nuclear-power stations faster than any other country. It has also invested heavily in renewable energy (see chart 2), such that it now has around 750 gigawatts of wind and solar generating capacity, about a third of the world's total. By the end of the decade the government aims to have 1,200GW of such capacity, more than the total power capacity of the European Union at the moment. China will probably well exceed that target.

But it is not just China's embrace of renewable energy that is helping it curb emissions. Its production of carbon-intensive steel and cement has been dropping. After decades of building roads and railways, the government is splurging less on big infrastructure projects. A long expansion of the property sector has ended in a meltdown that has shaken the economy—but led to fewer emissions. Going forward, few analysts expect China's GDP to grow as fast as it did at the end of the last century and the beginning of this one. Put another way, China's dirtiest phase of development is probably behind it.

More important than the peak, though, is what happens next. China has pledged to eliminate net emissions of greenhouse gases (or to become "carbon neutral") by 2060. This will be a much harder target to hit. Even after that massive injection of renewables, dirty coal still supplies well over half of China's energy. That is down from around 70% in 2011, but the amount of coal China burns continues to increase, as demand for electricity rises. Last year China mined a record 4.5bn tonnes of the black rock and approved around two new coal-fired power plants for construction every week on average.

Many of these may never be built. Declining utilisation rates of existing coal plants undermine the case for further construction. But China is not moving away from coal as fast as environmentalists would like or analysts

say is necessary to meet its 2060 target. Part of the problem is that the country has a lot of it. With little oil or gas, coal provides China a secure source of energy. Digging it up creates jobs. Building a coal plant, whether it is needed or not, is also a common way for local governments to boost economic growth.

China's power grid was built with coal in mind. At plants that burn the stuff, humans decide when to ramp things up or down. But when it comes to solar and wind power, nature is the boss. So the grid needs to be made more flexible. When there is a surplus of energy in one spot, it must be able to store it or move it elsewhere. Otherwise China will not be able to accommodate lots of new wind turbines and solar panels in the future.

| *Gridlock*

Most countries need to make similar changes to their grids. The challenge facing China, though, is unique, says David Fishman of the Lantau Group, an energy consultancy. The bulk of the country's solar and wind resources are located in the west. But the power they generate is needed mostly in the east, where the country's biggest cities are to be found. Transferring it over such long distances is tricky. Another problem is that provincial governments have a lot of say over how their portion of the grid operates. They don't like depending on each other for energy. So, for example, a province might prefer to use its own coal plant rather than a cleaner energy source located elsewhere.

Those who are concerned about China's progress also worry about methane, a powerful greenhouse gas. Some countries can cut their methane emissions in simple ways, such as by repairing leaky gas pipes. But most of the methane coming from China wafts out of coal mines or is produced by microbes in rice paddies. Fixing the problem is hard without closing mines or changing farming practices. So at the UN climate summit in 2021, China refused to join more than 100 other countries, including

America, which pledged to reduce global methane emissions by at least 30% by 2030. Earlier this month, though, China did say that it would address the issue in its national climate plan for 2035 (which may not be published for another two years).

In the face of these challenges, China's leaders must be bold. But their climate ambitions may have already peaked, says Li Shuo, the incoming director of the China Climate Hub at the Asia Society Policy Institute in New York. He believes power cuts caused by surging coal prices and droughts, which disrupt hydropower, have spooked the government in recent years. Now officials worry that climate-friendly policies will undermine the country's energy security (green types argue that some reforms, such as making the grid more flexible, would have the opposite effect). Mr Li expects China's emissions to plateau rather than decline.

China, though, has good reason to prioritise the climate. Some of its biggest cities, including Shanghai, lie on the coast and could be swallowed by rising seas. The arid north lacks drinking water. And extreme weather is already taking a toll. Last year deaths associated with heatwaves in China increased by 342% compared with the historical average, according to a study published by the Lancet, a medical journal. This summer floods damaged much of China's wheat crop.

Meanwhile, China has become a leader in green-energy technology. The rest of the world depends largely on Chinese solar-panel and battery supply chains. This year China overtook Japan to become the world's largest car exporter, thanks in part to Chinese dominance in electric vehicles.

| *Summits and peaks*

So there is some hope that China will play a productive role at the climate summit in Dubai. With ambitions to lead the global south, it will not want to look as if it is neglecting an issue that is foremost on the mind of many

officials in developing countries. Optimists also point to the meeting between Xie Zhenhua, China's climate envoy, and John Kerry, his American counterpart, in November. They agreed on some small steps, such as collaborating on carbon-capture projects.

Yet China has also made clear that it will not bow to pressure on climate change. Earlier this year Xi Jinping, its leader, reiterated his aim of reaching a carbon peak by 2030 and achieving carbon neutrality by 2060. "But the path, method, pace and intensity to achieve this goal should and must be determined by ourselves, and will never be influenced by others," he said.





气候大问题

中国会拯救地球吗？还是会毁灭它？

中国即将实现碳达峰。接下来才是大难题【深度】

尽管涂长望因脑癌而生命垂危，最后仍不忘嘱托一件事。这位受人尊敬的中国气象学家注意到气候在变暖。因此，他于1961年在党报《人民日报》上发表文章，警告气候变化可能会改变生命赖以生存的条件。不过他认为变暖是太阳活动周期的一部分，以后也可能会逆转。涂长望并没想到燃烧化石燃料正把二氧化碳排放到大气中而导致气候变化。在那一期的《人民日报》上，再往前翻几页，有一张煤矿工人咧着嘴笑的照片。那时中国正急于实现工业化，在经济上赶超西方。

今天，中国已是一个工业强国，制造业产值占世界四分之一以上，超过了美国和德国的总和。但其进步是以排放为代价的。过去三十年来，中国向大气排放的二氧化碳总量比其他任何国家都多（见图表1）。据美国研究公司荣鼎集团（Rhodium Group）称，中国现在每年排放的温室气体占全球总排放的四分之一以上，大约是排放第二多的美国的两倍（不过按人均排放来看还是美国更严重）。

因此，能否实现各国政府于2015年在巴黎举行的联合国年度气候峰会上所做的承诺，将工业革命以来的全球变暖幅度控制远低于2°C以下，很大程度上要取决于中国。今年的气候峰会（叫作COP28）于11月30日在迪拜开幕。中国既有好消息，也有坏消息带给大家。

好的一面是，中国的排放将很快停止上升。一些分析师认为，中国的排放今年就会达峰。中国明确提出要在2030年之前实现碳达峰，实现这个目标将毫无疑问。中国建设核电站的速度比任何其他国家都快。它还大量投资于可再生能源（见图表2），目前风能和太阳能发电装机容量已达到750吉瓦左右，约占全球的三分之一。政府的目标是到本十年末，风能和太阳能发电总装机容量达到1200吉瓦，超过目前欧盟的总发电容量。中国还可能远远超出这一目标。

但帮助中国抑制排放的不仅仅是积极发展可再生能源。它的钢铁和水泥等碳密集材料的产量一直在下降。经过几十年的公路和铁路建设，政府在大型基础设施项目上的投入正在减少。房地产行业的长期扩张以楼市崩盘告终，这动摇了经济，但排放量也因此减少。展望未来，很少有分析人士预期中国的GDP增速会像上世纪末和本世纪初那样快。换句话说，中国污染最严重的发展阶段可能已经过去了。

然而，比碳达峰更重要的是下一步将会如何。中国承诺到2060年实现温室气体净零排放（即“碳中和”）。实现这个目标的难度将大得多。即使在大规模利用可再生能源之后，今天中国一大半的能源仍靠肮脏的煤炭供应。这比起2011年时70%左右的占比有所下降，但随着电力需求的增加，中国的煤炭消耗量仍在持续增加。去年，中国的煤炭开采量达到创纪录的45亿吨，平均每周批准约两个新的火电厂项目。

许多获批的火电厂可能永远不会建成。现有火电厂的利用率不断下降，削弱了进一步建设新厂的理由。但中国“减煤”的速度不像环保人士希望的那样快，也达不到分析师认为要实现2060年目标所需的速度。一部分原因是中国煤炭资源丰富。由于石油和天然气很少，煤炭为中国提供了有保障的能源来源。采煤可以创造就业机会。无论是否需要，建设火电厂也是地方政府拉动经济增长的常用手段。

中国的电网是围绕煤炭发电建设的。在燃煤电厂，人可以决定何时多发，何时少发电。但在太阳能和风能上，做主的是大自然。因此电网需要变得更加灵活。当某个地方的电力过剩时，电网必须能够将其储存起来或转送到其他地方。否则，未来中国将无法消纳大量新增的风力涡轮机和太阳能电池板。

丨 电网僵局

大多数国家都需要对其电网进行类似的改造。不过，能源咨询公司Lantau Group的戴维·菲什曼（David Fishman）表示，中国面临的挑战与众不同。其大部分太阳能和风能资源都在西部。但它们产生的电力主要用来供应大城市云集的东部地区。在这么远的距离上输电并非易事。另一个问题

是，各省政府对本省电网的运营有很大的发言权。他们不喜欢靠外省供应电力。例如，各省可能更愿意使用自己的火电厂发的电，而不愿意依靠来自其他地方的更清洁的能源。

那些关注中国脱碳进展的人也担心甲烷这种强大的温室气体。一些国家可以通过修复泄漏的天然气管道等简单的方法减少甲烷排放。而中国的大部分甲烷来自煤矿泄露，或者是由稻田的微生物产生。如果不关闭矿井或改变耕作方式，这个问题就很难解决。因此，在2021年的联合国气候峰会上，中国拒绝加入包括美国在内的其他100多个国家共同签署的一项倡议，该倡议承诺到2030年将全球甲烷排放量减少至少30%。不过在11月初，中国确实表示将把减少甲烷排放问题纳入2035年国家气候计划（该计划可能要到两年后才会发布）。

面对这些挑战，中国领导人必须勇往直前。但设在纽约的亚洲协会政策研究所（Asia Society Policy Institute）中国气候中心（China Climate Hub）即将上任的总监李硕表示，他们在气候问题上的抱负可能已经到顶。他认为，近年来，煤炭价格飙升，干旱扰乱了水力发电，由此造成的停电令政府惊忧。现在，官员担心气候友好型政策会损害国家的能源安全（支持绿色发展的官员则认为，提高电网灵活度等一些改革反而会加强能源安全）。李硕预计中国的排放将趋于稳定而不是下降。

不过，中国有充分的理由重视气候问题。包括上海在内的一些最大的城市位于沿海，有被上升的海平面淹没的风险。干旱的北方又缺乏饮用水。极端天气已经造成了损失。医学杂志《柳叶刀》发表的一项研究显示，去年中国因热浪造成的死亡人数比历史平均水平高出342%。今年夏季的洪涝让中国很大一部分小麦收成受损。

与此同时，中国已成为绿色能源技术的领导者。世界其他地区很大程度上都依赖中国的太阳能电池板和电池供应链。今年，中国超越日本成为全球最大的汽车出口国，这在一定程度上要归功于中国在电动汽车领域的主导地位。

| 峰会与达峰

因此，中国有望在迪拜的气候峰会上发挥建设性作用。怀着领导全球南方的雄心，它不会想让人觉得它在忽视许多发展中国家的官员最关心的一个问题。乐观人士还会指出，中国气候变化事务特使解振华和美国气候特使约翰·克里（John Kerry）在11月碰了面。他们就一些小举措达成了一致，例如在碳捕获项目上开展合作。

但中国也明确表示不会屈服于气候变化方面的压力。今年早些时候，中国领导人习近平重申了2030年实现碳达峰、2060年实现碳中和的目标。“但达到这一目标的路径和方式、节奏和力度则应该而且必须由我们自己作主，决不受他人左右。”他说。■



Schumpeter

Charlie Munger was a lot more than Warren Buffett's sidekick

In business, he was a paragon of common sense

EVERY MAY tens of thousands of the faithful flock to Omaha, Nebraska, hometown of Berkshire Hathaway, to bask in the presence of the investment firm's two leaders: Warren Buffett, known for his folksy genius, and Charlie Munger, for his killer zingers. But for the truly hard core, for many years a more cloistered gathering took place near Schumpeter's current abode in Pasadena, a lush city on the edge of Los Angeles. At the Pasadena Convention Centre, Mr Munger alone would hold forth, his dry wit in full flow. Recording devices were not allowed, but notetakers scribbled furiously as they tried to keep up.

The last one took place in 2011, when Mr Munger, who died in an LA hospital on November 28th aged 99, was a sprightly 87-year-old. It was his last shareholder meeting as head of Wesco, a financial conglomerate about to be wholly swallowed up by Berkshire, and hence the end of his one-man show. He spoke for three hours. As usual, he poked gentle fun at the audience, telling them, "You folks need to find a new cult hero." Yet he clearly enjoyed delivering what one scribe called his sermon from the "Church of Rationality". He beamed when they gave him a standing ovation.

Looking back through notes of that meeting, the themes he dwelt on seem random. He discussed what he felt was his inadequate legacy, though he took pride in attributes such as basic morality, self-discipline and objectivity. He advised rich parents how to look after their children (don't try to motivate them with artificial hardships, he said, because they will inevitably hate you for it). He discussed the importance of being rational amid mistaken biases (which he called the "Lollapalooza effect"). He even put in a good word for The Economist, describing it, according to one

notetaker, as his favourite “adult magazine”.

And yet those were not scattershot musings. They echoed a carefully thought out worldview on life, investment and business culture that he expounded on extensively in writings and speaking engagements whenever he was not in the spotlight as the Sage of Omaha’s curmudgeonly sidekick. As Mr Buffett put it, Mr Munger influenced Berkshire’s entire investment philosophy by introducing the wisdom that it is “better to buy a good business at a fair price than a fair business at a good price”. In other words, he deserves a big share of the credit for turning the financial conglomerate into the \$780bn powerhouse that it has become.

Though the two men bore an uncanny physical resemblance (Mr Munger, at least later in life, was more portly), intellectually they had different strengths. Mr Buffett is a master of the plain and simple; Mr Munger was a complex thinker (“Charlie does the talking, I just move my lips,” Mr Buffett once quipped). Like the best duos—think Bill Gates and Paul Allen at Microsoft, Mickey Mantle and Roger Maris at the New York Yankees, and John Lennon and Paul McCartney in The Beatles—their strengths complemented each other, producing something almost magical. In the case of Messrs Buffett and Munger the magic lasted for 60 years. During that time they famously never had a row.

As with many successful partnerships, they shared common roots. Like Mr Buffett, Mr Munger grew up in Omaha. As teenagers both worked in the Buffett family store at different times. They met in Omaha in 1959, not long after Mr Buffett, then owner of a fledgling investment firm, had been told by a potential client that he resembled the erudite Mr Munger, who was six years his senior. He came to replace Benjamin Graham, a legendary “value” investor, as Mr Buffett’s sounding board, with four qualities that Janet Lowe, Mr Munger’s biographer, said resembled Graham’s. He was honest, realistic, profoundly curious and unfettered by conventional thinking.

Those are as good traits as any to summarise his approach to business.

In terms of honesty, he put the trustworthiness of business leaders, and the soundness of their accounts, above all else. He hated gimmickry (the accounting term EBITDA, he said, should be substituted with “bullshit earnings”). He was openly scornful of the “megalomania” of some investment bankers, whom he blamed for the financial crisis of 2007-09. In a deft parody penned in 2011 he described the perpetrators as Wantmore, Tweakmore, Totalscum and Countwrong. America was Boneheadia.

As for realism, he was no softy when it came to business. He believed in “moats” that safeguarded firms’ brand value, pricing power and scale. Take Wrigley’s Chewing Gum versus a cheaper competitor, for instance. “Am I going to take something I don’t know and put it in my mouth—which is a pretty personal place, after all—for a lousy dime?” Handle new technologies with care, he preached. Know your “circle of competence”. Don’t rush into new ventures you don’t understand.

For him, curiosity was a lifelong project, and he believed that business people should constantly refresh their knowledge, challenging their assumptions and learning from mistakes more than successes. As he said on the first page of “Poor Charlie’s Almanack”, a compilation of his writings and speeches: “Acquire worldly wisdom and adjust your behaviour accordingly. If your new behaviour gives you a little temporary unpopularity with your peer group...then to hell with them.”

| *Invert, always invert*

Finally, think unconventionally. Don’t follow the herd. He loved Confucius and boldly encouraged America to “get along with China” despite the current tensions. Apple, he said, was an example of how engaging with China was both good for business and good for China. Everything that worked in the opposite direction, he said earlier this year, was “stupid,

stupid, stupid”. Even by Mr Munger’s standards, that was blunt; he normally expressed himself with humour, not exasperation. But it summed up what was probably his greatest contribution to business thinking. He was a paragon of that old-style virtue—common sense. ■



熊彼特

查理·芒格远不止是巴菲特的副手

在商界，他是尊重常识的典范

每年5月，成千上万的信徒涌向内布拉斯加州的奥马哈市，也就是伯克希尔·哈撒韦的老家，接受这家投资公司的两位领袖——亲民天才巴菲特和金句达人芒格——的光芒洗礼。但在从前的很多年里，真正的铁杆粉丝会参加一个更私密的集会，地点就在洛杉矶边上郁郁葱葱的帕萨迪纳市

（Pasadena），笔者现在的住所附近。在帕萨迪纳会议中心（Pasadena Convention Centre），芒格一个人滔滔不绝，尽情发挥他的冷幽默。现场不允许录音录像，记录员们奋笔疾书，唯恐漏掉只言片语。

上一次集会是在2011年，当时芒格87岁，精神矍铄（他于11月28日在洛杉矶一家医院去世，享年99岁）。那是他最后一次作为韦斯科（Wesco）的老板主持股东大会，这家金融集团之后就被伯克希尔全盘收购，芒格也就此结束了他的独角戏。当时他讲了三个小时。和以往一样，他温和地调侃着听众，告诉他们：“你们得再找一个新偶像去崇拜了。”不过显然就如一位记录员所描述的那样，他很享受在“理性的圣堂”里的这番布道。当听众起立鼓掌时，他笑容满面。

回看那次会议的记录，那似乎是一场信马由缰的漫谈。他谈到自己能留给后世的还不够，不过他以基本道德、自律和客观等品质为傲。他给富有的父母该如何养育子女提供了些建议（不要故意制造困苦来试图激励他们，他说，因为他们日后一定会为此怨恨你）。他谈到了在各种错误偏见中保持理性的重要性（他称之为“合奏效应”[Lollapalooza effect]）。他甚至还为《经济学人》说了几句好话，从一份会议记录看，他说这是自己最喜欢的“成人杂志”。

然而这些都不是漫无目的的遐思。它们是他对生活、投资和商业文化深思熟虑得出的世界观的表达——每当不需要以“奥马哈圣人”的坏脾气副手身份出现在聚光灯下时，他就会在著述和演讲中详细阐述这些观点。正如巴

菲特所言，芒格带来的“以公道的价格购买一家好公司，好过以好价格购买一家平庸公司”的智慧，影响了伯克希尔的整个投资哲学。换句话说，这家金融集团能变为如今价值7800亿美元的巨头，他功不可没。

虽然两人离奇地长得很像（芒格更敦实些，至少在晚年），但他们在心智上各有所长。巴菲特是简洁明了风格的大师，芒格则是一位复杂思维者（“查理负责讲话，我就动动嘴唇。”巴菲特曾开玩笑说）。像那些最佳拍档一样——比如微软的盖茨和保罗·艾伦（Paul Allen）、纽约洋基棒球队的米奇·曼托（Mickey Mantle）和罗杰·马里斯（Roger Maris），还有披头士乐队的约翰·列侬和保罗·麦卡特尼——他们优势互补，产生了近乎神奇的效果。在巴菲特和芒格这对搭档身上，这种神奇效果持续了60年。在此期间，两人处得极好，从不吵架。

也和许多成功搭档一样，他们出身相像。和巴菲特一样，芒格也在奥马哈长大。他们在十几岁时先后在巴菲特家的商店里打过工。两人于1959年在奥马哈相见，在那之前不久，刚创办了一家投资公司的巴菲特听一位意向客户说他很像比他大六岁、博学多才的芒格。芒格就此取代了传奇“价值”投资者本杰明·格雷厄姆（Benjamin Graham），成了巴菲特的军师。为芒格作传的珍妮特·洛尔（Janet Lowe）说，他有四个类似格雷厄姆的特质。他诚实、现实、好奇心永无止境，思维不落窠臼。拿这些特质来概况他的经商之道也很适用。

在诚实方面，他把商业领袖的信誉和账目的准确可靠置于首位。他讨厌耍花招（他说，EBITDA这个会计术语应该被替换为“狗屁盈利”）。他公开鄙视某些投资银行家的“妄自尊大”，指责他们是2007到2009年金融危机的罪魁祸首。他在2011年的巧妙恶搞文章中把这些肇事者称为“要多”（Wantmore），“改多多”（Tweakmore），“胡扯扯”（Totalscum）和“总算错”（Countwrong）。美国则成了傻瓜国（Boneheadia）。

至于务实，他在涉及到生意时绝非轻信的软柿子。他信仰保卫企业的品牌价值、定价权和规模的“护城河”。比如他会这样对比箭牌口香糖和一个更低价的竞争对手。“我会把一个我一无所知的东西放进我嘴里吗？毕竟嘴

巴可是自己的——就图它便宜？”对待新技术要小心谨慎，他如此教诲。了解你的“能力圈”。不要急于进入你不了解的新商业项目。

对他来说，好奇心是终身工程，他相信商业人士应该不断更新他们的知识，挑战他们的假设，更多从错误而非成功中学习。正如他在他的著作和演讲集《穷查理宝典》第一页所说：“获取世俗的智慧并相应地调整你的行为。如果你的新的行为方式让你在同辈中暂时有点不受欢迎……那让他们见鬼去吧。”

| 反过来想，永远反过来想

最后，思考要敢于打破常规。不要随大流。他热爱孔子，并大胆鼓励美国“与中国和睦相处”，尽管当前两国关系紧张。他说，苹果就是一个例子，它展示了与中国接触对生意和中国都好。他在今年早些时候说，任何与此背道而驰的做法都是“蠢、笨、傻”。即使按芒格的标准，这话也很直白，毕竟他通常都用幽默而非恼怒来表达自己。但这恰好概括了或许可说是他对商业思维的最大贡献。他是那种老派美德的典范——尊重常识。■



The other greenhouse gas

Politics and technology are pushing oil firms to cut methane

When it comes to climate change, methane is low-hanging fruit

MOST DISCUSSIONS about climate change revolve around carbon dioxide. But that is not the only greenhouse gas. As delegates gather in Dubai for the COP28 summit, an annual UN-sponsored climate chinwag, much attention will be focused on methane instead.

Unlike carbon dioxide, which lingers in the air for centuries, methane hangs around for only a decade or so. But during that time it prevents more than 80 times as much heat from escaping. Nearly 45% of the difference between the world's temperature in the 2010s and its temperature in the second half of the 19th century was due to methane's warming effects. Methane emissions can often be cut cheaply. But until recently few have bothered to try.

That is changing. Methane leaks into the air from many sources. Some, such as landfills and farming, are man-made (see chart 1). Others, such as wetlands, are natural. At COP28, though, the focus will be on oil-and-gas companies. Their methane emissions are seen as some of the lowest-hanging fruit, for three reasons. A clutch of technologies have made it easier to measure them. Politicians are increasingly keen to cut them. And that combination of pressure and possibility has begun to change minds even among oil-industry bosses. With help from America and the EU Sultan al-Jaber, COP28's Emirati president, hopes to forge an ambitious deal on methane on the sidelines of the main talks.

To see what might be possible, look to Stavanger, a city of quaint wooden houses that is the capital of Norway's oil-and-gas industry. The country shares the hydrocarbon-rich North Sea with Britain, Denmark and the

Netherlands. Yet greenhouse-gas emissions from Norwegian oil and gas are only a third of what they are in Britain.

In 1971 Norway's government banned the routine "flaring"—or burning—of natural gas, which is mostly methane, from rigs in its area of the North Sea. Although burning methane turns it into carbon dioxide and water, a good deal of flared methane escape unburned, meaning the ban drove down emissions of both gases.

| *Ideal gas laws*

Newer rules have forced Equinor, Norway's state-owned oil company, to continue cleaning up (see chart 2). Some of its offshore platforms receive electricity from land, removing the need to burn gas onboard to provide it. The firm is even developing dedicated offshore wind-farms to power its rigs. The International Energy Agency (IEA), a quasi-official entity, reckons that if all countries reduced the intensity of emissions to Norwegian levels, methane emissions from oil and gas extraction would fall by 90%.

Other countries are making belated efforts to follow suit. China, the world's biggest methane emitter, said on November 7th that it would include the gas in its national climate plan. Coal mining, which liberates the stuff from coal seams, is the second-biggest source of Chinese methane after agriculture. Oil-and-gas production is likewise, after farming, the second-largest source of American methane. It has made regulation of the gas a priority, and has called on other countries to chip in to a global methane-reduction fund to help poor countries lower methane emissions. On November 15th the EU approved an ambitious set of standards on methane emissions covering both domestic and imported energy, which Mark Brownstein of the Environmental Defence Fund (EDF), an advocacy group, calls "a breakthrough".

Policing such promises has been made easier by technology, says Antoine

Halff, a founder of Kayrros, an environmental-intelligence firm. Methane emissions can be tracked by everything from satellites and aeroplanes to ground-based sensors, with artificial intelligence helping analyse the deluge of data. A paper published last year in Science analysed data from a satellite run by the European Space Agency. It identified 1,800 “ultra emitters”—methane sources that send more than 25 tonnes per hour into the air—in 2019 and 2020. Together those added up to between 8% and 12% of the oil-and-gas industry’s total methane emissions. Most were found in just six countries—Algeria, America, Iran, Kazakhstan, Russia and Turkmenistan.

That is good news, for two reasons. A few big sources are easier to tackle than lots of tiny ones. And it makes it harder for the industry to deny the scale of the problem. The IEA thinks the true quantity of methane produced by the sector might be 70% higher than the official figure.

That has helped prod big Western firms to acknowledge the need to tackle methane. Some oilmen worry about regulation. Others are eyeing nascent markets in Asia and Europe that may be willing to pay a premium for natural gas certified as having low methane emissions. A group of a dozen companies, including ExxonMobil, an American firm, and Shell, a British one, have cut the intensity of their methane emissions by half since 2017. They have used high-tech methods, such as airborne monitoring, and low-tech ones, like replacing leaky valves. Methane emissions now stand below 0.2% of the total volume of natural gas that each firm sells.

But most methane emissions in the oil-and-gas industry come not from Big Oil but from dozens of national oil companies (NOCs) that sit on top of most of the world’s hydrocarbons. Any deal done at COP-28 will have to include such firms if it is to make much difference. Besides his job running the conference, Mr al-Jaber is the boss of ADNOC, Abu Dhabi’s NOC. He has been meeting leaders of both private sector firms and other NOCs in the

run-up to the summit. According to someone involved in those meetings, he has been pressing his fellow oil bosses hard to agree to a deal.

An agreement is not certain. But there are good omens. America is keen that governments and philanthropic organisations should help poor countries make the needed investments. Big Western oil firms often run oilfields jointly with poor-country NOCs. After some reluctance, they are now thought to be ready to offer technical and financial assistance to cut methane leaks. After all, methane that is not vented or flared can be sold as fuel, helping pay for the investments needed to capture it.

Laggards will be squeezed as monitoring technology improves. Mr Halff's firm earlier this year used satellite data to expose big methane leaks from oil- and gas-fields in Turkmenistan. The bad publicity intensified negotiations between Turkmenistan and America on ways to plug them. And there will soon be even more eyes in the sky. The EDF has built a methane-monitoring satellite of its own. It is due to be launched next year. Soon there will be nowhere for rogue emitters to hide. ■



另一种温室气体

政治与技术合力推动油气公司减排甲烷

在对抗气候变化上，甲烷减排最易实现

关于气候变化的讨论大多围绕二氧化碳展开。但二氧化碳并非唯一的温室气体。在各国代表齐聚迪拜参加每年一次的联合国气候变化框架公约缔约方大会（这是第28次会议，即COP28）时，关注焦点更多转向了甲烷。

二氧化碳会在空气中存留几个世纪，甲烷只存留十来年。但在存留期内，甲烷阻碍热量散发的程度是二氧化碳的80多倍。对比2010年代与19世纪下半叶的全球气温，近45%的温差是甲烷带来的变暖效应。甲烷减排往往可以低成本完成，但直到不久之前都鲜有这方面的尝试。

现在情况正在改变。甲烷是从多种源头泄漏至空气中的。其中一些是人为的，如垃圾堆填和农场作业（见图表1），还有一些是天然的，如湿地。不过，在COP28峰会上，焦点将是石油和天然气公司。这些公司被认为是最容易实现甲烷减排的，原因有三：一系列技术使得测量甲烷排放变得更简单；政客越发积极推动甲烷减排；在这样的压力和可能性的交汇之下，连油企老板们也已开始改变想法。COP28主席是来自阿联酋的苏丹·贾比尔（Sultan al-Jaber），他希望在和美国和欧盟的助力下，在主要议题之外能就甲烷问题达成一项宏大的协议。

要了解这次峰会可能达成的成果，不妨把目光投向古雅木屋遍布的斯塔万格（Stavanger）——挪威的石油天然气工业之都。挪威与英国、丹麦和荷兰同为北海沿岸国家，这片海域拥有丰富的油气资源。但挪威的油气业温室气体排放量仅为英国的三分之一。

1971年，挪威政府禁止在北海地区的钻井平台上例行“燃除”主要成分为甲烷的天然气。尽管甲烷燃烧会转化为二氧化碳和水，但在燃除时有大量甲烷并未真正燃烧就逃逸到大气中，因此上述禁令实际上是减少了两种气体的排放。

再往后的新规定迫使挪威国家石油公司（Equinor）继续减排（见图表2）。其部分海上钻井平台现在从陆地获取电力，也就无需在平台上燃烧天然气来供电。该公司甚至正在开发专门的海上风电场来为钻井平台供电。半官方机构国际能源署（IEA）认为，假如所有国家的减排强度降低到挪威的水平，那么石油和天然气开采所产生的甲烷排放将减少90%。

其他国家也终于开始跟上。甲烷排放居全球之首的中国于11月7日表示将把甲烷管控纳入国家应对气候变化的规划中。煤炭开采会从煤层释放甲烷，是中国第二大甲烷排放源，仅次于农业。在美国，石油和天然气生产同样是仅次于农业的第二大甲烷排放源。美国已把甲烷监管作为一项优先工作，并呼吁其他国家向一个全球甲烷减排基金捐款，帮助贫穷国家减少甲烷排放。11月15日，欧盟通过了一系列雄心勃勃的甲烷排放标准，覆盖本地及进口能源，被倡导团体美国环保协会（Environmental Defence Fund）的马克·布朗斯坦（Mark Brownstein）誉为“一项突破”。

技术的发展令监督这些承诺的履行变得更容易，环境情报公司Kayrros的创始人安托万·哈尔夫（Antoine Halff）指出。甲烷排放可通过卫星、飞机以至地面传感器等各种方式追踪，海量数据可使用人工智能辅助分析。去年在《科学》上发表的一篇论文分析了来自欧洲航天局一颗卫星的数据。该卫星在2019年和2020年发现了1800个“超级排放源”，即每小时向大气中排放超过25吨甲烷的排放源。这些排放源加起来占石油天然气行业甲烷排放总量的8%到12%。其中大部分集中在阿尔及利亚、美国、伊朗、哈萨克斯坦、俄罗斯和土库曼斯坦这六个国家。

这是个好消息，有两方面原因。几个大污染源比许多小污染源更容易整治，而且也让油气行业更难否认问题的严重性。国际能源署认为，该行业的甲烷真实排放量可能比官方数字高70%。

这已促使西方大企业承认有必要解决甲烷排放的问题。一些石油公司担心监管变严，另一些则看中了亚洲和欧洲的新兴市场，那里也许愿意为经认证的低甲烷排放天然气支付溢价。自2017年以来，美国埃克森美孚和英国

壳牌等十几家公司已将甲烷排放强度降低了一半。这些公司既使用了空中监测等高科技方法，也运用了更换漏气阀门等低科技方法来减排，目前每家公司的甲烷排放量已低于其天然气销售总量的0.2%。

但是，油气行业的大部分甲烷排放并非来自私营石油巨头，而是来自数十家国家石油公司，它们坐拥全球大部分油气资源。在COP28峰会上达成的任何协议要取得实质成效，就必须把这些公司纳入其中。峰会主席贾比尔的另一身份是阿布扎比国家石油公司（ADNOC）的老板。在峰会召开前，他就已在会见私营油企和其他国家石油公司的领导。参与这些会议的某位知情人士表示，贾比尔一直在大力敦促其他石油公司老板，希望达成一项协议。

能否达成协议还是个未知数。但不乏好兆头。美国非常希望各国政府和慈善机构出手帮助穷国进行必要的投资。西方大型油企通常与贫穷国家的国家石油公司联合经营油田。经过一番迟疑后，前者现在看似愿意提供技术和资金援助来减少甲烷泄漏。毕竟，未放空或燃除的甲烷可以作为燃料出售，贴补捕集这些甲烷所需的投资。

随着监测技术改进，落后者将承受压力。今年早前，哈尔夫的公司利用卫星数据揭露了土库曼斯坦的油气田泄漏大量甲烷的事件。负面报道促使土库曼斯坦与美国加快了封堵泄漏的谈判。很快，天空中还将出现更多“眼睛”。美国环保协会已经建造了一颗自己的甲烷监测卫星，将于明年发射。用不了多久，无良排放者就将无处藏身。■



On the other hand...

The many prices of carbon dioxide

Not all tonnes are created equal

ASK AN ECONOMIST what something scarce should cost and they will normally say whatever someone is willing to pay for it. They will go on to say that the best way to establish that willingness is through markets. There are various systems that price carbon dioxide that way. But they do not provide the same answers. And nor do they tally with what economists think might actually be the right answer.

To most people the cost of emitting a tonne of carbon dioxide appears to be nothing. They have to pay for fuel, they have to pay for whatever burns it, but once it is an exhaust gas they can just let it go. In a few cases, they might even find someone to buy it—a fizzy-drink maker, say, or a DJ who wants dry ice.

But though the emissions may not cost the emitter anything, economists insist that they still have a value, and that it is a negative one. This is because the emitted carbon dioxide does harm to the environment, almost all of which is felt by people other than the emitter. To take into account those externalities means taking into account everything from the loss of seafront property and farm productivity to deaths caused by heatwaves (as well as those avoided in cold snaps).

This “social cost of carbon” is estimated through modelling. Those models must make assumptions, such as how much the effects of a future loss should be discounted and what to do about the uncertainty inherent to estimates of climate damage. Different assumptions yield wildly different costs.

In many places the outputs of such models are used to guide policy. In America, for example, cost-benefit analyses which make use of the social cost of carbon feed into decisions about fuel standards. The government currently estimates the social cost at \$51 for every tonne of carbon dioxide (or for an amount of some other greenhouse gas which provides the same warming). If the administration heeded the advice of its own Environmental Protection Agency, which approaches modelling in a different way, the cost would increase to \$190. During Donald Trump's administration, when only costs on other Americans were considered, it fell to \$5.

The social cost of carbon is notional, if sometimes consequential. The costs charged in carbon-pricing schemes are real. Such systems typically place a cap on emissions from a certain sector, and then distribute (often by auction) permits to emit that are equal to that cap. Firms then trade permits in a "compliance market".

Economists like these market-based "cap and trade" schemes because they discover the firms most willing to make cuts. That spreads the burden in an efficient way and lowers the total cost of keeping emissions below the cap. But even when efficiently spread, the total cost is something which most of the governments experimenting with such schemes have wanted to keep low: the average price charged in the world's emissions-trading systems is about \$20. The IMF estimates that for Paris-compliant decarbonisation the price per tonne would have to reach \$280 on all emissions by 2050. That, the fund drily notes, "might be politically unpalatable in many countries, despite carbon pricing's effectiveness".

A third way to establish a price is to find people willing to be paid not to emit, thus "offsetting" the emissions of those who do. This has various practical drawbacks and two fundamental flaws. One is that offsetting is voluntary; no one has to do it. The second is that offset emissions are still

emissions. They still warm the planet.

CDR avoids the second problem. If a tonne of carbon dioxide is removed from the atmosphere in one place at the same time as another is emitted somewhere else, the harm done is pretty much zero.

Unfortunately, the costs of removal are currently a lot higher than the estimates of the social cost of carbon favoured by governments or the prices charged in cap-and-trade schemes; they outstrip offset prices over a hundred-fold. The idea of a market where the cost of emitting carbon dioxide is the price you have to pay to have it removed is very appealing. Actually creating one will be very hard. ■



另一方面.....

二氧化碳的多种价格

此吨不同彼吨

问经济学家某种稀缺品应该卖多少钱，他们通常会说，有人愿意出多少钱就卖多少钱。他们接着会说，确认这种意愿的最佳途径就是市场。目前有各种如这般给二氧化碳定价的体系。但它们给出的答案各不相同，与经济学家认为应该符合实际的正确答案也不吻合。

在大多数人看来，排放一吨二氧化碳似乎没有任何成本。燃料要花钱，烧燃料的设备要花钱，但燃烧产生的废气可以直接排放掉。在少数情况下甚至可以找到买家，例如汽水制造商，或者想要干冰的DJ。

也许排放者不用为排废气花费任何钱，但经济学家坚持认为废气依然是有价值的，而且是负价值。因为被排放的二氧化碳会对环境造成危害，几乎都是由排放者之外的其他人承受。要计入这些外部性，就意味着要把沿海房产和农场生产率受损、热浪导致的死亡（以及因寒潮减少的这类死亡）等方方面面都考虑在内。

这种“碳社会成本”是通过建模估算的。这类模型必须做假设，例如未来损失的影响应该贴现多少，以及如何处理气候损害估算固有的不确定性。不同假设会得出截然不同的成本。

许多地方会运用这些模型的结果来指导政策。例如，在美国，有关燃料标准的决策是以运用碳社会成本的成本效益分析为依据的。根据美国政府目前的估算，每吨二氧化碳（或产生同等升温效果的一定量其他温室气体）的社会成本为51美元。假如该政府听从自家环境保护局的建议，改以不同方式建模，成本将增加至190美元。在特朗普执政期间，因为只考虑对其他美国人的影响，成本降至五美元。

碳社会成本也许有时意义重大，但毕竟是个名义概念。碳定价机制所收取

的价格才是实实在在的。这种机制通常会对某个行业的排放设定上限，然后分配（通常通过拍卖）与该上限相当的排放许可证。企业随后在“合规市场”上交易许可证。

经济学家喜欢这类基于市场的“总量控制与交易”机制，因为这样能发现最愿意削减排放的企业。这能有效分散负担，降低把排放控制在上限以下的总成本。但即使成本得到有效分摊，大多数试行此类机制的政府还是希望把总成本保持在低水平：全球排放交易机制的平均价格约为20美元。据国际货币基金组织（IMF）估计，要实现符合《巴黎协定》目标的减排，到2050年，所有排放的价格必须达到每吨280美元。IMF冷冷地指出：“但在许多国家可能难过政治关，尽管碳定价确有效果。”

定价的第三种方法是找到愿意用不排放换钱的企业，“抵消”排放者的排放。这种方法执行起来有各种弊端和两个根本缺陷。一是这种抵消是自愿的，没有人必须这样做。第二，被抵消的排放仍然是排放，还是会使地球变暖。

碳清除避免了上述第二个问题。假如在一个地方排放了一吨二氧化碳，就从另一个地方的大气中清除一吨二氧化碳，那么对环境造成的危害几乎为零。

遗憾的是，目前碳清除的成本远高于政府乐于采用的碳社会成本估算数字，也高于总量控制与交易机制中的价格——比抵消价格高出百倍。如果在一个市场中你排放二氧化碳的花费就是你要将它从大气中清除掉所需支付的价格，这听起来就很有吸引力。但要真正建立这样一个市场将非常困难。■



The carbon economy

A net-zero world needs new markets and institutions

It is just possible they will be built in time

THE EARTH'S great cycles are mostly driven by the sun. Sunlight evaporates water to create rain, thus powering the water cycle; it heats the tropics more than the poles, thus driving the ocean's gyres; it is used by plants and algae to turn carbon dioxide into wood and frond, food and fibre, mulch and decay, spinning the biological carbon cycle. Plate tectonics is the great exception, driven instead by the heat of the inner Earth.

Any anthropogenic addition to the roster of great recyclings will have to be driven, too, and the immediate motive force will be money. At the moment, the money driving durable carbon removals is coming mostly from investors willing to provide companies with the money needed to develop their technology and build their businesses and from rich firms and people willing to pay handsomely for the so far small amounts of removal on offer.

Over the past five years that money has spurred a boom in the sector, albeit from a base so low that even the boom is small. But in the medium term would-be carbon removers will find themselves moving beyond technological uncertainties—what methods are viable? how low can costs for different methods get?—to more fundamental ones. Where is the demand? Who will actually be willing, or required, to buy their services, and for how much?

Some governments are helping. By far the most generous is America's, offering a \$180-a-tonne tax credit for direct-air-capture projects under way by the end of 2032; there is also support for carbon-storage hubs and a small programme for buying removals directly. But “tax credits are not a long-term policy for the level of CDR deployment we'll need to remove

carbon dioxide from the atmosphere and meet our net-zero targets,” says Brad Crabtree, the assistant secretary for fossil energy and carbon management at the Department of Energy. “There will need to be longer-term policies that reward those actions in the marketplace.”

The obvious marketplaces are those of cap-and-trade systems. The inclusion of removals in such markets would mean that emitters could mix allowances issued under the scheme and credits for durable CDR when working off their carbon debt. Net zero would be the point where permits were no longer issued, and removals did all the work.

| *An obligation to the future*

Some emissions-trading schemes (ETS) are open to the idea of allowing carbon-removal credits. But the political economy is treacherous. For such schemes to work in terms of net emissions, any credits added to the allowances must have a real effect on what is in the atmosphere. For schemes to be palatable to the industries operating under them, the credits need to be cheap and plentiful, which experience suggests means dodgy. Thomas Gresham, a 16th-century merchant, held that bad money drives out good. The same would prove true of carbon credits.

The European Union, which has the most advanced ETS, currently allows no outside credits into its workings. It has said that by 2026 it will have reached a position on integrating removals into the scheme; first, it is concentrating its efforts on an official carbon-removal certification scheme. The California ETS allows companies to meet a small portion of their obligation with officially sanctioned offsets that are overwhelmingly based on storing carbon in forests. The South Korean ETS and the Colombian carbon tax have similar provisions.

If well monitored, these provisions may bring in some reputable “nature-based” schemes that make use of forestry, coastal mangroves and the like.

But the price of the allowances in cap-and-trade markets looks far too low to cover more durable forms of CDR. Hence the attraction of creating a separate mechanism for removals, at least as an interim measure.

One option is a reverse auction: the government sets a target for removals and awards contracts for the companies with the cheapest bids. Sweden is taking this route for bioenergy with carbon capture and storage; Britain is thinking about auctions with a “contract for difference” mechanism like the one it uses to encourage offshore wind and nuclear power: the government would pay not for the whole removal, but for the difference between the price of the removal and the carbon price.

Such an auction system could, in time, develop into a market for removals that operated in parallel with a market for emissions. Companies in some sectors would be required to buy removals to cover a fraction of their emissions. One version of this, championed by Myles Allen of Oxford University and his colleagues, would be a “carbon take-back obligation” under which the fossil-fuel industry would be required to cover an increasing fraction of its production with an equivalent amount of removals. When the fraction reached 100%—perhaps in 2050—the industry would be carbon-neutral. Such a predictable long-term increase in demand would motivate innovation.

The problem is trust. Could governments be relied on to ratchet up the obligation to buy removals? The fossil-fuel industry has a record of being duplicitous and unreliable when it comes to emissions reduction; its sheer size makes it a big influence on governments and its well-oiled lobbying operations amplify that. It is disturbingly easy to imagine the fossil-fuel industry contriving to have its removal obligations frozen at a fairly low level while continuing to make possible a lot of emissions.

That makes the case for institutions which build trust. Ottmar Edenhofer, a

German economist, and colleagues have suggested that the EU might create a central bank for carbon to supervise the use of removals, preventing politicians from debasing the currency or breaking commitments. Most of the EU's members have surrendered monetary policy to an independent bank. Perhaps they could do the same for carbon policy. But what other states, or groups of states, might do the same?

The Earth, isolated and ancient, recycles everything. It also brings forth novelties, such as apes ingenious enough to replumb fundamental flows of matter and energy at the level of the planet itself. It is strange to imagine institutions based on agreement and trust acting on a similar giga-scale. But the energy transition is showing that such things can be done, albeit too slowly and too late. If that transition continues in the way it needs to, the experience and planetary perspective gained could be the basis for concerted efforts to fix the remaining leaks in the carbon cycle. ■



碳经济

实现全球净零排放需要新市场和新机构

它们某天有望建成

太阳是地球各大循环的主要驱动力。水在阳光的照射下蒸发，形成降雨，从而驱动水循环；阳光让热带地区的温度高于两极地区，从而驱动了大洋环流；植物和藻类利用阳光将二氧化碳转化为树木和叶子、养料和纤维素、覆盖物和腐烂物，形成了生物圈的碳循环。板块运动是一个大大的例外，它由地球内部的热量驱动。

除了刚提到的那些大循环，任何人类活动的循环也需要驱动力，最直接的驱动力就是金钱。目前，用于推动持久性碳移除的资金主要来自愿意为企业研发技术和建立业务提供所需资金的投资者，还有愿意花大价钱购买目前供应量还很小的碳移除服务的财力雄厚的企业和个人。

在过去五年里，这些资金刺激了该行业的繁荣——尽管由于起点很低，这繁荣也没有多大。但从中期来看，那些想要投身碳清除业务的人们会发现自己面对的不确定性正从技术层面转向更基本的层面。原本面对的问题是：有哪些可行的方法？不同方法的成本能降到多低？此后问题会变成：需求在哪里？谁会愿意或是被要求来购买自己的服务？出价又会是多少？

有些政府正在给出支持。其中最慷慨的显然是美国——2032年底前，它为正在运营的直接空气碳捕获项目提供每吨碳180美元的税收抵免；此外，它还支持建立多个碳储存中心和一个直接购买碳清除的小型项目。但“税收抵免不是长久之计，不足以实现我们要移除大气中的二氧化碳并实现净零目标所需的碳清除水平，”美国能源部负责化石能源和碳管理的助理部长布拉德·克拉布特里（Brad Crabtree）表示，“需要有更长期的政策来奖励市场上的那些行动。”

最显而易见的市场是总量控制与交易机制的市场。将碳清除纳入这类市场后，排放者在偿还碳债务时既可以交易该机制下发放的碳配额，也可以交

易因持久性碳清除获得的碳信用。而达到净零时，将不再发放排放许可，所有的排放都用碳清除解决。

| 对未来的责任

一些排放交易计划（ETS）对于纳入碳清除信用的想法持开放态度。但现实中的政治经济变幻莫测。要让此类计划在净排放方面发挥作用，配额之外的任何碳信用都必须能真正对空气成分产生影响。要让在ETS下运营的行业欣然接受这些计划，需要向它们提供廉价且充足的碳信用，而经验表明这容易有问题。16世纪的商人托马斯·格雷沙姆（Thomas Gresham）认为劣币驱逐良币。碳信用也会如此。

欧盟拥有最成熟的ETS，目前未接受任何外部碳信用纳入。它已表示会在2026年之前将碳清除整合进该机制，而作为此举的第一步，它正集中精力制定一个官方的碳清除认证计划。加州的ETS允许企业使用官方认可的碳抵消（绝大多数基于森林碳储存）来履行一小部分减排义务。韩国的ETS和哥伦比亚的碳税也有类似的条款。

如果得到有效监管，这些条款可能会成就一些声誉良好的“基于自然”的碳排放机制，充分利用森林和沿海红树林等资源。但是总量控制与交易市场上的碳配额价格似乎太低，不足以支付更持久的碳清除方法。因此，创建一个独立的碳清除机制（至少作为一种临时措施）就变得很有吸引力。

一种选择是反向拍卖：政府设定碳清除目标，然后与出价最低的公司签订合同。瑞典正是通过这种途径来发展具有碳捕获和储存功能的生物能源；英国正在考虑采用“差价合约”拍卖机制，它在促进离岸风能和核能时已经采用了这种做法：政府不会为全部的碳清除买单，但会支付碳清除价格与碳价格之间的差价。

这样的拍卖系统可能会逐渐发展成一个与碳排放市场并行的碳清除市场。某些行业的企业将被要求购买碳清除，以抵消一部分碳排放。其中一种由牛津大学的迈尔斯·艾伦（Myles Allen）及其同事倡导的做法叫作“碳回收义务”，它要求化石燃料产业必须用等量的碳清除越来越多地抵消其产

生的碳排放。当抵消的碳排放达到100%时——可能在2050年——该行业就会实现碳中和。这种可预见的长期需求增长将会激励创新。

难点在于信任。是否可以信赖政府会逐步加码购买碳清除的义务？化石燃料行业在减排问题上惯于两面三刀，很不可靠；该行业规模庞大，因而对政府有很大的影响力，而其擅长游说又进一步加大了这种影响力。不难想象，化石燃料行业一方面想方设法将自己的碳清除义务冻结在相当低的水平，一方面又让自己可以继续排放大量二氧化碳，这令人不安。

因而就有必要建立一些能建立多方互信的机构。德国经济学家奥特马尔·埃登霍夫（Ottmar Edenhofer）及其同事建议欧盟可以创建一个碳央行来监督碳清除的利用，防止政客让碳货币贬值或者违背承诺。大多数欧盟成员国已经将本国的货币政策交付给了一家独立的银行，或许它们可以在碳政策上如法炮制。但是还有哪些别的国家或国家集团也会这么做呢？

孤零零的古老地球让万物循环往复。它同时也创造了很多新鲜事物，比如类人猿，他们的聪明才智重构了物质和能量在全球范围内的基本流动。很难想象，那些建立在共识和信任基础上的机构会以类似的巨大规模运行。但是能源转型表明这类事情是可以做到的，尽管进展太慢、起步也太迟。如果能源转型以应有的方式继续下去，那么从中获得的经验和全球视角就可能为齐心协力修复碳循环中尚存的泄露打下基础。■



Personal finance

How the young should invest

Markets have dealt them a bad hand. They could be playing it better

YOUNG INVESTORS, as well as everyone starting to save, have no shortage of lessons to learn. The main ones are classics. Begin early to give the magic of compounding time to work. Cut costs to stop that magic from being undone. Diversify. Do not try to time the market unless it is your job to do so. Stick to your strategy even when prices plummet and the sky seems to be falling in. Do not ruin it by chasing hot assets when the market is soaring, others are getting rich and you are getting jealous.

To this time-worn list, add an altogether more dispiriting lesson specific to today's youngsters: you will not enjoy anything like the returns your parents made. Even accounting for the global financial crisis of 2007-09, the four decades to 2021 were a golden age for investors. A broad index of global shares posted an annualised real return of 7.4%. Not only was this well above the figure of 4.3% for the preceding eight decades, but it was accompanied by a blistering run in the bond market. Over the same period, global bonds posted annualised real returns of 6.3%—a vastly better result than the 0% of the preceding 80 years.

That golden age is now almost certainly over. It was brought about in the first place by globalisation, quiescent inflation and, most of all, a long decline in interest rates. Each of these trends has now kicked into reverse. As a consequence, youngsters must confront a more difficult set of investment choices—on how much to save, how to make the most out of markets that offer less and how to square their moral values with the search for returns. So far, many are choosing badly.

The constant refrain of the asset-management industry—that past

performance is no guarantee of future returns—has rarely been more apt. Should market returns revert to longer-run averages, the difference for today's young investors (defined as under-40s) would be huge. Including both the lacklustre years before the 1980s and the bumper ones thereafter, these long-run averages are 5% and 1.7% a year for stocks and bonds respectively. After 40 years of such returns, the real value of \$1 invested in stocks would be \$7.04, and in bonds \$1.96. For those investing across the 40 years to 2021, the equivalent figures were \$17.38 and \$11.52.

This creates two sources of danger for investors now starting out. The first is that they look at recent history and conclude markets are likely to contribute far more to their wealth than a longer view would suggest. A corollary is that they end up saving too little for retirement, assuming that investment returns will make up the rest. The second is even more demoralising: that years of unusually juicy returns have not merely given investors unrealistically high hopes, but have made it more likely that low returns lie ahead.

Antti Ilmanen of AQR, a hedge fund, sets out this case in “Investing Amid Low Expected Returns”, a book published last year. It is most easily understood by considering the long decline in bond yields that began in the 1980s. Since prices move inversely to yields, this decline led to large capital gains for bondholders—the source of the high returns they enjoyed over this period. Yet the closer yields came to zero, the less scope there was for capital gains in the future. In recent years, and especially recent months, yields have climbed sharply, with the nominal ten-year American Treasury yield rising from 0.5% in 2020 to 4.5% today. This still leaves nowhere near as much room for future capital gains as the close-to-16% yield of the early 1980s.

The same logic applies to stocks, where dividend and earnings yields (the main sources of equity returns) fell alongside interest rates. Again, one

result was the windfall valuation gains enjoyed by shareholders. Also again, these gains came, in essence, from bringing forward future returns—raising prices and thereby lowering the yields later investors could expect from dividend payouts and corporate profits. The cost was therefore more modest prospects for the next generation.

As the prices of virtually every asset class fell last year, one silver lining appeared to be that the resulting rise in yields would improve these prospects. This is true for the swathe of government bonds where real yields moved from negative to positive. It is also true for investors in corporate bonds and other forms of debt, subject to the caveat that rising borrowing costs raise the risk of companies defaulting. “If you can earn 12%, maybe 13%, on a really good day in senior secured bank debt, what else do you want to do in life?” Steve Schwarzman, boss of Blackstone, a private-investment firm, recently asked.

Even so, the long-term outlook for stocks, which have historically been the main source of investors’ returns, remains dim. Although prices dropped last year, they have spent most of this one staging a strong recovery. The result is a renewed squeeze on earnings yields, and hence on expected returns. For America’s S&P 500 index of large stocks, this squeeze is painfully tight. The equity risk premium, or the expected reward for investing in risky stocks over “safe” government bonds, has fallen to its lowest level in decades (see chart 1). Without improbably high and sustained earnings growth, the only possible outcomes are a significant crash in prices or years of disappointing returns.

All this makes it unusually important for young savers to make sensible investment decisions. Faced with an unenviable set of market conditions, they have a stronger imperative than ever to make the most of what little is on offer. The good news is that today’s youngsters have better access to financial information, easy-to-use investment platforms and low-cost

index funds than any generation before them. The bad news is that too many are falling victim to traps that will crimp their already meagre expected returns.

| *A little flush*

The first trap—holding too much cash—is an old one. Yet youngsters are particularly vulnerable. Analysis of 7m retail accounts by Vanguard, an asset-management giant, at the end of 2022 found that younger generations allocate more to cash than older ones (see chart 2). The average portfolio for Generation Z (born after 1996) was 29% cash, compared with baby-boomers' 19%.

It could be that, at the end of a year during which asset prices dropped across the board, young investors were more likely to have taken shelter in cash. They may also have been tempted by months of headlines about central bankers raising interest rates—which, for those with longer memories, were less of a novelty. Andy Reed of Vanguard offers another possibility: that youngsters changing jobs and rolling their pension savings into a new account tend to have their portfolios switched into cash as a default option. Then, through inertia or forgetfulness, the vast majority never end up switching back to investments likely to earn them more in the long run.

Whatever its motivation, young investors' preference for cash leaves them exposed to inflation and the opportunity cost of missing out on returns elsewhere. The months following Vanguard's survey at the end of 2022 provide a case in point. Share prices surged, making gains that those who had sold up would have missed. More broadly, the long-run real return on Treasury bills (short-term government debt yielding similar rates to cash) since 1900 has been only 0.4% per year. In spite of central banks' rate rises, for cash held on modern investment platforms the typical return is even lower than that on bills. Cash will struggle to maintain investors'

purchasing power, let alone increase it.

The second trap is the mirror image of the first: a reluctance to own bonds, the other “safe” asset class after cash. They make up just 5% of the typical Gen Z portfolio, compared with 20% for baby-boomers, and each generation is less likely to invest in them than the previous one. Combined with young investors’ cash holdings, this gives rise to a striking difference in the ratio between the two asset classes in generations’ portfolios. Whereas baby-boomers hold more bonds than cash, the ratio between the two in the typical millennial’s portfolio is 1:4. For Gen Z it is 1:6.

Given the markets with which younger investors grew up, this may not be surprising. For years after the global financial crisis, government bonds across much of the rich world yielded little or even less than nothing. Then, as interest rates shot up last year, they took losses far too great to be considered properly “safe” assets.

But even if disdain for bonds is understandable, it is not wise. They now offer higher yields than in the 2010s. More important, they have a tendency to outpace inflation that cash does not. The long-run real return on American bonds since 1900 has been 1.7% a year—not much compared with equities, but a lot more than cash.

The name of the third trap depends on who is describing it. To the asset-management industry, it is “thematic investing”. Less politely, it is the practice of drumming up business by selling customised products in order to capture the latest market fad and flatter investors that they are canny enough to beat the market.

Today’s specialised bets are largely placed via exchange-traded funds (ETFs), which have seen their assets under management soar to more than \$10trn globally. There are ETFs betting on volatility, cannabis stocks and

against the positions taken by Jim Cramer, an American television personality. More respectably, there are those seeking to profit from mega-themes that might actually drive returns, such as ageing populations and artificial intelligence. An enormous subcategory comprises strategies investing according to environmental, social and governance (ESG) factors.

Niche strategies are nothing new, and nor are their deficiencies. Investors who use them face more volatility, less liquidity and chunky fees. Compared with those focused on the overall market, they take a greater risk that fashions will change. Even those who pick sensible themes are competing with professional money managers.

However the ease with which ETFs can be customised, advertised and sold with a few taps on a phone screen is something that previous generations of investors did not have to reckon with. So is the appeal to morality accompanying their marketing. ESG vehicles are presented to youngsters as the ethically neutral option. If there are investments that will save society and the planet while growing your savings at the same time, what kind of monster would buy the ordinary, dirty kind?

This both overstates the difference between ESG and “normal” funds, and papers over their impact on costs and returns. According to a recent study by the Harvard Business School, funds investing along ESG criteria charged substantially higher fees than the non-ESG kind. Moreover, the ESG funds had 68% of their assets invested in exactly the same holdings as the non-ESG ones, despite charging higher fees across their portfolios. Such funds also shun “dirty” assets, including fossil-fuel miners, whose profits are likely to generate higher investment yields if this shunning forces down their prices.

Next to the vast difference between the investment prospects of today’s youngsters and those of their parents, the benefits to be gained by avoiding

these traps may seem small. In fact, it is precisely because markets look so unappealing that young investors must harvest returns. Meanwhile, the investment habits they are forming may well last for some time. Vanguard's Mr Reed points to evidence that investors' early experiences of markets shape their allocations over many years.

Ordering the portfolios of Vanguard's retail investors by the year their accounts were opened, his team has calculated the median equity allocation for each vintage (see chart 3). The results show that investors who opened accounts during a boom retain significantly higher equity allocations even decades later. The median investor who started out in 1999, as the dotcom bubble swelled, still held 86% of their portfolio in stocks in 2022. For those who began in 2004, when memories of the bubble bursting were still fresh, the equivalent figure was just 72%.

Therefore it is very possible today's young investors are choosing strategies they will follow for decades to come. Mr Ilmanen's treatise on low expected returns opens with the "serenity prayer", which asks for "the serenity to accept the things I cannot change, the courage to change the things I can, and the wisdom to know the difference". It might be the best investment advice out there. ■



个人财务

年轻一代该如何投资

市场给他们发了一手烂牌。他们可以打得更好【深度】

年轻投资者以及每个开始储蓄的人都不乏值得学习的教训。主要的教训都很经典。投资要趁早，让时间这个带来复合增长的因素发挥魔法。削减成本以防止这一奇效被抵消。投资要多元化。不要试图择时入市，除非这就是你的工作。即使价格暴跌，感觉天要塌下来了，也要坚守你的策略。不要在市场飞涨、看着别人发财眼红就去追逐热门资产而毁了你的策略。

在这个历经时间考验的教训清单上，还可以专为当年轻人再加上一条更令人沮丧的教训，那就是他们根本得不到父母辈当年那么高的回报。即使算上2007年至2009年全球金融危机那段时间，2021年之前的四十年对于投资者来说仍然堪称黄金时代。一个全球股票广泛指数的年化实际回报率为7.4%。这不仅远高于之前80年的4.3%，而且还伴随着债券市场的大幅上涨。同期，全球债券的年化实际回报率为6.3%，远好于之前80年的0%。

那个黄金时代现在几乎肯定已经结束了。它最初是由全球化、通货膨胀平稳以及利率长期下降造成的，最后一个因素尤为重要。这些趋势现在都已发生逆转。因此，年轻人必须面对一系列更加困难的投资选择——该存多少钱、如何充分利用回报更少的市场，以及如何调和道德观与寻求回报。到目前为止，许多人都做出了错误的选择。

资产管理行业有一句老话——历史表现并不能保证未来回报，这说得再贴切不过了。如果市场回报恢复到更长期跨度的平均水平，对于当今的年轻投资者（40岁以下）来说，回报差异将是巨大的。算上20世纪80年代之前的低迷年份和之后的丰收年份，股票和债券的长期平均年投资回报分别为5%和1.7%。这种平均回报维持四十年之后，投资1美元股票的实际价值将为7.04美元，投资1美元债券的实际价值为1.96美元。对在2021年前的40年间持续投资的人来说，相应数字分别为17.38美元和11.52美元。

这给现在刚起步的投资者带来了两个危险源。首先，回顾近年的历史之后，他们对市场回报的期望会远高于根据更长期分析得出的期望。这样的结果就是他们最终为退休准备的储蓄太少，以为投资回报能补足退休所需。第二个更令人沮丧的危险是，多年来异常丰厚的回报不仅给投资者带来了不切实际的高期望，还使得未来更有可能出现低回报。

对冲基金AQR的安蒂·伊尔曼宁（Antti Ilmanen）在去年出版的《在低预期回报环境下投资》（Investing Amid Low Expected Returns）一书中陈述了这一观点。20世纪80年代开始的债券收益率长期下降最容易让人理解这一点。由于价格与收益率成反比，这种下跌为债券持有人带来了巨额资本收益，也是他们在此期间所享受的高回报的来源。然而，收益率越接近零，未来资本收益的空间就越小。近年来，尤其是近几个月来，收益率大幅攀升，十年期美国国债名义收益率从2020年的0.5%升至如今的4.5%。但由此造就的未来资本收益空间仍然远不及20世纪80年代初收益率接近16%时那么大。

同样的逻辑也适用于股票，股息和收益率（股票回报的主要来源）随着利率同步下降。同样，这产生的一个结果就是股东获得了意外的估值收益。同样，这些收益本质上是透支未来的回报——股价提高，这也就降低了后进入市场的投资者从股息和企业利润中可预期的收益。这样的代价便是年轻一代投资者的回报前景更乏善可陈。

去年几乎所有资产类别的价格都在跌，这似乎有一个好处，那就是由此带来的收益率上升将改善回报前景。对实际收益率由负转正的大量政府债券来说就是这样。对于公司债券和其他形式债务的投资者来说也是如此，但需要注意的是，借贷成本上升会增加公司违约的风险。“如果在行情特别好的时候，你能通过优先担保银行债务赚到12%、甚至13%的回报，那还有什么不知足的？”私人投资公司黑石集团（Blackstone）的老板苏世民（Steve Schwarzman）最近发问。

尽管如此，过去一直是投资者收益的主要收益来源的股票的长期前景并不乐观。虽然去年股价下跌，但今年大部分时间股价都在强劲复苏。这导致

收益率再度受压，预期回报率也就相应下降。对美国标普500指数中的大型股票来说，这种受压已经非常严重。股票风险溢价——即投资高风险股票获得的高于“安全”政府债券的预期回报——已降至数十年来最低水平（见图表1）。除非有超高且持续的盈利增长，否则唯一可能出现的结果就是股价大幅下跌，或是未来多年里回报令人失望。

对年轻的储蓄者来说，这些都让做出明智的投资决策变得异常重要。面对不理想的市场条件，他们比以往任何一代人都更有必要充分利用有限的机会。好消息是，如今的年轻人比以往任何一代人都更容易获取金融信息、接触易于使用的投资平台和低成本指数基金。坏消息是，太多年轻人正陷入会削减他们本就已微薄的预期回报的陷阱之中。

| 现金太多

第一个陷阱是持有过多现金，这是一个老问题，但年轻人特别容易犯这个错误。资产管理巨头先锋领航（Vanguard）在2022年底分析了700万个散户账户后发现，年轻人比前几代人的现金配置更多（见图表2）。Z世代（1996年后出生）的平均投资组合中，29%是现金，而婴儿潮一代为19%。

这可能是因为在各类资产价格普遍下跌的一年结束时，年轻投资者更有可能选择保留现金。他们也可能受到了几个月里有关央行加息的头条新闻的诱惑，而对于那些有更久远记忆的人来说，这并不是什么新鲜事。先锋领航的安迪·里德（Andy Reed）提出了另一种可能的解释。年轻人换工作并将养老金储蓄转入新账户时，往往会将其投资组合切换为默认选择现金。然后，出于惯性或忘记了这回事，绝大多数人最终没有切换回原本很可能在长期内为他们赚取更多回报的投资方式。

无论动机如何，年轻投资者对现金的偏好让他们容易受到通胀的影响，还会承担因错失其他投资回报而造成的机会成本。在先锋领航这项2022年底的调查过后的几个月里发生的情况就是一个很好的例子。当时股价飙升，那些之前将股票出手的人就错过了这些收益。更广泛地来看，自1900年以来，短期国债（短期政府债务，实际收益率与现金类似）的长期实际回报

率仅为每年0.4%。尽管央行多次加息，但在现代投资平台上持有的现金的典型回报率甚至低于短期国债。现金连维持投资者的购买力都难，更不用说增加了。

第二个陷阱是第一个陷阱的镜像：不愿拥有债券。债券是现金之外的另一种“安全”资产类别。它仅占Z世代典型投资组合的5%，而婴儿潮一代的比例为20%，而且每一代人投资债券的可能性都低于上一代。再加上年轻投资者的现金持有比例高，这导致不同代际的投资组合中这两种资产类别的比例存在显著差异。婴儿潮一代持有的债券高于现金，而在典型的千禧一代的投资组合中，两者之比为1:4。Z世代的这个比例是1:6。

考虑到年轻投资者成长过程中的市场状况，这可能并不奇怪。全球金融危机之后的那些年里，许多富裕国家的政府债券收益很少甚至根本没有。再后来，随着去年利率飙升，债券损失惨重，没法再被视为真正的“安全”资产。

但即使可以理解年轻人为什么看不上债券，这种鄙视也是不明智的。债券现在的收益率比2010年代更高。更重要的是，债券往往能跑赢通胀而现金不能。自1900年以来，美国债券的长期实际回报率为每年1.7%，与股票相比并不高，但比现金高得多。

第三个陷阱叫什么，不同的人有不同的说法。对于资产管理行业来说，这个陷阱叫“主题投资”。说得不客气点，这是一种通过销售定制产品来招揽生意的做法，目的是跟上最新的市场潮流，并让投资者忘乎所以，觉得自己足够精明，能够击败市场。

如今，专业押注主要通过交易所交易基金（ETF）进行，这些基金管理的资产在全球范围内飙升至超过10万亿美元。有些ETF专门押注波动性、大麻股票以及与美国电视名人吉姆·克莱默（Jim Cramer）的建议相反的头寸。更体面一些的ETF会试图从人口老龄化和人工智能等可能真正带来回报的大主题上获利。一个巨大的子类别包括根据环境、社会和治理（ESG）因素进行的策略投资。

利基策略并不新鲜，人们对它们的缺陷也不会陌生。使用利基策略的投资者面临更大的波动性、更小的流动性和高额的费用。与那些专注于整体市场的投资者相比，利基策略投资者要承受更大的投资潮流改变的风险。即使是那些选择明智主题的人也要和专业基金经理竞争。

然而，只需在手机屏幕上点击几下即可轻松定制、宣传和销售的ETF是前几代投资者不必考虑的事情。同样不需要他们考虑的还有ETF营销中的道德诉求。ESG投资工具作为道德中立的选择摆在了年轻人面前。如果有一些投资可以拯救社会和地球，同时又能增加个人积蓄，那什么样的恶人还会去买那些普通且肮脏的投资工具呢？

这既夸大了ESG基金与“普通”基金之间的差异，又掩盖了它们对成本和回报的影响。根据哈佛商学院最近的一项研究，按照ESG标准投资的基金收取的费用比非ESG基金要高得多。此外，尽管ESG基金投资组合收取的费用更高，其68%的投资资产与非ESG基金完全相同。此类基金还会回避化石燃料开采商等“肮脏”资产，而如果这种回避迫使这类资产价格下降，它们的利润可能会生成更高的投资收益率。

与当年轻人和其父辈巨大的投资前景差异相比，避免这些陷阱所获得的好处似乎不大。而事实上，正是因为市场看起来特别缺乏吸引力，年轻投资者才必须收获回报。与此同时，他们正在形成的投资习惯很可能会持续一段时间。先锋领航的里德指出，有证据表明，投资者的早期市场经历会在未来多年影响他们的资金配置。

里德的团队按照先锋领航的散户的开户年份对其投资组合进行排序，计算出了每个年份的中位股票配置（见图表3）。结果显示，那些在行情好的年份开户的投资者即使在几十年后也仍然保持着较高的股权配置。那些在互联网泡沫膨胀的1999年开户的投资者中，在2022年的中位投资组合中股票仍占86%。而在那些2004年开户的投资者中，相应的数字仅为72%，那时他们对互联网泡沫破裂仍然记忆犹新。

因此，今天年轻的投资者所选的策略很有可能将在未来数十年延续下去。

伊尔曼宁关于低预期收益率的论述以“宁静祷文”开篇，祈求“赐我宁静，去接受我无法改变的一切；赐我勇气，去改变我所能改变的一切；并赐我智慧，去分辨二者的不同”。这可能是最好的投资建议了。■



Well played

How maths can help you win your favourite games

A global history of gaming is educational and filled with practical tips

Around the World in 80 Games. By Marcus du Sautoy. Basic Books; 384 pages; \$30. Fourth Estate; £16.99

WHICH ARE the best properties to buy when playing Monopoly, and how many houses should you build on them? Which continent should you aim to take over first in Risk? And what is the best strategy when using the doubling cube in backgammon? These are some of the questions considered and answered by Marcus du Sautoy, a British mathematician and Oxford professor, in his sprightly, light-hearted history of games and gaming.

The narrative is organised geographically as a trip around the world, starting with ancient games from the Middle East—backgammon, the Royal Game of Ur, the Egyptian game of senet—and ending up in Europe with modern games such as Pandemic and Dobble. Along the way the author considers many old favourites (Cluedo, Scrabble, Risk), recent arrivals (Wordle, Settlers of Catan) and less familiar games from a wide range of cultures and historical periods, such as the African game of mancala and the Indian card game of ganjifa, whose rules change at night.

The list is not exhaustive or comprehensive but reflects his own collection. It includes a handful of video games (Prince of Persia, Game of Life) and one sport (the Mayan ball game of pitz).

All this is, of course, really an opportunity for Mr du Sautoy to sprinkle in plenty of mathematical explanations, to provide what he calls “a celebration of the mathematics that swims seductively just below the

surface of many of the games I love”. Playing games, he writes, “overlaps with what I enjoy about mathematics”: the challenge of solving a problem within a set of rules, the need to overcome obstacles and the victorious “aha” moment when a solution is found.

As well as forays into probability and game theory, he explains dice rolls in Monopoly using Markov chains; the torus-shaped playing field of video games like Spacewar!; and how the geometries of finite projective planes underpin the deceptively simple game of Dobble. And in many cases these explanations provide concrete advice to players.

In Monopoly, says Mr du Sautoy, the best properties to buy are the orange ones, followed by the red ones (and build three houses on them). In Risk, control of North America has the best risk-reward ratio, generating a good supply of bonus armies while being easy to defend. In backgammon, accept a double if you think you have more than a 20% chance of winning; offer one if you think you have more than an 80% chance of winning. Oh, and “TALES” is the best starting word in Wordle.

The hybrid history-travelogue approach is clunky at times, and some of the entries are not games at all, but mini-essays on game-related topics, from biography to psychology. And despite its high-concept framing, the book can be read in pretty much any order; indeed, the author suggests a game to randomise the order of the chapters. (In an appendix, he then works out how many possible options there are, which doubles as an illustration of the technique of proof by induction.)

Fun, unexpected, operating within fixed but arbitrary rules, producing a range of complex outcomes and offering insights that can be applied to everyday life—a good game combines all these elements. The same can also be said of this book. ■



玩得漂亮

数学如何帮你赢下你最爱的游戏

一部寓教于乐且提供大量实用技巧的全球游戏史【《环“游”世界八十题》书评】

《环“游”世界八十题》，马库斯·杜·索托伊著。Basic Books出版社；384页；30美元。Fourth Estate出版社；16.99英镑。

玩《大富翁》时，哪些地皮最值得买？该在这些地皮上建多少房子？玩《征服世界》（Risk）时，应该首先攻下哪个大洲？玩西洋双陆棋时，用倍数骰子的最佳策略是什么？这些都是英国数学家、牛津大学教授马库斯·杜·索托伊（Marcus du Sautoy）在一本轻松愉快的游戏史著作中思考并回答的问题。

从中东的古代游戏（西洋双陆棋、乌尔皇室博弈棋[Royal Game of Ur]、埃及的塞尼特棋戏[Egyptian game of senet]）开始，以欧洲的现代游戏（如《瘟疫危机》[Pandemic]、《嗒宝》[Dobble]）结束，本书按地理位置布局，恰似一趟环球之旅。一路上，作者探讨了许多以前的热门游戏（《妙探寻凶》[Cluedo]、《拼字游戏》[Scrabble]、《战国风云》[Risk]）、近期流行的游戏（填字游戏《Worldle》、桌游《卡坦岛》[Settlers of Catan]），还有来自各自不同文化和历史时期的不那么知名的游戏，比如非洲的播棋（mancala）和印度圆扑克（ganjifa），在这些游戏中入夜后规则会有所改变。

这不是一份巨细靡遗的清单，甚至在种类上也不全面。它是作者本人私藏的展示。其中包括一些电子游戏（《波斯王子》[Prince of Persia]、《生命游戏》[Game of Life]）和一款体育游戏（玛雅的球类游戏pitz）。

当然，所有这些游戏为杜·索托伊提供了一个机会，让他在书中穿插了大量的数学解释，他称之为“在我喜爱的许多游戏的表面之下流淌着的诱人的数学盛宴”。他写道，玩游戏“和我对数学的钟爱正好重合”：要在一套规则的范畴里解开一个问题，需要克服障碍，以及最终迎来恍然大悟、找

到破题口的胜利时刻。

除了运用概率和博弈论，他还用马尔可夫链解释了《大富翁》游戏中的掷骰子，还解释了《太空战争》（Spacewar!）等电子游戏的圆环形场地，以及有限射影平面的几何形状怎样支撑起乍看以为简单的《塔宝》桌游。在很多游戏中，这些解释给玩家提供了具体的建议。

杜·索托伊说，在《大富翁》里，最值得买的地皮是橙色的，其次是红色的（然后在上面盖三座房子）。玩《战国风云》时，控制北美洲的风险回报率最高，既能获得额外奖励的数目可观的部队，也易于防御。在西洋双陆棋中，如果你认为自己有超过20%的胜算，那就答应玩倍数骰子；如果你认为自己的胜算超过80%，就问对方玩不玩倍数骰子。对了，“TALES”是玩《Wordle》最好的起始词。

这种混合了历史和旅行日志的写法有时显得笨拙，而且有些日志根本不是游戏，而是游戏相关主题的小文章，涉及从传记到心理学的内容。尽管这本书有着鲜明的结构框架，但几乎可以按任意顺序阅读，作者甚至还提出了一个随机安排章节顺序的游戏。（他在附录中给出了有多少种可能顺序的答案，这同时也是用归纳法证明的一个范例。）

有趣、意想不到、在随意设定的固定规则下操作，产生各种复杂的结果，并且提供可用于日常生活的见解——一款优秀的游戏融合了所有这些元素。可以说这本书也是如此。■



Inflated hopes

Will Japan rediscover its dynamism?

Rising prices and animal spirits give it a long-awaited opportunity

GLOBAL INVESTORS are giddy about Japan again. Warren Buffett made his first visit to Tokyo in more than a decade this spring; he has built up big holdings in five trading houses that offer exposure to a cross-section of Japan Inc. Last month Larry Fink, CEO of BlackRock, the world's biggest asset manager, joined the pilgrimage to Japan's capital. "History is repeating itself," he told Kishida Fumio, the prime minister. He likened the moment to Japan's "economic miracle" of the 1980s. Even disappointing GDP figures released on November 15th will not dent investors' optimism.

Sceptics would say that the only history repeating itself is outsiders falling for yet another Japanese false dawn. The miracle of the 1980s ended with an asset bubble bursting and the country sliding into decades of deflation, or excessively low inflation, and stagnation. Every ten years or so since then, observers, this newspaper among them, have warmed to a new prime minister, identified promising signs of change and claimed to see the sun peeping over the horizon. Foreign investors flood back. Then a few years later they retreat, cold and disappointed. Is this latest promised dawn any different?

It really could be. Two external shocks and two internal shifts have coincided to change the landscape for the Japanese economy. The most palpable shock has to do with prices. Whereas most countries have been obsessed with keeping inflation down in recent years, Japan has been hoping it might finally pick up—and stay up. Global supply squeezes and a weak exchange rate have duly done what years of audacious monetary easing could not achieve, and pushed the headline inflation rate over the Bank of Japan's 2% target. Admittedly, that is not the demand-driven

inflation that the BoJ would like to see. Even so, it has changed how firms, workers and consumers think about prices and, crucially, wages. A path, albeit a narrow one, has opened to a healthier cycle of wage and consumption growth.

The other shock is geopolitical. The war in Ukraine and the superpower stand-off between America and China have spurred a new wave of investment in critical industries and a reconfiguration of regional supply chains that Japan could benefit from.

The internal shifts are subtler, but no less important. Corporate-governance reforms that began under a previous prime minister, Abe Shinzo, have become entrenched. Indeed, they have entered a promising new phase, as Japanese institutional investors—and even the Tokyo Stock Exchange—are putting more pressure on big companies to enhance their value.

Another underappreciated part of the story is generational change. At old firms, bosses attached to ways of doing business that worked during the glory days of the 1980s are exiting the scene. Young entrepreneurs want to build a new Japan Inc.

Yet much in the Japanese economy remains unchanged and unchanging. For Japan to make good on the promise of the moment, policymakers, executives and politicians must do more to nurture the green shoots of dynamism. For a start, the BoJ must execute a complex dance in the coming year. It must unwind unorthodox monetary policies that have outlived their usefulness, such as its yield-curve control, without suffocating the nascent inflation. In time the highly indebted government will probably have to find a way to cope with rising interest rates.

The process of corporate reform must also continue. Japanese firms are now well versed in the forms of good governance, but they need to get

better at the substance. Around 40% of companies in the TOPIX 500 trade below book value. In an unstable world corporate leaders must do more than just preserve the status quo. Luckily they have plenty of room for manoeuvre, after years of hoarding cash on their balance-sheets.

Mr Kishida has promised to focus on “economy, economy, economy”. Compared with his predecessors, he has spoken more about supporting startups. Yet his latest economic package, announced earlier last month, is heavy on one-off tax cuts and stimulus measures that seem designed to boost his popularity, rather than long-term growth. He could turn words into deeds by revising tax codes to reward risk-taking investors and entrepreneurs and by withdrawing support for zombie incumbents. The prime minister is right to trumpet the need for new-company formation. But he also needs to play his part in clearing away corporate dead wood. ■



【首文】膨胀的希望

日本会重新焕发活力吗？

价格上涨和“动物精神”给了它期待已久的机会

全球投资者再次为日本心醉神迷。今年春天，沃伦·巴菲特十多年来首次访问东京。他已积累了五大商社的大量股份，覆盖日本商业的广泛领域。上个月，全球最大资产管理公司贝莱德（BlackRock）的首席执行官拉里·芬克（Larry Fink）也加入前往日本首都的朝圣之旅。“历史正在重演。”他对日本首相岸田文雄说。他将眼下与日本上世纪80年代的“经济奇迹”相提并论。即使是11月15日公布的令人失望的GDP数据也不会削弱投资者的乐观情绪。

怀疑论者会说，唯一重演的历史是外人又一次被日本虚幻的曙光迷惑。80年代的奇迹以资产泡沫破裂告终，此后日本陷入了数十年的通缩（或过低通胀）和经济停滞。从那以后，差不多每过十年，包括本刊在内的观察者们就会对新一任首相产生兴趣，发现变革的可喜迹象，进而声称看到地平线上曙光乍现。外国投资者纷纷回流。几年后，他们又心灰意冷地打道回府。最新的这次破晓在望会不会有所不同呢？

真的有这种可能。两道外部冲击和两种内部转变同时发生，改变了日本经济的图景。最明显的冲击与价格有关。近年来，大多数国家都在竭力控制通胀，日本却希望通胀最终可能回升并不再下降。全球供应紧缩和疲软的汇率适时实现了大胆的货币宽松政策多年都无法实现的目标，推高总体通胀率突破了日本央行2%的目标。诚然，这不是日本央行希望看到的需求驱动型通胀。即便如此，它改变了企业、工人和消费者对价格的看法，以及最关键的——对工资的看法。一条通往更健康的工资和消费增长周期的道路得以铺就，尽管不是一条宽阔坦途。

另一道冲击来自地缘局势。乌克兰战争和中美之间的超级大国对峙刺激了对关键行业的新一波投资，并重新配置了区域供应链，令日本有可能从中受益。

内部的变化更微妙，但同样重要。在前任首相安倍晋三领导下开启的公司治理改革已经深深扎根。事实上，这些改革已经进入了一个充满希望的新阶段，因为日本的机构投资者——甚至东京证券交易所——正在向大公司施加更大的压力，以提升它们的价值。

这个故事中另一个被低估的环节是代际变化。在老公司里，那些因循1980年代辉煌时期经营方式的老板们正在退出舞台。年轻的企业家想要建立一个崭新的“日本公司”。

然而，日本经济的许多方面仍未改变，也没有改变的迹象。日本要兑现目前的承诺，其政策制定者、高管和政客必须采取更多措施，悉心培育经济活力的萌芽。首先，日本央行必须在未来一年跳好复杂的舞步。它必须在不扼杀刚刚萌发的通胀势头的前提下，解除已经失去效用的非正统货币政策，比如收益率曲线控制。一段时间后，债台高筑的政府可能需要想办法应对上升的利率。

企业改革也必须继续推进。日本公司现在精于良好治理的形式，但需要改进实效。东证500指数中约有40%的公司股价低于账面价值。在一个不稳定的世界里，企业领导人仅仅维持现状是不够的，必须要做得更多。幸好，多年来他们的资产负债表上囤积了不少现金，让他们有足够的操作空间。

岸田文雄已承诺会专注于“经济、经济、经济”。与前任们相比，他更多谈到支持创业公司。然而，他在上月早些时候宣布的最新的经济一揽子计划着重于一次性减税和刺激措施，似乎意在提高他本人的支持率而非长期增长。要做到言行合一，他可以修改税法来奖励敢于冒险的投资者和企业，而撤回对僵尸企业的支持。他宣扬创立新公司的必要性是正确的，但他也需要承担角色，清理企业枯木。■



Gut feelings

Faecal transplants are just the start of a new sort of medicine

Microbiome treatments are taking off

IN A SMALL laboratory at Guy's and St Thomas' hospital in London, Désirée Prossomariti is processing donations. Each is weighed, tested for pathogens, filtered, centrifuged and then freeze-dried, before being turned into a powder to be encapsulated and given to patients. The process takes a strong stomach, for the donations are of fresh faecal matter. "I don't smell it any more," says Dr Prossomariti.

The lab workers are not interested in the faeces themselves, but the tiny organisms they carry. Scientists have long known that the guts of animals, including humans, are full of bacteria, viruses and other micro-organisms. But it is only recently that they have come to understand just how important they are. Far from a collection of mere passengers, the microbiome is a vital part of a healthy body. Its members help break down food, produce chemicals that regulate the body within which they live, and repress the growth of other, harmful species of bacteria.

It is one of those harmful bacterial species that Dr Prossomariti's pills are designed to repress, through a process known as a "faecal microbiota transplantation" (FMT). Five pills (or "crapsules", as the lab workers like to call them) can overcome a recurrent infection of *Clostridium difficile*, a bacterium which has evolved resistance to many antibiotics. As its name suggests, the idea is to copy a healthy person's gut ecosystem and reproduce it in someone whose microbiome is out-of-kilter.

It works, too. FMT is a standard remedy for *C. difficile* infections in Britain, and is being investigated for diseases from irritable bowel syndrome to multiple sclerosis. But FMT is only the beginning of the microbial-

medicine revolution. Researchers believe that, rather than the relatively blunt approach of copying over a microbiome in toto, the future lies in tweaking microbiomes to meet a specific patient's needs. FMT is a stopgap, says Eric Pamer, a microbiologist at the University of Chicago.

Besides the “yuck” factor—which, say researchers, tends to evaporate when patients are presented with the evidence—FMT suffers from several problems. Those who donate the stool find the process off-putting. The stool itself is impossible to standardise, varying across donors and even across donations.

That makes it hard to regulate consistently. America and Canada regard FMT pills as investigational drugs. In Italy, the Netherlands and Belgium, FMT is viewed as a tissue transplant. Britain, meanwhile, considers it a medicinal product, which allows for more flexible regulation.

| *I contain multitudes*

All this strongly limits supply. Simon Goldenberg, who runs the laboratory where Dr Prossomariti works, reckons that of a thousand patients with recurrent *C. difficile* infections in Britain each year, only a few hundred get the treatment. There is also an open question as to whether chronic conditions could ever be reliably treated with FMT. Even if the entire microbiome is replaced, says Bernd Schnabl, a gastroenterologist at the University of California, San Diego, the benefits will be temporary if the root cause is untreated.

Hence the push for finer-tuned treatments. Rather than tweaking the populations of individual species of bacteria in a patient's microbiome, for instance, Dr Schnabl is focused on the metabolites that they produce. Take ammonia, which is linked to cirrhosis of the liver. One approach to limiting its presence in the gut (and, subsequently, the bloodstream) is to genetically engineer neighbouring bacteria to be better ammonia-eaters.

Another is to grow bacteria-killing viruses, known as phages, which can reduce the number of ammonia-producing microbes. Dr Schnabl hopes to begin a trial of such phages for alcohol-related hepatitis next year.

Trials with bacteria, meanwhile, are hampered by a shortage of bacteria produced to sufficiently high safety standards. Dr Pamer is therefore developing manufacturing methods that meet the stringent regulations—known as Good Manufacturing Practice—that apply to substances used in clinical trials. Dr Pamer hopes his facility, which can churn out bacteria in 50-litre batches, will receive its certification by the end of the month. If it gets it, says Dr Pamer, then to the best of his knowledge that would make it the first academic site capable of producing enough high-quality bacteria to supply trials. He hopes to run clinical trials on microbiome manipulation for liver disease early next year.

Industry is interested, too. Seres Therapeutics is a biotech firm based in Cambridge, Massachusetts. Its philosophy involves designing communities of bacteria that, when parachuted into the hostile environment of a malfunctioning gut, can restore order. Matthew Henn, the firm's chief scientific officer, says the idea is to use the bacteria themselves as a drug; one that has an evolved ability to get to where it needs to go, and whose diversity of constituent species endows it with many possible simultaneous effects.

In April, the Food and Drug Administration (FDA), an American regulator, approved a product called SER-109—the first oral microbiome therapeutic—for use against recurrent *C. difficile* infections. The company is now testing a cluster of 16 bacteria they call SER-155 in patients who have undergone an allogeneic haematopoietic stem-cell transplant, a treatment for diseases such as leukaemia in which bone-marrow stem cells are transplanted in order to strengthen the patient's immune system. This process, which often includes high antibiotic doses, can severely damage

the microbiome, making a dangerous infection harder to fight off.

Early results released in May showed that the treatment was well-tolerated and that, over 30 days, only one new infection occurred in nine patients given SER-155, compared with six that might have been expected without treatment. Additional results from a placebo-controlled trial are expected in late 2024.

The team at Seres have identified other types of immunocompromised patients that are susceptible to bacterial infections, and hope to begin other trials soon. And they have competition, too. Vedanta Biosciences is another biotech company also based in Cambridge. Earlier this year VE303, a product it produces that contains a mixture of eight strains of harmless *C. difficile* relatives, did well in clinical trials on 79 individuals with recurrent infections of the hostile version of the bacterium. After eight weeks, subjects who had taken high doses of the treatment were less likely to get a recurrent *C. difficile* infection than those on the placebo. The company has “fast track” designation from the FDA, and hopes to begin a larger trial soon.

It is early days, in other words, but the prospects for a new era of microbiome medicine, more sophisticated than crude-but-effective FMTs, look promising. “Our drugs are just that,” says Dr Henn, at Seres. “They are the next generation.” ■



肠里乾坤

粪菌移植只是一种新型疗法的开始

微生物组疗法正在兴起【新知】

在伦敦的盖伊和圣托马斯医院（Guy's and St Thomas'）的一个小型实验室里，德西里·普罗索马里蒂（Désirée Prossomariti）正在处理捐献物。它们每一份都要经过称重、病原体检测、过滤、离心等步骤，然后冷冻干燥，再制成粉末、装入胶囊，最后送到患者手里。这个过程需要很强的忍耐力，因为捐献物是新鲜粪便。“现在我已经闻不出它的味道了。”普罗索马里蒂说。

实验人员感兴趣的并不是粪便本身，而是它们所携带的微生物。科学家们早就知道，包括人类在内的动物的肠道中充满了细菌、病毒和其他微生物。但直到不久前，科学家们才意识到它们的重要性。肠道微生物组绝不是些碌碌无为的寄生物，而是健康身体不可或缺的一部分。其成员帮助分解食物、生成能调节宿主身体机能的化学物质，以及抑制其他有害细菌的生长等。

普罗索马里蒂制备的胶囊就是用来抑制这些有害细菌中的一种，所采用的工艺叫作“粪菌移植”（FMT）。五粒胶囊（实验人员通常叫它们“便便胶囊”）可以治疗复发性艰难梭菌感染——这种细菌对许多种抗生素都产生了抗药性。粪菌移植，顾名思义就是要复制一个健康人的肠道生态系统，再移植到一个微生物组失调的人身上。

这种方法也确实行之有效。在英国，FMT是治疗艰难梭菌感染的常规方法，目前人们正在研究用它来治疗肠易激综合征、多发性硬化症等多种疾病。但FMT仅仅是微生物疗法革命的开始。研究人员认为，这场革命的前途在于对微生物组进行调整，以满足特定患者的需求，而不是像目前这样相对简单粗暴地照搬一整套微生物组。芝加哥大学的微生物学家埃里克·帕默（Eric Pamer）表示，FMT是一种权宜之计。

除了“让人恶心”之外（不过研究人员表示，当疗效实实在在摆在患者面前时，他们的恶心感往往就消失了），FMT还有几个问题。比如，捐粪便的人也不会觉得捐献过程多愉悦身心；粪便本身无法标准化——不同捐献者、甚至同一捐献者不同批次的粪便都存在差异。

这就难以做到一致的监管。美国和加拿大将FMT胶囊视为研究性药物。在意大利、荷兰和比利时，FMT被视作组织移植。而英国则认为它是一种药品，对它的监管相对也就更加灵活。

｜我包罗万象

这一切严重限制了FMT的供应。据普罗索马里蒂所在实验室的负责人西蒙·戈登伯格（Simon Goldenberg）估计，英国每年有一千名复发性艰难梭菌感染的患者，其中只有几百人接受了FMT治疗。还有一个问题尚无定论，那就是FMT是否真的可以治疗慢性疾病。加州大学圣地亚哥分校的胃肠病学家贝恩德·施纳布尔（Bernd Schnabl）表示，如果不能治本，就算所有微生物组都被替换掉，疗效也只是暂时的。

因此就需要寻求更精准的疗法。举例来说，施纳布尔重点研究的不是调整患者体内微生物组中某些种类细菌的数量，而是它们产生的代谢物。以与肝硬化有关的氨为例。要减少肠道以及随后的血液循环中氨的存在，一种方法是对氨周围的细菌进行基因改造，提高它清除氨的能力。另一种方法是培养叫作噬菌体的能杀菌的病毒，它可以减少生成氨的微生物的数量。施纳布尔希望明年能够开始对这种噬菌体进行酒精肝方面的试验。

与此同时，由于生产不出那么多符合足够高的安全标准的细菌，那些要使用细菌的试验难以进行。为此，帕默正在研发一些符合严格规定（即GMP——“良好生产规范”，适用于临床试验中使用的各种物质）的生产方法。目前帕默的实验室可以批量生产50升细菌，他希望在11月底前能获得GMP认证。帕默表示，如果认证通过，那么据他所知，该实验室将成为第一个能够足量生产高质量临床试验用细菌的学术机构。他希望明年初能够开展用微生物组疗法治疗肝病的临床试验。

业界对此也很感兴趣。Seres Therapeutics是一家位于马萨诸塞州剑桥市（Cambridge）的生物技术公司。它的理念涉及细菌群落设计——将这些细菌群落送入失调肠道的不良环境中，可以让肠道功能恢复正常。Seres的首席科学官马修·海恩（Matthew Henn）表示，这里的思路是将细菌本身用作药物，这种药物拥有进化而来的本领，能够去往它该去的地点，并且因其由多种菌株组成，所以可能同时发挥多种功效。

今年4月，美国监管机构食品和药物管理局（FDA）批准了一款名为SER-109的产品。它是首个使用微生物组疗法的口服药，用于治疗复发性艰难梭菌感染。Seres目前正在用一种叫作SER-155的16联菌种微生物组疗法，对接受异体造血干细胞移植的患者进行试验。异体造血干细胞移植是一种治疗白血病等疾病的方法，通过移植骨髓干细胞来增强患者的免疫系统。其治疗过程中常常大量使用抗生素，有可能严重破坏微生物组，让患者更难抵抗危险的感染。

5月发布的早期试验结果显示，该疗法具有良好的耐受性，而且在接受SER-155疗法的九名患者中，在30天内只有一人受到了新的感染；而在未接受该疗法的情况下，一般会有六人受到新的感染。另一项安慰剂对照试验的结果预计将于2024年底公布。

Seres的研究小组已经选定了一些其他类型的易受细菌感染的免疫功能低下的患者，并希望很快开始另外的试验。同时他们也面临竞争。另一家同样位于剑桥市的生物技术公司Vedanta Biosciences生产的VE303由八种无害的艰难梭菌亲缘菌株组成，今年早些时候在79名反复感染有害的艰难梭菌的患者的临床试验中表现良好。八周后的试验结果表明，相比于服用安慰剂的受试者，服用高剂量VE303的受试者患复发性艰难梭菌感染的几率要低。Vedanta Biosciences已经获得了FDA授予的“快速通道”资格，公司希望很快启动一项更大规模的临床试验。

换句话说，微生物组疗法的新时代——比简单粗暴但也有效的FMT更精密复杂——仍处于起步阶段。但它看起来将大有作为。“我们的药物正是这样，”Seres的海恩说，“它们是新一代。”■



Climbing high

How to thrive in a fractured world

Lessons from the ambitious ascent of the United Arab Emirates

OVER THE next few weeks Dubai will be abuzz. Tens of thousands of diplomats, activists and business folk are due to fly in to join the UN's annual climate pow-wow. The United Arab Emirates' skill at wrangling countries and industries with vastly disparate interests, in the hope of making further progress on tackling climate change, will be on full display. But that is not the only reason to pay attention to the UAE. It also shows how to thrive in the multipolar age.

The country is home to just over 0.1% of the world's people and produces only 0.5% of its GDP, but it contains nearly 10% of the world's oil reserves, and this wealth helps it punch above its weight. Like many emerging countries today, it straddles political and economic divisions. It is a closed autocracy, yet one of the world's most open economies. It is a close ally of America, but its biggest trading partner is China. Although its GDP per person exceeds that of Britain or France, it is often seen as part of the global south and is a hub for Indian and African businesses, making it the Singapore of the Middle East. And in 2020 it was one of the first Gulf countries to normalise relations with Israel.

As a consequence, the UAE is prospering even as war rages in the Middle East and superpower rivalry unravels the world. The non-oil economy is growing at nearly 6% a year, a rate that India is enjoying but that the West—and these days even China—can only dream of. Talent and wealth are flocking to the country, as Chinese traders, Indian tycoons, Russian billionaires and Western bankers alike seek stability and success. Last year it attracted more foreign investment for greenfield projects than anywhere except America, Britain and India.

Like Singapore, the UAE is a haven for its region. But whereas Singapore's ascent coincided with a golden age of globalisation, the UAE is seizing opportunity in a time of chaos and disorder. It wants not just to thrive economically but, more dangerously, to exert its political influence abroad. Both its successes and its failures hold lessons for middling powers as they navigate a fragmenting world.

One lesson is to play to your economic strengths. The UAE has had its share of economic embarrassments, notably Dubai's debt-fuelled construction binge, which ended in crisis and a bail-out in 2009. An obsession with the blockchain has faded. But in other areas it has made the most of its advantages, to impressive effect. The operators of its vast ports now run sites from London and Luanda to Mumbai and Manila. DP World, one such firm, handles roughly a tenth of all global shipping-container traffic. Masdar, one of the world's biggest clean-energy developers, has ploughed money into everything from wind farms in Texas to solar plants in Uzbekistan. All told, the UAE is now one of the biggest investors in Africa, helping build vital infrastructure across the capital-starved continent.

Meanwhile, access to lots of capital, computing power and data has helped artificial-intelligence researchers in Abu Dhabi train up Falcon, an open-source large language model that in some ways beats Meta's. Some experts reckon that the UAE may well be the third-most-important country for AI, after America and China. And throughout, its rulers have doubled down on the utility of the country's position as an entrepot at the crossroads of Africa, Asia and Europe, by building institutions for good economic governance and technocracy.

Another lesson is to welcome foreign talent. With just 1m locals, the UAE needs lots of both highly skilled and low-skilled migrants. And the world is full of go-ahead people hoping to make their fortunes. Whereas Saudi Arabia is resorting to heavy-handed measures to attract expertise, such as

requiring regional offices to be set up in the country, the UAE focuses on making itself a more attractive place to live and do business. A golden-visa scheme set up in 2019 offers professionals long-term residency; a select few can even apply for citizenship, once unheard of in the Gulf. In time Saudi Arabia, which is just starting to wean its economy off oil, may become a serious rival. Although the UAE severely restricts political freedoms and has a bad record on human rights, the threat of competition is spurring it to become more socially and economically liberal.

Nor has the UAE forgotten the gains from trade. Other countries have favoured industrial policy and protectionism, but it has been doing deals. India, wary of free trade, signed its first such deal in a decade with the UAE; commerce between the two has since leapt by 16% in nominal terms. An agreement with Israel has given the UAE precious tech know-how and Israeli firms access to deep pools of capital and the bigger Gulf market. Western airlines stopped flying to Tel Aviv after the war in Gaza began. Etihad and Flydubai, two Emirati carriers, still make regular flights there.

Yet some opportunities are turning out to be pitfalls. As America's influence wanes, enterprising powers everywhere will be tempted to amass influence abroad for themselves. Muhammad bin Zayed, the UAE's ruler, has duly seized the initiative. The country's pragmatism has sometimes served it well. In much of Africa it is a welcome business partner, without the imperial baggage of the West; at the UN climate meeting, it hopes to be a broker between rich and poor. But the UAE has also made terrible mistakes.

| *Mirage in the desert*

Fearing the influence of political Islam in its backyard, and wanting to protect trade flows, the UAE is arming the Rapid Support Forces, a Sudanese militia that is committing genocide in Darfur. In the past that approach has failed miserably. In Libya the UAE backed a warlord who tried to march on

Tripoli in 2019 and lost. In Yemen it joined Saudi Arabia in a long war against the Houthi rebels, before partially withdrawing in 2019.

Over the years the UAE's rulers have built mechanisms to ensure a stable business environment at home; they know, too, that domestic failures would quickly incur the ire of their citizens. But the regime faces no such constraints abroad, allowing it to indulge its whims and protect its interests, no matter the consequences elsewhere. In a fragmented world, many countries will be looking for new ways to play on the global stage. The UAE shows the promise that lies ahead—and the perils, too. ■



【首文】攀登高峰

如何在一个分裂的世界里蒸蒸日上

阿联酋强势崛起的经验教训

未来几周的迪拜将热闹非凡。数以万计的外交官、活动家和商界人士将飞抵那里，参加联合国年度气候变化大会。阿联酋将充分展示它如何在利益截然不同的各个国家与行业间斡旋，以期世界在应对气候变化的问题上取得进一步进展。但这并不是阿联酋值得关注的唯一原因。这个国家也展示了如何在多极时代蒸蒸日上。

阿联酋仅占世界人口的0.1%，也只占世界GDP的0.5%，却坐拥全球石油储量的近10%，这一财富帮助它发挥了超越其体量的影响力。和当今许多新兴国家一样，它在政治和经济分歧中左右逢源。它是一个封闭式专制政体，却又是世界最开放的经济体之一。它是美国的亲密盟友，但它最大的贸易伙伴是中国。虽然其人均GDP超过了英国或法国，但却常常被视为全球南方的一员，它是印度和非洲商业的枢纽，使其成为中东的新加坡。2020年，它是首批与以色列关系正常化的海湾国家之一。

其结果是，就在中东战火肆虐、超级大国对抗使世界分裂之际，阿联酋却欣欣向荣。非油经济每年增长近6%，这样的增速目前只有印度达到，而西方国家——甚至如今的中国——都不可企及。随着中国商人、印度大亨、俄罗斯巨富和西方银行家纷纷寻求稳定和成功，人才和财富正涌入这个国家。去年，该国吸引的外国投资新建项目仅次于美国、英国和印度。

与新加坡一样，阿联酋也是本地区的避风港。然而，新加坡的崛起恰逢全球化的黄金时代，而阿联酋却在混乱无序的时代抓住了机遇。它不仅想实现经济繁荣，更危险的是，还想在海外施加政治影响力。对于其他在分裂的世界中寻找方向的中等强国来说，阿联酋的成功和失败都提供了经验教训。

一个经验是要发挥自身的经济优势。阿联酋也经历过经济上的窘境，尤其

是迪拜由债务推动的建设狂潮，最终导致了危机和2009年的紧急救助。对区块链的痴迷也已消退。但在其他领域，它充分利用自己的优势，取得了令人瞩目的成果。其大型港口的运营商如今在世界各地运作，从伦敦和罗安达，到孟买和马尼拉。迪拜环球港务集团（DP World）就是这样一家公司，其处理的集装箱运输量约占全球的十分之一。马斯达尔（Masdar）是世界最大的清洁能源开发商之一，从得克萨斯州的风力发电场到乌兹别克斯坦的太阳能发电厂，该公司均投下了巨额资金。总体而言，阿联酋现在是非洲最大的投资者之一，帮助这个资本匮乏的大陆在各地建设关键的基础设施。

与此同时，大量的资金、算力和数据帮助阿布扎比的人工智能（AI）研究人员训练出了Falcon——这个开源的大语言模型在某些方面已经胜过了Meta的模型。有专家认为，阿联酋很可能是AI领域里第三重要的国家，仅次于美国和中国。而自始至终，其统治者通过建立良好的经济治理和技术官僚制度，加倍押注于该国作为亚非欧交汇处转口港的价值。

另一条经验是欢迎外国人才。阿联酋本国人口仅100万，需要大量移民，无论技能高低。而世界上到处都是充满干劲、梦想致富的人。沙特阿拉伯在吸引专业人才方面采取严格措施，例如要求在该国设立地区办事处，而阿联酋则专注于成为更有吸引力的居住和经商之地。2019年设立的黄金签证计划为专业人士提供了长期居留权，少数人甚至可以申请公民身份，这在海湾地区闻所未闻。随着时间的推移，刚刚开始摆脱对石油经济依赖的沙特可能会成为劲敌。尽管阿联酋严格限制政治自由，人权记录也不佳，但竞争的威胁正促使它在社会和经济上变得更加自由。

阿联酋也没有忘记贸易的好处。当其他国家纷纷采取产业政策和保护主义时，阿联酋却一直在签署贸易协定。长期警惕自由贸易的印度与阿联酋签署了十年来的首个自贸协定；自那以后，两国的名义贸易额跃升了16%。与以色列的协定则为阿联酋带来了宝贵的技术知识，以色列公司则得到了接触雄厚资金池和进入更大的海湾市场的机会。加沙爆发战争后，西方航空公司停飞了前往特拉维夫的航班。两家阿联酋航空公司——阿提哈德航空（Etihad）和迪拜航空（Flydubai）——还在执行定期航班。

然而，一些机会最终却成了陷阱。随着美国的影响力减弱，雄心勃勃的其他大国都将试图为自己在海外积累影响力。阿联酋的统治者穆罕默德·本·扎耶德适时地掌握了主动权。这个国家的实用主义有时非常有用。在非洲大部分地区，它是受欢迎的商业伙伴，且没有西方的帝国主义包袱；在联合国气候会议上，它希望成为富国和穷国之间的中间人。但阿联酋也犯下了可怕的错误。

| 沙漠里的海市蜃楼

由于担心政治伊斯兰在其后院作祟，并希望保护贸易流动，阿联酋正在武装快速支援部队（Rapid Support Forces），这是一支在达尔富尔（Darfur）实施种族灭绝的苏丹民兵。在过去，这种做法遭遇了惨败。在利比亚，阿联酋曾支持一名军阀，他试图在2019年进军的黎波里但失败了。在也门，它曾加入沙特阿拉伯对胡塞叛军的长期战争，直到2019年部分撤军。

多年来，阿联酋的统治者建立起各种机制来确保国内商业环境的稳定，因为他们也知道，内部的失败会很快招致国民的愤怒。但该政权在国外却没有这样的顾虑，这使得它可以随心所欲地维护自己的利益，而不顾这会在其他地方造成什么后果。在一个支离破碎的世界里，许多国家都将寻找新的路径在全球舞台上博弈。阿联酋展现了未来的机遇——还有危险。■



A gulf between them?

Three climate fights will dominate COP28

Whether the summit ends in breakdown or breakthrough depends on one man

THE UNITED ARAB EMIRATES, venue for COP28, the latest climate summit convened by the United Nations, is a controversial choice. Some 70,000 climate advocates, diplomats and other hangers-on will attend an event that begins on November 30th in Dubai, one of the gleaming cities built on wealth that fossil fuels have brought to the region. The fact that the world's most important climate gathering will be hosted by a leading oil producer has sparked outrage among environmentalists. That the summit's president, Sultan Al Jaber, runs ADNOC, the UAE's national oil company (NOC), is proof, whisper conspiracists, that the fix is in on behalf of Big Oil.

Yet from Abu Dhabi on the Persian Gulf, the shipping route to global markets for the world's greatest concentration of oil reserves, to Fujairah on the Gulf of Oman, an entrepot abuzz with tankers carrying Russian oil evading Western sanctions, comes a sense of vulnerability to climate change. The region is short on water and home-grown food. The rising heat of summer is becoming inhumane. The cities built on these desert sands are at risk from a rising sea level. That the UAE shares the threat from increasing global temperatures makes the gathering no less fraught.

So low is trust among many delegates that the talks may break down. That would be alarming. A UN report analysing the national climate-action plans of the 198 parties to the COP found them woefully inadequate for tackling emissions (see chart 1) and hence achieving the goal of limiting the global temperature rise called for in the Paris agreement of COP21 in 2015. In short, the stakes are high. Amid the summit's myriad technical and procedural goals, three big topics cry out for action.

The first is the task of cracking down on emissions of methane, an overlooked greenhouse gas (GHG). The second is the need to fill massive shortfalls in climate finance. And the third is an ideological battle over how and how fast to end the use of fossil fuels. The outlook for meaningful progress can be summed up as good, bad and ugly, respectively.

The good news surrounds methane, a GHG that is much shorter-lived in the atmosphere than carbon dioxide but causes at least a quarter of atmospheric warming. Fred Krupp, head of EDF, an environmental group, insists that addressing methane “is the single fastest opportunity available to slow the rate of global warming”.

As methane is the main component of natural gas, tackling emissions from the energy industry would have a significant impact (see chart 2). And often the payback is quick since methane neither vented nor flared during gas extraction can be sold, says Bjorn Sverdrup of the Oil and Gas Climate Initiative (OGCI), a consortium of a dozen leading oil and gas firms. Its members have reduced their methane emissions roughly by half since 2017, from a leakage rate of 0.3% of total marketed gas to 0.15% in 2022, using technologies that monitor leaks and improve operations. They have pledged to keep that level below 0.2%.

Rumours suggest that many NOCs are resistant but Mr Sverdrup reports that “momentum is building for action at COP” even among those companies. As part of a deal struck earlier this month with America, China (the world’s largest methane emitter) says it will, for the first time, include the gas in its national climate plan. The EU has also just agreed strict curbs on methane emissions from fossil fuels, including imports. A credible side deal involving many big oil companies “would mean more than an ambitiously worded diplomatic communiqué” from official proceedings, reckons Mr Krupp. Mr Al Jaber has been pressing big oil and gas firms hard in private to commit to slash methane emissions.

The prospects for improved climate finance are gloomier. Emerging economies will complain about the failure of the rich world to keep its promises. The \$100bn that was due to have been provided by 2020 by rich countries has yet to turn up in full. At COP27 in Egypt last year a “loss and damage” fund was agreed in principle, to compensate vulnerable countries (which often contribute the least emissions). After an acrimonious process, negotiators recently agreed to give the World Bank a temporary role in hosting this new facility but failed to agree to fund it. The EU may announce some funding for it at COP28.

Armond Cohen, head of CATE, an environmental group, calls \$100bn “the tip of the iceberg” compared with the trillions of dollars needed annually by 2030 and beyond to transform energy systems, mostly in energy-hungry economies of the developing world (see chart 3). Carlos Pascual of S&P Global, a financial-data firm, insists “those trillions of dollars will not come from the public sector, so we have to leverage the private sector.” Rumours suggest that the UAE wants to play a catalytic role by launching a \$25bn global climate-finance fund seeded with its own oil riches.

The third arena of battle is the ugliest. Much blood will be spilt over the question of whether fossil fuels should be “phased down” or “phased out” and whether the use of “abatement” technologies (which enable the capture and storage of GHG emissions from energy use) should permit the continued use of fossil fuels.

A deal is hard to reach because the legitimate climate ambition of a rapid end to burning fossil fuel runs into the equally legitimate reality of fossil dependence (see chart 4). As Mr Cohen observes, “You can wish fossil fuels away, but they still comprise 80% of world energy supply and are growing.” A new scenario from the IEA, a global forecaster, for achieving net-zero emissions envisions a significant amount of fossil-fuel use even in 2050 (albeit at much lower levels than today), making a mockery of talk of rapid

phase-out.

At least the direction of travel is clear if not the pace, with fossil fuels likely to peak and decline in coming decades as efficiency, renewables and alternative clean fuels take off. But when it comes to technologies for abatement of emissions like carbon capture and sequestration (CCS), scepticism runs deep in some quarters, including countries that want a fast end to fossil fuel and which think this will be a “get-out-of-jail-free card” for dirty energy.

If negotiators can agree to allow well-monitored use of abatement, it would permit a managed end to fossil-fuel use that spares consumers painful supply shocks. The IPCC, the UN’s official climate-science body, makes clear that technologies for “negative” emissions could well be needed at massive scale in the second half of the century, which means nascent abatement technologies need a big push now.

The UAE wants to play a leading role on climate innovation, too. It has been investing heavily in decarbonisation. A big CCS project capable of removing GHGs equivalent to the annual emissions of half a million petrol-powered cars was unveiled in September. ADNOC recently brought forward its net-zero GHG target for its operations by five years to 2045. It stopped routine methane venting and flaring long before its peers. The company is spending nearly \$4bn on undersea cables to ship carbon-free electricity to offshore rigs to replace burning natural gas.

Huge solar farms run by Masdar produce the world’s cheapest renewable energy. This Emirati clean-energy giant, in which ADNOC has a stake, is the world’s second-biggest developer of clean energy. It has committed to installing 100 gigawatts of renewable-energy capacity globally by 2030, up from 15 gigawatts in 2021. How did this green behemoth emerge in a land flush with oil riches? It was started back in 2006, before the solar

revolution took off and climate tech became fashionable—by Mr Al Jaber. ■



海湾鸿沟？

三场气候争论将成为COP28的重头戏

此次峰会的成败取决于一个人【深度】

联合国气候变化框架公约第28次缔约方大会（COP28）将于11月30日开幕，阿联酋被选为会议举办国引发了各方争议。届时将有大约七万名气候问题倡议者、外交官及其他随从队伍前往迪拜参会。化石燃料给海湾地区带来了巨大财富，很多光鲜亮丽的城市应运而生，迪拜便是其中之一。全球最重要的气候峰会将由一个产油大国主办，这让环保人士群情激愤。而此次会议的主席苏丹·贾比尔（Sultan Al Jabe）正是阿联酋国有石油公司阿布扎比国家石油公司（ADNOC）的掌舵人。阴谋论者私底下议论说，这足以证明一切早安排好了要为石油巨头谋利益。

然而，从波斯湾的阿布扎比（Abu Dhabi）这个从世界上储油最集中的地区通往全球各地市场的航道，到阿曼湾的富查伊拉（Fujairah）这个转运港口——装载着绕开西方制裁的俄罗斯石油的油轮让这里熙熙攘攘——都能感受到面对气候变化的脆弱性。这一地区水资源匮乏，粮食也无法自给。夏季越来越高的气温开始让人难以忍受。建在这些沙漠上的城市要承受海平面上升的危险。事实是阿联酋同样面对全球气温不断上升的威胁，此次会议的忧虑气氛并不会淡一些。

鉴于很多与会代表之间的信任度之低，会谈可能会破裂。这令人担忧。联合国的一份报告分析了COP198个缔约方的国家气候行动计划后指出，它们在限制温室气体排放（见图表1）上的作为远远不够，因此也就难以实现在2015年的COP21上通过的《巴黎协定》所提出的限制全球升温的目标。简而言之，此次会议成败与否事关重大。在此次峰会设定的五花八门的技术层面和程序层面的目标中，有三大议题急需采取行动。

一是严格控制甲烷排放，甲烷是一种被忽视的温室气体。二是需要填补气候金融中巨大的资金缺口。三是就如何以及多快停用化石燃料展开一场意见斗争。而这三项在此次峰会上取得重大进展的前景可以分别用“好”、

“坏”和“糟糕透顶”来概括。

好消息来自甲烷，尽管这种温室气体在大气中存留的时间比二氧化碳短得多，但它对全球变暖至少也有四分之一的贡献。环保组织美国环保协会（EDF）的负责人弗雷德·克虏伯（Fred Krupp）坚称，解决甲烷排放问题“是现有的减缓全球变暖速度的唯一最快机会”。

鉴于甲烷是天然气的主要成分，解决能源行业的甲烷排放问题将产生重大影响（见图表2）。而由于天然气开采过程中未被放空或燃除的甲烷可以出售，回报往往会很快，油气行业气候倡议组织（Oil and Gas Climate Initiative，简称OGCI）的比约恩·斯韦德鲁普（Bjorn Sverdrup）表示。该组织是由12家主要的石油和天然气公司组成的联盟，自2017年以来，其成员公司使用监测泄漏以及改进操作的技术，将甲烷排放量减少了大约一半，泄漏率从占天然气总销量的0.3%降至2022年的0.15%。它们承诺将把这一水平保持在0.2%以下。

有传言称许多国有石油公司对此态度抵触，但斯韦德鲁普表示，“在COP上行动的势头在加强”，就连这些国有公司也是如此。作为本月稍早时与美国达成协议的一部分，中国（世界上最大的甲烷排放国）首次表示，将把甲烷问题纳入其国家气候计划。欧盟也刚刚同意严格控制化石燃料的甲烷排放，包括进口的化石燃料。克虏伯认为，一份有许多大型石油公司参与的可行的附带协议，会比官方公布的“措辞雄心勃勃的外交公报更有意义”。贾比尔一直在私下大力督促大型油气公司承诺大幅减排甲烷。

相比于甲烷排放，改善气候金融的希望就比较渺茫了。新兴经济体抱怨发达国家没有履行承诺。富裕国家本应在2020年前提供的1000亿美元至今还未全部到位。去年在埃及举行的COP27上，各方原则上同意设立一个“损失与损害”基金，以补偿易受气候变化影响的国家（这些国家往往排放最少）。经过激烈的谈判，代表们不久前同意将该基金暂时交由世界银行代管，但未能就其资金来源达成一致。欧盟可能会在COP28上宣布为该基金提供部分资金。

环境组织CATF的负责人阿蒙德·科恩（Armond Cohen）认为，相比到2030年及以后每年需要在能源系统改造上花费的数万亿美元，1000亿美元只是“杯水车薪”，而能源系统改造的主体主要是发展中世界需要大量能源的经济体（见图表3）。金融数据公司标普全球（S&P Global）的卡洛斯·帕斯卡尔（Carlos Pascual）坚称“这数万亿美元不会来自公共部门，所以我们必须充分调动私营部门的力量。”有传言称，阿联酋希望发挥推动作用，以自己的石油财富为种子资本，发起一个250亿美元的全球气候基金。

第三个战场最为血雨腥风。应该“逐步减少”还是“逐步淘汰”化石燃料，以及“消减”技术（能够捕获和储存能源使用过程中产生的温室气体）的应用是否可以让化石燃料被继续使用，这两个问题将引发唇枪舌战。

协议很难达成，因为尽快停用化石燃料这一合理的气候目标遭遇到了依赖化石燃料这一同样合理的现实（见图表4）。正如科恩所言：“你可以希望化石燃料消失，但现实是，它们仍然占到世界能源供应的80%，而且还在增长。”全球预测机构国际能源署（IEA）提出的实现净零排放的新构想认为，即使到2050年，化石燃料的使用量也会很大（尽管远低于目前的水平），这让尽快淘汰化石燃料的说法成为笑料。

如果说速度很难讲，至少行进的方向是明确的——随着能效提高、可再生能源以及清洁替代燃料的流行，化石燃料需求很可能在未来几十年达到峰值，然后开始减少。但是，对于碳捕获与封存（CCS）等消减技术，某些群体深表怀疑，包括那些希望尽快停用化石燃料的国家，它们认为这会成为使用肮脏能源的“免死金牌”。

如果谈判代表能一致同意在有效监测的情况下使用消减技术，那么就能逐步有序地停用化石燃料而让消费者免受供应危机之苦。联合国官方气候科学机构政府间气候变化专门委员会（IPCC）明确表示，本世纪下半叶可能迫切需要大规模使用“负”排放技术，这意味着现在就需要大力推动新兴的消减技术。

阿联酋也希望在气候创新方面扮演领导角色。它已经在大力投资脱碳技术。今年9月，阿联酋公布了一个大型碳捕获与封存项目，预计消除的温室气体相当于50万辆汽油车的年排放量。ADNOC不久前将其温室气体净零排放目标提前至2045年，比原计划提前了五年。它还大大早于同行，率先停止了甲烷的常规放空和燃除。如今该公司正斥资近40亿美元铺设海底电缆，将无碳电力输送到海上钻井平台，以取代燃烧天然气。

阿联酋的马斯达尔可再生能源公司（Masdar）经营的大型太阳能发电厂生产了世界上最便宜的可再生能源。这家清洁能源巨头是全球第二大清洁能源开发商，ADNOC持有其股份。它承诺到2030年在全球安装100吉瓦的可再生能源容量，而2021年这一数字为15吉瓦。这个绿色的庞然大物是如何在一片盛产石油的土地上冒头的？它创建于2006年，当时太阳能革命尚未兴起，气候技术尚未流行，而创建人正是贾比尔。■



Schumpeter

The many contradictions of Sam Altman

Is the boss of OpenAI a genius or an opportunist?

CALL IT THE “Burning Man” theory of tech. Every so often, the hopes and dreams of a technological visionary are almost torched by those who surround them. In 1985 Steve Jobs was fired from Apple, the company he fathered, and did not return for 11 years. In 2000 Elon Musk’s co-founders ousted him as CEO of X.com, the firm that went on to become PayPal, a digital-payments platform. In 2008 Jack Dorsey’s fellow creators of Twitter ended his short reign as chief executive of the social-media app. On November 17th Sam Altman looked like he would become the Bay Area’s next burnt effigy, ousted from OpenAI, the artificial-intelligence (AI) firm he co-founded in 2015, by a board that accused him of lacking candour. But on November 21st, after four days in which he, his employees and OpenAI’s investors, such as Microsoft, wrangled feverishly for his reinstatement, he was back in control of the firm. “Wow it even took Jesus three days,” one wag tweeted in the midst of the drama. Instead of Mr Altman, three of the four board members who gave him the boot are toast.

It is not the first time in his 38 years on Earth that Mr Altman has been at the centre of such an imbroglio. He is a man of such supreme self-confidence that people tend to treat him as either genius or opportunist—the latter usually in private. Like Jobs, he has a messianic ability to inspire people, even if he doesn’t have the iPhone creator’s God-like eye for design. Like Mr Musk, he has ironclad faith in his vision for the future, even if he lacks the Tesla boss’s legendary engineering skills. Like Mr Dorsey, he has shipped a product, ChatGPT, that has become a worldwide topic of conversation—and consternation.

Yet along the way he has irked people. This started at Y Combinator (YC), a

hothouse for entrepreneurs, which he led from 2014 until he was pushed out in 2019 for scaling it up too fast and getting distracted by side hustles such as OpenAI. At OpenAI, he fell out with Mr Musk, another co-founder, and some influential AI researchers who left in a huff. The latest evidence comes from the four board members who clumsily sought to fire him. The specific reasons for their decision remain unclear. But it would not be a surprise if Mr Altman's unbridled ambition played a role.

If there is one constant in Mr Altman's life, it is a missionary zeal that even by Silicon Valley standards is striking. Some entrepreneurs are motivated by fame and fortune. His goal appears to be techno-omnipotence. Paul Graham, co-founder of YC, said of Mr Altman, then still in his early 20s: "You could parachute him into an island full of cannibals and come back in five years and he'd be the king."

Forget the island. The world is now his domain. In 2021 he penned a Utopian manifesto called "Moore's Law for Everything", predicting that the AI revolution (which he was leading) would shower benefits on Earth—creating phenomenal wealth, changing the nature of work, reducing poverty. He is an ardent proponent of nuclear fusion, arguing that coupled with ChatGPT-like "generative" AI, falling costs of knowledge and energy will create a "beautiful exponential curve". This is heady stuff, all the more so given the need to strike a careful balance between speed and safety when rolling out such world-changing technologies. Where Mr Altman sits on that spectrum is hard to gauge.

Mr Altman is a man of contradictions. In 2016, when he still led YC, Peter Thiel, a billionaire venture capitalist, described him to the New Yorker as "not particularly religious but...culturally very Jewish—an optimist yet a survivalist" (back then Mr Altman had a bolthole in Big Sur, stocked with guns and gold, in preparation for rogue AIs, pandemics and other disasters). As for his enduring optimism, it rang out clearly during an

interview he recorded just two days before OpenAI's boardroom coup, which he did not see coming. "What differentiates me [from] most of the AI companies is I think AI is good," he told "Hard Fork", a podcast. "I don't secretly hate what I do all day. I think it's going to be awesome."

He has sought to have it both ways when it comes to OpenAI's governance, too. Mr Altman devised the wacky corporate structure at the heart of the latest drama. OpenAI was founded as a non-profit, in order to push the frontiers of AI to a point where computers can out-think people, yet without sacrificing human pre-eminence. But it also needed money. For that it established a for-profit subsidiary that offered investors capped rewards but no say in the running of the company. Mr Altman, who owns no shares in OpenAI, has defended the model. In March he told one interviewer that putting such technologies into the hands of a company that sought to create unlimited value left him "a little afraid".

And yet he also appears to chafe against its constraints. As he did at YC, he has pursued side projects, including seeking investors to make generative-AI devices and semiconductors, which could potentially be hugely lucrative. The old board is being replaced by a new one that may turn out to be less wedded to OpenAI's safety-above-all-else charter. The incoming chairman, Bret Taylor, used to run Salesforce, a software giant. On his watch the startup could come to resemble a more conventional, fast-scaling tech company. Mr Altman will probably be happy with that, too.

| *Mercury rising*

If that happens, OpenAI may become an even hotter ticket. With the latest version of its AI model, GPT-5, and other products on the way, it is ahead of the pack. Mr Altman has a unique knack for raising money and recruiting talented individuals, and his task would be all the easier with a more normal corporate structure. But his ambiguities, especially over where to strike the balance between speed and safety, are a lesson. Though Mr

Altman has been welcomed into the world's corridors of power to provide guidance on AI regulation, his own convictions are still not set in stone. That is all the more reason for governments to set the tone on AI safety, not mercurial tech visionaries. ■



熊彼特

矛盾体山姆·阿尔特曼

*OpenAI*的老板是天才还是机会主义者？

就叫它科技业的“火人节”理论吧。时不时地，科技先行者的希望与梦想就几乎被身边的人付之一炬。1985年，乔布斯被他一手创立的苹果公司解雇，11年后才回归。2000年，身为X.com（数字支付平台PayPal的前身）CEO的马斯克被他的联合创始人赶走。2008年，杰克·多尔西（Jack Dorsey）就任推特首席执行官不久，被当初一同创建该社交媒体应用的同僚逼下台。11月17日，山姆·阿尔特曼（Sam Altman）眼看着要成为旧金山湾区下一个被点燃的“火人”。他在2015年与人共同创立的人工智能公司OpenAI的董事会指斥他不够坦诚，把他扫地出门。但在11月21日，在他本人和他的员工以及OpenAI的投资者（例如微软）为他的复职疯狂争吵四天之后，他又重新执掌这家公司。大戏如火如荼展开之时，有人在推特上打趣说：“哇，耶稣复活都要花三天呀。”这次最终惹火上身的不是阿尔特曼，而是赶他下台的四位董事中的三人。

在他38年的人生历程中，这不是阿尔特曼头一回陷入这样的漩涡中心。他是个极度自信的人，人们往往视其为天才或机会主义者（后者往往是私下的态度）。与乔布斯一样，他有一种救世主般启迪他人的能力，尽管他没有这位iPhone创造者在设计上的上帝视角。与马斯克一样，阿尔特曼对自己的未来愿景抱有坚定的信念，尽管他缺乏这位特斯拉老板传奇的工程本领。与多尔西一样，他推出的产品ChatGPT不仅引发了全球热议，也引发了恐慌。

然而，一路走来，他惹恼了不少人。这始于创业孵化器Y Combinator（以下简称YC）。他从2014年开始执掌YC，直到2019年因引领它扩张过快和分心忙于OpenAI等副业而被赶走。在OpenAI，他与马斯克、另一位联合创始人以及几位举足轻重的AI研究人员闹翻，这些研究人员负气出走。最新证据来自笨手笨脚想要解雇他的四位董事。他们做此决定的具体原因尚不清楚。但如果阿尔特曼无节制的雄心是一个原因，也并不让人意外。

假如说在阿尔特曼的生命中有什么是不变的，那就是他那份传教士般的狂热，即使以硅谷的标准来看也是惊人的。有些企业家是在追逐名利。而阿尔特曼的目标似乎是追求“技术全能”。YC的联合创始人保罗·格雷厄姆（Paul Graham）这样评价当时仅20岁出头的阿尔特曼：“你可以把他空降到一个满是食人族的小岛上，五年后你再去看，他是那里的王了。”

别说小岛了。现在全世界都是他的领地。2021年，他写下名为《万物摩尔定律》（Moore's Law for Everything）的一份乌托邦宣言，预言AI革命（他在领导）将泽被地球——创造惊人的财富，改变工作的性质，减少贫困。他是核聚变的狂热支持者，认为它将与ChatGPT这类“生成式”AI一道，令知识和能源成本的下降呈现一条“漂亮的指数曲线”。这是令人激动上头的东西，更何况推出这种颠覆世界的技术时尤其需要谨慎平衡速度和安全。阿尔特曼在这一光谱中更偏向哪一端难以判断。

阿尔特曼是个充满矛盾的人。2016年，他还是YC老板时，亿万富翁风投家彼得·蒂尔（Peter Thiel）曾向《纽约客》表示阿尔特曼“不是特别笃信宗教，但.....他在文化上的犹太教色彩非常浓——是乐观主义者，但又是生存主义者”（当时，阿尔特曼在加州大苏尔地区有一栋避难屋，里面备有枪支和黄金，以备流氓AI、大流行病和其他灾难侵袭）。至于他一直以来的乐观性格，在他全无预警的OpenAI董事会“政变”前两天录制的一次采访中清晰显露。“我和大多数AI公司的不同之处在于，我认为AI是好的，”他对播客《Hard Fork》说，“我不会私底下怨恨自己的事业。我认为它会很棒。”

在管理OpenAI时，他也想两全其美。阿尔特曼设计的古怪公司架构是最近这起戏剧性事件的核心所在。OpenAI当初是作为非营利机构成立的，目的是推动AI的前沿发展，让计算机能超越人类思维而不损害人类的主导地位。但公司也需要资金。为此，OpenAI成立了一家营利性子公司，为投资者提供有上限的回报，但他们对公司的运营没有决定权。没有OpenAI股份的阿尔特曼曾为这种模式辩护。今年3月，他对一位采访者称，把这样的技术交到一家想创造无限价值的公司手中会让他“有点害怕”。

然而，他似乎也对这种模式的限制感到厌烦。和在YC时一样，他一直忙于其他副业，包括寻找投资者制造生成式AI设备和半导体，这些东西可能带来巨额利润。董事会正在换血，新的董事会可能不会那么坚持OpenAI安全至上的宗旨。新任董事长布雷特·泰勒（Bret Taylor）之前是软件巨头Salesforce的CEO。在他的监督下，这家创业公司可能会变得更像一家快速扩张的传统科技公司。阿尔特曼也可能乐见这种变化。

丨 热度上升

如果真会这样，OpenAI可能还会变得更炙手可热。凭借其最新版本的AI模型GPT-5和即将推出的其他产品，OpenAI已是一马当先。阿尔特曼在筹集资金和招募人才方面有着独门本领，有了更常规的公司架构后，他的工作还会变得更轻松。但他暧昧不明的特性值得警醒，尤其是在速度与安全的平衡点设在哪里的问题上。虽然阿尔特曼被迎入世界各地的权力机构为AI监管提供指导，但他仍未完全确立自己的信念。这就更需要政府给AI安全确立基调，而不是指望反复无常的技术远见者。■



Soft-currency power

The Chinese yuan is losing value, yet gaining ground

Low interest rates have a paradoxical effect

CHINA OWES a lot to foreign investment. Long before Foxconn started making iPhones for Apple, manufacturers from Hong Kong tiptoed across the border to Guangdong in search of cheap labour. In 1982 Jetta, a toymaker, opened a spray-painting plant among the nearby lychee orchards of Dongguan, according to “Toy Town”, a book by Sarah Monks. Water for a shower was boiled in a wok; the plant was in a tin shack. At another firm, Ms Monks reports, the workers decided that Mickey Mouse’s nose should be red, not black.

By the end of last year, the accumulated stock of direct investment in China amounted to almost \$3.5trn. But in the third quarter of this year, something remarkable happened. The flow of FDI turned negative, for the first time since quarterly data began in 1998 (see chart 1). Foreign investors removed more money from the country than they put in, through a mixture of repatriated profits, repaid intra-firm loans and asset sales.

This reversal may reflect foreign disillusionment with China’s economic prospects and policymaking. Although the country will most probably meet its official growth target of 5% this year, it could shrink in dollar terms, according to the IMF’s latest forecasts. China’s government has unnerved many investors with its overbearing reaction to the covid-19 pandemic, its regulatory crackdown on technology companies and its investigations of foreign due-diligence firms, including Bain, Capvision and Mintz.

Intensifying geopolitical rivalry has not helped either. It is becoming harder for foreign investors to find opportunities that are both commercially exciting and politically palatable in their home and host

countries. In a survey of its members published in March, the American Chamber of Commerce in China found that 24% were considering relocating manufacturing out of China or had already begun to do so, up from only 14% the year before.

But the sharp reversal in the third quarter may also reflect a technical calculation. As interest rates remain high in America and fall in China, multinational companies have an incentive to spirit spare cash out of the country and unwind any loans to their subsidiaries that can be replaced with Chinese funding. “Many firms can now borrow more cheaply in China and nearly all can earn a higher return on their financial reserves by moving them offshore,” points out Julian Evans-Pritchard of Capital Economics, a research firm.

The combination of an interest-rate gap and a geopolitical gulf has, then, hurt one kind of globalisation. But it may be helping another kind: the embrace of China’s currency, the yuan (or “redback”, as it is sometimes called outside the country).

In a report last month, China’s central bank pointed out that the cost of borrowing in yuan had fallen relative to other big economies. As a result, foreign firms had issued 106bn yuan (\$15bn) worth of yuan-denominated “Panda bonds” in China during the first eight months of the year, an increase of 58% compared with the same period in 2022. Indeed, in September the yuan surpassed the euro to become the second-most-popular currency for trade financing, with 6% of lending, according to SWIFT, a payments-messaging firm.

A meticulous new report on China’s overseas lending by AidData at William and Mary, an American university, also shows how government-owned lenders have made a “strategic pivot” away from the dollar in their lending to low- and middle-income countries (see chart 2). The share of new

commitments in yuan soared from 6% in 2013 to 50% in 2021.

Many of these loans were made by China's central bank to countries that are in debt distress. The recipients were then able to use the yuan to repay Chinese creditors and the IMF, preserving their scarce dollar reserves for other needs. The authors of the AidData report wonder if China's rulers saw a chance to "kill several birds with one stone"—preventing defaults and encouraging the international use of the yuan at the same time.

After all, countries that borrow in the yuan are more likely to use the currency for international payments, according to work by Saleem Bahaj of University College London and Ricardo Reis of the London School of Economics. Forty economies have now signed a swap agreement with China's central bank, which obliges it to temporarily exchange yuan for an equivalent amount of the other party's currency. Signing such an agreement increases the yuan's share in a country's international payments by 1.3 percentage points, they find.

The sanctions imposed on Russia by America and Europe have also helped the yuan. Indeed, more than half of mainland China's transactions with the rest of the world are now settled in its own currency, points out Mr Evans-Pritchard. In the pioneering province of Guangdong the share is even higher, at over 54% in the first three quarters of this year. Guangdong's workers never got Mickey to embrace a red nose. But the province has at least persuaded some foreigners to embrace the redback. ■



软币实力

人民币在贬值，地位却提升

低利率产生矛盾的效果

外资对中国的贡献很大。早在富士康开始为苹果生产iPhone前很久，香港制造商就偷偷越过边境前往广东寻找廉价劳动力。据莎拉·蒙克斯（Sarah Monks）所著的《玩具城》（Toy Town）一书记载，1982年，玩具制造商镇泰在附近的东莞荔科技园里开设了一家喷漆厂。当时洗澡水用铁锅烧，工厂就是一个铁皮屋。蒙克斯说，在另一家公司，工人们认为米老鼠的鼻子应该是红色的，而不是黑色的。

截至去年底，中国的外商直接投资（FDI）存量达到近3.5万亿美元。但是，在今年第三季度出现了某种显著的变化。FDI流量自1998年开始发布季度数据以来首次出现负值（见图表1）。外国投资者通过汇回利润、偿还公司内部贷款和出售资产等方式从中国撤出资金，多于他们投入的资金。

这种逆转可能反映了外国对中国的经济前景和政策制定不再抱有幻想。尽管中国今年很可能实现官方5%的增长目标，但根据国际货币基金组织的最新预测，以美元计算的GDP可能会出现萎缩。中国政府对疫情的专横应对、对科技公司的监管打压，以及对贝恩（Bain）、凯盛（Capvision）和Mintz等外国尽职调查公司的调查，令许多投资者感到不安。

地缘竞争加剧是另一个因素。外国投资者越来越难找到既有商业前景又在本国和东道国具政治可行性的机会。中国美国商会（American Chamber of Commerce in China）3月发布的对会员公司的调查发现，24%的公司正在考虑将制造业迁出中国，或已经开始这样做了，而去年这一比例仅为14%。

但三季度的大幅逆转或许也反映出了技术面的考量。由于美国利率保持高位，而中国利率在下降，跨国公司有动力将闲置资金转移出中国，并解除

子公司既有的任何可以用中国的融资替代的贷款。研究公司凯投宏观（Capital Economics）的朱利安·埃文斯-普里查德（Julian Evans-Pritchard）指出：“许多公司现在可以在中国以更低的成本贷款，而且几乎所有公司都可以通过将资金储备转移到海外来获得更高的回报。”

这样下来，利率差和地缘分歧相结合损害了一种全球化的发展。但它可能有助于另一种全球化：接受中国的人民币（国外有时称之为“红币”[Redback]）。

中国人民银行在10月的一份报告中指出，相对于其他大型经济体，人民币借贷成本已经下降。因此，今年前八个月，外国公司在中国发行了价值1060亿元的以人民币计价的“熊猫债”，与2022年同期相比增长了58%。事实上，根据支付信息传输组织SWIFT的数据，9月，人民币超越欧元，成为贸易融资中第二受欢迎的货币，占贷款金额的6%。

美国大学威廉玛丽学院（William and Mary）的AidData项目发布的一份新报告详尽整理了中国的对外贷款，也显示出国有贷款机构在向中低收入国家提供贷款时已做出了“战略转向”，不再以美元为主（见图表2）。新贷款中人民币贷款所占份额从2013年的6%飙升至2021年的50%。

其中许多贷款是人行向陷入债务困境的国家提供的。借债国收到贷款后就能够用人民币偿还中国债权人和国际货币基金组织的债务，留下自己手上不多的美元储备以满足其他需求。AidData报告的作者认为中国当局可能看到了“一石多鸟”的机会——既能防止违约，同时又能促进人民币在国际上的使用。

毕竟，以人民币借款的国家更有可能使用人民币进行国际支付，伦敦大学学院（University College London）的萨利姆·巴哈吉（Saleem Bahaj）和伦敦政治经济学院（London School of Economics）的里卡多·雷斯（Ricardo Reis）的研究显示。目前已有四十个经济体与人行签署了双边本币互换协议，根据协议，人行要在一定期限内以人民币交换协议国的等值货币。两位研究人员发现，签署这样的协议将让人民币在一国国际支付

中的份额增加1.3个百分点。

美国和欧洲对俄罗斯的制裁也推了人民币一把。埃文斯-普里查德指出，事实上，中国大陆与世界其他地区一半以上的交易现在都是以人民币结算的。在先行省份广东，这一比例更高，今年前三季度已超过54%。广东的工人从没能让米老鼠变成红鼻子，但该省至少说服了一些外国人接受人民币。 ■



Buttonwood

Forget the S&P 500. Pay attention to the S&P 493

The alternative benchmark offers a better view of America's stockmarket

THINK OF AMERICA'S stockmarket. What is the first firm that springs to mind? Perhaps it is one that made you money, or maybe one whose shares you are considering buying. If not, chances are you are thinking of one of the big hitters—and they don't come much bigger than the “magnificent seven”.

Alphabet, Amazon, Apple, Meta, Microsoft, Nvidia and Tesla are Wall Street's superstars, and deservedly so. Each was established in the past 50 years, and five of them in the past 30. Each has seen its market value exceed \$1trn (although those of Meta and Tesla have since fallen, to \$800bn and \$700bn respectively). Thanks to this dynamism, it is little wonder that America's stockmarket has raced ahead of others. Those in Europe have never produced a \$1trn company and—in the past three decades—have failed to spawn one worth even a tenth as much. Hardly surprising that the average annual return on America's benchmark S&P 500 index in the past decade has been one-and-a-half times that on Europe's Stoxx 600.

There is just one problem with this story. It is the hand-waving with which your columnist cast the magnificent seven as being somehow emblematic of America's entire stockmarket. This conflation is made easily and often. It is partly justified by the huge chunk of the S&P 500 that the magnificent seven now comprise: measured by market value, they account for 29% of the index, and hence of its performance. Yet they are still just seven firms out of 500. And the remaining 98.6% of companies, it turns out, are not well characterised by seven tech prodigies that have moved fast, broken things and conquered the world in a matter of decades. Here, then, is your guide to the S&P 493.

Most obviously, having discarded the tech behemoths, our new index now looks substantially older. Consider its biggest companies. At the top of the list is Berkshire Hathaway, an investment firm led by two nonagenarians, and Eli Lilly, a pharmaceuticals-maker established in the 19th century by a veteran of America's civil war. Further down is JPMorgan Chase, a bank that made its name before the founding of the Federal Reserve. That is not to suggest that these firms do not innovate. All of them, by definition, have remained highly successful, even if none has crossed the \$1trn threshold. Whippersnappers, though, they are not.

As a result of this maturity, the S&P 493 is less susceptible to the market's changing mood (see chart). This is a double-edged sword. On the plus side, it offered protection during the crash of 2022. The more established business models of S&P 493 companies started the year with less hype than those of the magnificent seven, leaving them less vulnerable when the hype duly evaporated. Meanwhile, a smaller proportion of their value came from the promise of distant future earnings—the present value of which fell dramatically as interest-rate expectations soared. The net effect was that, while the magnificent seven together lost 41% of their value, the S&P 493 lost just 12%.

This year, however, the tables have turned. On the face of it, the old-timers ought to have done well, since the American economy has remained remarkably buoyant. This, combined with enthusiasm concerning the potential of artificial intelligence to juice their profits, led to a stellar recovery for the magnificent seven. In the first ten months of the year their share prices rose by 52%, nearly erasing the losses of 2022. By contrast, the value of the S&P 493 fell by 2%.

What to make of this bifurcation? One conclusion is that America's tech giants have become overvalued and must eventually face a crash. Another is that, just as share prices have diverged, so too will the companies' sales

and profits, meaning that the magnificent seven really are about to leave the dinosaurs in the dust. Investors seem to choose between these hypotheses largely according to their own temperament, since traditional valuation measures such as the price-to-earnings ratio, which for the magnificent seven is roughly double that for the S&P 493, lend support to both camps.

A third conclusion, now aired increasingly often, is that the S&P 500's domination by seven stocks which are so different from the rest means it is no longer a good benchmark. That is not quite right. Many people invest in funds tracking the index precisely so they can capture the gains of the winners without having to care about its composition. Still, if you want to know what America's stockmarket really looks like, avoid the headline index. Look at the S&P 493. ■



梧桐

忘了标普500指数吧。标普493了解一下

这个替代基准可以更好地反映美国股市

试想一下美国的股市，你脑海中第一个蹦出来的公司是哪个？也许是一家让你赚到了钱的公司，或者是你正在考虑购买它的股票的那家。如果都不是，那么你很可能想到了某个大牌公司，而再大也大不过“七巨头”。

Alphabet、亚马逊、苹果、Meta、微软、英伟达和特斯拉是华尔街的超级明星，确实也都实至名归。它们都是在过去50年里成立的，其中五个成立不超过30年。每家公司的市值都超过了1万亿美元（尽管Meta和特斯拉的市值后来分别跌至8000亿和7000亿）。如此活力充沛，也难怪美国股市把其他股市都甩在后面。欧洲股市从来没有产生过价值1万亿美元的公司，而且在过去的30年里，连市值1000亿美元的公司也没产生过。在过去的十年里，美国基准指数标普500的平均年回报率是欧洲斯托克600指数（Stoxx 600）的1.5倍，也就不足为奇了。

只不过这样的讲述存在一个问题，那就是笔者就这么把七巨头描绘成整个美国股市的象征，经不起推敲。如此划等号很容易，也常有人这么做。这在一定程度上倒也说得通，因为七巨头如今构成了标普500指数的巨大份额：以市值衡量，它们占该指数的29%，自然也就占了股价行情的29%。然而，它们仍不过是500家公司中的七家而已。事实证明，这七个快速行动、打破常规、在短短几十年内征服世界的科技骄子并不足以代表剩下的98.6%的公司。因此，在此特奉上一份标普493指南。

剔除科技巨头后，最明显的变化是新指数看起来年长了不少。来看其中最大的公司。排在最前的是伯克希尔哈撒韦（Berkshire Hathaway），一家由两位九旬老人领导的投资公司，以及礼来（Eli Lilly），一家由一位美国内战老兵于19世纪创立的制药公司。再往下是摩根大通，这家银行在美联储成立之前就已扬名。这并不表示这些公司就不创新。它们显然全都保持着高度成功，即使没有一家跨过了市值1万亿美元的门槛。不过，它们

也确实不是轻狂少年了。

由于这份成熟老道，标普493指数不太容易受市场情绪波动的影响（见图表）。这是一把双刃剑。好的一面是这在2022年的股市暴跌期提供了保护。去年年初，标普493的成分股公司更为成熟的商业模式远未像七巨头那样掀起狂潮，等到热潮自然而然消退时也就没那么脆弱。与此同时，这些公司的价值中有赖遥远未来收益的那部分占比更小——随着利率预期飙升，这部分收益的现值急剧下降。最终的结果是，虽然七巨头的市值总共下跌了41%，但标普493仅下跌了12%。

然而，今年形势发生了逆转。从表面上看，老前辈们应该表现不俗，因为美国经济仍旧相当活跃。再加上人们强烈看好人工智能提升利润的潜力，七巨头上演了亮眼的复苏。今年前10个月，它们的股价上涨了52%，几乎填平了2022年的损失。相比之下，标普493下跌了2%。

该如何看待这样的分化呢？一个结论是，美国的科技巨头先前被高估了，最终必然会面临重创。另一个结论是，就像股价出现分化一样，这些公司的销售额和利润也会分化，这意味着七巨头真的要把那些老古董甩在身后了。投资者在这两种假设中选哪一种似乎主要由他们自己的性情决定，因为两者都能从传统的估值指标（如市盈率）中找到依据。七巨头的市盈率大约是标普493的两倍。

现在日益流行的第三个结论是，标普500由七只股票主导，而且它们与其余的成分股殊为不同，因而已不再是一个好的基准。这么说并不完全正确。许多人之所以投资于跟踪该指数的基金，恰恰是为了从赢家的收益中分一杯羹，而不必关心指数的构成。不过，如果你想知道美国股市的真实情况，还是避开整体指数，看看标普493吧。■



An innovator's dilemma

When should a founder step down?

With investors prizing profits over growth, new skills are required of bosses

“I’M AN ENTREPRENEUR. I’m a founder. That’s the way my mind and brain works,” mused Whitney Wolfe Herd in an interview with Fortune magazine on November 6th, the day she announced she would be stepping down as chief executive of Bumble, a dating app she founded in 2014. Ms Wolfe Herd, who had previously co-founded Tinder, a rival app, confessed to her lack of enthusiasm for the drudgery of running a public company. She will move to the role of executive chairwoman, where she will spend her time “looking at the future of love and connection”.

Into her place will step Lidianne Jones, who currently runs Slack, a chat platform bought by Salesforce, a tech giant, in 2021. Slack’s own founder, Stewart Butterfield, stepped down as its boss at the start of the year. Investors will be hoping that Ms Jones will spend less of her time looking at the future and more at the present; shares in Bumble have lost 82% of their value since the company listed on the stockmarket in 2021. Ms Wolfe Herd’s grand vision of turning Bumble into a wider platform for women to make friends and professional connections has been a flop. Meanwhile, it has been caught in a tussle for growth with arch-rival Match Group, which owns Tinder and various other dating apps including Hinge. Costs have risen.

Investors have long found merit in founder-led companies. Indeed, Bumble’s share price dropped by 4% on the day Ms Wolfe Herd announced the reshuffle. Ben Horowitz, a venture-capital (VC) titan, believes that founder-bosses can spot shifts in technology better than imported ones. And since the company is their life’s work, they are often able to take a longer-term view and bet on innovative ideas that may take years to pay off.

Yet there are signs that the so-called “founder premium” may be waning in a world in which capital is no longer cheap and investors prefer jam today to jam tomorrow. The Economist has analysed the performance of the publicly listed software firms in the Nasdaq Emerging Cloud index produced by Bessemer Venture Partners, a VC outfit. From 2018 until the end of 2021, the share prices of founder-led firms in the index outperformed the rest by a half (see chart 1). Beginning in 2022, however, that gap disappeared.

To understand why, consider that founder-bosses in the index invest more money in research and development, expand their teams faster, deliver higher revenue growth—but generate less cash (see chart 2). During the tech boom of the past decade, a founder’s success depended chiefly on their ability to set a bold vision, raise funding from venture capitalists, gobble up talent and get a head start on possible rivals. Investors now demand greater attention to costs and a speedier path to profits.

What are founders to do? One option is to temper their lofty ambitions and reinvent themselves as fastidious stewards of capital. After incurring the wrath of investors, Mark Zuckerberg, the founder of Meta, a tech titan, toned down his grandiose plan to build a metaverse, declaring in February that 2023 would be the jolly-sounding “year of efficiency”. Its shares have regained most of the value they lost last year.

On November 2nd Shopify, an e-commerce platform, reported its results for the quarter from July to September. Investors were cheered by a return to profitability; its share price rose by 22% on the day. In May the firm cut its workforce by 20% and offloaded its logistics arm. Tobias Lütke, its co-founder and boss, admitted that the company had become distracted by “side quests” and grew too quickly during the pandemic. Salesforce, run by its co-founder Marc Benioff, offers one more example. For years it prioritised growth over margins and splurged on acquisitions, including

the \$28bn it paid for Slack. As the tech industry sank last year, activist investors circled the firm. In response, it shed 10% of its workforce, paused acquisitions and raised prices. It, too, has been rewarded by investors for its efforts.

As Ms Wolfe Herd's remarks suggest, however, all this may sound terribly dull to some founders. Some may bow out altogether—Mr Butterfield now spends his time gardening and buying luxury properties. Others, like Ms Wolfe Herd, will choose to carve out a role more to their liking, leaving the tedious job of generating profits to others. Whether such an arrangement works may come down to the personalities involved. Bradley Hendricks of the University of North Carolina notes that although founders are in greater need of advice than seasoned professionals, they are also more likely to ignore it. If tensions emerge between the grand hopes of a founder and the pragmatic priorities of the boss they bring in, sparks may fly. ■



创新者的困境

创始人何时该退位？

随着投资者更看重利润而非扩张，老板们需要掌握新技能

“我是企业家。我是创始人。我的思维和大脑就是这么运转的。”11月6日，惠特尼·沃尔夫·赫德（Whitney Wolfe Herd）在接受《财富》杂志采访时若有所思地说。当天她宣布将辞去Bumble首席执行官一职。Bumble是她于2014年创立的约会应用，她此前还曾与人共同创立了竞争对手应用Tinder。她承认自己对经营一家上市公司这种繁重又无聊的差事没什么热情。她将转而担任董事会执行主席，将在这个职位上花时间“展望爱和连结的未来”。

莉迪亚恩·琼斯（Lidiane Jones）将接替她的职位，她目前执掌Slack，这家聊天平台于2021年被科技巨头Salesforce收购。Slack自家的创始人斯图尔特·巴特菲尔德（Stewart Butterfield）于今年年初辞去了公司老板的职务。投资者希望琼斯少花点时间展望未来，多花点时间关注当下：自Bumble于2021年上市以来，公司股价已经跌去了82%。沃尔夫·赫德的宏伟愿景是把Bumble打造成一个更广阔的平台，供女性交友和建立职业人际关系，但遭遇滑铁卢。与此同时，它还陷入了与头号劲敌Match Group的扩张之争。Match Group拥有Tinder和Hinge等多款约会应用。Bumble的成本增加了。

投资者早就发现了由创始人领导公司的优势。事实上，在沃尔夫·赫德宣布管理层洗牌的当天，Bumble的股价下跌了4%。风投大亨本·霍洛维茨（Ben Horowitz）认为，创始人老板比后来请来的老板更能察觉技术的变迁。而因为公司是他们毕生的心血，他们通常能抱之以更长远的眼光，押注于可能需要好些年才有回报的创新想法。

不过，有迹象表明，在一个资本不再便宜、投资者更喜欢一鸟在手而不是双鸟在林的世界里，所谓的“创始人溢价”可能正在减弱。本刊分析了由风投机构Bessemer Venture Partners发布的纳斯达克新兴云指数中上市软件

公司的表现。从2018年到2021年底，这一指数中由创始人领导的公司的股价比其他公司高出一半（见图表1）。但从2022年开始，这一差距消失了。

要理解其中缘由，需要想到的是这批创始人老板在研发上投入的资金更多，招兵买马更快，实现的收入增长更高，但带来的现金却更少（见图表2）。在过去十年的科技繁荣时期，创始人的成功主要依靠他们能够做大胆设想、从风险投资家那里融资、大举吸纳人才，以及赶在潜在对手前行动，获取先发优势。投资者现在要求更多地关注成本，更快地盈利。

创始人该怎么做？选择之一是收一收雄心壮志，变身一丝不苟的资本管家。在点燃了投资者的怒火之后，科技巨头Meta的创始人扎克伯格言语间淡化了他建立元宇宙的宏伟计划，在2月宣布2023年将是“效率年”——这听起来令人舒心。Meta的股票已经收复了去年的大部分失地。

11月2日，电子商务平台Shopify公布了从7月到9月的季度业绩。投资者因它恢复盈利而欢欣鼓舞，其股价当日上涨了22%。今年5月，该公司裁员20%，并剥离了物流部门。联合创始人兼老板托比亚斯·吕特克（Tobias Lütke）承认，公司被“支线任务”分散了精力，而且在疫情期间发展过快。由联合创始人马克·贝尼奥夫（Marc Benioff）执掌的Salesforce提供了又一个例子。多年来，公司将扩张置于利润之上，并斥巨资进行收购，包括以280亿美元收购Slack。去年科技行业低迷，维权投资者围攻该公司。作为回应，Salesforce裁掉了一成员工，暂停收购并且提高了价格。它的这番努力也得到了投资者的嘉奖。

不过，正如沃尔夫·赫德的一席话暗示的那样，对有的创始人来说，这一切听起来也许实在太乏味了。有些人可能会彻底退出——巴特菲尔德现在把时间花在园艺和购置豪宅上。其他人，比如沃尔夫·赫德，会选择创造一个更合自己口味的角色，把创造利润的无趣工作留给别人。这样的安排能否奏效可能还是得看相关人物的个性。北卡罗来纳大学的布拉德利·亨德里克斯（Bradley Hendricks）指出，尽管创业者比资深专业人士更需要建议，但他们也更有可能不把这些建议当回事。如果创始人的宏伟愿景和

他们请来的老板的务实优先项之间起了冲突，可能免不了要火花四溅。■



Son rise, Son set

After WeWork's fall, what next for SoftBank?

Son Masayoshi is ready to splurge again

"HIS EYES were very strong. Strong, shining eyes." So Son Masayoshi explained his decision back in 2000 to invest \$20m in a Chinese e-commerce startup founded by Jack Ma. By the time SoftBank, Mr Son's investment group, finished selling most of its stake in Alibaba earlier this year, it had made \$65bn from the gamble. Less successful was the Japanese billionaire's bet on Adam Neumann, the charismatic founder of WeWork, an office-rental firm that declared bankruptcy on November 6th. SoftBank is estimated to have torched around \$14bn backing it.

Mr Son's career has been a tale of soaring highs and crushing lows that have followed the hype cycles in tech. A strategy of doling out big cheques to buzzy firms has served SoftBank well in the upswings but poorly in the downswings. Now, after a bruising year, the indefatigable Mr Son is jumping on tech's latest craze for all things artificial intelligence (AI). It promises to be a wild ride.

SoftBank, which began life as a software distributor in Japan, reinvented itself amid the dotcom boom of the 1990s as an investment vehicle, buying stakes in hundreds of startups, including Yahoo, a once-popular search engine. At the height of dotcom mania, Mr Son was briefly the richest man in the world. After the bubble burst, he reoriented SoftBank around mobile internet, launching a telecoms business in Japan in 2005, buying a majority stake in Sprint, an American carrier, in 2013, and acquiring Arm, a British designer of smartphone chips, in 2016.

A year later Mr Son launched SoftBank's Vision Fund, a \$100bn war chest bankrolled in part by Saudi Arabia's sovereign-wealth fund, and began

pouring capital into loss-making startups. Despite some notable flops, including WeWork, by the summer of 2021 the investment binge looked like a resounding triumph, with the Vision Fund and its successors having made a cumulative gain of \$66bn. Since then, a collapse in tech valuations has flipped that into a \$6bn loss (see chart).

SoftBank is doubly exposed to higher interest rates, which decrease the value of startups whose profits lie mostly in the future and increase the cost of debt, of which the investment group has plenty. In May S&P Global, a rating agency, downgraded SoftBank's credit deeper into junk territory. To ease jittery investors, it has sold assets and expanded its cash pile from \$25bn two years ago to \$34bn, equal to a quarter of its interest-bearing debt. The initial public offering of Arm, in which SoftBank retains a 90% stake, has also made its portfolio more liquid.

Mr Son is now itching to start writing cheques again, having declared SoftBank ready to switch back into "offence mode". The firm has done only 23 deals so far this year, compared with 125 last year and 251 in 2021, according to PitchBook, a data provider. Mr Son has his eyes on AI, which he predicts will "surpass the total intelligence of humankind by ten times in ten years".

The danger is that the investment giant is entering the market at its frothiest. Valuations of AI companies have rocketed in recent months as investors have piled into competitive fundraising processes. As a result, SoftBank is also looking to carve out novel investment opportunities for itself, says Alex Clavel, co-head of the group's Vision Funds.

He gives the example of GreenBox, a new joint venture between SoftBank and Symbotic, a robotics company, that will develop and rent out automated warehouses. In September SoftBank was also reported to be in discussions with OpenAI, the startup behind ChatGPT, and Jony Ive, a

designer of the iPhone, to fund the development of an AI device powered by Arm's chips.

Yet other elements of SoftBank's approach to investment will remain. "We usually put our eggs in fewer baskets," says Mr Clavel, a pattern he expects to continue. Mr Son's willingness to trust his gut is also unlikely to change.

In a decade's time, when Mr Son's prognostications on AI have been tested, he will be 76, pointing to another question hanging over SoftBank: succession. Mr Son, who hopes the business will endure for at least 300 years, began talking publicly of handing over the reins in 2015. A string of potential successors have since left and SoftBank continues to revolve around its enigmatic founder. If it is to last, Mr Son must ready it for a future without him. ■



孙正义的大起大落

WeWork倒下之后，软银将何去何从？

孙正义将再有大动作

“他的眼神非常坚定。坚定的、发着光的眼神。”在回顾自己2000年为什么决定向马云新创的中国电子商务公司阿里巴巴投资2000万美元时，孙正义这样解释道。今年稍早时，孙正义的投资集团软银（SoftBank）卖掉了持有的大部分阿里巴巴股份，至此它已经从这个投资赌局中获利650亿美元。不过，这位日本亿万富翁的另一场押注就没那么成功了——11月6日，魅力十足的亚当·诺伊曼（Adam Neumann）创立的办公室租赁公司WeWork宣布破产。据估计，软银已经在这家公司上烧掉了约140亿美元。

孙正义的事业一直随着科技行业的技术成熟度曲线而大起大落。大举投资热门公司的策略在曲线上扬期让软银收获颇丰，但在下落期却让它表现惨淡。如今，在经历了一年的坎坷之后，不服输的孙正义正投身于科技界新一轮“万物皆可AI”的热潮。这应该会是一段剧烈动荡的狂野之旅。

软银最初是日本的一家软件分销商，在上世纪90年代的互联网泡沫中，它转型为一家投资机构，购入了数百家创业公司的股份，包括当时很受欢迎的搜索引擎雅虎。在那次互联网热潮的高峰期，孙正义还曾短暂登上世界首富的宝座。泡沫破裂后，他将软银重新定位为移动互联网公司，并于2005年在日本推出电信业务，2013年买入美国通讯公司Sprint的大部分股份，2016年收购了英国智能手机芯片设计公司安谋（Arm）。

一年后，孙正义成立了1000亿美元的软银愿景基金，其中部分资金来自沙特阿拉伯的主权财富基金，并开始向亏损的创业公司注资。尽管有WeWork等显著的失败案例，但到2021年夏天，这轮大手笔投资似乎取得了巨大成功，愿景基金及其后来成立的几只基金累计获利660亿美元。但此后，由于科技企业估值暴跌，这些浮盈变成了60亿美元的亏损（见图表）。

利率上升给软银带来了双倍风险：一方面降低了利润主要有待未来实现的创业公司的价值；另一方面加大了本来就负债累累的软银的债务成本。今年5月，评级机构标普全球（S&P Global）将软银的信用评级进一步下调至垃圾级。为了安抚担惊受怕的投资者，软银出售了部分资产，从而将现金储备从两年前的250亿美元增加到340亿美元，相当于其有息债务的四分之一。此外，软银在安谋上市后仍然持有其90%的股份，这也让软银的投资组合更具流动性。

孙正义现在跃跃欲试要开写新支票，他此前已宣布软银即将切换回“进攻模式”。数据提供商PitchBook称，今年截至目前，软银只完成了23笔投资，而去年和2021年分别为125笔和251笔。孙正义盯上了AI，他预测AI将“在十年后超出人类智能总和十倍”。

危险在于，这家投资巨头进入AI市场之际，正是泡沫最严重之时。近几个月来，随着投资者蜂拥加入融资争夺战，AI公司的估值飙升。因此，软银集团愿景基金联席负责人亚历克斯·克拉维尔（Alex Clavel）表示，软银也在寻求为自己开拓全新的投资机会。

他以GreenBox为例。GreenBox是软银和机器人公司Symbotic合资组建的新公司，将要开发和出租自动化仓库。据称，今年9月软银还与开发了ChatGPT的创业公司OpenAI以及曾担任iPhone设计师的乔尼·艾夫（Jony Ive）商谈，计划为一款由安谋芯片驱动的AI设备的研发提供资金。

不过，软银将继续保持它投资方式中的其他一些特点。克拉维尔表示：“我们通常会把鸡蛋放在较少的篮子里。”他预期这种模式会持续下去。孙正义愿意相信自己的直觉，这一点也不太可能改变。

十年后，当孙正义对AI的预言得到验证时，他将76岁。这意味着软银还面临另一个问题——接班人。孙正义希望这家企业至少能存续300年，他从2015年开始公开谈论交棒的话题。但此后，一些潜在接班人都相继离开，而软银则继续以这位高深莫测的创始人作为中心。如果能让软银长久存在下去，孙正义就必须让公司为一个没有他的未来做好准备。■



Buttonwood

Ray Dalio is a monster, suggests a new book. Is it fair?

The founder of the world's largest hedge fund comes under scrutiny

THE TOME opens with Ray Dalio laying into an employee he apparently knew to be pregnant. He calls her an “idiot” over and over, until she runs from the room sobbing. The founder of Bridgewater Associates, the world’s largest hedge fund, was supposedly “delighted”. His “probing” of this woman was evidence of his commitment to “truth-seeking” at any cost. The meltdown, which had been recorded, was uploaded to a library of firm meetings. He had it edited into a clip to be shown to future employees.

This is just the first of many damaging titbits in “The Fund”, a new book about Mr Dalio by Rob Copeland, a reporter at the New York Times. The book’s narrative builds to two points. One is that Mr Dalio’s “principles”, a philosophy he described as being centred on “radical transparency”, are really little more than time-wasting tools which he uses to bully employees. The system requires meetings to be recorded, for employees to rank one another and for them to upload complaints onto a platform. This is supposed to foster an “ideas meritocracy” but instead leads, at best, to petty gripes about how the peas in the cafeteria are too “wrinkled” and, at worst, to a culture of fear. Mr Dalio is supposed to have manipulated this system so that his opinion always mattered most.

The second is that there is “no secret” to Bridgewater’s success. Mr Dalio’s hundreds of research staff write reports he does not even read. Mr Copeland claims Mr Dalio made all the investing decisions himself, or with some input from lieutenants. Far from having a codified set of rules, as he tells clients, he uses hunches and simple “if then” statements such as: if interest rates fall in a country then you should sell its currency. These worked, the story goes, for a while, but the rise of high-frequency traders and

quantitative funds, which often follow market “momentum”, eroded his edge. Returns for Bridgewater’s flagship “Pure Alpha” fund have been pretty paltry for the past 10 or 15 years.

The conclusions of the two intertwine: the cult of Bridgewater is pointless. Bridgewater’s employees have time to waste on nonsense because the investing process is simple, really. Mr Dalio might have been a gifted investor—since 1991 he has earned \$58bn for those who have bought into his funds—but his efforts to codify investment rules and culture were a waste of time. His legacy will fade.

Mr Copeland’s deep reporting unearthed damning tales, but they seem to have been told so as to place Mr Dalio in the worst possible light. Take, for example, a passage where Mr Dalio invites Niall Ferguson, a celebrated historian, to Bridgewater. Mr Dalio supplied Mr Ferguson with a copy of his book, which offers a sweeping theory of economic history and a model of “the economic machine”—only for Mr Ferguson to tell the assembled staff that there was no way of modelling history since models could not account for the “caprices of decision-makers”. Mr Dalio began shouting at Mr Ferguson, who soon left. Mr Copeland writes that Mr Dalio then sent round a poll asking who won the debate (Mr Dalio triumphed).

It is one of many anecdotes that are supposed to reveal that Mr Dalio is unprincipled. Far from listening to unfiltered criticism he uses his power to silence others. But apparently Mr Dalio later solicited advice asking whether he had behaved inappropriately. His employees implored him not to invite people to Bridgewater just to shout at them—advice to which he is said to have listened. Mr Dalio’s radical transparency might be strange and misguided, but perhaps he is not a hypocrite.

The book’s arguments about Mr Dalio’s investment process are harder still to swallow. Macro funds that follow trends are a dime a dozen, and few

come close to touching Bridgewater's record. As for the erosion of his edge, the earliest momentum funds were established in the 1980s, before Bridgewater set up its first funds. They grew in the 1990s and 2000s, when his edge was as sharp as ever. How Mr Dalio achieved what he did is something of a mystery. Perhaps some of the magic could have been codified or captured. It was worth trying, anyway.

Mr Dalio dismisses Mr Copeland's book out of hand. He has written that it is "another one of those sensational and inaccurate tabloid books written to sell books to people who like gossip". The hagiography of Mr Dalio already exists: he penned his own tale in 2017. Mr Copeland seems to have written its foil, which can find only the ill in Bridgewater's founder. The book is worth a read—but only with that in mind. ■



梧桐

一本新书把瑞·达利欧描绘成恶魔。这公允吗？

全球最大对冲基金的创始人受到严厉审视

这本书一开头就是瑞·达利欧（Ray Dalio）在大骂一名他显然知道已经怀孕的员工。他一遍又一遍地骂她“白痴”，直到她抽泣着跑出房间。这位全球最大对冲基金桥水基金（Bridgewater Associates）的创始人想来“很高兴”。他对这位女士的“盘问”证明了他坚守不惜一切代价“寻求真相”的原则。这位员工崩溃的场面被录了下来，上传到公司的会议资料库。他让人把它剪辑成一段视频，好展示给未来的员工看。

这只是《纽约时报》记者罗布·科普兰（Rob Copeland）所著关于达利欧的新书《桥水基金》（The Fund）中众多骇人轶事中的第一桩。该书的叙述可以归结为两点。一是达利欧的“原则”——他自述以“极端透明”为核心的一套理念——实际上不过是他用来欺压员工的一堆浪费时间的工具。这套体系要求对会议录像，让员工互评名次，把抱怨上传到一个平台上。其初衷是促进“想法择优”，但最好的结果也只是让员工能抱怨自助餐厅的豌豆太“皱巴巴”这样鸡毛蒜皮的小事，而最糟糕的是导致了一种恐惧文化。达利欧看来是操纵了这套体系来让自己的意见永远凌驾于一切之上。

第二点是桥水的成功“全无秘诀”。达利欧手下数百名研究人员撰写的报告他甚至看也不看。科普兰称，达利欧的所有投资决策都是他一个人拍板，或者是听了副手的一些意见后做出的。他并不像他对客户声称的那样有一套规范的行事法则，而是运用直觉和简单的“如果-就”思维，比如如果某个国家的利率下降，那么你就该卖出该国的货币。按作者所述，这些方法一度行之有效，但高频交易员和量化基金（往往追随市场“大势”）的崛起削弱了他的优势。桥水公司的旗舰基金“纯阿尔法”（Pure Alpha）在过去10年或15年的回报就低得可怜。

两方面的结论交织为一点：崇拜桥水基金是毫无意义的。桥水的员工能浪费时间浪费在扯淡的事情上是因为投资过程实则很简单。达利欧可能是一位

天才投资者——自1991年以来他为购入其基金的人赚到了580亿美元，但他将投资法则和文化集结成典的努力纯属浪费时间。他的传奇功业终将褪色。

科普兰的深入报道发掘出了一些非常负面的故事，但似乎写来只是为了极力丑化达利欧，例如有一个段落讲述了达利欧邀请著名历史学家尼尔·弗格森（Niall Ferguson）访问桥水基金的经过。达利欧送给弗格森一本他的书，其中提出了一套笼统的经济史理论和一个“经济机器”模型，但弗格森却对在场的桥水员工说，历史是无法建模的，因为模型无法解释“决策者的任性妄为”。达利欧开始冲弗格森大吼大叫，弗格森很快拂袖而去。科普兰写道，达利欧之后向员工发起了调查，问这场辩论谁胜谁负（达利欧大胜）。

这是用来揭露达利欧不讲原则的诸多轶事之一。他不但不听取直截了当的批评，还利用手中权力打压反对声。但看起来达利欧之后是征求了意见的，看自己是否举止失当了。他的员工恳求他不要邀请了别人到访桥水最后却把人骂走，据作者说他也听取了这个建议。达利欧的“极端透明”理念可能怪异、误入歧途，但他或许并不是个伪君子。

书中关于达利欧投资过程的论点更难令人信服。追随大势的宏观基金比比皆是，但很少有基金能企及桥水的战绩。至于达利欧的优势被削弱这一点，最早的趋势基金是在1980年代成立的，早于桥水创立的第一批基金。这些基金在1990年代和21世纪初发展壮大，而期间达利欧一直保持着明显优势。他究竟是如何取得这番成就的多少还是个谜。也许他确实能将其中一些魔法整理成册或捕捉下来，无论如何这值得一试。

达利欧对科普兰的书不屑一顾。他写道，此书“又是一本耸人听闻、内容失实的低俗读物，写出来就是为了赚八卦爱好者的钱”。达利欧的圣人传记已经有了：他在2017年自己写了一本。科普兰的新书仿佛是它的陪衬物——专挑他毛病的。此书值得读一读，但得记着这一点。■



Free exchange

In praise of America's car addiction

How vehicle-dependence makes the country fairer and more efficient

NO TRADITION IS sacred—not even trick-or-treating. In recent Halloween festivities, many Americans switched to trunk-or-treating. Instead of going door-to-door on neighbourhood streets, children shuffled between cars in parking lots and collected candy from their open boots, which were bedecked by giant spiders and terrible ghouls. It was the latest demonstration of something that has long been true: cars have a remarkably tight grip on American life. America is far more car-reliant than any other big country, averaging roughly two vehicles per household. This, in turn, is linked to many ills: obesity, pollution, suburban sprawl and so on.

Despite such horrors, more Americans than ever are consigning themselves to a car-defined existence by choosing to live in the suburbs. Census figures reveal that after decades of steady growth, a little more than half the American population is now based in the 'burbs. It seems a classic case of elite opinions (cars and suburbs are awful) diverging from mass preferences (people quite enjoy them). For many, the main attractions of suburbia are lower housing costs and greater safety. Yet recent research sheds light on how cars are a crucial part of the equation, making America's suburbs both impressively efficient and equitable.

Start with convenience. It is well-known that American cities are configured for vehicles, a process that began in the 1920s with the Model T. Car-centric urban designs became dominant throughout the country, involving wide roads, ample access to expressways and parking galore. To varying degrees, other countries have copied that model. Yet America has come closest to perfecting it. In a paper released in August, supported by

the World Bank, a group of economists examined road speeds in 152 countries. Unsurprisingly, wealthy countries outpace poor ones. And within the rich world, America is streets ahead: its traffic is about 27% faster than that of other members of the OECD club of mostly rich countries. Of the 20 fastest cities in the world, 19 are in America.

It is not that American roads are better in and of themselves. Rather, speed is a testament to America's love affair with both suburbia and smaller towns that feel suburban. Compared with those in other OECD countries, American cities are 24% less populous, cover 72% more area and have 67% more large roads. All this enables drivers to zip around. New York, the country's densest city, is an outlier, as anyone who has sat in its gridlock knows. But most of American suburbia more closely resembles Wichita, Kansas, and Greensboro, North Carolina, where drivers rarely face jams.

Driving speed shrinks distance. One fashionable concept among urban planners these days is the "15-minute city", the goal of building neighbourhoods that let people get to work, school and recreation within 15 minutes by foot or bike. Many Americans may simply fail to see the need for this innovation, for they already live in 15-minute cities, so long, that is, as they get around by car. Most of the essentials—groceries, school, restaurants, parks, doctors and more—are a quick drive away for suburbanites.

The car's ubiquity has another rarely appreciated benefit. A recent study by Lucas Conwell of Yale University and colleagues examined urban regions in America and Europe. They calculated "accessibility zones", defined as the area from which city centres can be readily reached. Although European cities have better public transport, American cities are on the whole more accessible. Consider the size of accessibility zones 15-30 minutes from city centres. If using public transport, the average is 34 square kilometres in America versus 63 square kilometres in Europe. If using private cars, the

difference is much starker: 1,160 square kilometres in America versus 430 square kilometres in Europe.

Just as it is easier to get into American city centres, so it is easier to get out of them. Over time that has sapped vibrancy from their downtown cores as people flee offices at the end of the day for far-flung homes. However, there is a more positive way of looking at this phenomenon: it is precisely such accessibility that has put larger homes and quieter streets within reach for a remarkably wide cross-section of the country. In his analysis of the census from 2020, William Frey of the Brookings Institution, a think-tank, showed that suburbia has become far more diverse over the years. In 1990 roughly 20% of suburbanites were non-white. That rose to 30% in 2000 and 45% in 2020.

Not that cars are a panacea. Owning or renting one costs plenty of money, and is an especially big burden for the working poor. It is therefore common to hear laments in American cities about the sorry state of mass transit. Yet this general perception, though widespread, is not entirely accurate. Even if primarily built for private cars, roads are a shared resource and can be viewed as the “tracks” for buses. In their study Mr Conwell and his colleagues conclude that bus-based transportation in America is surprisingly effective: public-transit options between distant suburbia and city centres are roughly comparable in America and Europe. Although America could do more to improve its bus services within its urban cores, the crucial point is that cities designed for cars can also support mass transit.

| *Honk for motors*

Today some things are in flux. Younger Americans are driving less. More cities are building walkable neighbourhoods. New York may soon introduce congestion charging. It is, in short, possible to imagine an America that is less addicted to cars.

At the same time, though, covid-19 has changed lifestyles in ways that may favour vehicles. People are venturing into offices less often. That has reduced demand and revenues for public transit while making roads less congested and thus more pleasant for drivers. If the rise of remote work enables families to drift ever deeper into suburbia, cars will become more indispensable. How will it all shake out? Given how ingrained cars are in American life, trunk-or-treating is probably here to stay. ■



自由交流

夸一夸美国的汽车情结

对汽车的依赖让美国更公平、更高效

没有什么传统是神圣不可改变的，就连“不给糖就捣蛋”也不例外。在最近的万圣节活动中，许多美国人把它改成了“后备箱讨糖”。孩子们不再在街区里挨家挨户地敲门，而是在停车场的汽车之间穿梭，从装饰着巨型蜘蛛和可怕鬼怪的敞开的后备箱里收集糖果。这再次反映了长期以来一个事实：汽车在美国人的生活中拥有惊人的支配力。美国对汽车的依赖远远超过任何其他大国，平均每个家庭大约拥有两辆车。而这又与许多弊病相关联：肥胖、污染、郊区无序扩张等。

尽管如此，仍有越来越多的美国人选择住在郊区，过着高度依赖汽车的生活。人口普查数据显示，经过几十年的稳步增长，现在有略多于一半的美国人居住在郊区。这似乎是精英观点（汽车和郊区糟透了）与大众偏好（人们很喜欢它们）背道而驰的经典案例。对许多人来说，郊区的主要吸引力是较低的住房成本和更高的安全性。然而，最近的研究揭示了汽车也是一个关键因素，它让美国的郊区实现了非凡的效率与公平。

首先是便利性。众所周知，美国的城市是围绕着汽车设计的，这一进程始于福特T型车风行的1920年代。以汽车为中心的城市设计在全美成为主流，包括宽阔的道路、充足的高速公路出入口以及大量停车场。其他国家在不同程度上效仿了这种模式。但美国几乎做到了极致。今年8月由世界银行资助的一篇论文中，一群经济学家研究了152个国家的道路车速。不出所料，富裕国家的车速高于贫穷国家。而在富裕国家当中，美国遥遥领先：其交通速度比成员大部分为发达国家的经合组织（OECD）的其他成员国快约27%。世界上车速最快的20个城市中有19个在美国。

这并不是因为美国的道路本身更好。速度佐证了美国人有多么热爱郊区和感觉很像郊区的小镇。与其他经合组织国家的城市相比，美国城市的人口少24%，面积大72%，大型道路多67%。所有这些都让驾驶者可以快速穿

梭往来。美国人口密度最高的城市纽约是个例外，领教过其交通拥堵的人都知道这一点。但大多数美国郊区更像堪萨斯州的威奇托（Wichita）和北卡罗来纳州的格林斯博罗（Greensboro），那里的司机很少遇到堵车。

行驶速度缩短了距离。如今在城市规划者中流行“15分钟城市”的概念，也就是建设让人们步行或骑车15分钟内可到达公司、学校和娱乐场所的社区。许多美国人可能根本看不出这种创新的必要性，因为他们已经生活在15分钟城市里了，只要有车一切都不成问题。对于郊区居民来说，大多数生活要素——杂货店、学校、餐馆、公园、医生等等——开车一小会儿就到了。

汽车无处不在，还有一个鲜为人知的好处。耶鲁大学的卢卡斯·康威尔（Lucas Conwell）及其同事最近研究了美国和欧洲的城市区域。他们计算了“可通达区”——可以很方便就到达市中心的区域。尽管欧洲城市拥有更好的公共交通系统，但总体而言，美国城市的通达性更高。如果计算距离市中心15到30分钟路程的可通达区的面积，使用公共交通的话，美国平均为34平方公里，而欧洲为63平方公里。如果使用私家车，差距就大得多：美国为1160平方公里，欧洲为430平方公里。

抵达美国城市中心更容易，同样，要从市中心离开也更容易。人们下班后纷纷逃离办公室，回到远处的家中。长此以往，市中心的活力也随之流失。不过，这种现象也有积极的一面：正是这种可通达性让美国广泛阶层的人们都能住上更大的房子和更安静的街区。智库布鲁金斯学会（Brookings Institution）的威廉·弗雷（William Frey）分析了2020年人口普查数据后发现，郊区在过去这些年里明显变得更加多元化。1990年，大约20%的郊区居民是非白人。2000年这一比例上升到30%，2020年升至45%。

汽车并非万能灵药。养车或租车要花很多钱，对于贫穷的工薪阶层来说更是沉重的负担。因此，在美国城市里经常可以听到人们抱怨糟糕的公共交通。然而，这种大众看法虽然普遍，却并不完全准确。即使道路主要是为私家车而建，它也是一种共享资源，可以视为公交车的“轨道”。康威尔及

其同事在研究中认为，美国基于大巴的公共交通出人意料地有效：在美国和欧洲，远郊区 and 市中心之间可选择的公交路线数量大致相当。虽然美国城市中心区的巴士服务还有改善的空间，但有一点很关键：为汽车设计的城市同样可以支持公共交通。

| 为汽车鸣笛

如今，一些变化正在发生。年轻的美国人开车变少了。更多的城市正在建设适合步行的社区。纽约可能很快就会开征拥堵费。简而言之，可以想象未来的美国可能不再那么沉迷于汽车。

但与此同时，新冠疫情改变了人们的生活方式，又可能有利于汽车的流行。人们去办公室的次数减少了。这减少了公共交通的需求和收入，同时也让道路不那么拥堵，使驾驶体验更加愉快。如果远程工作的兴起使家庭能够日益深入郊区，汽车将变得更加不可或缺。这一切将如何演变？鉴于汽车在美国人生活中根深蒂固的地位，“后备箱讨糖”可能会继续下去。■



Bartleby

How to get the lying out of hiring

A process that rewards exaggeration would benefit from greater realism

HIRING PROCESSES can be thought of as a battle between candour and dishonesty. You might imagine this is a simple fight between truth-seeking firms and self-promoting candidates, and to a certain extent it is. But companies themselves are prone to bend reality out of shape in ways that are self-defeating.

Start with the obvious culprits: job applicants. The point of a CV or a LinkedIn profile is to massage reality into the most appealing shape possible. Everyone beyond a certain level of experience is a transformational leader personally responsible for generating millions in revenue; the world economy would be about 15 times bigger than it actually is if all such claims were true. The average Briton spends four and a half hours a day watching TV and online videos. But the average job candidate uses their spare time only for worthy purposes, like volunteering in soup kitchens or teaching orphans to code.

The cover letter is so open in its insincerity (“When I saw the advertisement for this job, I almost fainted with excitement”) that people are starting not to bother with it. At the interview stage one task facing the firm’s recruiters is to winkle out the truth of what a person actually contributed to a project. Those hoary questions about a candidate’s weaknesses and failures are there for a reason; no one will bring them up unprompted. Cognitive and behavioural tests are useful in part because they are harder for applicants to game.

But a tendency to stretch the truth infects companies as well as applicants. The typical firm will write a job description that invariably describes the

work environment as fast-paced and innovative, and then lays out a set of improbable requirements for the “ideal candidate”, someone who almost by definition does not exist. Sometimes—as when ads demand more years of experience in a programming language than that language has existed for—these requirements include an ability to go back and alter the course of history.

Industrialised hiring processes can often reward mindless exaggeration. Services that scan your résumé when you are making an application mark you down if your CV does not match the keywords that appear in the original job advertisement. The message is clear: to get through to the next stage, you have to contort yourself to meet corporate expectations.

Substance can matter less to recruiters than form. One software engineer says she got a 90%-plus response rate with a spoof CV showing apparent spells at Microsoft and Instagram but also boasting, among other things, that she had increased team-bonding by organising the company potato-sack race and “spread Herpes STD to 60% of intern team”. References are so prone to inaccuracy that many firms have a policy of not giving them, fearing legal action from defamed candidates or deceived employers.

Too few firms offer an accurate account of what a position actually involves. Tracey Franklin, the chief HR officer for Moderna, a fast-growing drugmaker—and an interviewee in this week’s episode of Boss Class, our new podcast—is a fan of “realistic job previews” (RJPs). These are meant to give prospective recruits a genuine sense of the negatives and positives of the job, as well as a clear idea of the company’s corporate culture. One effective tactic is to lay out, in text or video, what a typical day in the role would look like.

Such honesty can be its own reward. Research has long suggested that RJPs lead to lower turnover and higher employee satisfaction. A paper in 2011 by

David Earnest of Towson University and his co-authors concluded that favourable perceptions of the organisation's honesty are the best explanation for why.

The incentives on both sides of the hiring process lean naturally towards glossing reality. If candidates were to give genuinely truthful answers ("I have a habit of making basic but calamitous errors"), many would rule themselves out of jobs. And if firms were to give a warts-and-all description of themselves, many would end up deterring good applicants. But a process designed to uncover the truth about job applicants would run a lot more smoothly if firms were also honest about themselves. ■



巴托比

如何在招聘中消除谎言

来点“写实风”，会让这个奖赏夸大其词的流程受益

招聘过程可以被看作是坦率与欺瞒之间的一场战斗。你可能会认为这不过是寻求真相的公司和自我推销的候选人之间的简单斗争，在某种程度上确实如此。但企业自己也会扭曲现实，而且往往会弄巧成拙。

先来看公认的始作俑者：求职者。简历或领英个人资料的要义就是把现实情况尽可能地美化成最亮眼的样子。只要超过了一定的经验水平，人人都是变革型领导者，负责创造了数百万美元的收入。如果这些自我标榜全都是真的，世界经济应该是实际规模的15倍左右才对。一般的英国人每天要花四个半小时看电视和刷视频。但一般的求职者却会把业余时间都花在有价值的事情上，比如在施粥处做志愿者，或者教孤儿编程。

求职信中的虚情假意是如此直白（“当我看到这份工作的招聘广告时，兴奋得都快晕过去了”），人们已渐渐不再把它当回事。在面试阶段，公司招聘人员面临的一个任务就是套出一个人对某个项目究竟贡献几何。问候选人有什么弱点和失败经验这种老掉牙的问题是有原因的，因为没有人会主动提起这些。认知和行为测试之所以有用，部分原因是申请者更难钻空子。

沾染上这种夸大事实倾向的不单是应聘者，还有企业。公司通常都会一成不变地在职位描述中用“快节奏”和“创新”来描述自己的工作环境，再为“理想候选人”列出一连串难以企及的要求，而这样的人顾名思义基本上就不存在。有时，这些要求还包括穿越时空改变历史进程的能力——有的招聘广告要求应聘者具备的某个语言的编程经验年数比该语言本身存在的年头都长。

在工业化的招聘流程中，盲目的夸张往往会得到回报。当你申请某个职位时，如果你的简历与原本的招聘广告中出现的关键词不匹配，浏览你简历

的服务机构就会给你打低分。由此传达的信息很明确：要想进入下一阶段，就得扭曲自我以满足公司的期望。

在招聘人员那里，形式可能已经大于内容。一名软件工程师说，她恶搞了一份简历，上面显眼地列举了在微软和Instagram的工作经历，但同时也罗列了自己的其他许多功绩，包括组织了公司的袋鼠跳比赛，并“把生殖器疱疹传染给了60%的实习生”，从而增强了团队凝聚力。她收到回复的比率达到90%以上。推荐信很容易失真和不准确，因而许多公司都有不提供推荐信的政策，担心自觉受到诋毁的候选人或被蒙骗的雇主会采取法律行动。

准确描述某个职位实际上涉及什么工作内容的公司少之又少。特雷西·富兰克林（Tracey Franklin）是快速发展的制药公司莫德纳（Moderna）的首席人力资源官，也是我刊的新播客《老板课堂》（Boss Class）本周的受访者。她很推崇“实际工作预演”（RJP），它们意在让未来的新员工真切地感受所申请职位的优缺点，并对公司的企业文化有清晰的认识。一个有效的方法是用文字或视频的形式展示担任这个职位后一个典型的工作日是怎样的。

这种诚实本身就可能是一种回报。早有研究表明，RJP可以降低员工流失率，提高员工满意度。陶森大学（Towson University）的大卫·欧内斯特（David Earnest）及合著者在2011年的一篇论文中得出结论称，对此最好的解释是员工对公司的诚实作风的认同感。

招聘过程中的双方自然都有动机粉饰现实。如果求职者在回答问题时都实话实说（“我惯于犯灾难性的低级错误”），那许多人就会自砸饭碗。同样，如果公司对自己的描述毫无保留，那么许多公司会令优秀的求职者却步。但是，如果公司自己也能坦诚相告，那么这个旨在看见求职者真面目的流程就会顺畅许多。■



Unrolled at last

AI could help unearth a trove of lost classical texts

Computers could let archaeologists read hundreds of burnt scrolls from a Roman library

THE OBJECT known as P.Herc.Paris.3 resembles a dark grey lump of charcoal, about the size and shape of a banana. That explains its nickname: Banana Boy. It is in fact a papyrus scroll, found in the ruins of a villa in the Roman town of Herculaneum, in Campania. Along with hundreds of other scrolls in the villa's library, it was carbonised when scorching gases engulfed the town during the same eruption of Mount Vesuvius, in 79AD, that also buried the nearby town of Pompeii.

Although the scrolls survived, their charring means that unrolling them is almost impossible. Now, nearly 2,000 years later, words from inside Banana Boy have been revealed for the first time, after volunteers competing in a prize challenge used X-rays and artificial intelligence to do the unrolling virtually.

The first word to be found, announced on October 12th, was "porphyras", which means "purple" in ancient Greek (see picture below). It was uncovered by Luke Farritor, a computer-science student at the University of Nebraska-Lincoln, earning him a \$40,000 prize. Mr Farritor built on work by Casey Handmer, a former NASA physicist, whose examination of X-ray images of Banana Boy's charred layers identified a characteristic "crackle pattern" indicating the presence of ink.

| *Scroll up*

The same word was later found by Youssef Nader, a robotics student at the Free University of Berlin. (Dr Handmer and Mr Nader both received \$10,000 prizes.) Mr Nader has since produced an image from the scroll showing

four columns of text, side by side. For classicists, this is heady stuff. The villa in question is thought to have belonged to Lucius Calpurnius Piso, the father-in-law of Julius Caesar. The ability to read its well-stocked library could significantly expand the number of texts that have survived from antiquity. Already there is excited speculation about forgotten plays, new works of philosophy—or even lost Homeric poems.

Efforts to read the scrolls began in the 1750s, when the villa was rediscovered. Attempts to unpick them with knives caused them to disintegrate. Recognising their fragility, Antonio Piaggio, a conservator from the Vatican, built a machine in 1754 to unroll them slowly, using weights on strings. Even then, the unrolled scrolls fell to pieces. And the resulting fragments were almost impossible to read: charcoal-based ink is hard to see against the shiny black of charred papyrus. But the few characters that could be read revealed some scrolls to be philosophical works written in ancient Greek.

A quarter of a millennium later, in 1999, scientists from Brigham Young University illuminated some of those fragments with infrared light. That created a strong contrast between papyrus and ink, making the writing more legible. Multi-spectral imaging in 2008, combining many wavelengths of light, was even better, revealing previously unreadable words. Many fragments turned out to belong to texts written by a Greek philosopher called Philodemus of Gadara. Until then, they had been known only from mentions in other works. (Cicero, though, was a fan of his poetry.)

Around 500 scrolls remain unopened. Given the damage it does, physical unrolling is no longer attempted. Instead the focus has shifted towards finding ways to unwrap them virtually, by using 3D scans of the rolled-up scrolls to produce a series of legible 2D images. The pioneer of this approach is W. Brent Seales, a computer scientist at the University of

Kentucky. In 2009 he arranged for Banana Boy, and another scroll known as Fat Bastard, to be scanned in a computerised tomography (CT) X-ray machine, of the sort usually used for medical scans. This produced detailed images of their internal structures for the first time. But the ink within the scrolls could not be made out.

In 2015 Dr Seales analysed a different carbonised scroll found in 1970 at En-Gedi, near the Dead Sea in Israel. It had been written using a metal-rich ink, which stood out strongly in X-ray images. (The text turned out to be the Book of Leviticus.) This confirmed that, in the right circumstances, digitally unrolling a carbonised scroll and reading the contents could indeed be done.

The next step was to combine the existing approaches into a new one. In 2019 Dr Seales arranged for Banana Boy, Fat Bastard and four fragments of other scrolls to be scanned at high resolution using the Diamond Light Source in Britain, a particle accelerator that can produce much more powerful X-ray light than a CT scanner. He then paired infrared images of the fragments, in which the ink can be readily seen, with X-ray scans of the same fragments in which it cannot.

Earlier this year Stephen Parsons, a graduate student working with Dr Seales, fed the two sets of images into a machine-learning model, which used the infrared scans to teach itself how to recognise the faint signs of ink in the X-ray ones. By applying the resulting model to X-ray images from the rolled-up scrolls it would be possible to reveal their contents. At this point, deciphering the scrolls had, in theory, been reduced to a very complex software problem. But that software still needed to be improved and scaled up.

Enter Nat Friedman, a technology executive and investor with an interest in ancient Rome. Mr Friedman offered to help fund Dr Seales's work. Over a

whisky, they decided that the best way to accelerate things was to organise a contest, with prizes handed out for completing various tasks. Mr Friedman and Daniel Gross, another entrepreneur, launched the Vesuvius Challenge in March, with a prize fund of \$250,000. Other tech-industry donors soon increased that to over \$1m. To get the ball rolling, an initial challenge was posted on Kaggle, a website that hosts data-science contests, to improve the ink-detection model developed by Dr Parsons.

More than 1,200 teams entered. Many competed in subsequent challenges to improve the tools for ink detection and “segmentation”, as the process of transforming the 3D scans into 2D images of the scroll’s surface is known. Scrutinising segmented images from Banana Boy, Dr Handmer realised that the crackle pattern signified the presence of ink. Mr Farritor used this finding to fine-tune a machine-learning model to find more crackles, then used those crackles to further optimise his model, until eventually it revealed legible words.

Mr Nader used a different approach, starting with “unsupervised pretraining” on the segmented images, asking a machine-learning system to find whatever patterns it could, with no external hints. He tweaked the resulting model using the winning entries from the Kaggle ink-detection challenge. After seeing Mr Farritor’s early results, he applied this model to the same segment of Banana Boy, and found what appeared to be some letters. He then iterated, repeatedly refining his model using the found letters. Slowly but surely its ability to find more letters increased. All the results were assessed by papyrologists before the prizes were awarded.

| *Multae manus onus levius reddunt*

No less important than the technology is the way the effort has been organised. It is, in effect, the application of the open-source software-development method, Mr Friedman’s area of expertise, to an archaeological puzzle. “It’s a unique collaboration between tech founders and academics

to bring the past into the present using the tools of the future,” he says. Dr Seales reckons the spur of competition means the equivalent of ten years’ worth of research has been done in the past three months.

An active community of volunteers is now applying the new tools to the two scanned scrolls. Mr Friedman thinks there is a 75% chance that someone will claim the grand prize of \$700,000, for identifying four separate passages of at least 140 characters, by the end of the year. “It’s a race now,” he says. “We will be reading entire books next year.”

Being able to read Banana Boy would indeed just be the beginning. Only a small fraction of Greek and Roman literature has survived into modern times. But if the hundreds of other scrolls recovered from the villa could be scanned and read using the same tools, it would dramatically expand the number of texts from antiquity. Dr Seales says he hopes the Herculaneum scrolls will contain “a completely new, previously unknown text”. Mr Friedman is hoping for one of the lost Homeric epic poems in particular.

Even more important, all this might in turn revive interest in excavating the villa more fully, says Mr Friedman. The existing scrolls were recovered from a single corner of what scholars believe is a much larger library spread across several floors. If so, it might contain thousands of scrolls in Greek and Latin.

One reason that classical texts are so scarce is that the papyrus upon which they were written does not survive well in Europe’s temperate, rainy climate. So it is a delicious irony, notes Dr Seales, that the carbonisation of the scrolls, which makes them so difficult to read, is also what preserved them for posterity—and that fragments of scrolls that disintegrated when they were unrolled physically would eventually provide the key to unrolling the rest of them virtually. ■



终于展开

人工智能可以帮助大批失传的古希腊罗马文本重见天日

计算机让考古学家可以阅读一座古罗马图书馆中数百个被烧焦的卷轴【深度】

这个被称为P.Herc.Paris.3的物体看上去像一块深灰色的木炭。因其大小、形状都和香蕉差不多，而得到了“香蕉小子”（Banana Boy）的绰号。它实际上是一个莎草纸卷轴，出土于意大利坎帕尼亚大区（Campania）的古罗马城镇赫库兰尼姆（Herculaneum）的一座庄园遗址中。公元79年，维苏威火山（Mount Vesuvius）喷发，灼热的气体吞噬了整个城镇，“香蕉小子”和庄园图书馆里的其他千百个卷轴全部被烧成焦炭。也正是这一场火山喷发埋葬了附近的庞贝城。

虽然这些卷轴得以幸存，但因为被烧成了焦炭，所以几乎不可能打开了。如今，在近2000年之后的一场有奖挑战赛中，参赛者使用X射线和人工智能（AI）虚拟展开了“香蕉小子”，从而首次揭示了它内部的文字。

10月12日公布的首个被发现的单词是“porphyras”，在古希腊语中意为“紫色”（见下图）。它的发现者是内布拉斯加大学林肯分校（University of Nebraska-Lincoln）计算机科学专业的学生卢克·法里托（Luke Farritor），他也因此获得了四万美元的奖金。法里托的发现建立在前美国国家航空航天局（NASA）物理学家凯西·汉德默（Casey Handmer）的研究成果之上。汉德默查看“香蕉小子”炭化层的X射线图像后发现了一种特有的“裂纹”，表明有墨迹的存在。

徐徐展开

柏林自由大学（Free University of Berlin）机器人技术专业的学生尤瑟夫·纳德（Youssef Nader）之后也发现了同样的单词。（汉德默和纳德各获得一万美元的奖金。）此后，纳德得出的卷轴的一页图像展示了并排的四列文字。对于研究古希腊罗马文明的学者来说，这是件激动人心的事情。上述庄园的主人被认为是凯撒大帝的岳父卢修斯·卡尔普尔尼乌斯·皮索（Lucius Calpurnius Piso）。能够读出庄园图书馆的丰富藏书大大扩展了

从古希腊罗马时期存留下来的文本数量。人们已经开始兴奋地猜测这其中是否会有一些被遗忘的戏剧和全新的哲学著作，甚至失传的荷马史诗。

从18世纪50年代这座庄园重见天日开始，人们为打开这些卷轴费尽心思。先是尝试用刀子割开，结果把它们弄碎了。意识到它们易碎之后，罗马教廷的文物修复员安东尼奥·皮亚焦（Antonio Piaggio）在1754年造了一台机器，利用绳子上的重物缓慢剥开它们。但展开的部分还是碎了。这些碎片几乎无法阅读：碳基的墨迹在烧焦的莎草纸的亮黑色中难以辨认。但从寥寥几个依稀可辨的文字中可以看出，一些卷轴是用古希腊文书写的哲学著作。

250年后的1999年，杨百翰大学（Brigham Young University）的科学家用红外线照亮其中一些碎片，在莎草纸和墨水之间形成强烈的明暗对比，使得字迹更易辨识。2008年使用的将多个波长的光结合在一起的多光谱成像技术效果更好，让从前无法辨认的文字显现出来。结果发现，许多碎片上书写的是希腊哲学家菲劳德乌斯（Philodemus of Gadara）的著作。而在此之前，这些著作之所以为人们所知，只是因为在其他作品中被提及过。（不过西塞罗[Cicero]很喜欢菲劳德乌斯的诗。）

还有约500个卷轴尚未打开。鉴于用物理方式展开会造成损毁，人们不再尝试这种方法，而是专注于想办法虚拟打开它们——对卷起来的卷轴进行3D扫描，生成一系列可辨识的2D图像。最先采用这种方法的是肯塔基大学（University of Kentucky）的计算机科学家布伦特·西尔斯（W. Brent Seales）。2009年，他使用一种常用于医学扫描的计算机断层成像

（CT）X光机扫描“香蕉小子”和另一个被称为“胖家伙”（Fat Bastard）的卷轴。卷轴内部结构的详细图像首次被展现出来，但里面的墨迹无法分辨。

2015年，西尔斯分析了1970年在以色列死海附近的恩盖迪（En-Gedi）发现的另一个碳化卷轴。该卷轴在书写时用了一种富含金属的墨水，在X射线图像中非常显眼。（这段文本被发现是圣经旧约的《利未记》。）这表明，在适当的情况下，用数字化方式展开碳化卷轴并读取其内容确实是可行的。

下一步是把现有的方法整合成一种新方法。2019年，西尔斯用英国的“钻石光源”（Diamond Light Source）对“香蕉小子”、“胖家伙”和其他卷轴的四块碎片进行了高分辨率扫描。“钻石光源”是一种粒子加速器，可以产生比CT扫描机强得多的X射线。然后，他将这些碎片的红外图像（其中的墨迹很容易看到）与其X射线扫描图像（墨迹难以分辨）配对。

今年早些时候，与西尔斯共事的研究生斯蒂芬·帕森斯（Stephen Parsons）将这两组图像投喂给一个机器学习模型，该模型使用红外扫描图像来自学如何识别X射线图像中模糊的墨迹。将由此得到的模型应用于未展开卷轴的X射线图像，就有可能揭示卷轴上的内容。这时候，从理论上说，破译卷轴已经简化成了一个非常复杂的软件问题。但这种软件仍需要改进和扩展。

此时纳特·弗里德曼（Nat Friedman）登场了，这位科技公司高管兼投资者对古罗马历史文化很感兴趣。弗里德曼表示愿意资助西尔斯的研究。他们在一起喝威士忌时认定，加快进度的最好办法便是组织一场竞赛，参赛者完成不同的任务会得到相应的奖励。今年3月，弗里德曼和另一位企业家丹尼尔·格罗斯（Daniel Gross）发起了维苏威火山挑战赛（Vesuvius Challenge），总奖金为25万美元。科技业的其他捐款者很快把奖金加码到超过100万美元。活动伊始，第一轮初始挑战赛发布在举办数据科学竞赛的网站Kaggle上，目标是改进帕森斯开发的墨迹检测模型。

1200多支队伍参加了竞赛。许多队伍参加了随后的多轮挑战赛，以改进墨迹检测工具以及将卷轴表面的3D扫描图像转换为2D图像（此过程被称为“分段”）的工具。仔细查看“香蕉小子”的分段图像后，汉德默意识到裂纹模式表明了墨迹的存在。法里托利用这一发现微调了机器学习模型以发现更多裂纹，然后利用这些裂纹进一步优化自己的模型，直到模型最终揭示出可辨识的单词。

纳德则另辟蹊径，他从对分段图像的“无监督预训练”开始，要求一个机器学习系统在没有外部提示的情况下，尽可能多地从中找出任何可能存在的模式。然后他使用Kaggle上的墨迹检测挑战赛的获奖作品微调自己的模

型。在看到法里托早些时候的研究结果后，他在“香蕉小子”的同一分段上使用了这个模型，并发现了一些看似字母的东西。然后不断重复这一做法，用已发现的字母反复改进自己的模型。模型自行寻找更多字母的能力得到了缓慢但稳步的提高。所有研究结果在颁奖之前都要经过莎草纸古文稿专家的评估。

｜ 众人拾柴火焰高

与技术同等重要的是这项工作的组织方式。可以这么说，这是把开源软件的开发方法（这是弗里德曼的专业领域）应用到了解决考古难题上。弗里德曼表示：“这是科技公司创始人和学界之间一次非同寻常的合作，使用未来的工具，把过去带到现在。”西尔斯认为，在竞争的激励下，人们过去三个月里完成了一般需要十年的研究工作。

一批踊跃的参赛者正在使用这些新工具来分析这两个扫描过的卷轴。维苏威火山挑战赛的大奖奖金为70万美元，要求参赛者能够辨认出独立的四段内容，每段至少包含140个字母。弗里德曼认为，今年年底前有75%的概率会有人斩获这一大奖。“这是一场竞速赛了，”他表示，“明年我们将能看上整本整本的书了。”

能够阅读“香蕉小子”着实只是个开始。古希腊罗马文学只有一小部分流传到了现代。不过，如果能用同样的工具扫描庄园中发现的其他几百个卷轴来阅读它们，将大大增加古希腊罗马时期的文本数量。西尔斯表示，他希望这些赫库兰尼姆卷轴中会包含“某个前所未有的全新文本”。弗里德曼尤其希望看到一首失传的荷马史诗。

更重要的是，所有这些可能继而重燃人们更完整地发掘这座庄园的兴趣，弗里德曼表示。现存的卷轴都是在图书馆的一个角落中被发现的，而学者们认为图书馆本身要大得多，有好几层楼。如果是这样的话，这个图书馆里可能藏有成千上万个古希腊文和拉丁文的卷轴。

现今古希腊罗马文本如此罕见的一个原因是，欧洲温和多雨的气候很难让它们书写其上的莎草纸完好保存下来。西尔斯指出，这便有了美妙的戏剧

性结果：碳化一方面让这些卷轴变得极难阅读，一方面却也为后世保存了它们；同时，当初用物理方式打开它们而得到的碎片，最终又为以虚拟方式打开其余的那些提供了钥匙。■



When the map becomes the territory

Lab-grown models of embryos increasingly resemble the real thing

Embryoids promise many benefits, but pose tricky ethical questions

THE TRADITIONAL way to make an embryo is to combine a sperm cell with an egg, often after dinner and a bottle of wine. But a new way may be around the corner. In recent years scientists have discovered that they can persuade stem cells—those with the ability to transform into many other sorts of cells—to form structures that look and behave very much like embryos.

“Embryoids”, as such creations are called, can help with the study of embryology and pregnancy, and how they can go wrong. Some of the facsimiles look strikingly real. In 2022 two teams, one led by Magdalena Zernicka-Goetz, who works at the California Institute of Technology and the University of Cambridge, and another by Jacob Hanna at the Weizmann Institute of Science, in Israel, published papers describing mouse embryoids with rudimentary guts, brains and beating hearts. In June Dr Zernicka-Goetz published a paper describing a human embryoid designed to mimic the earliest stages of development, shortly after a real embryo would have implanted into its mother’s womb.

That second study was controversial, with some other scientists dubious that it represented as much of an advance as its authors claimed. But the state of the art is moving fast enough that some think embryoids may soon become hard to distinguish from the embryos they are meant to model. In many ways, that would be a good thing: the more accurate a model, the more useful it is. Human embryoids could shed light on developmental heart defects or diseases like spina bifida, and boost the success rates of in-vitro fertilisation (IVF).

But research on embryos—which, after all, have the potential to develop into human beings—is strictly regulated. Many countries ban the use in research of human embryos that are more than 14 days old, and researchers in countries without such laws usually adhere to the same standard voluntarily. The more similar embryoids become to the real thing, the harder it becomes to avoid the question of whether they should be subject to similar rules.

A natural embryo begins with a single fertilised egg. To make an embryoid scientists grow a mix of different stem cells derived from embryos or, sometimes, from adult organisms. They may tweak the molecular signals between the cells and which of their genes are active. Within days, embryo-like structures appear.

Embryoids are desirable partly because real embryos are scarce: the main source is leftovers from IVF treatment. They are also hard to grow. That makes it tricky to run large-scale experiments. Embryoids offer a less ethically fraught alternative.

| *A rose by any other name*

One example of their benefits is the study of implantation, the process by which an embryo implants into the womb. It is here that most pregnancy losses happen. But the reasons were almost impossible to study in detail before the advent of embryoids. “You cannot go through the body of the mother to see the development of this embryo,” says Dr Zernicka-Goetz.

Embryoids—specifically, a type called a blastoid—offer the next-best thing. First created by Nicolas Rivron at the Austrian Academy of Sciences, they resemble an embryo at the blastocyst stage, just before implantation. In humans implantation happens around day seven and in mice, around day four. Each blastoid consists of a hollow ball of cells that would, in a real embryo, go on to become part of the placenta. Attached to the inner wall is

a smaller ball that would, in other circumstances, develop into the fetus. By rolling blastoids across uterine tissue in a dish, Dr Rivron's team found that they only stick when they are oriented so that this inner mass is closest to the womb tissue.

That implies the inner mass sends signals to the outer cells, instructing them to stick to the womb. Dr Rivron thinks he has identified those signals, and plans to publish his results soon. He hopes to help explain why so many embryos fail to attach. That might, in turn, improve the success rates of IVF, which in America is only about 35%. Blastoids have made such discoveries much easier, says Dr Rivron. He has started a company, Dawn Bio, which uses blastoids to screen drug candidates that might be useful in fertility treatment.

Other embryoids try to capture what embryos look like after implantation. The most advanced are made with mouse stem cells, such as the brain-and-heart models described above, which represent day eight in mouse development. Dr Hanna holds the record for human embryoids. In a paper published in September he and his colleagues described embryoids that mimic the development of human embryos between days eight and 14. He is keen to try to push things further, perhaps to day 35. At that point, his embryoids, like the mouse ones, would be starting to develop organs.

Dr Hanna believes that could make them a source of medically useful cells. They might, for instance, provide stem cells that could in turn be turned into bone marrow for transplant in leukaemia patients. If the stem cells used to create the embryoid were taken from the patient, then the marrow would be genetically identical to the patient's own. That would remove the risk of immune rejection, and the need for immune-suppressing drugs.

Convincing the embryoids to develop still further might open up truly mind-bending possibilities. From day 50 or so, the embryoids would have

gonads. That might mean, one day, that women struggling to get pregnant could be given a brand new, freshly baked set of their own eggs. (Dr Hanna's company, Renewal Bio, is pursuing such goals.)

No one knows when—or even if—these goals might be achieved. Naomi Moris, a developmental biologist at the Francis Crick Institute in London, agrees that Dr Hanna's 14-day-old embryoids look the part. But she does not think they yet qualify as full replacements. For one thing, Dr Hanna's embryoids never go through a blastocyst-like stage. That missing link prevents them from attaching to a natural womb, and might impose limits on how long they can carry on developing in a dish.

Still, the fact that such goals are being pursued at all has convinced some scientists that the time to think about regulation is now. Dr Moris has proposed a new legal definition for embryos that would be based on their potential to develop into a fetus, a developmental stage that begins eight weeks after fertilisation and lasts until birth. In many countries human embryos are legally ill-defined. Dr Moris hopes her proposal would make clear that an embryoid could qualify as an embryo—if it had the same developmental potential.

Working out if they do, though, might be tricky. The only way to know for certain whether an embryoid could develop into a fetus would be to try it and see—though such an experiment might risk violating the law if it were successful. Instead Dr Moris and her colleagues, including Dr Rivron, have suggested a two-part test that would make at least a compelling argument that embryoids had closed the gap.

The first step would be to check just how closely human embryoids track the developmental trajectory of real embryos. The second would be to push animal embryoids as far as possible, ideally to the point of producing live, fertile offspring. Such a process might start with mice before moving on to

pigs or monkeys. If such long-developing embryoids look biochemically similar to the human state-of-the-art, caution would be warranted.

Dr Moris reckons that, within two to five years, someone will have produced animal embryoids that can reach the fetal stage. In April, Chinese researchers transplanted monkey blastoids into surrogate animals, producing pregnancies that lasted for up to 20 days. And there is always the chance that someone goes rogue. In 2018 He Jiankui, a Chinese researcher, announced that he had created gene-edited human babies. He was jailed, and widely condemned. But it is not inconceivable that someone might try to push the boundaries in a similar way with embryoids.

| *Pushing the limits*

Amander Clark, the president of the International Society for Stem Cell Research, highlights another irony that could make regulation difficult. Since human embryos cannot be cultured for longer than 14 days, scientists do not have a detailed picture of how they develop afterwards. That would make it very difficult to tell if embryoids older than 14 days were behaving as they are supposed to. The only comparators are animal embryos and dissections of wombs surgically removed from pregnant women. In other words, the very rule meant to protect embryos means researchers could struggle to tell whether their alternatives were good enough—or so good they should be given legal protection in turn. ■



当模型变成实体

实验室培养的胚胎模型越来越接近真胚胎

拟胚体有望带来诸多益处，但也带来了棘手的伦理问题【深度】

传统生成胚胎的方法是让精子细胞与卵子结合，通常发生在两个人吃完晚餐喝了点酒之后。但一种新的方式可能即将到来。近年来，科学家发现，他们可以诱使干细胞（那些能够转化为许多其他类型细胞的细胞）形成外观和机能都非常类似胚胎的结构。

这种被称为“拟胚体”的结构有助于胚胎学和妊娠研究，以及探究相关病症的原因。有些拟胚体看起来异常接近真胚胎。2022年，由在加州理工学院和剑桥大学任职的马格达莱纳·泽妮可-格兹（Magdalena Zernicka-Goetz）领导的研究团队和另一个由以色列的魏茨曼科学研究所

（Weizmann Institute of Science）的雅各布·汉纳（Jacob Hanna）领导的团队分别发表了论文，介绍了具有肠道、大脑和跳动的心脏雏形的小鼠拟胚体。今年6月，泽妮可-格兹又发表了一篇论文，描述了一种人类拟胚体，旨在模仿真正的胚胎植入母体子宫后的最初发育阶段。

第二项研究引起了争议，一些科学家怀疑其成果并不像作者所声称的那样，算得上很大的进展。但这方面的最前沿迅速推进，一些人认为拟胚体和真胚胎之间可能很快就会难辨真假。从很多方面来说，这将是一件好事，因为模型越准确，用处就越大。人类拟胚体可以揭示发育性心脏缺陷或脊柱裂等疾病的病因，并提高试管婴儿（IVF）的成功率。

但胚胎研究是受到严格监管的，毕竟胚胎有可能发育成人。许多国家禁止在研究中使用体外培养超过14天的人类胚胎，而在没有此类立法的国家，研究人员通常会自愿遵守同样的标准。拟胚体与胚胎越相似，就越难回避拟胚体研究是否应该遵守类似规则的问题。

一个自然胚胎始于单个受精卵。为了生成拟胚体，科学家会培养不同干细胞的混合物，这些干细胞取自胚胎，或者有时取自成体生物体。他们可能

会调整细胞之间的分子信号，并决定让哪些细胞的基因处于活跃状态。几天之内，胚胎样结构就出现了。

研究拟胚体之所以可取，部分原因是真正的胚胎非常稀缺——主要来源是IVF手术剩余的胚胎。这些真胚胎也很难培养发育，因此很难开展大规模实验。拟胚体提供了一种道德风险较低的替代选择。

| 不是胚胎胜似胚胎

体现拟胚体好处的一个例子是着床研究，即研究胚胎植入子宫的过程。大多数流产都是在这个过程中发生的。但在拟胚体出现之前，几乎不可能详细研究流产的原因。“我们无法通过母亲的身体来观察胚胎的发育过程。”泽尼可-格兹说。

拟胚体——确切来说是一种称为类囊胚的拟胚体——为研究人员提供了次优选择。它们最先由奥地利科学院的尼古拉斯·里夫龙（Nicolas Rivron）创造出来，类似于尚未着床、还处于囊胚期的胚胎。人类胚胎的着床发生在受精后的第七天左右，小鼠是在第四天左右。每个类囊胚都有一个空心细胞球，在真正的胚胎中，空心细胞球会成为胎盘的一部分。附着在细胞球内壁上的一个更小的细胞团在正常情况下会发育成胎儿。里夫龙的团队让类囊胚在培养皿中的子宫组织上滚动，由此发现只有在经过诱导，让其内细胞团最接近子宫组织时，类囊胚才能着床。

这意味着内细胞团会向外部细胞发送信号，指示它们粘附在子宫上。里夫龙认为他已经识别出了这些信号，并计划很快公布研究结果。他希望这将有助解释为何很多胚胎无法着床。这进而又可能会提高IVF的成功率，在美国，IVF的成功率仅为35%左右。里夫龙说，类囊胚大大方便了研究人员获得此类新发现。他创办了一家名为Dawn Bio的公司，利用类囊胚来筛选可能治疗不孕不育的候选药物。

研究人员尝试利用其他拟胚体来了解胚胎着床后的状态。最先进的拟胚体是用小鼠干细胞培养成的（例如前文提到的具有大脑和心脏的拟胚体），再现了小鼠胚胎发育到第八天的情况。汉纳博士持有人类拟胚体发育的最

高记录。在9月发表的一篇论文中，他和同事描述了拟胚体模拟人类胚胎在第8天至第14天之间的发育状况。他还在积极地向前推进，也许最终能来到第35天。那时，他的人类拟胚体将和老鼠的拟胚体一样，开始发育出器官。

汉纳相信这可能让拟胚体成为有医疗价值的细胞的来源。例如它们也许可以提供干细胞，干细胞又能转化为可以给白血病患者移植的骨髓。如果用于生成拟胚体的干细胞取自患者，那么最后得到的骨髓将与患者本人的骨髓有相同的基因。这将消除免疫排斥的风险，患者也就无需服用免疫抑制药物。

如果能让拟胚体进一步发育，可能会释放出真正令人震撼的可能性。从第50天左右开始，拟胚体就会长出性腺。这可能意味着，有朝一日，那些难以怀孕的女性可以得到新鲜培养出来的自己的全新卵子。（汉纳的公司Renewal Bio正在朝着这类目标努力。）

没有人知道这些目标何时能实现，甚至能否实现。伦敦的弗朗西斯·克里克研究所（Francis Crick Institute）的发育生物学家内奥米·莫里斯（Naomi Moris）也认为汉纳的第14天的拟胚体看起来还挺像回事。但她认为这些拟胚体不能完全替代人类胚胎。一方面，汉纳的拟胚体从未经历过像囊胚那样的阶段。缺失这一环节让它们无法附着在真正的子宫里，并可能限制它们可以在培养皿中继续发育的时间。

尽管如此，既然实验室已经在追求这些目标了，一些科学家认为现在就应该开始考虑监管问题。莫里斯提议赋予胚胎新的法律定义，其依据将是胚胎是否有可能发育成胎儿，胎儿阶段从受精后八周开始一直持续到出生。在许多国家，人类胚胎的法律定义并不明确。莫里斯希望她的提议能够明确，如果拟胚体也有可能发育成胎儿，就应该视为胚胎。

不过，要确定拟胚体是否能发育成胎儿可能会很棘手。唯一的方法就是试试看，不过一旦成功，这样的实验就可能违法。莫里斯和包括里夫龙在内的同事则建议进行一个两步走的试验，以求至少可以提出令人信服的论

据，证明拟胚体已经接近于胚胎。

第一步是看看人类拟胚体的发育轨迹有多接近真实胚胎。第二步是尽可能长时间地培养动物拟胚体，最好能达到生成有生育能力的活体后代的阶段。这样的研究可能会从小鼠开始，然后再转到猪或猴子上。如果这种长期培养的拟胚体在生化方面看起来与人类最先进的胚胎相似，那么就应当谨慎对待。

莫里斯估计，在两到五年之内，就会有人创造出可以进入胎儿阶段的动物拟胚体。今年4月，中国的研究人员将猴子类囊胚移植到母猴体内，产生了20天之久的妊娠期。而且有人走上歪路的可能性总是存在的。2018年，中国的研究人员贺建奎宣布他已经创造出基因编辑的人类婴儿。他因此入狱，并受到广泛谴责。但并不难想象，有人可能会在拟胚体上做出类似的越界行为。

| 突破极限

国际干细胞研究学会（International Society for Stem Cell Research）主席阿曼德·克拉克（Amander Clark）强调了另一个可能让监管变得困难的尴尬局面。由于在体外培养人类胚胎不能超过14天，科学家无法充分了解胚胎之后的发育过程。这就使得他们极难判断14天以上的拟胚体是否在按照“应有”的路线发育。唯一的参照物是动物胚胎和通过手术从孕妇身上取出的子宫的解剖结构。换句话说，这条旨在保护胚胎的规定导致研究人员可能很难判断其替代物是否足够好，或者好到需要给予法律保护。■



Schumpeter

Chinese apps are a mixed blessing for American big tech

How long will the advertising blitzes of Shein and Temu last?

DURING THE past year Shein and Temu, two ultra-fast-fashion upstarts famous both for \$5 frocks and for playing down their Chinese heritage, have waged an internecine legal battle in America. Singapore-based Shein, the better-known of the two, threw down the frilly gauntlet, accusing Temu, which has invaded its territory in America, of stealing its trademarks and using social-media influencers to disparage it. Temu, which is based in Boston but owned by PDD, a Chinese e-commerce giant, struck back. It accused Shein of monopolistic practices like using its market power to force a network of 8,000-plus suppliers in China to refuse to do business with Temu. Then, on October 27th, Reuters reported that the firms had suspended hostilities.

To observers in the West these goings-on might once have seemed like an entertaining sideshow. But they illustrate that the cut-throat drama of Chinese e-commerce has now arrived in America. The fortunes of Shein and Temu are intricately bound up with those of some of America's biggest technology firms, such as Meta, with its social-media empire, Alphabet, owner of Google, and Amazon, America's e-commerce behemoth—not to mention physical retailers like Walmart and the dollar stores ubiquitous across American strip malls. No one likes to say this out loud, but for all the talk of Sino-American decoupling, China-linked e-commerce platforms are muscling into American business with the same shock-and-awe tactics that TikTok, a video app, used to besiege social media. For digital advertisers it is a mixed blessing. For discount retailers it is a curse. For everyone it may change the warp and weft of cross-border commerce.

Take advertising for starters. In its third-quarter results announced in late

October, Meta revealed that advertisers from China, including e-commerce and gaming firms, had an “outsized” impact on revenue growth. Meta did not name the firms or quantify their impact, but supersleuths went to work. One was Brian Wieser, a former adman turned analyst, who five years ago first drew attention to the importance of Chinese advertisers on Facebook after spotting differences in company data between the geographic location of those who sell ads on its platforms and those who see them. Only this year did Meta start acknowledging China’s importance, vindicating his work. Using similar location data, MoffettNathanson, a research firm, estimates that Shein and Temu provided nearly a third of Meta’s revenue growth in the nine months to September, or almost \$3bn (a figure well short of Mr Wieser’s estimates). Alphabet, too, is reaping the bonanza. Tinuiti, a marketing firm, says that in the third quarter Temu was as big a competitor in auctions for ads on Google Shopping as Walmart. A year ago the fledgling firm was nowhere.

Then there is e-commerce. Amazon’s platform has long hosted sellers of cheap goods from China. They seldom advertise their provenance. Nonetheless, Juozas Kaziukenas, founder of Marketplace Pulse, an e-commerce research firm, has combed through physical addresses to estimate that many merchants selling on Amazon are based in China. As Shein and Temu surge in popularity, some of those vendors may switch to their platforms. For now, Mr Kaziukenas does not expect the cut-price duo to materially challenge Amazon’s business, which is much bigger, has a broader range of goods for sale and vastly outpaces them on speed of delivery. That said, if e-commerce in China is any guide, the upstarts will not rest until they have taken market share from American competitors, undaunted by their rivals’ heft. TikTok, too, is becoming a force to be reckoned with in online shopping, using live jamborees to attract shoppers, a common practice in China. MoffettNathanson calls the triple-barrelled onslaught the “biggest disruptive threat” to e-commerce in years.

If the Asian trio loom so large, why are America's tech giants so hush-hush about them? For those enjoying the ad windfall, one reason may be questions about the longevity of Shein's and Temu's marketing sprees. In mass-market retail, with wafer-thin margins, pouring billions of dollars into digital ads is a road to ruin if it goes on too long. Meta and Alphabet may not want to draw attention to the potential volatility of the revenue streams.

Political headwinds in America may be mounting, too. Sinosceptics in Congress, in a similar tizzy about Shein and Temu as they are about TikTok, accuse the fast-fashion duo of exploiting an exception in American law that allows packages under \$800 in value to enter the country duty-free and with scant inspection. It reckons the two firms are responsible for 30% of packages entering America under this rule. Closing the loophole could significantly cut the discounts the two platforms offer in America. Moreover, their algorithms draw on oceans of data about shoppers. That opens them up to the same attacks as TikTok.

One risk that the retail firms are apparently spared is a crackdown in China. With headquarters outside the country, they are less likely to suffer the fates of successful Chinese tech firms that have fallen foul of President Xi Jinping in recent years. Sky Canaves of Insider Intelligence, a data-gatherer, says their success may in fact be helping their Chinese suppliers offset the economic slowdown at home. She thinks that will boost their standing with the government.

| *The cat is out of the bag*

It is not clear why Shein and Temu settled their legal grievances, but it will surely be a relief to the powers that be in Beijing. After all, a common front is better for the country's image abroad than a catfight on the digital catwalk. Whether the truce means they will spend less to out-market each other remains to be seen. But American tech giants are in a new world

order. They are still largely shut out of China. China, by proxy, is all over their home turf. The new competition no doubt frustrates big tech. To its customers, it is a neatly wrapped gift. ■



熊彼特

对美国科技巨头来说，中国应用是把双刃剑

Shein和Temu的广告闪电战会持续多久？

在过去的一年里，两家以五美元连衣裙和淡化自己的中国出身闻名的“超快时尚”新贵Shein和Temu在美国掀起了一场法律“内讧”。总部设在新加坡的Shein在这两家公司中更为出名，它率先发难，指责抢夺它美国地盘的Temu盗用它的商标以及利用网红来抹黑它。总部位于波士顿、但隶属于中国电商巨头拼多多的Temu发起反击，指斥Shein垄断，比如利用市场支配力迫使中国8000多家供应商拒与Temu做生意。随后，10月27日，路透社报道称两家公司已经暂停敌对行动。

要放在以前，这难看的场面在西方观察家的眼里可能不过是一些娱乐花絮。但它们表明，中国的电商恶战现在已经打到了美国。Shein和Temu的命运与美国一些最大的科技公司的命运紧密交织，比如拥有社交媒体帝国的Meta、拥有谷歌的Alphabet，以及美国电商巨头亚马逊，更不用说像沃尔玛这样的实体零售商和遍布美国商业街的一元店了。没有人愿意大声说出这一点，然而尽管大家都在谈论中美脱钩，事实上中国背景的电子商务平台正在强势挤入美国商界，它们所用的“震慑战术”与视频应用TikTok用来围攻社交媒体的打法如出一辙。对于数字广告主来说，这喜忧参半。对于折扣零售商来说，这是一大祸根。对所有人而言，这可能会改变跨境贸易的方方面面。

先来看广告。Meta在10月下旬公布的第三季度业绩中透露，来自中国的广告主（包括电子商务和游戏公司）对其收入增长产生了“特别大”的影响。Meta没有列出这些公司的名字，也没有量化它们的影响，但超级侦探们也没闲着。其中一位是布赖恩·维泽（Brian Wieser），他曾是一名广告人，后来转行做了分析师。五年前，他从公司数据中发现，在Facebook平台上卖广告的人和看广告的人的地理位置存在差异，这促使人们第一次注意到中国广告主在Facebook上的重大份额。直到今年，Meta才开始承认中国的重要性，证实了他的发现。研究公司MoffettNathanson利用类似的位

置数据估计，在截至9月的九个月里，Shein和Temu贡献了Meta近三分之一的收入增长，也就是将近30亿美元（这一数字远低于维泽的估计）。Alphabet也在发类似的横财。市场营销公司Tinuiti表示，第三季度在Google Shopping的广告拍卖中，Temu和沃尔玛是旗鼓相当的竞争者。一年前这家羽翼未丰的公司还榜上无名。

再来看电子商务。亚马逊的平台上一直都有来自中国的廉价商品卖家。他们很少宣传自己的来路。不过，电子商务研究公司Marketplace Pulse的创始人尤扎斯·卡兹尤科纳斯（Juozas Kaziukenas）梳理了实际地址，推测出在亚马逊上销售商品的许多商家都在中国。随着Shein和Temu的迅速流行，其中一些商家可能会转向这两个平台。目前，卡兹尤科纳斯并不认为这两家主打折扣营销的公司会对亚马逊的业务构成实质性挑战，因为亚马逊的业务规模要大得多，销售的商品类别更多，交货速度也快得多。话虽如此，如果中国的电子商务发展有什么借鉴意义的话，那就是这些新贵们不会被对手的实力吓倒，它们会不懈努力，直到从美国竞争对手那里夺取市场份额。TikTok也正在成为网络购物领域不可忽视的力量，它通过直播卖货吸引购物者，这在中国是一种常见的做法。MoffettNathanson称这三管火炮齐发是近年来对电子商务的“最大的颠覆性威胁”。

如果这亚洲三强的影响力如此之大，为什么美国的科技巨头面对它们不动声色？对于那些乐享广告横财的公司来说，原因之一可能是Shein和Temu的营销狂欢能否持续是个问题。在大众零售这个利润微薄的行业里，如果往数字广告狂砸数十亿美元的战略持续过久，就是走上一条自我毁灭之路。Meta和Alphabet可能不想让人们注意到这一收入流存在潜在不稳定性。

美国的政治阻力也可能越来越大。国会中的中国怀疑论者像担忧TikTok那样担心起Shein和Temu来，指责这对快时尚双雄利用了美国法律中的一个例外，即允许价值低于800美元的包裹免税进入美国，而且很少受到检查。据估计，在这一规定下进入美国的包裹中有30%是这两家公司的。堵上这一漏洞可能会大大降低这两家平台在美国能提供的折扣。此外，它们的算法利用了大量关于购物者的数据，这让它们面临与TikTok相同的攻

击。

这些零售公司貌似躲过的一个风险是中国国内的整顿运动。由于总部设在国外，它们不太可能像一些成功的中国科技公司那样，在近年开罪了国家主席习近平而遭打压。数据收集机构Insider Intelligence的斯凯·卡纳维斯（Sky Canaves）认为，它们的成功其实可能是在帮助其中国供应商抵消国内经济放缓的影响。她认为这会提升它们在政府心中的地位。

| 伸出利爪

目前尚不清楚Shein和Temu为什么会握手言和，结束法律纠纷，但这肯定会让北京当局松一口气。毕竟，共同战线比在数字T台上互撕更有利于国家的海外形象。休战是否意味着它们会少费些火力跟对方打营销战，还有待观察。但美国科技巨头正处于一个新的世界秩序中。它们在很大程度上仍被中国拒之门外。而中国则通过代理全面进入它们的主场。新的竞争无疑让科技巨头沮丧，对它们的客户来说却是一份包装精美的礼物。■



The omnistar is born

How artificial intelligence will transform fame

Those complaining the loudest about the new technology stand to benefit the most

COMPUTERS HAVE spent decades disrupting humdrum jobs. Now artificial intelligence (AI) is coming for the most glamorous ones. Hollywood has been at a standstill for half the year, until studios agreed on November 8th to offer striking stars protection from robotic rivals. Living artists were nudged down last week's music charts by a dead Beatle, resurrected by AI. Actors like Scarlett Johansson and authors like John Grisham are suing tech firms over the unauthorised use of their image and words.

Stars may worry that AI is stealing their work and giving less talented performers the skills to snatch their audience. In fact, the famous folk complaining the loudest about the new technology are the ones who stand to benefit the most. Far from diluting star power, AI will make the biggest celebrities bigger than ever, by allowing them to be in all markets, in all formats, at all times. Put your hands together—or insert your earplugs if you prefer—for the rise of the omnistar.

This is not the first time that technology has changed the rules of the fame game. People began to talk of stars in the 18th century, after the spread of reading made it possible to be truly famous within your lifetime. Film and radio initially seemed like a threat to stars, who worried that their live performances would be devalued. In fact, those technologies ushered in the era of the superstar, a term that caught on in the 1920s. A similar panic greeted the invention of television (and led to the last big Hollywood strike, in 1960). But again, the new tech made the famous even more so, bringing them into every living room. By the 1960s people were talking of megastars.

As AI-generated content floods into the entertainment business, the

hardworking folk of Malibu are worrying once more that their fame will be diluted—and again, the outcome is likely to be the opposite. One of the paradoxes of the internet age is that, even as uploads to YouTube, TikTok and the like have created a vast “long tail” of user-made content, the biggest hits by the biggest artists have become even bigger. The number of musicians earning over \$1,000 a year in royalties on Spotify has more than doubled in the past six years, but the number earning over \$10m a year has quintupled. Even as niche content thrives—sea shanties, whistling and all kinds of eccentricities—Taylor Swift is marching through the most lucrative concert tour in history. It is the mid-ranking artists who have suffered.

Similar patterns hold across entertainment. The number of feature films released each year has doubled in the past two decades, but the biggest blockbusters have simultaneously doubled their share of the total box office. A tide of self-published books has not eroded the sales of star writers. In a sea of choice audiences rely more on recommendations, both algorithmic and human, which funnel them towards the most popular content. AI promises even more choice, and thus even higher search costs for audiences, who will continue to gravitate to the handful of stars at the top.

AI will give these megastars the ability to be truly omnipresent for their fans. AI-powered dubbing is already allowing actors and podcasters to speak to foreign audiences instantly and in their own voice. It will soon be standard for video to be edited so that their lips match the new language, too. In-demand actors may get more work because AI removes the perennial Hollywood problem of crowded schedules, allowing stars to perform alongside each other while not being together at all. Digital Botox will increase actors’ shelf-life and even enable them to perform posthumously. Disney has acquired the rights to the voice of James Earl Jones, 92, so that Darth Vader can scare children for generations to come.

| *Everything, everywhere, all at once*

Stars will also be able to perform for fans in formats that are only beginning to emerge. The ABBA avatars that sell out a London arena seven times a week, and the celebrity-voiced chatbots recently launched by Meta, are just a taste of the ways in which the biggest stars will be able to satisfy—and monetise—their fans.

These opportunities come with strings attached. Artists are right to worry about copyright, which must be protected if AI is not to become a legalised form of piracy. Past technologies were no different: the printing press led to the first copyright laws in the 18th century; royalty payments were rejigged in the 1960s to compensate big-screen actors whose work was shown on TV; the musical free-for-all unleashed by companies like Napster at the turn of the century eventually gave way to deals between streamers and record companies. Content creators have legitimate questions about permission and payment (we declare an interest here). Until those are answered, AI will be a legal Wild West.

The bigger question is how the age of the omnistar will suit audiences. The risk is boredom. AI is brilliant at remixing and regurgitating old material, but less good at generating the pulse-racing, spine-tingling stuff that is, for now, a human speciality. AI output may nonetheless appeal to film studios, record labels and other creative middlemen, who prefer to minimise risk by sticking to tried-and-tested ideas. Hollywood already favours franchises over new work: witness the rash of sequels and reboots at the box office. AI will let studios apply the same principle to actors. A de-aged Luke Skywalker stars in Disney's latest "Star Wars" spin-off. At present, audiences are wowed by such trickery. They may grow tired of it long before "Fast and Furious 94".

Yet the entertainment market is strongly self-correcting. Audiences have the power to turn a hot property into a has-been in an instant, as stars are

all too aware. And even as AI-powered entertainment grows, consumers still seem to relish human drama. Sport, perhaps the most AI-proof, flesh-and-bones spectacle there is, has seen its value to media companies soar in recent years (meanwhile, no one watches computer-powered chess, though its best players could beat any human). Moreover, AI will make entertainment's long tail even longer, with deeper niches and more personalised content. In the AI age, audiences will face heavy bombardment from a handful of omnistars, from Taylor Swift to Darth Vader. But it will be easier than ever for them to change the channel. ■



【首文】“全能明星”诞生

人工智能将如何改变名利场

对这项新技术怨声最大的群体很可能获益最大

几十年来，计算机一直在颠覆枯燥乏味的工作。现在，人工智能（AI）正向最光彩夺目的工作发起冲击。好莱坞已停摆了大半年，直到11月8日各大影视公司与罢工演员们达成协议，同意保护他们不被机器人对手抢走饭碗。在上周的各大音乐排行榜上，在世的音乐人被一位通过AI复活的已故披头士成员挤到了后头。斯嘉丽·约翰逊（Scarlett Johansson）等演员和约翰·格里森姆（John Grisham）等作家正在起诉科技公司未经授权使用他们的形象和文字。

明星们可能担心AI在窃取他们的作品，还让资质平平的演员有了跟他们抢观众的能耐。但事实上，最高声抱怨AI的明星恰恰是最能从这种新技术中受益的人群。AI非但不会削弱明星的影响力，还会让最大牌的明星可以随时随地以各种形式出现在所有市场上，收获空前的名气。来为“全能明星”的崛起鼓掌吧（或者你更想戴上耳塞的话也可以）。

技术改变了名利场的规则，这也并非头一回。18世纪，阅读的普及让人有可能在有生之年真正成名，开始有了“明星”一说。电影和广播电台最初看似是对明星的一种威胁，他们担心自己的现场表演会贬值，而事实上，这些技术引领人们走入了“超级明星”（在上世纪20年代流行起来的说法）的时代。类似的恐慌也出现在电视发明之际，并在1960年导致好莱坞上一次大罢工。但是，当时的这项新技术又一次让名人变得更出名，让他们走进了每家每户的客厅。到上世纪60年代，更是出现了“巨星”一说。

随着AI生成的内容涌入娱乐业，住在洛杉矶富人区马里布（Malibu）的敬业明星们再一次担心自己的名气会遭稀释。然而，结果很可能再一次是相反的。互联网时代有一个悖论，在上传到YouTube、TikTok等平台上的内容创造了海量用户自制内容的“长尾”的同时，大牌艺人的热门作品也越发声名远播。在过去六年里，Spotify上每年版税收入超过1000美元的音乐人

数量翻了一番不止，但每年收入超过1000万美元的音乐人数量已是原来的五倍之多。即使小众内容（船夫号子、口哨以及各种古怪音乐）蓬勃发展，也无碍泰勒·斯威夫特（Taylor Swift）成功举办了史上最赚钱的巡回演唱会。受冲击的是中游艺人。

整个娱乐业都呈现类似的模式。过去二十年里，每年上映的剧情长片的数量翻了一番，但最卖座的大片占总票房的份额也翻了一番。自费出书的浪潮并没有侵蚀明星作家的销量。在海量选择面前，观众和读者愈加依赖算法及他人推荐，把自己引向最受欢迎的内容。AI势必将带来更多选择，受众的搜索成本也就会进一步增加，他们将继续被少数头部明星所吸引。

AI将使得这些巨星能真正做到对粉丝来说无处不在。AI配音已经可以让演员和播客主用自己的声音与外国观众即时对话。很快，能让口型和新语言相匹配的视频剪辑技术也将成为标配。当红演员可能会得到更多工作，因为AI可以让明星们在根本不同场的情况下共同演出，解决艺人档期太满这个好莱坞的老问题。“数字肉毒素”将延长演员的演艺生命，甚至让他们能在死后继续“表演”。迪士尼已获得92岁的詹姆斯·厄尔·琼斯（James Earl Jones，《星球大战》电影中黑武士的配音演员）的声音使用权，这样黑武士就可以吓唬一代又一代的孩子了。

丨 瞬息全宇宙

明星还可以通过最近才出现的新形式为粉丝表演。伦敦一座场馆内一周七场的ABBA乐队虚拟演唱会门票火热售罄，还有Meta最近推出的明星语音聊天机器人，这些都只是顶级明星满足粉丝需求并借此盈利的开胃小菜而已。

这些机会是有附加条件的。艺人的确有理由担忧版权问题；若不想AI成为一种合法化的盗版，就必须使版权受到保护。过往的新技术也不例外：18世纪，印刷机的出现促使第一部版权法诞生；上世纪60年代，版权费被重新调整以补偿那些作品在电视上播出的电影演员；本世纪初，Napster等公司掀起的盗版音乐免费下载狂欢最终让位给流媒体与唱片公司之间的协议。内容创作者对内容使用权限和报酬有疑问是合理的（在此我们应声

明，此处关涉我们自己的利益）。而在这些问题得到解答之前，AI将是法律的“狂野西部”。

更大的问题是，“全能明星”时代如何让观众满意。风险在于厌倦。AI在把旧素材拿来混剪和重制方面才华过人，但不那么擅长制作令人心跳加速、脊背发麻的内容，目前为止这还是人类的专长。但AI作品还是可能会吸引到电影制片厂、唱片公司和其他创意中间商，它们倾向沿袭旧有的成功套路，把风险降到最低。好莱坞就已经更愿意把系列电影“炒冷饭”而非开拍新作品，看看票房榜上那一长串续集和翻拍电影就知道了。AI将使制片厂把同样的原则应用到演员身上。迪士尼最新推出的《星球大战》衍生片仍由卢克·天行者的原扮演者出演，但经过AI处理而令其长相年轻化。目前，观众会被这样的花招惊艳。但是可能远等不到《速度与激情94》上映，他们就已经生厌了。

但娱乐市场具有很强的自我修正能力。观众能瞬间让炙手可热的节目过气，这一点明星们再清楚不过了。而且，就在AI支持的娱乐发展之时，消费者看起来仍然钟爱真人戏剧。体育竞技也许是最有血有肉、最能抵御AI的观赏盛事了，近年来它对于媒体公司的价值不断飙升（与此同时，没有人观看由电脑驱动的国际象棋比赛，即使其中最强大的电脑可以击败任何人类棋手）。此外，AI将进一步拉长娱乐业的长尾，形成更深厚的利基市场，更个性化的内容。在AI时代，观众将面对从泰勒·斯威夫特到黑武士等少数“全能明星”的轰炸，但他们想要换台的话也将比以往任何时候都容易。 ■



Too good to be true

The world economy is defying gravity. That cannot last

Threats abound, including higher-for-longer interest rates

EVEN AS WARS rage and the geopolitical climate darkens, the world economy has been an irrepressible source of cheer. Only a year ago everyone agreed that high interest rates would soon bring about a recession. Now even the optimists have been confounded. America's economy roared in the third quarter, growing at a stunning annualised pace of 4.9%. Around the world, inflation is falling, unemployment has mostly stayed low and the big central banks may have stopped their monetary tightening. China, stricken by a property crisis, looks likely to benefit from a modest stimulus. Unfortunately, however, this good cheer cannot last. The foundations for today's growth look unstable. Peer ahead, and threats abound.

The irrepressible economy has encouraged bets that interest rates, though no longer rising rapidly, will not fall by much. Over the past week the European Central Bank and Federal Reserve have held rates steady; the Bank of England was expected to follow suit shortly after we published this on November 2nd. Long-term bond yields have accordingly risen sharply. America's government must now pay 5% to borrow for 30 years, up from just 1.2% in the depths of the pandemic recession. Even economies known for low rates have seen sharp increases. Not long ago Germany's borrowing costs were negative; now its ten-year bond yield is nearly 3%. The Bank of Japan has all but given up on its promise to peg ten-year borrowing costs at 1%.

Some people, including Janet Yellen, America's treasury secretary, say these higher interest rates are a good thing—a reflection of a world economy in the rudest of health. In fact, they are a source of danger. Because higher

rates are likely to persist, today's economic policies will fail and so will the growth they have fostered.

To see why today's benign conditions cannot continue, consider one reason why America's economy in particular has fared better than expected. Its consumers have been spending the cash they accumulated during the pandemic from handouts and staying at home. Those excess savings were expected to have been depleted by now. But recent data suggest households still have \$1trn left, which explains why they can get away with saving less out of their incomes than at any point in the 2010s.

When those excess savings buffers have been run down, high interest rates will start to bite, forcing consumers to spend less freely. And trouble will start to emerge across the world economy if rates stay higher for longer. In Europe and America business bankruptcies are already rising; even companies that locked in low rates by issuing long-term debt will in time have to face higher financing costs. House prices will fall, at least in inflation-adjusted terms, as they respond to dearer mortgages. And banks holding long-term securities—which have been supported by short-term loans, including from the Fed—will have to raise capital or merge to plug the holes blown in their balance-sheets by higher rates.

Fiscal largesse has added to the world economy's sugar rush. In a higher-for-longer world, it too looks unsustainable. According to the IMF, Britain, France, Italy and Japan are all likely to run deficits in the region of 5% of GDP in 2023. In the 12 months to September America's deficit was a staggering \$2trn, or 7.5% of GDP after adjusting for accounting distortions—about double what was expected in mid-2022. At a time of low unemployment, such borrowing is jaw-droppingly reckless. All told, government debt in the rich world is now higher, as a share of GDP, than at any time since after the Napoleonic wars.

When interest rates were low, even towering debts were manageable. Now that rates have risen, interest bills are draining budgets. Higher-for-longer therefore threatens to pit governments against inflation-targeting central bankers. Already, Ms Yellen has felt obliged to argue that Treasuries carry no risk premium, and Jerome Powell, the Fed's chairman, has insisted that his bank would never cut rates and let inflation rip to ease pressure on the government's budget.

Whatever Mr Powell says, a higher-for-longer era would lead investors to question governments' promises both to keep inflation low and also to pay their debts. The ECB's bondholdings are already becoming skewed towards the Italian government debt that it tacitly backstops—a task that has become far harder in a high-rate world. Even when Japanese government-bond yields were a paltry 0.8% last year, 8% of Japan's budget went on interest payments. Imagine the strain if yields reached even Germany's relatively modest levels. Some governments would go on to tighten their belts as a result. But doing so may bring economic pain.

These strains make it hard to see how the world economy could possibly accomplish the many things that markets currently expect of it: a dodged recession, low inflation, mighty debts and high interest rates all at the same time. It is more likely that the higher-for-longer era kills itself off, by bringing about economic weakness that lets central bankers cut rates without inflation soaring.

A more hopeful possibility is that productivity growth soars, perhaps thanks to generative artificial intelligence (AI). The resulting boost to incomes and revenues would make higher rates bearable. Indeed, figures published on November 2nd are expected to show that America's measured productivity surged in the third quarter. The potential of AI to unleash further productivity gains may explain why higher-for-longer has so far not punctured stockmarkets. Were it not for the rising valuations of seven tech

firms, including Microsoft and Nvidia, the S&P 500 index of American stocks would have fallen this year.

| *Don't look down*

Set against that hope, though, is a world stalked by threats to productivity growth. Donald Trump vows swingeing new tariffs should he return to the White House. Governments are increasingly distorting markets with industrial policy. State spending is growing as a share of the economy as populations age, the green-energy transition beckons and conflicts around the world require more spending on defence. In the face of all this, anyone betting that the world economy can just keep carrying on is taking a huge gamble. ■



【首文】好到难以置信

违背重力法则的世界经济不可持续

威胁重重，包括“长期高息”

战争肆虐、地缘局势恶化之际，世界经济却捷报频传。仅仅一年前，所有人都还认为高利率将很快引发经济衰退。现在，就连乐观派也感到困惑。美国经济在第三季度强劲增长，年化增速达到惊人的4.9%。在世界各地，通胀正在下降，失业率大多保持在低位，各大央行可能已经停止了货币紧缩。饱受房地产危机困扰的中国似乎很可能在适度刺激政策下有所起色。不幸的是，这种欢欣鼓舞无法长久。当前增长的根基看起来并不稳固。眺望前路，威胁重重。

无法压制的经济亢奋已经促使人们押注利率虽不再快速上升，也不会大幅下降。过去一周里，欧洲央行和美联储都维持了利率稳定；预计本文发表后不久，英国央行也会在11月2日的议息会议上效仿。长期债券收益率也相应大幅攀升。美国政府现在必须为30年期国债支付5%的利息，而在疫情造成的萧条最为严重时利息仅为1.2%。即使是以低利率著称的经济体也出现大幅上涨。不久前，德国的借贷成本还是负数；现在其十年期债券收益率接近3%。日本央行几乎已经放弃了将十年期借贷成本维持在1%的承诺。

包括美国财长耶伦在内的一些人士表示，利率上升是件好事——反映世界经济正处于最健康的状态。而事实上，它是一个危险的源头。因为利率很可能会持续高企，今天的经济政策将会失效，它们促成的经济增长也就无法持续。

要想知道为什么今天的良好状况无法持续下去，不妨考虑一下美国经济尤其好于预期的一个原因。美国消费者在疫情期间因政府补贴和闭门不出而积累了许多现金，他们一直在花这些钱。本来预计这些超额储蓄到现在已经见底了，但近期数据显示居民仍有1万亿美元的剩余资金。这就解释了为什么尽管他们现在存下的收入比2010年代任何时候都要少，却仍然问题

不大。

当这些超额储蓄的缓冲耗尽时，高利率的不利影响就会开始显现，迫使消费者不再那么自在地花费。而如果利率继续走高，世界各地的经济将开始出现问题。在欧洲和美国，企业破产已经在增加；即使是通过发行长期债务锁定低利率的公司，也终究不得不面对更高的融资成本。随着房贷成本上升，房价将会下跌，至少按通胀调整后的房价会下跌。而持有长期证券的银行原本依靠短期贷款（包括美联储的贷款）来维持，现在将不得不筹集资本或进行合并，以填补因利率上升而在资产负债表上出现的窟窿。

财政刺激政策加剧了世界经济的亢奋。在“长期高息”的世界里，这同样看起来不可持续。根据国际货币基金组织（IMF）的数据，2023年英国、法国、意大利和日本的赤字都可能达到GDP的5%左右。在截至9月的12个月里，美国的赤字达到了惊人的2万亿美元，在经会计信息失真调整后占GDP的7.5%，约为2022年中所做预期的两倍。在低失业率时期，这种不计后果的举债令人惊掉下巴。综合看来，目前发达国家的政府债务占GDP的比重处于拿破仑战争以来的最高水平。

在低利率时代，即使债务高企也是可控的。而今利率上升，利息支出正逐步掏空预算。因此，“长期高息”有可能使政府与以控制通胀为目标的央行形成对立。耶伦已经不得不喊话，称美债并没有风险溢价，而美联储主席鲍威尔则坚称，美联储绝不会降息、放任通胀飞涨来缓解政府的预算压力。

无论鲍威尔怎么说，“长期高息”的时代将导致投资者质疑政府保持低通胀和偿还债务的承诺。欧洲央行持有的债券已经开始向其默默支持的意大利政府债务倾斜——在高利率的世界里，这么做的难度大增。即使去年日本国债收益率只有区区0.8%，利息支出仍然占了预算的8%。试想一下，如果收益率达到哪怕德国这种相对适中的水平，压力会有多大。一些政府会因此勒紧裤腰带。但这又可能给经济带来痛苦。

在这些压力之下，很难想象世界经济何以实现市场当前的诸多期望：躲过

衰退、低通胀，同时又能承受巨额债务和高利率。更有可能出现的情形是，“长期高息”的时代将会自行终结：它引发了经济疲软，促使央行降息而不致通胀飙升。

一种更让人心存希望的可能性是生产率飞速增长，或许要归功于生成式人工智能。由此带来的收入和税收增长应该会让高利率变得可以承受。事实上，预计11月2日公布的数据将显示美国测得生产率在第三季度飙升。人工智能有潜力进一步提高生产率，这或许可以解释为什么“长期高息”到目前为止还没有击穿股市。若不是微软和英伟达等七家科技公司估值上升，美股标普500指数今年早已下跌。

| 别往下看

然而与这一希望背道而驰的是，世界也被各种拖累生产率增长的威胁困扰。特朗普誓言，如果他重返白宫，将大幅开征新关税。各国政府纷纷出台产业政策，日益扭曲市场。随着人口老龄化、绿色能源转型推进，以及世界各地的冲突要求增加国防开支，政府支出在经济中所占的比重正在不断增加。面对这一切，如果还寄望于世界经济能够继续高歌猛进，那就是一场豪赌。■



ConsumerZZZZZZZZZ

Welcome to the age of the hermit consumer

The world economy is witnessing a \$600bn-a-year shift in behaviour

IN SOME WAYS covid-19 was a blip. After soaring in 2020, unemployment across the rich world quickly dropped to pre-pandemic lows. Countries re-attained their pre-covid GDP in short order. And yet, more than two years after lockdowns were lifted, at least one change is enduring: consumer habits across the rich world have shifted decisively, and perhaps permanently. Welcome to the age of the hermit.

Before covid, the share of consumer spending devoted to services was rising steadily. As societies became richer, they sought more luxury experiences, health care and financial planning. Then in 2020 spending on services, from hotel stays to hair cuts, collapsed. With people spending more time at home, demand for goods jumped, with a rush for computer equipment and exercise bikes.

Three years on, the share of spending devoted to services remains below its pre-covid level (see chart 1). Relative to its pre-covid trend, the decline is sharper still. Rich-world consumers are spending around \$600bn a year less on services than you might have expected in 2019. In particular, people are less interested in leisure activities that take place outside the home, including hospitality and recreation. Money is being redirected to goods, ranging from durables like chairs and fridges, to things such as clothes, food and wine.

In countries that spent less time in lockdown, hermit habits have not become ingrained. Elsewhere, though, the behaviour looks pathological. In the Czech Republic, which was whacked by covid, the services share is three percentage points below trend. America is not far off. Japan has

witnessed a 50% decline in restaurant bookings for client entertainment and other business purposes. Pity the drunken salaryman staggering round Tokyo's pleasure districts: he is an endangered species.

At first glance, the figures are difficult to reconcile with the anecdotes. Isn't it harder than ever to get a table at a restaurant? Yet the true source of the crowding is not sky-high demand, but constrained supply. These days fewer people want to work in hospitality—in America employment in the industry remains lower than in 2019. And pandemic disruption means many new hotels and restaurants that would have opened in 2020 and 2021 never did. The number of hotels in Britain, at around 10,000, has not grown since 2019.

Firms are noticing the \$600bn shift. In a recent earnings call an executive at Darden Restaurants, which runs one of America's finest restaurant chains, Olive Garden, noted that, relative to pre-covid times, "we're probably in that 80% range in terms of traffic". At Home Depot, which sells tools to improve homes, revenue is up by about 15% on 2019 in real terms. Goldman Sachs, a bank, tracks the share prices of companies that benefit when people stay at home (such as e-commerce firms) and those that thrive when people are out (such as airlines). Even today, the market looks favourably upon firms that serve stay-at-homers (see chart 2).

Why has hermit behaviour endured? The first possible reason is that some tremulous folk remain afraid of infection, whether by covid or something else. In Britain, car use is in line with the pre-covid norm, whereas public-transport use is well down. People also seem less keen on up-close-and-personal services. In America spending on hairdressing and personal grooming is 20% below its pre-covid trend, while spending on cosmetics, perfumes and nail preparations is up by a quarter.

The second reason relates to work patterns. Across the rich world people

now work about one day a week at home, according to Cevat Giray Aksoy of King's College London and colleagues. This cuts demand for services bought at the office, including lunches, and raises demand for do-it-yourself goods. Last year Italians spent 34% more on glassware, tableware and household utensils than in 2019.

The third relates to values. Covid may have made people genuinely more hermit-like. According to official data from America, last year people slept 11 minutes more a day than in 2019. They also spent less on clubs that require membership and other social activities, and more on solitary pursuits, such as gardening and pets. Meanwhile, global online searches for "Patience", a card game otherwise known as Solitaire, are running at about twice their pre-pandemic level. Covid's biggest legacy, it seems, has been to pull people apart. ■



嗜睡的消费者

欢迎来到隐士消费者的时代

全球经济见证价值每年6000亿美元的行为转变

从某些方面来看，新冠疫情只是一个小插曲。富裕世界的失业率经历了2020年的飙升后，迅速降至疫情前的低点。各国在短时间内恢复到了疫情前的GDP水平。然而，在解除封锁两年多后，至少有一个变化留存了下来：富裕国家的消费者习惯已经发生了决定性的、也许是永久性的转变。欢迎来到隐士时代。

在疫情前，服务业占消费支出的份额稳步上升。随着社会变得更加富裕，人们更多地寻求奢侈体验、医疗照护和财务规划。然后到了2020年，从酒店住宿到理发，服务支出暴跌。人们待在家的时间越来越长，他们对商品的需求激增，蜂拥购买电脑设备和健身自行车。

三年过去了，用于服务的支出份额仍低于疫情前的水平（见图1）。相比疫情前的趋势预测，下降幅度还要更大。与在2019年时会做出的预期相比，富裕国家消费者现在每年在服务上的支出要少6000亿美元左右。人们尤其对餐饮住宿和休闲娱乐等需要走出家门的休闲活动兴致减退。消费被重新导向了各种各样的商品，从椅子和冰箱等耐用品，到服装、食品和葡萄酒等消耗品。

在封锁时间较短的国家，隐士式习惯还没到根深蒂固的程度。然而在其他地方，行为的改变似乎已深入骨髓。在遭受新冠重击的捷克，服务业的份额比趋势水平低了三个百分点。美国也差不多。在日本，用于招待客户和其他商业目的的餐厅预订量下降了50%。对在东京的声色犬马之地仍能见到的脚步踉跄、醉醺醺的上班族多些怜惜吧，他们可是濒临灭绝的物种。

乍一看，这些数字很难与坊间传闻对上号。现在要在餐馆找个位子难道不是前所未有地难吗？然而，人满为患的真正原因并不是需求高涨，而是供应受限。如今，想从事餐饮接待业的人变少了——在美国，该行业的就业

率仍低于2019年。受疫情影响，许多本应在2020年和2021年开业的新酒店和餐馆始终没有开张。自2019年以来，英国的酒店数量一直没有增长，仍在1万家左右。

企业界注意到了这个价值6000亿美元的转变。在最近的财报电话会议上，美国优质连锁餐厅之一橄榄园（Olive Garden）的经营者达登餐饮（Darden Restaurants）的一名高管指出，相较于疫情前的水平，“我们的客流量大概恢复到了80%”。销售家装工具的家得宝（Home Depot）的实际收入比2019年增长了约15%。高盛跟踪了两类公司的股价，一类是从人们足不出户中受益的公司，如电子商务公司，另一类是靠人们迈出门而生意兴隆的公司，如航空公司。即使在今天，市场仍然看好那些为宅家族提供服务的公司（见图2）。

为什么隐士行为会持续？第一个可能的原因是一些紧张不安的人们依然害怕感染，无论是新冠还是其他疾病。在英国，汽车使用量与疫情前的常态一致，而公共交通的使用量显著下降。人们似乎也不再那么热衷于近距离的私人服务。在美国，美发和个人护理方面的支出比疫情前的趋势低20%，而化妆品、香水和美甲护甲产品方面的支出增长了四分之一。

第二个原因与工作模式有关。根据伦敦国王学院的切瓦特·吉雷·阿克索伊（Cevat Giray Aksoy）及其同事的研究，在整个富裕世界，人们现在差不多每周在家工作一天。这导致他们减少了在办公室内购买包括午餐在内的服务的需求，提高了对DIY类商品的需求。去年，意大利人在玻璃器皿、餐具和家用器具上的支出比2019年增加了34%。

第三个与价值观有关。新冠可能真的让人们变得更像隐士了。根据美国官方数据，去年人们每天的睡眠时间比2019年增加了11分钟。他们在需要会员资格的俱乐部以及其他社交活动上的开销也减少了，在园艺和宠物等自得其乐的活动上花费得更多。与此同时，全球对接龙这种单人纸牌游戏的在线搜索量相比疫情前差不多翻了个倍。看起来，新冠最大的“后遗症”是人与人之间的距离越来越远了。■



A battery ReNaissance

Firms are exploring sodium batteries as an alternative to lithium

Unlike lithium, sodium is cheap and abundant

THEY POWER tiny phones and two-tonne electric cars. They form the guts of a growing number of grid-storage systems that smooth the flow of electricity from wind and solar power stations. Without them, the electrification needed to avoid the worst effects of global warming would be unimaginable. And in 2019 they earned three of their pioneers a Nobel prize.

But lithium-ion (Li-ion) batteries have downsides. Lithium is scarce, for one. And the best Li-ion batteries, those with layered-oxide cathodes, also require cobalt and nickel. These metals are scarce, too—and cobalt is also problematic because a lot of it is mined in the Democratic Republic of Congo, where working conditions leave much to be desired. A second sort of Li-ion battery, a so-called polyanionic design that uses lithium iron phosphate (LFP), does not need nickel or cobalt. But such batteries cannot store as much energy per kilogram as layered-oxide ones.

A clutch of companies, though, think they have an alternative: making batteries with sodium instead. Unlike lithium, sodium is abundant: it makes up most of the salt in the oceans. And chemists have found that layered-oxide cathodes which use sodium rather than lithium can get by without cobalt or nickel to jazz them up. The idea of making sodium-ion (or Na-ion) batteries at scale is therefore gaining traction. Engineers are tweaking designs. Factories, particularly in China, are springing up. For the first time since the Li-ion revolution began, lithium's place on the electrochemical pedestal is being challenged.

Lithium and sodium, members of a group called the alkali metals, sit just below hydrogen in the first column of the Periodic Table. Alkali metals are famously reactive. (Dropping some in water will give you a lot of fizzing. Others will produce explosions.) This is because the outermost shell of electrons surrounding the nucleus of an alkali-metal atom has but a single occupant. These “valence” electrons are easily shed, creating positive ions (cations) that can link up with negative counterparts (anions), such as hydroxyl ions derived from water. The results are compounds like lithium hydroxide and sodium chloride, better known as table salt.

If, however, the lost electrons are routed to their destinations via a wire, rather than hopping directly to a neighbouring atom or group of atoms, while the cations make the journey separately, through a medium called an electrolyte, the result is an electrochemical cell. Energy can be drawn from this as the electrons journey through the wire (see diagram). Conversely, if the whole process is put into reverse by applying a current, the cell can be recharged.

All this applies as much to sodium as to lithium. Given sodium’s cost advantages, non-chemists may wonder why it was not preferred to lithium in the first place. The answer is that sodium atoms, which have 11 protons, 12 neutrons and an extra electron shell, are bigger and heavier than lithium ones (three protons and three neutrons). A sodium battery will be bigger and heavier than a lithium one of the same capacity.

Small size and a low weight are crucial for phones, and at least desirable in cars. But they do not matter everywhere. Sodium batteries could work for grid-scale storage, home storage and heavy forms of transport, such as lorries and ships.

China’s interest stems partly from the government’s current five-year

economic plan, which began in 2021, and which aims, among other things, to explore a variety of battery chemistries. Benchmark Mineral Intelligence, a firm in London, lists 36 Chinese companies that are either making or investigating sodium batteries. These firms mostly play their cards close to their chests—in four cases Benchmark's researchers cannot even determine exactly which battery chemistry is involved. The leader of the pack is, nevertheless, generally agreed to be CATL, based in Fujian.

CATL is already the world's largest maker of Li-ion vehicle batteries. In 2021 it announced the world's first sodium battery for electric vehicles. Chery, a Chinese carmaker, will use CATL's sodium batteries, alongside some lithium ones, in its iCAR brand, to be launched shortly.

BYD, CATL's chief rival and a carmaker in its own right, is similarly active. Its Seagull hatchback, which was unveiled at the Shanghai Auto Show in April, will also soon sport Na-ion batteries. Farasis Energy, another established battery-maker, has teamed up with Jiangling Motors; HiNa Battery Technology, a firm created specifically to develop Na-ion batteries, is collaborating with JAC group, yet another carmaker; and Svolt, a subsidiary of Great Wall Motor, has a ready-made automotive partner in its parent company.

According to Benchmark, these five firms, together with 22 of the others, are using layered-oxide cathodes (besides the four unknowns, the remainder are working either on polyanionic designs or a third approach involving an iron-containing substance called Prussian blue). And this is where the cobalt and nickel come in. Experience has shown that oxide layers involving cobalt and nickel ions (together with those of manganese, which is cheap and uncontroversial to mine) result in the best lithium battery cathodes.

Cobalt and nickel (and also manganese and iron) are so-called transition

metals, with more than one valence electron. Whereas lithium and sodium ions always have a single positive charge, cobalt, for example, can form ions with charges of +2 or +3. When an electron arrives at a layered-oxide battery's cathode, it reacts with a transition-metal ion, reducing its positive charge by one and creating a net negative charge. An alkali-metal ion (which is positively charged) moves into the crystal structure to balance out the charges.

In sodium batteries, layered-oxide cathodes can be made with just manganese and iron (though they may be spiced with metals such as copper and titanium to improve performance). Why is not entirely clear. Dominic Bresser of the Karlsruhe Institute of Technology, in Germany, reckons it is because sodium atoms' larger sizes and somewhat different electronic properties allow them to fit into a wider range of crystals. Whatever the answer, the practical upshot is a big reduction in cost of materials. This flexibility also allows the engineering into Na-ion batteries of properties, such as higher power output, that are harder to achieve with Li-ions.

| *Starting grid*

Between them, according to Rory McNulty, a research analyst at Benchmark, Chinese firms have 34 Na-ion-battery factories built, being built or announced inside the country, and one planned in Malaysia. Established battery-makers in other places, by contrast, are not yet showing much interest. Even without a five-year plan to guide them, though, some non-Chinese startups are seeking to steal a march by developing alternatives to layered oxides, in the hope of improving the technology, reducing its cost, or both.

One of the most intriguing of these neophytes is Natron Energy, of Santa Clara, California. It is taking the Prussian blue approach. Prussian blue, which is a common dyestuff, is cheap. But Natron hopes it can prolong a

battery's service life. At least at the moment, Na-ion layered-oxide cathodes are less durable than their Li-ion counterparts. Natron claims that its cells can endure 50,000 cycles of charging and discharging—between ten and 100 times more than commercial Li-ion batteries can manage. The firm has built a factory in Michigan, which it says will begin production later this year.

Other non-Chinese firms are less far advanced, but full of hope. Altris, in Sweden, which is also building a factory, employs a material called Prussian white that substitutes some of the iron in Prussian blue with sodium. Tiamat, in France, uses a polyanionic design involving vanadium. And Faradion, in Britain (now owned by Reliance, an Indian firm), intends to stick with a layered-metal-oxide system.

How things will all play out remains to be seen. Dr McNulty urges caution, at least in the short term. Battery technologies take time to mature (the first research into lithium batteries dates back to the 1960s). Benchmark predicts that sodium battery manufacturing capacity in 2030 will be about 140 gigawatt-hours of storage a year. However, the firm thinks that only just over half of this capacity will actually be churning out cells. This amounts to 2% of its projection for lithium-cell production in that year.

Sodium batteries do, nevertheless, look attractive. For grid storage, they seem like serious competitors with LFPs—though they will also have to compete with other novel approaches, such as vanadium flow-batteries. Their chief rivals in the lorry and shipping markets are probably hydrogen fuel cells, but these are an untested technology that rely on an as-yet-unbuilt infrastructure to supply the hydrogen.

For weight-sensitive, high-value applications such as electric cars or even aircraft, their future is less certain. The crucial factor will be materials prices. If prospecting for lithium, cobalt and nickel creates enough new

mines to keep these down, the incentive to pay scientists and engineers to drive up the amount of energy per kilogram which sodium batteries can store may evaporate. But if the costs of those metals remain high, then for sodium the sunny uplands could beckon. ■



钠电池新生

一些公司正在探索用钠电池替代锂电池

与锂不同，钠便宜又丰富【深度】

它们驱动小巧的手机和两吨重的电动汽车。它们成为越来越多的电网蓄电系统的核心，平抑风能和太阳能发电站的输出波动。没有它们，很难想象能够实现电气化，从而避免全球变暖带来的最坏影响。2019年，三位研发它们的先驱获得了诺贝尔奖。

但是锂离子电池也有缺点。首先是锂的稀缺性。性能最好的锂离子电池使用层状氧化物阴极，还需要钴和镍。这两种金属也很稀缺——并且钴具有争议性，因为很多钴矿都在刚果（金），那里的工作条件亟待改善。第二种锂离子电池即所谓的聚阴离子型使用磷酸铁锂（LFP），不需要镍或钴。但是这种电池的能量密度比不上层状氧化物的电池。

不过，一些公司认为自己还有另一种选择——用钠来制造电池。与锂不同，钠资源非常丰富：海水中的盐大部分成分就是钠。化学家们发现，相比锂，使用钠的层状氧化物阴极在没有钴或镍助力的情况下依然堪用。因此，大规模生产钠离子电池的想法正得到越来越多的支持。工程师们正在改进设计。生产钠离子电池的工厂如雨后春笋般涌现，尤其是在中国。自锂离子革命开始以来，锂在电化学上的骄人地位首次受到挑战。

| 中坚资源

锂和钠都属于碱金属，位于元素周期表的第一列中，紧跟在氢的下面。众所周知碱金属具有很高的反应活性。（在水中投入一些碱金属，水便会嘶嘶地冒很多泡。有的还会引起爆炸。）这是因为碱金属原子的最外层只有一个电子。这些“价电子”很容易脱离出去，产生正离子（阳离子），正离子可以与负离子（阴离子，比如源自水的羟基离子）结合。这样便产生了氢氧化锂和氯化钠等化合物——后者也就是我们熟知的食盐。

但是，如果脱离的电子是通过导线传递到指定目的地，而不是直接跑到附

近的原子或原子团上，而与此同时阳离子单独通过一种叫作电解液的介质移动，这就构成了电化学电池。当电子经过导线时，可以从中提取能量（见示意图）。反之，如果通过施加电流逆转整个过程，就可以给电池充电。

这个过程对锂和钠都成立。既然钠更具成本优势，非化学专业人士可能就会疑惑了，为什么不一开始就考虑钠而考虑锂呢？答案是：钠原子比锂原子更大、更重。锂原子有三个质子和三个中子，而钠原子有11个质子、12个中子，此外还多了一个电子壳层。相同容量的钠电池会比锂电池更大更重。

小而轻的电池对手机来说至关重要，在汽车上至少也是加分项。但小而轻并非在所有情形下都要紧。钠电池可以用于电网级储能、家庭储能，以及货车和船舶等重型运输工具。

中国对钠电池的兴趣部分源于政府现行的五年经济规划（始于2021年）。除了其他目标，该规划提出要探索各种电池化学。伦敦的基准矿业情报机构（Benchmark Mineral Intelligence，以下简称Benchmark）列出了36家正在生产或研究钠电池的中国公司。这些公司大多对外保密——Benchmark的研究人员甚至无法确定其中四家涉及哪种电池化学材料。不过人们普遍认为领头羊是总部位于福建的宁德时代。

宁德时代已经是全球最大的锂离子汽车电池制造商。2021年，它发布了世界上首款用于电动汽车的钠电池。中国汽车制造商奇瑞即将推出的iCAR品牌会使用宁德时代的钠电池和锂电池。

宁德时代的主要竞争对手、本身也是汽车制造商的比亚迪同样活跃。今年4月比亚迪在上海车展发布的掀背式汽车海鸥很快也会采用钠离子电池。另一家老牌电池制造商孚能科技已与江铃汽车联手；专注于钠离子电池研发的中科海钠正与另一家汽车制造商江汽集团合作；蜂巢能源则有一个现成的汽车合作伙伴，同属于它的母公司长城汽车。

Benchmark称，这五家公司和其他22家公司都在使用层状氧化物阴极（而

除了那四家情况不明的公司，其余几家要么在研究聚阴离子，要么在研究第三种方式，其中涉及一种叫做普鲁士蓝的含铁物质）。而层状氧化物阴极正是钴和镍的用武之地。经验表明，含有钴离子和镍离子（还有价格便宜、开采起来也没有争议的锰的离子）的氧化物层是最好的锂电池阴极材料。

钴和镍（还有锰和铁）是所谓的过渡金属，有不只一个价电子。锂离子和钠离子总是带单一的一个正电荷，而像钴这样的原子可以形成带2到3个正电荷的离子。当一个电子到达层状氧化物电池的阴极时，它与一个过渡金属离子发生反应，使其失去一个正电荷，同时产生一个净负电荷。带正电荷的碱金属离子进入晶体结构，让电荷保持平衡。

在钠电池中，可以只用锰和铁（不过为提高性能，也可加入铜和钛等金属）来制造层状氧化物阴极。原因尚不完全清楚。德国卡尔斯鲁厄理工学院（Karlsruhe Institute of Technology）的多米尼克·布雷塞尔（Dominic Bresser）认为，这是因为钠原子体积更大且电子性质有所不同，因此能够适应更多类型的晶体。无论是什么原因，实际结果是大幅降低了原料成本。这种灵活度也让钠离子电池可以得到性能上的改进，比如更高的功率输出，而这些是锂离子电池难以做到的。

| 起跑排位

Benchmark的研究分析师罗里·麦克纳尔蒂（Rory McNulty）表示，中国企业在本土已建、在建或宣布待建的钠离子电池工厂共有34家，并计划在马来西亚新建一家。相比之下，其他地方的老牌电池制造商还没有表现出太大的兴趣。不过，中国以外有一些创业公司（即便并没有什么五年规划在指引它们）正在研发层状氧化物的替代品以求抢占先机，它们希望能改进技术、降低成本，或者两者兼得。

在这些新进者中，最令人瞩目的当属加州圣克拉拉（Santa Clara）的Natron Energy。它所采用的方法用到了普鲁士蓝。普鲁士蓝是一种价格低廉的常见染料，但Natron希望能用它来延长电池的使用寿命。至少在目前，钠离子的层状氧化物阴极不如锂离子的耐用。Natron声称，它生产的

电池可以经受五万次充放电循环，是商用锂离子电池的10到100倍。Natron已经在密歇根州建立了一家工厂，表示将于今年底投产。

其他非中国公司没有那么先进，但也信心满满。瑞典的Altris也在建厂，它使用了一种叫做普鲁士白的材料，用钠代替普鲁士蓝中的一些铁。法国的Tiamat采用了含钒的聚阴离子材料。英国的Faradion（现在归印度的信实公司[Reliance]所有）打算坚持使用层状金属氧化物体系。

事情会如何发展还需拭目以待。麦克纳尔蒂呼吁人们谨慎行事，至少在短期内如此。电池技术的成熟需要时间，比如人们对锂电池的研究最早可以追溯到上世纪60年代。Benchmark预测，到2030年，钠电池的产能将达到每年约140吉瓦时。不过，该公司认为，届时这些产能中将只有一半略多会有实际产出。这相当于Benchmark预测的2030年锂电池产量的2%。

尽管如此，钠电池看起来确实很有吸引力。就电网储能而言，它们似乎是磷酸铁锂电池的有力竞争对手——尽管它们还必须与全钒液流电池等其他新技术竞争。它们在货车和航运市场上的主要竞争对手可能是氢燃料电池，但这种技术还未经检验，因为它所依赖的氢能供应基础设施尚未建成。

而在那些对重量敏感的高价值应用领域，比如电动汽车，甚至飞机，它们的未来就不那么确定了。关键还是原料价格。如果对锂、钴和镍的勘探能带来足够多的新矿，继而把它们的价格打下来，那么可能就没有必要花钱让科学家和工程师去提高钠电池的能量密度了。但是，如果那些金属的成本维持高位，钠可能会迎来光明的前景。■



Bartleby

Are leaders sexier than managers?

The distinction is both valid and unhelpful

IF YOU WERE asked to imagine a manager, you might well conjure up someone comically boring, desk-bound and monotonal. Now do the same for a leader. You may well be picturing someone delivering a rousing speech. A horse may be involved. You almost certainly have different types in mind. There is indeed a distinction between managers and leaders, but it should not be overdone.

Various attempts have been made to pin down the differences between the two, but they boil down to the same thing. Managers, according to an influential article by Abraham Zaleznik in the Harvard Business Review in 1977, value order; leaders are tolerant of chaos. A later article in the same publication, by John Kotter, described management as a problem-solving discipline, in which planning and budgeting creates predictability. Leadership, in contrast, is about the embrace of change and inspiring people to brave the unknown. Warren Bennis, an American academic who made leadership studies respectable, reckoned that a manager administers and a leader innovates.

Some of these definitions might be a tad arbitrary but they can be useful nonetheless. Too many firms promote employees into management roles because that is the only way for them to get on in their careers. But some people are much more suited to the ethos of management. They are more focused on process; they like the idea of spreadsheets, orderliness and supporting others to do good work. Shopify, an e-commerce firm, has created separate career paths for managers and developers with these differences in motivation in mind.

The difference between managing and leading is not just a matter of semantics. Research by Oriana Bandiera of the London School of Economics and her co-authors looked at the diaries of 1,114 CEOs in six countries, and categorised their behaviours into two types.

On their definitions, “leaders” have more meetings with other C-suite executives, and more interactions with multiple people inside and outside the company. “Managers” spend more time with employees involved in operational activities and have more one-to-one meetings. Leaders communicate and co-ordinate; managers drill downwards and focus on individuals. The research suggested that firms that are run by leaders perform better than those run by managers.

But pointing to the differences between managers and leaders can also be unhelpful, for two reasons. The first is that being a leader seems so much sexier than being a manager. That is partly because leadership qualities are associated with seniority. As people scale the corporate ladder, they go on leadership courses, join leadership teams and start sentences with phrases like “as a leader”. It is also because the two archetypes are not created equal. Would you rather be the person who likes to do budgeting or the one who holds others in thrall? The type that likes the status quo or the one that wants to change the world? “It takes neither genius nor heroism to be a manager,” wrote Zaleznik. No wonder there are feted programmes for young global leaders but not for young global managers.

The capacity to inspire others and to head into uncharted waters does become more salient the higher you rise. But management skill does not become less important. Dr Bandiera and colleagues concluded that although CEOs who displayed the behaviour of leaders were associated with better company performance overall, different firms may require different types of boss. Some would be better off with “manager” CEOs. And performance is independently correlated with other things, including the

quality of management practices.

The second unhelpful by-product of the debate about managers and leaders is that it tends to separate people into one camp or the other. In fact, bosses must combine the qualities of both. Just as it is hard to motivate people if you are highly efficient but have the inspirational qualities of feta cheese, so it is not much use laying out ambitious visions for the future if you don't have a clue how to make them reality. You need to turn the dial back and forth—from strategy to execution, change to order, passion to process, leader to manager. ■



巴托比

领导者比管理者更拉风吗？

区分两者有理据，但无裨益

如果让你想象一个管理者，你很可能会想到一个无聊透顶、终日伏案、单调乏味的人。要是让你想象一个领导者，你很可能会想到一个人正在发表一场激动人心的演讲。可能还会有匹马。你脑子里肯定还有各种各样的领导者。管理者和领导者之间确实有区别，但不应过度区分。

人们做了各种各样的尝试来确定两者之间的差异，但最后都归结为同一点。亚伯拉罕·扎列兹尼克（Abraham Zaleznik）1977年在《哈佛商业评论》上发表的一篇影响颇广的文章指出，管理者重视秩序，领导者能容忍混乱。约翰·科特（John Kotter）后来在同一刊物上发表的一篇文章将管理描述成一门解决问题的学科，通过做计划和做预算创造出可预测性。相比之下，领导力则是拥抱变化，激励人们勇敢面对未知。让领导力研究登堂入室的美国学者沃伦·本尼斯（Warren Bennis）认为，管理者做管理，领导者做创新。

这些定义有的可能有点武断，但仍可能有用。太多的公司把员工提升到管理岗位，是因为这是他们获得职业发展的唯一途径。但有些人的管理者气质远在其他人之上。他们更注重过程；他们喜欢电子表格、井然有序，以及支持他人做好工作。电子商务公司Shopify考虑到这些内驱力上的差异，给管理人员和开发人员提供了不同的职业发展道路。

管理和领导不仅仅是在语义方面有差别。伦敦政治经济学院的奥莉安娜·班迪埃拉（Oriana Bandiera）和她的合著者研究了六个国家的1114位CEO的日志，并将他们的行为分为两类。

根据他们的定义，“领导者”同其他高管有更多的会议，与公司内外的许多人有更多的互动。“管理者”则花更多的时间与参与业务活动的员工在一起，并有更多的一对一会议。领导者做沟通和协调；管理者向下深入，关

注个体。这一研究表明，由领导者经营的公司比由管理者经营的公司表现得更好。

但指出管理者和领导者之间的差异可能并无裨益，原因有二。首先，做领导者似乎比做管理者风光太多。这在一定程度上是因为领导素质与资历有关。随着人们在职场上升迁，他们会参加领导力课程，加入领导团队，并以“作为领导者”这样的话开头。还有一个原因是这两种类型生来就不平等。你愿意做个喜欢做预算的人，还是能深刻影响别人的人？是安于现状的人，还是想要改变世界的人？“成为管理者既不需要天才，也不需要英雄主义。”扎列兹尼克写道。难怪有那些个著名的全球年轻领导者课程，而不是全球年轻管理者课程。

职位升得越高，激励他人和探入未知领域的能力确实愈显重要。但管理技能的重要性并没有降低。班迪埃拉及其同事的结论是，尽管总体而言，CEO展现出领导者风范与公司业绩更好存在关联，但不同的公司可能需要不同类型的老板。有些公司拥有“管理者”CEO会更好。而且公司业绩也和其他因素独立相关，包括管理实践的质量。

管理者和领导者之争的第二个无益的副产品是，它往往会把人们分成非此即彼的两个阵营。而实际上当老板必须把两方面的品质结合起来。即便你非常高效，但鼓舞人心的本事就像菲达奶酪一样臭，那也很难激励别人；同样，如果你给未来定下雄心勃勃的愿景，对于如何实现它们却毫无头绪，那也没什么用处。你得要来回转换——从战略到执行，从变革到秩序，从激情到过程，从领导者到管理者。■



The impossible job

Pity the modern manager—burnt-out, distracted and overloaded

Corporate leadership is more daunting, but also more important, than ever

MANAGERS DO NOT make for obvious objects of compassion. It is hard to feel sorry for the bossy office lead, let alone the big-shot chief executive who pockets millions of dollars a year in compensation. Yet their lot deserves scrutiny and even some sympathy. From the corner office to the middle manager's cubicle, the many demands on their time are intensifying.

A recent survey of workers in 23 countries by Adecco Group, a recruitment and outsourcing firm, found that 68% of the 16,000 managers in the sample suffered burnout in the past 12 months, compared with 60% for non-managers, and up from 43% the year before. "I feel like I jumped on a treadmill where someone controls both the incline and the speed," says a big-tech executive with a sigh. Plenty of his peers share the sentiment. Managers increasingly require literal stamina: recruiters report that firms often ask candidates for executive positions how much they exercise.

That is a problem not just for the haggard individuals, but also for their employers and, given the boom in management jobs in recent decades, whole economies. Today America has 19m managers, 60% more than in 2000. One in five employees at American companies manages others.

As firms in knowledge industries automate routine tasks and rely on the same digital tools—Amazon Web Services, Gmail, Microsoft office software—it is better management, not investments in technology, that can give them a competitive edge. Poor management can blunt it, by killing productivity and raising staff turnover. According to a Gallup survey from 2015, half of Americans who left a previous job did so because of a bad

manager. Last year McKinsey, a consultancy, found that a similar share of job-leavers said they did not feel valued by their managers.

The value of good management, then, is rising. At the same time, the environment in which managers do their job is being transformed. This new landscape rewards some skills more and some less than in the past. As a result, your manager tomorrow will not look the same as your parents' did.

Until the 2000s, remembers Christoph Schweizer, boss of BCG, a consultancy, "CEOs were superheroes": larger than life, seldom wrong, never in doubt. For all manner of executive, "the highest compliment was 'brilliant,'" says Hubert Joly, who ran Best Buy, an electronics retailer, and now teaches at Harvard Business School (HBS).

Intellect still matters. A study of Swedish bosses found that the typical head of a large firm was in the top 17% of the population by IQ. But across all layers of management, the emphasis has gradually shifted towards softer social skills, such as clear communication, ability to build trust and willingness to show vulnerability. Executives, including CEOs, need to be comfortable with uncertainty, and happy to delegate even the strategic responsibilities that they would once have hogged, observes Nitin Nohria, a former dean of HBS. (Mr Nohria is also chairman of Exor, which part-owns The Economist's parent company.)

David Deming of Harvard University has found that the number of jobs that require social interaction is rising faster than average, as are wages for such roles. A study of executive job listings, by Raffaella Sadun of HBS and colleagues, found that between 2000 and 2017 descriptions mentioning social skills rose by nearly 30%. Those singling out an ability to manage financial and material resources declined by 40% (see chart 1). The most common goals requested by firms that employ management coaches for

their managers on EZRA, Adecco's coaching platform, include communication, emotional intelligence, building trust and collaboration. One of the hottest courses at Stanford University's Graduate School of Business is "Touchy Feely", which teaches students to assess how they come across to others.

Social skills are increasingly sought-after because they enable better co-ordination of people, goals and resources. And 21st-century business requires more such co-ordination than ever. Managers once used to supervise individuals performing repetitive tasks. Today they often oversee professionals working in teams on complicated projects with outcomes that are hard to measure with precision. The world outside the firm is becoming more complex, too. All this means that, as Mr Deming remarks, "it takes more time to converge on a decision." A good manager, whose main role boils down to that of co-ordinator, can cut this time. This ability to get disparate people and goals to coalesce smoothly is thus at a premium, especially relative to purely intellectual and technical skills.

One thing making co-ordination harder is an otherwise welcome development—greater workforce diversity. For much of the 20th century in America the manager and the managed were the same white men. "You used to run mini-mes," says Nicholas Bloom of Stanford University. That, Ms Sadun notes, meant managers could be assumed to possess an implicit "theory of mind" of their underlings—an intuitive understanding of how they thought and felt about the world.

This is, thankfully, no longer a safe assumption. In America, women make up 42% of managers, up from 38.5% in 2010. Between 2013 and 2022 the share of non-whites in managerial posts has risen from 14% to over 18% (see chart 2). Women and non-whites are still underrepresented in such roles, relative to their share of America's population; non-white employees in particular are likelier than white colleagues to leave a job because they

didn't feel they belonged at their companies. But progress is undeniable. Diversity has, says Mr Nohria, "caught up with us".

The problem for managers, be they women or men, white or not, is that putting yourself in subordinates' shoes is no longer automatic. Because you cannot assume you know what others are thinking, you need keen social "antennae", Mr Nohria observes. Hybrid work, where managers, in Mr Bloom's words, "adjudicate private lives" via decisions about home-working, makes the task even more delicate.

Like diversity, the post-pandemic spread of remote work brings benefits while raising co-ordination costs. Running a workforce virtually imposes what organisational scholars call "management overhead". Even when the network connection is not patchy and people don't forget to unmute themselves, virtual meetings strip out lots of signals, such as eye-contact and gestures. They are more tiring; one study found that people speak more loudly on Zoom than face-to-face.

And they are taking up more and more of managers' time. A study by Microsoft of 31,000 corporate users of its 365 office software in 31 countries found that in March 2023 the average person participated in three times as many Teams video-conferencing meetings and calls as in February 2020. In roughly the same period the typical user sent 32% more chat messages.

The number of unscheduled calls rose by 8% between 2020 and 2022, to 64% of all Teams meetings. Some 60% of such encounters are now under 15 minutes. Shorter activities probably mean more interruptions, says Ms Sadun. Two in three workers in the Microsoft study complained they did not have enough uninterrupted focus time during the workday. "Work has become more staccato," sums up Jared Spataro, who oversaw the research at Microsoft. That, Ms Sadun adds, imposes a heavy cognitive cost—and may explain some of the troubling burnout numbers.

Focus is scarcer for executives, too, including CEOs. When Ms Sadun and co-authors looked at how 1,100 bosses in six countries spent their time, they discovered that only a quarter of their working days involved being alone, and some of that was taken up by writing emails. A long-running study of 27 leading chief executives' time use by Mr Nohria and Michael Porter found that bosses often used long-haul travel to think. The post-pandemic decline in business trips means there is less of this time to recoup. If the composition of executives' working hours reflects the relative value of the things those hours consume, then co-ordination outweighs pondering strategy.

A final thing that may lift the premium for social skills is technology. Ever since ChatGPT, an artificially intelligent chatbot developed by a startup called OpenAI, took the world by storm a year ago, progress in AI has kicked up a notch. Boosters argue that machines can take on some of the tasks that would in the past have required "brilliance", to echo Mr Joly. The comparative value of the non-artificial intelligence required to perform them may decline. OpenAI's boss, Sam Altman, went so far as to declare that the cost of intelligence is "going to be on a path towards near-zero".

It is unclear when—if ever—AI will live up to such bold forecasts. But it is likely to have at least some effect on the practice of management and the competences required for it. Fully 70% of respondents told the Adecco survey that they were already using "generative" AI at work. Mr Spataro of Microsoft (which has a big stake in OpenAI) says that managers are such tools' most effective users. "They treat it as the newest member of the team, and delegate tasks to it." And not just routine administrative chores: nearly 80% of people in Microsoft's study said they would be comfortable using AI for analytical work; three-quarters said the same of creative work.

Managers are not about to become clueless empaths. Many still seek old-school markers of good management. Those on Adecco's EZRA platform are

much likelier than their employers to ask for coaching on strategy, individual development and articulating ambition, and much less likely to pick emotional intelligence, trust-building and collaboration (see chart 3). Maybe more popular still than Stanford's "Touchy Feely" course is "Paths to Power", in essence a how-to guide for aspiring Machiavellian princes.

These competing priorities may be why so many managers feel overwhelmed. The new model of management, which favours social aptitude and co-ordination skills, is taking hold before the old one, which rewarded expertise and intellect, has loosened its grip. Amid all this managers are, in the words of Denis Machuel, head of Adecco Group, "lost in translation". The quicker they find themselves, the better: for them and their employers alike. ■



不可能的任务

可怜的现代管理者——他们精疲力尽、心烦意乱、不堪重负

企业的领导岗位比以往任何时候都更具挑战，但也更加重要

管理者不是显而易见值得同情的对象。要为颐指气使的办公室头头们感到难过就很难了，更别提那些年入百万的高管大佬了。然而他们的处境值得仔细研究，甚至也值得一些同情。从高管办公室到中层领导的工位，他们繁忙的工作有增无减。

招聘和外包公司德科集团（Adecco Group）最近对23个国家的员工进行的一项调查发现，在1.6万名受访管理者中，在过去12个月内感到筋疲力尽的人数比例从去年的43%增加到68%，高于非管理人员的60%。“我感觉自己就像跳上了一台跑步机，坡度和速度都由别人控制着。”一位科技大厂高管叹了一口气说道。他的许多同行也有同样的感受。管理者越来越需要精力耐力——招聘公司称，公司经常询问高管职位的候选人是否经常锻炼身体。

这不仅对疲惫的个人来说是一个问题，对他们的雇主来说同样是一个问题，而且鉴于近几十年来管理岗位不断增加，对整个经济体来说都是个问题。如今美国有1900万名管理者，比2000年增加了60%。美国公司有五分之一的员工管理他人。

由于知识产业里的公司逐渐把日常任务自动化，而且都依赖同样的数字工具（Amazon Web Services、Gmail、微软办公软件），因此能给它们带来竞争优势的是更好的管理，而不是对技术的投资。管理不善可能会降低生产率并提高员工流失率，导致竞争力削弱。盖洛普（Gallup）2015年的一项调查显示，一半的美国人离职是因为上司差劲。去年，麦肯锡咨询公司发现，同样比例的离职者表示，他们感觉自己没有受到上司的重视。

因此，良好管理的价值越来越大。与此同时，管理者的工作环境正在发生转变。与过去相比，某些技能在新环境中的回报会增加，另一些技能的回

报会变少。其结果是，你未来的上司将会和你父母那一代的上司不一样。

波士顿咨询公司的老板施伟策（Christoph Schweizer）回忆道，直到2000年代时，“CEO还都是超级英雄”，他们非同凡响，很少犯错，从不犹疑。对于各式高管来说，“最高的赞美就是‘才华横溢’”，休伯特·乔利（Hubert Joly）说。他曾是电子产品零售商百思买（Best Buy）的CEO，如今在哈佛商学院执教。

智力仍然很重要。一项针对瑞典企业老板的研究发现，大公司领导的智商水平一般位列总人口的前17%。但在各个管理层级上，更软性的社交技能都逐渐变得更为重要，例如清晰沟通、建立信任，以及愿意展现出脆弱的一面。哈佛商学院前院长尼廷·诺里亚（Nitin Nohria）表示，包括CEO在内的高管需要能从容面对不确定性，并愿意把那些放在过去他们绝不会放手的战略责任也委托给他人。（诺里亚出任董事长的Exor持有《经济学人》母公司的股份。）

哈佛大学的大卫·戴明（David Deming）发现，需要社交互动的管理岗位的数量增速快于平均水平，此类职位的工资增速也是如此。哈佛商学院的拉法埃拉·萨顿（Raffaella Sadun）及其同事对高管招聘广告的一项研究发现，2000年至2017年间，提及社交技能的职位描述增加了近30%。那些列明对财务和物质资源的管理能力的减少了40%（见图表1）。公司到德科的培训平台EZRA上为自家主管聘用管理教练时，最常提出的目标包括沟通、情商、建立信任和协同合作。斯坦福大学商学院最热门的课程之一是《人际互动》（Touchy Feely），教学员如何评估自己给他人的印象。

社交技能可以更好地协调人员、目标和资源，因而越来越受欢迎。而21世纪的商业又比以往任何时候都更需要这样的协调。以前，管理者管理的是执行重复性任务的个人。如今，他们管理的往往是组成团队做复杂项目的专业人员，而项目的结果难以精确衡量。公司的外部环境也变得更加复杂。正如戴明所说，所有这些都意味着“综合所有因素做出一项决定需要更多的时间”。管理者归根结底主要扮演协调者的角色，好的管理者可以减少决策所需的时间。因此，这种让不同的人和目标顺利融合起来的能力

非常宝贵，特别是相对于纯粹的智力和技术技能而言。

让协调变得更加困难的一个因素是一个原本受欢迎的变化——员工更加多元化。在美国20世纪的大部分时间里，管理者和被管理者都是白人男性。“过去你管理的差不多是些小号的你。”斯坦福大学的尼古拉斯·布鲁姆（Nicholas Bloom）说。萨顿指出，这意味着可以假定管理者拥有不言自明的对下属的“心理推测能力”，即对下属的世界观和感受有直觉式的了解。

值得庆幸的是，这已经不再是一个可靠的假定。如今在美国，女性管理者占42%，高于2010年的38.5%。2013年至2022年间，管理职位上非白人的比例从14%上升至18%以上（见图表2）。相对于女性和非白人在美国人口中所占的比例，他们在管理岗位上的代表性仍然不足，而且相较于白人员工，非白人更有可能离职，因为他们觉得自己在公司没有归属感。但进步是不可否认的。诺里亚表示，多元化“已开始显现其影响”。

对于管理者来说，无论其性别和肤色，问题在于不再能自然而然地站在员工的角度换位思考。诺里亚指出，因为不能认为自己知道别人在想什么，所以需要具有敏锐的社交“触角”。用布鲁姆的话来说，在混合工作模式下，管理者通过对居家工作做出决定，“判决着员工的私人生活”，这让管理的工作变得更加微妙。

与多元化一样，疫情后远程工作的普及在带来好处的同时也增加了协调的成本。在线管理员工队伍带来了组织学学者所说的“管理开销”。即使网络连接没问题，没有人忘记取消静音，虚拟会议也会让交流失去大量眼神交流和手势等非语言信号。虚拟会议也让人更加疲惫。一项研究发现，人们在Zoom上说话的声音比面对面交流时更大。

而且虚拟会议正越来越多地占用管理者的时间。微软对31个国家使用365办公软件的3.1万名企业用户的一项研究发现，2023年3月，人均参加Teams视频和音频会议的次数是2020年2月的三倍。在大概同一段时间内，人均发送的聊天消息增加了32%。

2020年至2022年间，临时线上会议的次数增加了8%，占有Teams会议的64%。现在大约60%的此类会议在15分钟内结束。萨顿说，较短的会议可能意味着更多干扰。在微软的研究中，有三分之二的员工抱怨他们在工作日缺乏足够的时间去不间断地专注于工作。“工作变得越来越断断续续。”负责微软这项研究的贾里德·斯帕塔罗（Jared Spataro）总结道。萨顿补充说，这会带来沉重的认知成本——或许也给前述令人不安的疲惫数据提供了一些解释。

高管们也比以前更难专注了，包括CEO在内。萨顿和合著者研究了六个国家1100名老板的时间分配，他们发现这些高管的工作日只有四分之一的时间无人打扰，其中一些时间用来写电子邮件。诺里亚和迈克尔·波特（Michael Porter）对27位大公司CEO的时间利用情况进行了长期跟踪研究，发现他们经常利用长途旅行的时间思考问题。疫情后商务旅行的减少意味着这一部分时间更少了。如果高管工作时间的构成反映了这些时间所处理的工作的相对价值，那么比起战略思考，协调的价值更高。

最后一个可能推高社交技能的价值因素是技术。自从一年前创业公司OpenAI开发的聊天机器人ChatGPT席卷全球以来，AI大大向前迈进了一步。支持者认为，机器可以承担一些过去需要“才华”才能完成的任务，这与乔利的观点相呼应。执行这些任务所需的非人工智能的相对价值可能会下降。OpenAI的老板山姆·阿特曼（Sam Altman）甚至宣称智力成本“将逐渐趋近于零”。

目前尚不清楚AI何时能够实现这种大胆预测——如果它能够实现的话。但它应该至少会对管理的实践及其所需的能力产生一定影响。足有70%的受访者在德科的调查中表示，他们在工作中已经在使用“生成式”AI。微软（持有OpenAI大量股份）的斯帕塔罗表示，此类工具对管理者最为有效。“他们将这些工具视为团队的最新成员，并向其委派任务。”而且委派的不仅仅是日常行政事务。在微软的研究中，近80%的人表示他们愿意利用AI处理分析工作，四分之三的人对创意类工作也持同样的态度。

管理者不会成为只有共情能力但缺乏专业能力的人。许多主管仍然追求擅

长管理的传统特征。与其雇主相比，德科EZRA平台上的用户寻求战略、个人发展和清晰表达抱负方面的指导的可能性要高得多，选择提高情商、建立信任和协同合作方面的培训的可能性要小得多（见图表3）。也许比斯坦福大学的《人际互动》课程更受欢迎的是《通往权力之路》（Paths to Power），这门课本质上是为那些野心勃勃的马基雅维利主义者提供的成功指南。

这些相互竞争的侧重点可能是许多管理者感到不堪重负的原因。偏重社交能力和协调能力的新管理模式正开始占据主导，而奖励专业知识和才智的旧模式尚未放松其掌控。在所有这些对他们的要求和期待之中，用德科集团负责人丹尼斯·马丘埃尔（Denis Machuel）的话说，管理者“迷失了方向”。他们越快明确自己的角色越好——对于他们自己和他们的雇主来说都是如此。■



A year in the life of Meta

How Mark Zuckerberg escaped a metaverse-sized hole

His long-term bet still stands, though

IT HAS BEEN quite a year for Mark Zuckerberg. The co-founder of Facebook, a social-media Goliath now called Meta, is no stranger to public rebuke. But exactly a year ago even investors appeared to throw in the towel, accusing him of trashing the core business while lavishing money on his pharaonic dreams for the metaverse, a virtual world where he alone appeared to float in a deluded fantasy realm. On the day Meta issued weak third-quarter earnings last year, its share price fell by more than a fifth. Zuck's name was mud.

In the year since it has been rehabilitated. Meta's core business—engaging 3.1bn people a day on Facebook, Instagram and WhatsApp, and selling advertisers access to their attention—is back to rude health. On October 25th the company reported revenues of \$34.1bn in the third quarter, up by 23% year on year. That was the sharpest rise since the digital boom of the covid-19 pandemic. Net profits more than doubled to \$11.6bn. Meta's share price has risen by 250% since last year's nadir.

In the media, Mr Zuckerberg gets little credit for his business nous. There is more focus on other stuff: his recent passion for martial arts; the cage fight with Elon Musk that never happened; public harangues, such as lawsuits filed by dozens of American states on October 24th, alleging that Meta intentionally sought to make users addicted to Facebook and Instagram. And yet, in the space of a few months late last year, he made two transformative business decisions that were remarkable for their humility and agility—all the more so, given that he controls 58% of the firm's overall voting rights and barely needs to work, let alone listen to shareholders.

In response to investor pressure, Mr Zuckerberg performed one of the fastest pivots in tech history. Within a fortnight of the third-quarter rout he slashed Meta's spending plans, cut costs and fired staff. And in response to OpenAI's ChatGPT and the blaze of excitement around generative artificial intelligence (gen AI for short) he launched an internal revolution aimed at using the technology to galvanise Meta's core business. Those manoeuvres reveal a lot about Mr Zuckerberg's leadership style. They may even end up vindicating his faith in the metaverse.

When Mr Zuckerberg realised he had incensed investors, those around him say, he did not panic. He became methodical. As Nick Clegg, a close adviser to Mr Zuckerberg, explains, his boss doesn't like people around him "shouting and yelling". He prefers, like an engineer, to break down a problem to its component parts and decide on a course of action. In this case, he understood that his long-term focus was at odds with investors' short-term horizons. So he decided to "cut his cloth accordingly". But he kept many of his long-term investment plans intact, emphasising that they mainly concerned AI, not the metaverse. That emphasis looked shrewd weeks later, when ChatGPT burst onto the scene.

Meta had spent years building up its AI infrastructure. Rather than creating chatbots, it was looking for ways to use AI to improve engagement and make its ad business more efficient, as well as working on mixed-reality headsets for the metaverse. Its top brass soon realised they had all the ingredients—enough data centres, graphics processing units (GPUs) and boffins—to make the most of gen AI. By February they had worked out what to focus on. By July they had made their Llama 2 large language model available free of charge to developers. In September they announced the first gen-AI-related gadgets, such as smart spectacles. Mr Zuckerberg, for his part, threw himself into the technical nitty-gritty. His competitive instinct awakened. He appears to have been rejuvenated by working on a new technology rather than on the irksome task of cost-cutting.

Making Llama open-source helped turn Mr Zuckerberg from Silicon Valley's villain to its hero. Leigh Marie Braswell of Kleiner Perkins, a venture-capital firm, says startups "really applauded" the move, which helped many develop AI-related businesses. And gen AI may be no less transformative for Meta itself than for Microsoft and Alphabet, owner of Google, whose early bets on proprietary large language models have attracted most of the attention.

Start with engagement. Meta is populating its social-media platforms with chatbot avatars which, it hopes, will increase the amount of time people spend on their feeds, and help businesses interact with customers on messaging apps. Some users call them a bit humdrum, probably because the firm is worried about AI's "hallucinations". Nonetheless, there is potential. Take Jane Austen, an avatar that emulates the author's haughty humour. When asked to describe Mr Zuckerberg, she says he is "bright, driven but perhaps a bit too fond of his own ideas". She describes the metaverse as a "virtual world where people can escape reality and live their best lives. Dear me, how...unromantic."

More compelling in the near term is AI's potential for advertising. Since Apple restricted Meta's ability to track user data across third-party apps on iPhones, Mr Zuckerberg's firm has had to overhaul its advertising business "down to the studs", says Eric Seufert, an independent analyst. It has done that fairly effectively, he thinks, by using AI to model user behaviour, rather than tracking the behaviour itself. Last year the company rolled out ad technology called Advantage+, which used AI to automate the creation of ad campaigns. Brent Thill of Jefferies, an investment bank, says that advertisers are impressed. J. Crew Factory, a clothing retailer, has told Meta that the features boosted its return on ad spending almost seven-fold.

Gen AI could take automation further. This month Meta launched tools that let advertisers instantly doodle with different backgrounds and wording.

These are baby steps so far, but Andy Wu of Harvard Business School likens them to the start of a gold rush. He says that by creating gen-AI-infused ad campaigns Meta could benefit from the technology as much as Nvidia, the leading maker of GPUs.

Advertisers have their concerns. An ad man at AdWeek NYC, an industry jamboree, described Meta's AI-assisted campaigns as "black boxes" where it controls all the data. That gives it huge influence over a brand's identity, which could be tarnished if the AI goes rogue. Others worry about AIs doing untoward things to boost engagements on Meta's social networks, which could hurt brands by association. Controversies over fake images of the conflict in Gaza on social media illustrate how fraught the terrain remains. Not everyone is convinced by Mr Clegg's insistence that Meta is prepared for this thanks to years of investment in safety and platform integrity.

Some investors, too, remain sceptical. Mark Mahaney of Evercore ISI, another investment bank, reckons that 95% of them would prefer Mr Zuckerberg to spend less on the metaverse. Many are wary of investments in hardware, such as virtual-reality headsets, which tend to generate lower margins than digital products.

Still, Mr Zuckerberg has "not resiled at all" from his long-term bet, Mr Clegg says. Some VR enthusiasts see AI as the metaverse's saviour, helping with the development of crucial hand-tracking technologies and making it cheaper for creators to build three-dimensional worlds. Meta's Smart spectacles, integrated with its chatbot, MetaAI, and built by Ray-Ban, offer a hint of things to come. They capture what the wearer sees, can live-stream it on social media, and answer questions. Asked for sources on critical thinking in business, the AI replied "The Economist". Smart, smarmy or scary? Take your pick. ■



Meta这一年

扎克伯格逃出元宇宙级大坑

但他的长期赌注并未动摇

对扎克伯格来说，过去的一年可谓跌宕起伏。这位社交媒体巨头Facebook（现已改名Meta）的联合创始人对公众的指责全不陌生。但到了一年前此时，就连投资者似乎也心灰意冷，指斥他丢弃了公司的核心业务，将大把金钱撒在了春秋大梦般的元宇宙中，在这个虚拟世界里，似乎只有他独自漂浮在妄想的幻境中。去年Meta发布疲软的第三季度财报的当天，股价急挫超过五分之一。扎克伯格深陷泥潭。

在那之后的一年来，Meta恢复了元气。其核心业务——在Facebook、Instagram和WhatsApp上每天吸引31亿人并向广告主出售获取这些人注意力的机会——重新焕发出强健活力。10月25日，该公司公布第三季度收入341亿美元，同比增长23%。这是自新冠疫情催生的数字经济繁荣以来的最大涨幅。净利润翻了一番不止，达到116亿美元。与去年的谷底相比，Meta的股价已上涨了250%。

在媒体报道中，鲜有人称道扎克伯格的商业头脑。人们更关注别的东西：他近来对武术的热衷；迟迟没有举行的与马斯克的笼中格斗；公众的叱责，例如10月24日美国数十个州提起诉讼，指控Meta故意要让用户对Facebook和Instagram上瘾。然而，在去年最后几个月的时间里，他做出了两项变革性的商业决策，其中展现出的谦逊和灵活令人刮目相看——考虑到他控制着公司58%的总投票权，几乎不需要工作，更不用说听取股东的意见，这就更难能可贵了。

面对投资者施压，扎克伯格完成了科技史上最快的转向动作之一。在去年第三季度业绩大跌后的两周内，他大幅裁减了Meta的支出计划，削减成本并解雇员工。面对OpenAI的ChatGPT以及围绕生成式人工智能的热潮，他发起了一场内部革命，目标是利用这项技术来激活Meta的核心业务。这些动作在很大程度上揭示了扎克伯格的领导风格，甚至最终可能证明他对元

宇宙的信仰是正确的。

扎克伯格身边的人说，当他意识到自己激怒了投资者时，他并没有惊慌失措。他变得很有章法。扎克伯格的亲密顾问尼克·克莱格（Nick Clegg）解释道，他的老板不喜欢身边的人“大喊大叫”。他更喜欢像工程师一样，把难题分拆成各个组成元素，然后确定一系列行动方案。在这种情况下，他明白自己的长期聚焦与投资者的短期关注不一致。因此，他决定“相应地量入为出”。但他完好无损地保留了自己的许多长期投资计划，强调它们主要涉及AI，而不是元宇宙。几周后，当ChatGPT横空出世时，这番强调看起来十分精明。

Meta此前已经花了很多年建立自己的AI基础设施。重点不是打造聊天机器人，而是设法利用AI提高用户沉浸度、提升广告业务的效率，以及为元宇宙开发混合现实头显。公司高层很快就意识到他们具备了充分利用生成式AI的所有要素——足够的数据中心、图形处理器（GPU）和研发人员。到2月，他们已经确定了重点方向。7月，他们向开发者免费提供了Llama 2大语言模型。9月，他们发布了第一批生成式AI相关的小设备，例如智能眼镜。扎克伯格自己则潜心钻研技术要点。他的竞争本能被唤醒了。看起来，研究一项新技术——而不是令人厌烦的成本削减工作——让他重新充满了活力。

开源的Llama让扎克伯格从硅谷的反派变成了英雄。风险投资公司凯鹏华盈（Kleiner Perkins）的利·玛丽·布拉斯韦尔（Leigh Marie Braswell）说，创业公司“非常赞赏”这一举动，它帮助许多公司发展了AI方面的业务。生成式AI对Meta本身的变革作用可能不亚于对微软和谷歌母公司Alphabet的影响，后两家公司由于先人一步押注自营的大模型而吸引了最多关注。

先来看对用户参与度的影响。Meta正在其社交媒体平台上添加聊天机器人的虚拟化身，希望它们会带动人们花更多时间刷信息流，并帮助企业通过即时通讯应用与客户互动。一些用户说这些化身有点乏味，这可能是因为该公司担心AI的“幻觉”效应。无论如何，在这方面还有潜力可挖。比如简

- 奥斯汀（Jane Austen）这个化身，它模仿了同名作者高傲的幽默感。请她描述扎克伯格时，她说他“聪明、有干劲，但可能有点太陶醉于自己的想法了”。她将元宇宙描述为“一个人们可以逃避现实、活出最美好人生的虚拟世界。天啊，太.....不浪漫了”。

短期内，更令人瞩目的是AI在广告方面的潜力。独立分析师埃里克·塞弗特（Eric Seufert）说，自从苹果限制Meta在iPhone上通过第三方应用追踪用户数据以来，扎克伯格的公司不得不“彻底改造”其广告业务。他认为，Meta取得了不俗的成效，它不再追踪用户行为本身，而是利用AI为用户行为建模。去年，该公司推出了名为Advantage+的广告技术，用AI自动创建广告推广活动。投资银行杰富瑞（Jefferies）的布伦特·蒂尔（Brent Thill）表示，广告主为之折服。服装零售商J. Crew Factory告诉Meta，这些功能将其广告支出的回报提高了近七倍。

生成式AI有可能进一步提升广告自动化。Meta在10月推出了几款工具，可以让广告主即时生成不同的背景图像和文案。到目前为止，这些还只是初步尝试，但哈佛商学院的安迪·吴（Andy Wu）将其比作一场淘金热的开端。他说，通过创建生成式AI加持的广告活动，Meta从这项技术中的获益或许能与GPU龙头商英伟达相当。

广告主也有自己的顾虑。在行业盛会AdWeek NYC上，一位广告人将Meta的AI辅助营销形容为“黑盒子”，它控制着所有数据。这让Meta对品牌形象拥有了巨大的影响力，如果AI失控，品牌形象就可能受损。还有人担心AI会为了提高Meta社交网络上的用户参与度而做一些不光彩的事情，导致品牌遭到连带损害。社交媒体上关于加沙冲突的虚假图片引发的争议就说明了这个问题仍然令人担忧。克莱格坚称，凭借多年来在安全和平台操守上的投入，Meta已经对此做好了准备。但并非人人都信服。

一些投资者也仍然持怀疑态度。另一家投资银行Evercore ISI的马克·马哈尼（Mark Mahaney）认为，95%的投资者会希望扎克伯格在元宇宙上少花些钱。许多人对虚拟现实头显等硬件投资态度谨慎，因为这些产品的利润率往往低于数字产品。

尽管如此，扎克伯格"完全没有撤回"他的长期赌注，克莱格表示。一些虚拟现实迷将AI视为元宇宙的救星，认为它能帮助开发关键的手部追踪技术，并降低创作者构建三维世界的成本。由雷朋（Ray-Ban）制造的Meta的智能眼镜集成了其聊天机器人MetaAI，透露出未来的发展方向。它能捕捉佩戴者的所见所闻，在社交媒体上直播，还能回答问题。当被问及在哪里可以找到商业中的批判性思维时，这个AI的回答是“《经济学人》”。是机智、谄媚，还是可怕？你自己看吧。■



Television

A golden age of TV is losing its shine

How Ted Lasso killed Tony Soprano

Pandora's Box. By Peter Biskind. William Morrow; 400 pages; \$32.50. Allen Lane; £25

You Are What You Watch. By Walt Hickey. Workman; 240 pages; \$30 and £25

"SHH, IT'S OK," whispers Frank Underwood (played by Kevin Spacey), as he strokes an injured dog just hit by a car. As the dog whimpers, he soothes it—then, after looking the viewer directly in the eye, wrings its neck.

Not so long ago this scene, which launched Netflix's "House of Cards" in 2013, would have been unshowable on American television. Broadcasters were bound by federal rules against rude or racy content and cowed by advertisers who demanded wholesome heroes and happy endings. But in the 21st century bad guys have had a good run. The amoral Congressman (later President) Underwood, the violent mobster Tony Soprano, the cocaine-smuggling Pablo Escobar of "Narcos" and the megalomaniacal media baron Logan Roy have lit up the small screen in what critics have hailed as a golden era for TV. As viewers migrated from broadcast channels to cable, and then to streaming, shows became darker and more daring.

Yet today, the TV business is in flux once more—and so is the nature of its output. Insurgent streamers have settled in as cosy incumbents. Big tech firms are using streaming to promote their other products. The upshot, argues Peter Biskind in "Pandora's Box", a binge-worthy book about TV, is that the risky, rule-breaking shows that defined television in the early 21st century are giving way to less original fare.

Mr Biskind, a cultural critic, traces TV's recent golden era to the launch in 1972 of Home Box Office (HBO), a cable network. With its "G-String Divas", "Taxicab Confessions" and so on, HBO was initially known for "fighting and fondling". But then it began to commission original drama series and ventured where broadcast television did not. HBO and other cable networks could ignore the nanny rules that constrained broadcasters. And their subscription fees meant no ads, and therefore no jittery advertisers demanding bland, brand-safe content.

Writers relished this freedom. "The things I'm getting away with, I should be arrested for," said a writer on "Oz", a boundary-pushing HBO prison drama whose plotlines include an inmate having a swastika burnt onto his bottom with a cigarette. Bossy advertisers got short shrift. When executives at AMC, another cable network, tried to arrange a product placement for Jack Daniel's whisky in "Mad Men", a writer responded: "If you want me to work this thing into the show, I'm going to have it sterilising equipment in the back alley of an abortionist clinic."

New television was not just about shock. Cable allowed writers to make shows more sophisticated. As David Chase, the creator of "The Sopranos", put it: "On network, everybody says exactly what they're thinking at all times. I wanted my characters to be telling lies." Since cable aired episodes repeatedly, writers could assume that viewers were up to date, meaning that story arcs could last whole seasons rather than being crammed into self-contained episodes. This attracted star directors and actors to try out the small screen, including Steven Spielberg and Tom Hanks, who made "Band of Brothers" for HBO in 2001. In drama, "The beginning is inevitable, the end is inevitable, but the middle is not so inevitable, and television is about the middle," says Brian Cox, who played Logan Roy in HBO's "Succession".

Streaming took what cable started and pushed it further. Making whole

seasons available on demand has allowed viewers to binge, reviving the importance of plot, which had been subordinated to character in shows like “The Sopranos”. With past episodes fresh in the viewer’s mind, less plodding exposition is needed. Streamers’ offering of thousands of shows at once has also enabled niches to thrive. Streaming has found a home for ideas that were too daring, weird or obscure even for cable, from Korean horror to Swedish romance. As Reed Hastings, Netflix’s co-founder, put it, “We are to cable networks as cable networks were to broadcast networks.”

Today Hollywood’s output is changing. Six months of strikes by writers and actors have halted production this year. (Writers have gone back to work, but actors have not.) Even before that, studios were preparing to cut back, as investors began to demand evidence of profits rather than just subscriber growth. In America more than 2,000 original series were released last year (see chart). This will probably be the high-water mark, believes John Landgraf, chairman of FX, a cable network.

| *The upcoming season*

As the quantity of new shows falls, some believe the quality is diminishing, too. Several studios have been plagued by real-life drama: from 2018, HBO endured four unhappy years of ownership by AT&T, a phone company that knew little about TV. (Its boss suggested producing “Game of Thrones” in 20-minute episodes to be mobile-friendly.) Across the industry, a shift is under way. Mr Biskind quotes writers and actors who complain that streamers are returning to the safe centre ground that broadcast networks used to occupy. “I want to do in-your-face shit,” says Kenya Barris, the creator of inventive shows such as “Black-ish”. But “Netflix wants down-the-middle...Netflix became CBS.”

Advertising has made a comeback, as streamers try to squeeze more dollars out of subscribers. And bingeing is being reined in. Most streamers now release new shows weekly to keep subscribers on board for longer. Even

Netflix, the pioneer of bingeing, is moving this way, dripping out episodes of some new shows one by one.

With hundreds of millions of subscribers, the likes of Netflix and Amazon Prime Video have bigger audiences than any broadcaster. As they grow, streamers seem to be edging away from niches and towards the mainstream. One example is sport. Amazon has shelled out for the rights to American football, and Netflix will air its first live sporting event (a celebrity golf tournament) in November. Streamers and cable firms are also becoming like film studios by developing a dependence on franchises and sequels. HBO, which long resisted spin-offs and prequels, has embraced a “Sex and the City” reboot and multiple “Game of Thrones” spin-offs, including animations and a stage play.

It is hardly surprising that studios are leaning on franchises during hard times: they are safe bets, argues Walt Hickey in “You Are What You Watch”, a chart-filled tour through the entertainment business. Mr Hickey, a data journalist at Insider, a news site, calculates that since 1980 the average movie sequel has made 4.2 times its budget at the box office, while the equivalent figure for original works is 2.8 times.

Perhaps the biggest driver of the move to the mainstream is the tech titans’ push into streaming. Both Amazon and Apple TV+ will survive the financially ruinous streaming wars. (They will “hold everybody’s head under water until they drown,” Steven Soderbergh, a film director, tells Mr Biskind.) But Amazon and Apple see streaming as a way to bolster audiences’ interest in their other businesses. As Jeff Bezos, Amazon’s founder, once said to groans in Hollywood: “When we win a Golden Globe, it helps us sell more shoes.”

The result is resolutely brand-safe output. Rather than the “nudity, raw language and violence” on other streamers, Apple wants to make shows

with “broad appeal”, Tim Cook, the company’s boss, has said. This leads to shows like “Ted Lasso”—a “sunshine enema”, in the words of one of its producers—and “The Morning Show”, which debuted as a hard-hitting drama about a broadcast-news network’s toxic culture but has degenerated into a mindless soap opera. Amazon, whose early TV commissioning was more daring, now also focuses on the middle ground, with series such as “Citadel”, a big-budget, low-imagination thriller with plenty of explosions and no surprises.

There are some subjects where the globe-spanning tech titans are even touchier than the old broadcast networks. Apple recently cancelled “The Problem with Jon Stewart”, a satirical current-affairs show, reportedly because of concerns about Mr Stewart’s critical stances on China and AI.

Some of the people who helped to create TV’s golden age are downbeat about its future. HBO “died at 50”, Michael Fuchs, who ran the network in the 1980s, tells Mr Biskind. “There’s no longer an HBO.” A producer of “The Wire”, one of HBO’s grittiest and most celebrated shows, says the company would never make it today. For creatives, television’s golden age is turning into a gilded cage. ■



电视

电视的黄金时代正在褪色

足球教练如何干掉黑道家族【《潘多拉的盒子》、《人如其观》书评】

《潘多拉的盒子》，彼得·比斯金德著。William Morrow出版社，400页，32.50美元；Allen Lane出版社，25英镑。

《人如其观》，沃尔特·希基著。Workman出版社，240页；30美元/25英镑。

“嘘，没事儿。”弗兰克·安德伍德（凯文·史派西饰）轻抚着一只刚被车撞伤的狗，低声说道。狗在呜咽，他安抚着它——然后，他抬头直视着观众的眼睛，拧断了狗的脖子。

这是奈飞（Netflix）2013年开播的《纸牌屋》开头的一幕，而就在那之前不久，这样的画面还没法在美国的电视上播出。广播电视公司一方面受到联邦法令的限制，不得随意播出粗俗或淫秽的内容，一方面又受到广告主的胁迫，被要求刻画正义英雄并安排圆满结局。但是到了21世纪，反派人物却大行其道。比如缺德的国会议员（后来成为总统的）安德伍德、《黑道家族》中的暴徒托尼·索普拉诺、《毒梟》中走私可卡因的巴勃罗·埃斯科瓦尔，以及《继承之战》中不可一世的媒体大亨洛根·罗伊等，他们在电视荧屏上大放异彩。剧评人则誉之为电视的黄金时代。随着观众从传统广播电视转移到有线电视，再到流媒体，剧集变得越发暗黑和大胆。

然而今天，电视业再次处于变化之中——而它产出的内容亦是如此。此前异军突起的流媒体已经站稳脚跟，变成了春风得意的在位者。大型科技公司正使用流媒体来推广自己的其他产品。其结果是，21世纪初那些以大胆冒险、打破常规为特色的剧集正在让位于原创度不高的大众化节目——彼得·比斯金德（Peter Biskind）在他让人欲罢不能的关于电视业的《潘多拉的盒子》（Pandora's Box）一书中指出。

文化评论家比斯金德认为，电视的黄金时代可以追溯到1972年有线电视网Home Box Office（HBO）的开播。凭借《丁字裤天后》（G-String Divas）、《出租车实录》（Taxicab Confessions）等剧集，HBO最初以“黄暴”闻名。但后来它开始委托制作原创剧集，并涉足广播电视公司从未进入的领域。HBO和其他有线电视网可以无视对那些限制传统广播电视公司的条条框框。它们收取订阅费，也就没有了插播广告，因此也就不会有神经过敏的广告主要求它们制作平淡乏味而不会伤及品牌的内容。

编剧们很享受这种自由。《监狱风云》的一位编剧说：“我搞的那些事情都够他们把我逮进去啦。”HBO的这部以监狱为题材的剧集不断挑战人们的底线，其中有一段，一名囚犯被人用香烟在屁股上烫了个纳粹标志。喜欢发号施令的广告主受到了冷遇。当另一家有线电视网AMC的高管们试图在《广告狂人》中植入杰克丹尼威士忌的广告时，一位编剧回应：“如果你想让我把这玩意儿加到剧里头，我就让人拿它在堕胎诊所后头的巷子里给器械消毒。”

新派电视不只是能让观众目瞪口呆。有线电视也让编剧们得以创作出复杂精良的剧集。正如《黑道家族》的编剧大卫·蔡斯（David Chase）所说：“在网络上，人人都心直口快，直抒胸臆。我希望我笔下的人物是会说谎的。”由于剧集在有线电视上反复播放，编剧可以认为观众始终都跟得上剧情进展，这也就使得故事线可以贯穿整个播出季，而不是塞进单独一集里。这吸引了明星导演和演员来试水小荧幕，斯皮尔伯格和汤姆·汉克斯就在2001年为HBO制作了《兄弟连》。在戏剧中，“开头不能省，结尾不能省，中间部分却没那么紧要，而电视剧是关于中间部分的。”在HBO的《继承之战》中扮演洛根·罗伊的布莱恩·考克斯（Brian Cox）说。

流媒体继承并发展了有线电视开创的模式。观众可以随时点播整季剧集，痛快刷剧，这让剧情重新变得重要起来，一改过去在《黑道家族》等剧集中塑造人物优先于构造情节的取向。由于观众对前几集的内容还记忆犹新，所以不需要过多冗长的剧情回顾。流媒体同时提供成千上万个节目，这也让小众内容得以蓬勃发展。过去那些即使对有线电视来说都过于大

胆、怪异或晦涩难懂的故事创意——不管是韩国恐怖片还是瑞典爱情片，都在流媒体中找到了一席之地。奈飞的联合创始人里德·黑斯廷斯（Reed Hastings）说：“我们之于有线电视网，就如有线电视网之于传统广播电视网。”

如今好莱坞的产出正在变化。今年编剧和演员持续了六个月的罢工导致影视剧制作停摆。（目前编剧们已经返回岗位，但演员们还没有。）甚至在罢工之前，由于投资者开始要求看到利润、而不仅仅是订户增长，影视公司就在准备减产了。去年，美国发行了2000多部原创剧集（见图表）。这或许是产出的最高点，有线电视网FX的董事长约翰·兰德格拉夫（John Landgraf）认为。

| 新一季将开播

随着新剧数量的下降，一些人认为质量也在降。好几家影视公司遭遇了让它们焦头烂额的现实戏剧：HBO自从2018年被电视业门外汉、电信公司AT&T收购以来，经历了不愉快的四年。（AT&T的老板建议把《权力的游戏》制作成20分钟一集的剧集，以便在手机上播放。）放眼整个行业，一种转变正在发生。比斯金德引述了一些编剧和演员的抱怨，他们称流媒体正在回归传统广播电视网过去一贯秉持的安全的中间立场。“我就想写些让你难受的玩意。”《喜新不厌旧》（Black-ish）等原创剧的编剧肯亚·巴里斯（Kenya Barris）说。但“奈飞要的是中间路线，四平八稳……奈飞变成了CBS”。

随着流媒体试图从订户身上榨取更多利润，广告又卷土重来。刷剧也不如过去那么痛快了。如今大多数流媒体会每周发布一次新剧，以期更长久地留住订户。就连刷剧模式的先驱奈飞也在转向这条路，挤牙膏似地一集一集播放某些新剧。

奈飞和亚马逊Prime Video这类平台拥有数亿订户，超过了任何一家传统广播电视公司的观众数。随着它们羽翼渐丰，流媒体似乎正在从小众走向主流。体育赛事就是一个例证。亚马逊已经花大钱买下了美国橄榄球赛事的转播权，奈飞将在11月直播其第一场体育赛事（一场名人高尔夫锦标

赛）。流媒体和有线电视公司也开始像电影公司一样，对系列作品和续集产生了依赖。HBO长期以来拒拍衍生剧和前传，但现在已经欣然接受了《欲望都市》的重启版和《权力的游戏》的多部衍生剧，后者包括几部动画片和一部舞台剧。

电影公司在困难时期依赖系列作品并不奇怪：这是保险的选择，沃尔特·希基（Walt Hickey）在《人如其观》（You Are What You Watch）中指出。该书使用了大量图表来展现影视娱乐业。希基是新闻网站Insider的数据记者，据他计算，自1980年以来，电影续集的平均票房收入是其预算的4.2倍，而原创作品是2.8倍。

或许让流媒体走向主流的最大推手是科技巨头的挤入。亚马逊和Apple TV+都将在这场烧钱的流媒体大战中活下来。（电影导演史蒂文·索德伯格告诉比斯金德，它们会“把每个人的头摁在水里，直到他们淹死”。）但亚马逊和苹果把流媒体视为提高观众对它们其他业务的兴趣的一个途径。亚马逊的创始人贝索斯曾在好莱坞对那些满腹牢骚的人说，“赢得金球奖能帮我们卖出更多鞋子。”

这导致节目制作要保证绝对的品牌安全。苹果公司老板蒂姆·库克说过，苹果希望制作具有“广泛吸引力”的节目，而不是其他流媒体上充斥的“裸露、粗言秽语和暴力”。如此就诞生了像《足球教练》（Ted Lasso）和《早间新闻》（The Morning Show）这样的剧：前者用其中一位制片人的话来说，是一瓶包治百病的“阳光疏通剂”；后者最初是一部针砭广播电视新闻网络有害文化的正剧，后来却退化成一部无脑肥皂剧。亚马逊早期委托制作的剧集还很大胆，现在也开始主打中间立场，比如缺乏想象力的大制作谍战片《堡垒》（Citadel），其中充斥着大量爆炸场面，剧情却毫无悬念。

在一些话题上，这些业务遍布全球的科技巨头甚至比传统广播电视网络更敏感。苹果不久前取消了讽刺类时事节目《囧斯图的问题》（The Problem with Jon Stewart）的播出，据说是因为担心斯图尔特在中国和AI问题上所持的批评立场。

一些帮助创造了电视黄金时代的人们如今对它的未来感到悲观。HBO“卒于50岁”，在1980年代执掌这个电视网的迈克尔·富克斯（Michael Fuchs）告诉比斯金德，“HBO已经不复存在了。”HBO最写实、最有名的电视剧之一《火线》的一名制片人表示，如果放在今天，HBO根本拍不出这部剧。对于创作者来说，电视的黄金时代正在变成一个镀金的笼子。■



Free exchange

The Middle East's economy is caught in the crossfire

Before the war in Gaza, it had been poised to boom

A MONTH AGO, on the eve of Hamas's attack on Israel, there were reasons to be hopeful about the Middle East. Gulf states were ploughing billions of dollars of oil profits into flashy investments, building everything from sports teams and desert cities to entire manufacturing sectors. Perhaps, optimists thought, the wealth would even trickle down to the region's poorer countries.

What prompted such hope was the longest period of calm since the Arab spring in 2011. Gnarly conflicts, such as civil wars in Libya and Yemen, as well as organised Palestinian resistance to Israel, appeared to have frozen. Violent clashes were rare, which some believed a precursor to them disappearing altogether. The region's great rivals were inching towards warmer relations. International investors flocked to the Gulf to get in on the action.

Hamas's attack and Israel's response suggest that the region will now be laden with a bloody, destructive conflict for months to come, if not longer. Under pressure from their populations, Arab leaders have blamed Israel for the situation, even if they have been careful in their language. Overnight, their focus has shifted from economic growth to containing and shortening the war. Countries across the region, including Egypt and Qatar, are pulling out all the diplomatic stops to stop the spread of fighting.

Even if the conflict remains between just Hamas and Israel, there will be costs. Analysts had been upbeat about the prospects for economic integration. In 2020 the United Arab Emirates (UAE) and Bahrain normalised relations with Israel, opening the door to deeper commercial

ties. Although many other Arab countries refused to recognise Israel, many were increasingly willing to do business with it on the quiet. Even Saudi Arabian firms surreptitiously traded with and invested in their Israeli counterparts, whose workers are among the region's most productive; the two countries were working on a deal to formalise relations.

How long the pause in such negotiations lasts remains to be seen, but the greater the destruction in Gaza, the harder it will be for Arab leaders to cosy up to Israel in future, given their pro-Palestinian populations and pressure from neighbours. Although Thani al-Zeyoudi, the UAE's trade minister, has promised to keep business and politics separate, others are unsure that will be possible. A Turkish investment banker, who draws up contracts for firms in the Gulf, reports that most of his clients considering Israel as an investment destination are waiting to see what happens next.

For the Middle East's poorer countries, the consequences will be worse—and nowhere more so than in Egypt. The country was already struggling, with annual inflation at 38% and the government living between payments on its mountain of dollar debts by borrowing deposits from Gulf central banks. Now it has lost out on the gas that flowed from Israel. On November 1st officials in Cairo allowed across the border a handful of injured Gazans, as well as those with dual nationalities. Some diplomats hope that a larger influx might follow, perhaps even on the scale seen by Jordan when it welcomed Palestinians in the 1940s and Syrians in the 2010s, if Egypt were given the right financial incentives. In 2016 looking after 650,000 Syrian refugees cost Jordan's state \$2.6bn, much more than the \$1.3bn it received in foreign aid. There are twice as many internally displaced people in Gaza.

What if the conflict escalates? In the worst case, the region descends into war—perhaps including direct confrontation between Iran and Israel—and economies are turned upside down. Any such war is likely to see a sharp

rise in oil prices. Arab oil producers might even restrict supplies to the West, as they did during the Yom Kippur war in 1973, which the World Bank reckons could push up prices by 70%, to \$157 per barrel. Even though the world economy is less energy-intensive today, the Gulf's oil producers would benefit. All-out war, however, would hinder efforts to diversify their economies. Migrant workers would leave. Manufacturing industries would be hard to get off the ground without secure transport. Futuristic malls and hotels would lack the tourists to fill them. And for the region's energy importers, which include Egypt and Jordan, a spike in oil prices would be a disaster.

There is another, more plausible escalation scenario. So far Iran has declined to turn threats and errant missiles into a direct attack. Israel's ground invasion—smaller and slower than expected—is helping keep a lid on things. Nevertheless, conflict could still spill across Gaza's borders. Imagine, say, fighting in the West Bank or greater involvement from Hizbullah. In this scenario, investing in the Middle East would look much riskier. If fighting flashed in neighbouring countries, leaders in the Gulf would find themselves working harder to convince investors that a return to calm and closer ties with Israel might happen soon.

| *In need of a parachute*

In such a world, Egypt would not be the only country exposed. Lebanon's economic free fall—now in its third year, as inflation rages above 100%—would accelerate with clashes between Israel and Hizbullah, which is based in the country. Fighting in the West Bank, where tensions are high, would spell trouble for Jordan, which sits next door. Like Egypt, the country is almost broke. It took out a \$1.2bn loan from the IMF last year, and was recently told by the fund that its annual growth of 2.6% was insufficient to fix its problems. Refugees could leave the state unable to repay debts. Unrest along its borders could deter creditors.

If either Egypt or Jordan were to run out of cash the results would be destabilising for the region. Both countries border a Palestinian territory, feeding it with supplies and providing allies with information. Both have the ear of the Palestinian Authority. And both have a young, unhappy population. The Arab spring showed how easily unrest in one Arab country can spread to another. Even Gulf officials, relatively insulated though they may be, would rather avoid such instability. ■



自由交流

中东经济卷入战火

加沙开战之前，这里曾势头兴旺

一个月前，也就是在哈马斯袭击以色列之前，人们有理由对中东充满希望。海湾国家把数以十亿计美元的石油利润投资到各种光鲜夺目的项目中，打造运动队、沙漠城市乃至整个制造业。乐观者认为，这些财富也许还能惠及该地区较贫穷的国家。

人们之所以抱持这样的希望，是因为中东在此前经历了自2011年“阿拉伯之春”以来最长的安定时期。在此期间，利比亚和也门的内战等激烈冲突以及巴勒斯坦人对以色列的有组织抵抗运动似乎冷却了下来。暴力冲突少有发生，有人认为这是暴力冲突完全消失的前兆。中东地区的死敌之间关系渐趋缓和。国际投资者纷纷涌入海湾地区抢占先机。

哈马斯的袭击和以色列的反应显示，在未来数月甚至更长的时间内，该地区将深陷一场血腥的、摧毁性的冲突之中。碍于来自本国民众的压力，阿拉伯国家的领导人把当前局势归咎于以色列，尽管措辞谨慎。一夜之间，他们的关注焦点从经济增长转到遏制并缩短战事。包括埃及和卡塔尔在内的中东各国正采取一切外交措施来阻止战火蔓延。

即使冲突只限于哈马斯和以色列之间，整个地区还是会付出代价。分析师曾对该地区经济一体化的前景满怀希望。2020年，阿联酋和巴林实现与以色列关系正常化，为深化商业联系打开了大门。尽管不少其他阿拉伯国家仍拒绝承认以色列，但它们中有许多越来越愿意私下和以色列做生意。连沙特阿拉伯的公司也在偷偷和以色列的同行做贸易以及向它们投资，毕竟以色列劳动者的生产率是该地区数一数二的，两国之前还在谈判一项关系正常化协议。

这种谈判会停顿多久还有待观察，但是鉴于本国民众亲巴勒斯坦加之来自邻国的压力，加沙遭受的破坏越大，阿拉伯国家领导人今后就越发难以与

以色列交好。尽管阿联酋对外贸易国务部长塔尼·阿尔-泽尤迪（Thani al-Zeyoudi）承诺商业归商业，政治归政治，但其他人怀疑这是否可能。一名为海湾地区企业起草合同的土耳其投资银行家表示，他那些考虑投资以色列的客户大多在观望局势走向。

对于较贫穷的中东国家而言，后果将更严重，日子最难过的将是埃及。该国本就举步维艰，年通胀率高达38%，政府依靠从海湾国家央行贷款来偿还堆积如山的美元债务。现在，它又遭遇了以色列停供天然气。11月1日，开罗官员允许少数加沙伤员和拥有双重国籍的人入境埃及。一些外交官希望，如果埃及得到适当的经济激励，它或许能接收更多难民，甚至可能达到约旦在上世纪40年代接收巴勒斯坦人和在2010年代接收叙利亚人的规模。2016年，约旦政府为照顾65万叙利亚难民耗资26亿美元，远高于它收到的13亿美元的外国援助。而当前加沙境内流离失所的难民数量是上述数字的两倍。

如果冲突升级会怎样？最坏的情况是整个地区陷入战争（或许包括伊朗和以色列之间的直接对抗），各经济体被搅得天翻地覆。这样的战争规模很可能导致石油价格急剧上涨。阿拉伯产油国甚至可能收紧对西方的供应，正如它们在1973年赎罪日战争期间的做法。世界银行估计这可能会导致油价上涨70%，达到每桶157美元。尽管当今世界经济的能源密集度下降了，但海湾产油国仍将从中获益。然而，全面战争爆发将阻碍海湾国家追求经济多元化。外籍劳工会离开。没有安全的运输条件，制造业将难以起步。未来主义风格的购物中心和酒店将游客寥寥。而对于该地区的能源进口国（包括埃及和约旦）而言，油价飙升将是一场灾难。

冲突升级还有另一种更可能的情形。到目前为止，伊朗虽然屡有口头威胁和误射导弹，但并未转为直接攻击。以色列的地面进攻规模和速度都低于预期，有助局势不致失控。然而，冲突仍有可能外溢出加沙边境。试想一下，如果约旦河西岸爆发战事，或者真主党进一步介入，这种情况下，投资中东的风险似乎将大大提高。假如邻国战火四起，海湾国家的领导人将更难以说服投资者相信短期内可实现地区稳定以及加深与以色列的关系。

丨 需要降落伞

在那种情况下，埃及不会是唯一岌岌可危的国家。黎巴嫩经济的自由落体式下滑已进入第三个年头，通胀飙升至超过100%，随着以色列和以黎巴嫩为基地的真主党之间爆发冲突，这种自由落体还会加速。约旦河西岸局势高度紧张，在这里开战将给毗邻的约旦带来麻烦。跟埃及一样，约旦也几近破产。去年，约旦从国际货币基金组织获得了12亿美元的贷款，但最近被该组织告知，其2.6%的年增长率不足以解决问题。难民问题可能导致约旦无力偿还债务。其边境地区的动乱也可能令债权人不敢施救。

一旦埃及或约旦破产，就会加剧该地区的不稳定。这两个国家都与巴勒斯坦领土接壤，为其提供补给，向盟友提供情报。两国都在巴勒斯坦权力机构那里说得上话。它们也都拥有年轻而不满的人口。“阿拉伯之春”表明，一个阿拉伯国家发生动荡，很容易就会蔓延到另一个阿拉伯国家。就连可能相对不易受影响的海湾国家官员也宁愿避免这种不稳定。■



Spread bets

Why big oil is beefing up its trading arms

A volatile world makes for choppy markets, and choppy markets make for rich profits

IN THE 1950S the oil market was in the gift of the “Seven Sisters”. These giant Western firms controlled 85% of global crude reserves, as well as the entire production process, from the well to the pump. They fixed prices and divvied up markets between themselves. Trading oil outside of the clan was virtually impossible. By the 1970s that dominance was cracked wide open. Arab oil embargoes, nationalisation of oil production in the Persian Gulf and the arrival of buccaneering trading houses such as Glencore, Vitol and Trafigura saw the Sisters lose their sway. By 1979, the independent traders were responsible for trading two-fifths of the world’s oil.

The world is in turmoil again—and not only because the conflict between Israel and Hamas is at risk of escalating dangerously. Russia’s war in Ukraine, geopolitical tensions between the West and China, and fitful global efforts to arrest climate change are all injecting volatility into oil markets (see chart 1). Gross profits of commodity traders, which thrive in uncertain times, increased 60% in 2022, to \$115bn, according to Oliver Wyman, a consultancy. Yet this time it is not the upstarts that have been muscling in. It is the descendants of the Seven Sisters and their fellow oil giants, which see trading as an ever-bigger part of their future.

The companies do not like to talk about this part of their business. Their traders’ profits are hidden away in other parts of the organisation. Chief executives bat away prying questions. Opening the books, they say, risks giving away too much information to competitors. But conversations with analysts and industry insiders paint a picture of large and sophisticated operations—and ones that are growing, both in size and in sophistication.

In February ExxonMobil, America's mightiest supermajor, which abandoned large-scale trading two decades ago, announced it was giving it another go. The Gulf countries' state-run oil giants are game, too: Saudi Aramco, Abu Dhabi National Oil Company and QatarEnergy are expanding their trading desks in a bid to keep up with the supermajors. But it is Europe's oil giants whose trading ambitions are the most vaulting.

BP, Shell and TotalEnergies have been silently expanding their trading desks since the early 2000s, says Jorge León of Rystad Energy, a consultancy. In the first half of 2023 trading generated a combined \$20bn of gross profit for the three companies, estimates Bernstein, a research firm. That was two-thirds more than in the same period in 2019 (see chart 2), and one-fifth of their total gross earnings, up from one-seventh four years ago. Oliver Wyman estimates that the headcount of traders at the world's largest private-sector oil firms swelled by 46% between 2016 and 2022. Most of that is attributable to Europe's big three. Each of these traders also generates one and a half times more profit than seven years ago.

Today BP employs 3,000 traders worldwide. Shell's traders are also thought to number thousands and TotalEnergies' perhaps 800. That is almost certainly more than the (equally coy) independent traders such as Trafigura and Vitol, whose head counts are, respectively, estimated at around 1,200 and 450 (judging by the disclosed number of employees who are shareholders in the firms). It is probably no coincidence that BP's head of trading, Carol Howle, is a frontrunner for the British company's top job, recently vacated by Bernard Looney.

The supermajors' trading desks are likely to stay busy for a while, because the world's energy markets look unlikely to calm down. As Saad Rahim of Trafigura puts it, "We are moving away from a world of commodity cycles to a world of commodity spikes." And such a world is the trader's dream.

One reason for the heightened volatility is intensifying geopolitical strife. The conflict between Israel and the Palestinians is just the latest example. Another is the war in Ukraine. When last year Russia stopped pumping its gas west after the EU imposed sanctions on it in the wake of its aggression, demand for liquefied natural gas (LNG) rocketed. The European supermajors' trading arms were among those rushing to fill the gap, making a fortune in the process. They raked in a combined \$15bn from trading LNG last year, accounting for around two-fifths of their trading profits, according to Bernstein.

This could be just the beginning. A recent report from McKinsey, a consultancy, models a scenario in which regional trade blocs for hydrocarbons emerge. Russian fuel would flow east to China, India and Turkey rather than west to Europe. At the same time, China is trying to prise the Gulf's powerful producers away from America and its allies. All that is creating vast arbitrage opportunities for traders.

Another reason to expect persistent volatility is climate change. A combination of increasing temperatures, rising sea levels and extreme weather will disrupt supply of fossil fuels with greater regularity. In 2021 a cold snap in Texas knocked out close to 40% of oil production in America for about two weeks. Around 30% of oil and gas reserves around the world are at a "high risk" of similar climate disruption, according to Verisk Maplecroft, a risk consultancy.

Then there is the energy transition, which is meant to avert even worse climate extremes. In the long run, a greener energy system will in all likelihood be less volatile than today's fossil-fuel-based one. It will be more distributed and thus less concentrated in the hands of a few producers in unstable parts of the world. But the path from now to a climate-friendlier future is riven with uncertainty.

Some governments and activist shareholders are pressing oil companies, especially in Europe, to reduce their fossil-fuel wagers. Rystad Energy reckons that partly as a result, global investment in oil and gas production will reach \$540bn this year, down by 35% from its peak in 2014. Demand for oil, meanwhile, continues to rise. “That creates stress in the system,” says Roland Rechtsteiner of McKinsey.

| *Future traders*

This presents opportunities for traders, and not just in oil. Mr Rechtsteiner notes that heavy investment in renewables without a simultaneous increase in transmission capacity also causes bottlenecks. In Britain, Italy and Spain more than 150-gigawatts’-worth of wind and solar power, equivalent to 83% of the three countries’ total existing renewables capacity, cannot come online because their grids cannot handle it, says BloombergNEF, a research firm. Traders cannot build grids, but they can help ease gridlock by helping channel resources to their most profitable use.

Europe’s three oil supermajors are already dealing in electric power and carbon credits, as well as a lot more gas, which as the least grubby of fossil fuels is considered essential to the energy transition. Last year they had twice as many traders transacting such things than they did in 2016. Ernst Frankl of Oliver Wyman estimates that gross profits they generated rose from \$6bn to \$30bn over that period. Other green commodities may come next. David Knipe, a former head of trading at BP now at Bain, a consultancy, expects some of the majors to start trading lithium, a metal used in battery-making. If the hydrogen economy takes off, as many oil giants hope, that will offer another thing not just to produce, but also to buy and sell. ■



价差赌注

为什么石油巨头正在加强其贸易部门

世界动荡导致市场波动，市场波动带来丰厚利润

上世纪50年代，石油市场掌控在“七姐妹”手中。这七家西方石油巨头控制着全球85%的原油储量，以及从油井到油泵的整个生产过程。它们联手固定价格，瓜分了石油市场。撇开七姐妹做石油贸易几乎不可能。到了70年代，这种统治地位被彻底打破。阿拉伯石油禁运、波斯湾石油生产国有化，以及嘉能可（Glencore）、维多（Vitol）和托克（Trafigura）等贸易商的大胆闯入，让七姐妹失去了影响力。到1979年，独立贸易商交易了世界五分之二石油。

如今世界再次陷入动荡，不单单是因为以色列和哈马斯之间的冲突很可能有升级失控的风险。俄乌战争、西方与中国之间的地缘紧张，以及全球在遏制气候变化方面断断续续的努力都在给石油市场注入波动性（见图表1）。在充满不确定性的时期，大宗商品贸易商的毛利润会大幅提升；奥纬咨询（Oliver Wyman）的数据显示，它们在2022年增长了60%，达到1150亿美元。但是，这一次挤进市场的可不是什么新贵，而是七姐妹的后代及其他石油巨头，它们视贸易为自己的未来中日益扩大的部分。

这些公司不喜欢谈论它们的这部分业务。其贸易队伍的利润被隐藏在组织架构的其他部分中。面对打听刺探，高管会回避问题。他们说一旦公开数据，可能会向竞争对手泄露过多信息。但与分析师和业内人士聊聊，即可窥见一幅大而复杂的业务图景，而且它们还在不断增长——不论是规模还是复杂度。

今年2月，美国最强大的超级石油巨头埃克森美孚（ExxonMobil）宣布将重拾它在二十年前放弃的大规模石油贸易。海湾国家的国有石油巨头也愿意一试：沙特阿美（Saudi Aramco）、阿布扎比国家石油公司（Abu Dhabi National Oil Company）和卡塔尔能源公司（QatarEnergy）正在扩大贸易业务，以跟上超级石油巨头的步伐。但贸易野心最大的还是欧洲的

石油巨头。

自本世纪初以来，BP、壳牌和道达尔能源（TotalEnergies）一直在悄悄扩大自己的贸易业务，咨询公司睿咨得能源（Rystad Energy）的豪尔赫·莱昂（Jorge León）表示。据研究公司盛博（Bernstein）估计，2023年上半年，这三家公司的贸易部门总计创造了200亿美元的毛利润。这比2019年同期增加了三分之二（见图表2），占总毛利的五分之一，而四年前只占七分之一。奥纬咨询估计，2016年至2022年间，全球最大私营石油公司的交易员人数增加了46%。其中大部分增长都来自欧洲三巨头。这些交易员的人均利润产出也比七年前增加了一倍半。

目前，BP在全球雇有3000名交易员。据信壳牌的交易员也有数千人，道达尔能源可能有800名。这几乎可以肯定要比托克和维多这类独立贸易商（同样对外含糊其辞）的交易员队伍更大——这两家的交易员人数估计分别在1200人和450人左右（根据已披露的作为公司股东的员工人数推断）。BP的CEO伯纳德·鲁尼（Bernard Looney）最近刚刚离职，最热门的继任人选是其贸易主管卡罗尔·豪尔（Carol Howle），这可能并非巧合。

这些超级巨头的贸易部门在未来一段时间内很可能会很忙碌，因为世界能源市场看起来不太可能平静下来。正如托克的萨阿德·拉希姆（Saad Rahim）所说：“我们正从一个大宗商品周期性波动的世界转向一个大宗商品价格飙升的世界。”这样的世界是贸易商梦寐以求的。

波动加剧的原因之一是地缘冲突加剧。以巴冲突只是最新一例。另一个是俄乌战争。去年，欧盟因俄侵略行为对其实施制裁后，俄罗斯停止向西输送天然气，触发对液化天然气（LNG）的需求猛增。欧洲那些石油巨头的贸易部门等立即采取行动弥补需求缺口，在此过程中大赚了一笔。盛博的数据显示，去年这些公司从LNG贸易中共赚取了150亿美元，约占其交易利润的五分之二。

这可能只是一个开始。咨询公司麦肯锡近期的一份报告模拟了出现区域油

气贸易联盟的场景。俄罗斯燃料将向东流向中国、印度和土耳其，而不会向西流向欧洲。与此同时，中国正试图将海湾地区的产油大户从美国及其盟友手中撬走。所有这些都为石油贸易公司创造了巨大的套利机会。

预计波动将持续的另一个原因是气候变化。气温升高、海平面上升，再加上极端天气，将更频繁地扰乱化石燃料的供应。2021年，德克萨斯州的一场寒流让美国近40%的石油生产关停了约两周。风险咨询公司Verisk Maplecroft表示，全球约30%的油气储量有“高风险”遭遇类似的气候干扰。

还有一个原因是为了避免更严重的极端气候而推进的能源转型。从长远来看，更绿色的能源系统很可能比当今基于化石燃料的能源系统的波动性更小。它将更加分散，因而不会像化石燃料那样集中在世界不稳定地区的少数生产国。但从现在通往气候友好型未来的道路上充满了不确定性。

一些政府和维权股东正在敦促石油公司（尤其是欧洲的石油公司）减少在化石燃料方面的押注。睿咨得能源估计，一定程度上因为这类施压，今年全球对石油和天然气生产的投资将达5400亿美元，比2014年的峰值下降35%。与此同时，对石油的需求继续上升。“这会给能源系统带来压力。”麦肯锡的罗兰·雷希斯坦纳（Roland Rechtsteiner）说。

| 未来的贸易商

这为贸易商提供了机会，而且不仅仅是在石油上。雷希斯坦纳指出，大量投资可再生能源却没有同时增加输电容量也会造成瓶颈。研究公司彭博新能源财经（BloombergNEF）表示，在英国、意大利和西班牙，由于电网无法消纳，超过150吉瓦的风能和太阳能发电（相当于这三个国家现有可再生能源发电总量的83%）无法并网。贸易商建不了电网，但可以协助将可再生电力引导到最有利可图的用途，帮助缓解电网拥堵。

欧洲石油三巨头已经在交易电力和碳信用，天然气交易也大幅增长——这种污染程度最低的化石燃料被认为对能源转型至关重要。去年它们处理这些交易的交易员人数是2016年的两倍。奥纬咨询的恩斯特·弗兰克尔

（Ernst Frankl）估计，他们在此期间创造的毛利润从60亿美元增至300亿美元。接下来这些公司可能还会交易其他绿色大宗商品。现就职于咨询公司贝恩的BP前贸易主管戴维·奈普（David Knipe）预计，一些巨头会开始交易用于电池制造的金属锂。如果氢经济能如许多石油巨头希望的那样起飞，它们既能生产也能买卖的东西就又多了一样。■



Buttonwood

Why it is time to retire Dr Copper

The red metal no longer tells investors much about the global economy

DOCTORS ARE famously reluctant to hang up their stethoscopes. But a time comes in the career of every medic when their skills fade, and a gentle push is the best thing for them—and their patients. The same applies for the metaphorical physicians of the financial world, whose ability to diagnose the market's health changes over time. Now the end may be nigh for the most illustrious of all such physicians: Dr Copper.

Copper, a metal crucial to the construction of all manner of fittings, pipes and wires, has earned its nickname on Wall Street owing to its role as a bellwether for the health of global industry. A surge in copper prices is taken as an early sign of an economic upswing; a big drop is a portent of recession, or at the very least a manufacturing downturn.

So what is going on at the moment? Manufacturing looks peaky. Global industrial output is up by just 0.5% year on year, well below the average of 2.6% over the past two decades, and the rich world is in an industrial recession. A wobble of a similar scale in 2015 sent copper prices plunging by about a quarter. Yet so far this year they are down by only 6%. Futures maturing in 2025 are flat, and those maturing in 2026 are up a bit.

The breakdown in the usual rules of thumb is most striking in China, which consumes over half of the world's annual copper supply. Its stricken housing market might have led you to think the metal was doomed. After all, investment in property, once a key driver of copper demand, is down by 9% year on year. Curiously, though, Chinese demand for the metal is up by around 10% this year.

The explanation for this lies in the radical shifts that are under way in the energy system. China will install around 150 gigawatts (GW) of copper-intensive solar-energy capacity this year, according to Goldman Sachs, a bank, almost double the amount it installed last year. And methods for storing energy require the metal, too. Pumped-storage hydropower is one example. This involves moving water from one reservoir to another, either to hoard excess energy from wind and solar power or to release it. China already has 30% of the world's hydropower-storage capacity, at 50GW. Another 89GW of capacity is being built, which will require vast amounts of copper.

Other countries are also spending big on the green transition, and putting in place legislation that will increase appetite for the metal. S&P Global, a financial-data firm, suggests that demand for refined copper will almost double by 2035, to 49m tonnes. Batteries, energy transmission, solar cells, transport—all need the metal. An electric car contains over 50 kilograms of the stuff, more than twice the amount used in a conventional vehicle. Across the world new rules, intended to reduce emissions, will steer consumers towards electric vehicles and away from their copper-light predecessors. In Europe sales of new petrol-powered cars will be banned from 2035.

The squeeze on supplies will therefore be historic, meaning that sky-high copper prices will no longer be indicative of optimism on the part of industrial machinery-makers, construction firms, electronics manufacturers and the like. Instead, rising demand for copper will increasingly reflect a desire among politicians for more environmentally friendly energy, and sometimes also a reduced dependence on imports.

In normal times, building an electrical network from scratch would at least be a signal of greater economic activity to come. However, the energy transition is intended to replace existing activity, rather than add to it. In

the case of energy infrastructure, China's new solar investment this year can generate 150 gigawatt-hours of energy when working at full pelt, which is equivalent to almost 90,000 barrels of oil per hour. That is energy which China now does not need to purchase from overseas producers. The result may well be good for the planet, but it will not have much effect on aggregate economic activity.

With so much of the growth in demand for copper locked in, and proceeding in large part according to legal diktat, the metal's price will over time say less and less about the state of the global economy, and more and more about the state of the energy transition. Copper prices will still be worth watching, then, albeit for different reasons. Investors wanting a hint about the state of the global economy will be replaced by policymakers wanting a sense of how their green policies are faring. Dr Copper's retirement may be a sad moment, but it is not the end of the story. ■



梧桐

为什么该让铜医生退休了

这种红色金属不再能为投资者指明全球经济状况

众所周知，医生都不大情愿挂起听诊器退休。但是，每个医师的职业生涯都会迎来技术衰退的那一刻，这时候温和地推一把，让他们离场，对他们和他们的病人来说都是最好的选择。这一点同样适用于金融世界里的“大夫”，它们诊断市场健康状况的能力也会随时间而变化。现在，此类医生当中最杰出的一位——“铜医生”，可能就要走到事业的尽头了。

铜是制造各种配件、管道和电线的关键金属，作为全球工业健康状况的风向标，在华尔街赢得了“铜医生”的绰号。铜价飙升被视为经济复苏的先兆，暴跌则预示着经济衰退，或者至少是制造业衰退。

那么目前是什么情形？制造业似乎萎靡不振。全球工业产值同比仅增长0.5%，远低于过去二十年来2.6%的平均增速，发达国家正处于工业衰退之中。2015年也发生了类似规模的动荡，导致铜价暴跌约四分之一。然而，今年迄今为止铜价仅下跌了6%。2025年到期的铜期货价格保持平稳，2026年到期的还略有上涨。

惯常的经验法则被打破在中国最为凸显，这里每年消耗全球铜供应量的一半以上。鉴于中国房地产市场遭受重创，你可能会以为铜价劫数难逃。毕竟，曾经是铜需求大户的房地产投资已经同比下降了9%。但奇怪的是，今年中国对铜的需求却增长了10%左右。

究其原因，能源系统正在发生翻天覆地的变化。据高盛称，中国今年将安装约150吉瓦的太阳能发电容量，是去年装机量的近两倍，而太阳能发电要使用大量的铜。储能也需要铜。抽水蓄能电站就是一例。这种方法把水从一个水库转移到另一个水库，用来储存过剩的风电和光电，抑或用于释放这些能量。中国的抽水储能容量已达到50吉瓦，占全球总容量的30%。另有89吉瓦容量在建，这将需要大量的铜。

其他国家也在斥巨资推进绿色转型，相关立法将推高对铜的需求。金融数据公司标普全球（S&P Global）预测，到2035年，精炼铜的需求量将翻一番，达到4900万吨。电池、能源传输、太阳能电池、交通运输都需要这种金属。一辆电动汽车含铜50多公斤，是传统汽车用量的两倍多。全球各地旨在减少排放的新规将引导消费者选择电动汽车，而不是含铜较少的传统汽车。在欧洲，从2035年起将禁止销售新的燃油车。

因此，供应将空前紧张，意味着铜价飙升将不再是工业机械制造商、建筑公司、电子产品制造商等部门的乐观情绪的指标。对铜的需求上升将越来越多地反映出政客对更环保的能源的追求，有时也反映出对能源进口的依赖减少。

在往常，建设全新的电力网络至少也是一个预示着更多经济活动即将到来的信号。然而能源转型的目的是取代现有活动，而不是新增。就能源基础设施而言，中国今年新增的太阳能投资在满负荷运转时可产生150吉瓦时的能量，相当于每小时近9万桶石油。这意味着中国不再需要从海外生产商购买这部分能源。其结果很可能对地球有益，但对经济活动总量并没有太大影响。

鉴于铜需求的增长中有很一大块已锁定，且在很大程度上依照法律指令推进，随着时间的推移，铜价将越来越难以反映全球经济的状况，而越来越多地反映能源转型的状况。因此，铜价仍然值得关注，但原因已经不同。原本是投资者通过铜价窥见全球经济状况，取而代之的是政策制定者从中了解其绿色政策的进展。“铜医生”退休或许是个伤感的时刻，但故事仍在继续。■



Training days

China is educating engineers around the world

Its technical schools are less controversial than its Confucius Institutes

CHINESE OFFICIALS often talk of the Belt and Road Initiative, a global infrastructure building spree, in hyperbolic terms. On October 17th and 18th Xi Jinping, China's leader, hosted a big summit in Beijing to celebrate the tenth anniversary of what the government likes to call the "project of the century". Lately this hype has masked an awkward reality. Since 2020 China has scaled back the scheme as governments have found it harder to repay Chinese infrastructure loans.

Yet in recent years one part of the project has stood out as a quiet success. Since 2016 China has set up some 27 vocational colleges in two dozen countries, mostly poorer ones. These "Luban Workshops" (named after a fabled carpenter from the fifth century BC) have trained thousands of students in fields including artificial intelligence, electric vehicles, railway operations and robotics. One of the newest workshops opened on September 4th at Meru University of Science and Technology in Kenya.

The purpose is not charity. Luban workshops promote technology and standards that China wants to export to developing countries. Gear for the new workshop in Kenya will come from Huawei, a Chinese telecoms giant America would like to see excluded from its allies' mobile networks, for fear its kit could assist Chinese spying. Huawei (which denies America's allegations) helped build Kenya's mobile network and is now working with its biggest telecoms provider to roll out 5G services.

The workshops also help assuage worries about the Belt and Road. Participating governments sometimes complain that the companies which win its infrastructure projects rely too much on labour and supplies from

China. Several Luban workshops now provide training directly related to Belt and Road projects. One in Djibouti has trained employees of a new rail line to Ethiopia. That \$4bn railway was built and financed by China but struggled to make a profit after opening in 2018.

The Luban programme has echoes of China's earlier drive to expand its influence by opening more than 500 "Confucius Institutes" to teach Mandarin in universities around the world. Yet so far it has avoided the controversies that have dogged those institutes, many of which closed after being accused of promoting propaganda and stifling dissent. This is in part because the Luban workshops focus on technical skills and in part because China has spent more time consulting host governments before setting them up. "Unlike Confucius Institutes, Luban workshops are actually different in each country, because of the different skills that are demanded by host countries," says Niva Yau of the Atlantic Council, an American think-tank. She sees them as evidence that China is responding to criticism of Belt and Road without abandoning core goals, such as exporting its technology.

The workshops compete with training that America, Japan and other rich countries offer countries in the global south. Germany, for example, has given more than 100 countries guidance on how to copy its famed system of vocational education. The Luban workshops are unusual, though, in providing equipment as well as teaching, and in having their own brand.

When the Luban programme began it was led by the local government in Tianjin, a big city near Beijing that was known for technical training (local authorities have been encouraged to support and profit from Belt and Road). The first workshop (pictured) opened in Thailand in 2016; it used equipment sent by a Tianjin chemical company. For a time Luban workshops cropped up in rich countries as well as poor ones. Between 2018 and 2020 a workshop at Crawley College, near London, taught Chinese

cuisine; one in Portugal still offers training in electrical automation and industrial robots. The programme was not always restricted to Belt and Road participants: India (a sceptic) has a Luban workshop in Chennai.

More recently, however, the programme appears to have been co-opted by China's central government. It has grown to involve training providers and companies from outside Tianjin, and been linked more explicitly to Mr Xi's foreign policy. In 2018 Mr Xi pledged to open ten workshops in Africa; a dozen have since opened there. In May he promised leaders of Central Asian countries that China would set up more workshops in their region (the first opened in Tajikistan last December).

It remains to be seen how long China will subsidise Luban workshops, and how far they will live up to their promise. Some are questionable, such as one in war-torn Mali that teaches traditional Chinese medicine. But for the moment they represent a refreshing example of China's government listening to critics—and learning from its mistakes. ■



培训日

中国正在世界各地培训工程师

它的技术学校不像孔子学院那样有争议

中国官员经常以夸张的言辞谈论推动全球基础设施建设的“一带一路”倡议。10月17日到18日，中国领导人习近平在北京举行了一场大规模高峰论坛，为中国政府津津乐道的这一“世纪工程”庆祝十周年。近来，这样热火朝天的宣传掩盖了一个尴尬的现实。自2020年以来，中国已经缩减了这一工程的规模，因为各国政府越来越难以偿还中国的基础设施贷款。

不过近年来，这一工程的一个组成部分静悄悄地取得了成功。自2016年以来，中国在二十多个国家（大多为较贫穷国家）建立了27所职业学院。这些“鲁班工坊”（以公元前五世纪的一位传奇木匠命名）在人工智能、电动汽车、铁路运营和机器人等领域培训了数千名学生。最新一批工坊之一于9月4日在肯尼亚的梅鲁理工大学（Meru University of Science and Technology）揭牌。

这并不是为了做慈善。鲁班工坊推广中国想要输出到发展中国家的技术和标准。肯尼亚的这所新工坊所用的设备将来自中国通讯巨头华为。因为担心华为的设备会帮助中国监听，美国想要把它排除在盟友的移动网络之外。华为（它否认了美国的指控）帮助建设了肯尼亚的移动网络，现在正与该国最大的电信运营商合作推广5G服务。

鲁班工坊还帮助缓解了对“一带一路”的忧虑。参与其中的各国政府有时抱怨赢得本国基础设施项目的公司太过依赖来自中国的工人和物资。一些鲁班工坊现在提供与“一带一路”项目直接相关的培训。吉布提的鲁班工坊已经为一条通往埃塞俄比亚的新铁路培训了员工。这条40亿美元的铁路由中国建设并出资，但自2018年投入运营以来一直难以盈利。

鲁班工坊计划类似于中国更早时候为扩大影响力而开办的500多所“孔子学院”，这些学院在全球各地的大学里教授普通话。许多孔子学院因被指进

行政宣传 and 压制异见而关闭，但迄今为止，鲁班工坊并没有引发同样的争议。这在一方面是因为鲁班工坊专注传授职业技能，另一方面是因为中国在开设这些工坊之前花了更多时间与东道国政府协商。“与孔子学院不同，鲁班工坊实际上是因国家而异，因为各个东道国所需要的技能都不一样。”美国智库大西洋理事会（Atlantic Council）的邱芷恩说。她认为这些工坊证明了中国正在回应对“一带一路”的批评而并没有放弃其核心目标，例如输出技术。

鲁班工坊与美国、日本和其他富裕国家向南方世界提供的培训竞争。例如德国指导了100多个国家如何复制其著名的职业教育体系。不过鲁班工坊不太一样，它不仅提供教学，还提供设备，还拥有自己的品牌。

鲁班工坊项目在启动时是由天津市政府主导的，这座邻近北京的大城市以技术培训闻名（中国鼓励地方政府支持“一带一路”倡议并从中获益）。第一所鲁班工坊（如图）于2016年在泰国建成，使用由天津一家化工企业赠送的设备。有一段时间，鲁班工坊不仅出现在贫穷国家，也出现在富裕国家。从2018年到2020年，在伦敦附近的克劳利学院（Crawley College）里的鲁班工坊教授中餐烹饪；葡萄牙的一个工坊至今提供电气自动化和工业机器人方面的培训。这个项目并不总是局限于“一带一路”的参与国：在对这一倡议心怀疑虑的印度的金奈（Chennai）也有一所鲁班工坊。

不过后来，这个项目似乎被中央政府采用。项目扩大到引入天津之外的培训提供机构和公司，而且与习的对外政策有了更明确的联系。2018年，习承诺在非洲开设十所鲁班工坊；自那以后已有十二所工坊在非洲设立。今年5月，他向中亚各国领导人承诺要在中亚开设更多工坊（那里的第一所工坊于去年12月在塔吉克斯坦开办）。

中国将补贴鲁班工坊多长时间以及它们会在多大程度上兑现承诺，还有待观察。有一些是存疑的，比如在备受战火摧残的马里，一个工坊在教中医。但在目前，它们提供了令人耳目一新的一例，表明中国政府听得进批评，并能从错误中汲取教训。■



Chipping away

South Korean chipmakers get a reprieve

But the pressure from geopolitical tension and China's domestic manufacturing drive will increase

IT HAS BEEN an anxious year for Samsung Electronics and SK Hynix, South Korea's leading chipmakers. Last October America restricted exports of advanced chipmaking equipment to China in an attempt to cripple its ability to procure or produce chips for weapons systems. The South Korean firms, which rely on China as both a manufacturing base and market, received a year-long exemption, but fretted about what might happen after it expires.

On October 9th their minds were put somewhat at ease. South Korea's government announced that, thanks to "close co-operation" with America, the waivers would become indefinite. Yet the unpredictability of the Sino-American tech war and China's attempts to bolster domestic manufacturers mean South Korea's most important industry may still have to look beyond China.

Chips made up some 19% of South Korea's total exports in 2022, more than any other product. Memory chips, which store information, make up almost 60% of that total, and South Korean companies control about the same percentage of the global market. Factories in China are key to this dominance. Samsung manufactures 40% of its NAND chips in the country, while SK makes 20% of its NAND chips and 40% of its DRAM chips there. China is a big market for both, accounting for 16% and 44% of their respective sales in 2021. So the exemption is hugely valuable; it allows the firms to keep sending spare parts to their factories in China.

Chey Tae-won, the head of SK Group, has said it is "not possible to give up

the Chinese market”. Yet even with the exemption it may be harder to make chips there. The details of the extended regime are not public, but if they constrain the use of specific types of equipment it might be difficult for South Korean companies to upgrade their factories beyond a certain point. Japanese and Dutch export restrictions on semiconductor technology used by Samsung and SK Hynix remain in place. And if companies want to receive tax incentives offered by America’s CHIPS Act, a law designed to encourage semiconductor manufacturers to set up shop in America, they may be constrained by limits it puts on the expansion of production in China.

Chinese demand for South Korean chips is also uncertain. China’s sluggish economic recovery from the pandemic, and the stockpiles of chips that semiconductor firms have built up as a result, mean South Korean exports of semiconductors to China are down this year. And China has been pumping money into its own semiconductor industry. As a result YMTC, China’s memory-making champion, has survived being cut off from global chipmaking tool supply chains by American export controls. It is due to complete a new factory this year, relying on Chinese machine tools instead of foreign ones. Almost 56% of South Korean semiconductor firms surveyed by the Bank of Korea in June said unhelpful market conditions, China’s industrial policy and its advancing chip industry mean export levels are unlikely to recover.

The unpredictability of the Sino-American tech war creates further risk. South Korean officials like to say the row highlights the relative closeness of America and South Korea. It also reveals America’s tendency to design industrial policy without consulting allies. Its roll-out last August of the Inflation Reduction Act, which incentivises EV and battery manufacturers to reroute supply chains away from China and towards America, was a particular shock to South Korea. If America makes another such move to hamstring China’s semiconductor development, Samsung and SK could

again face being collateral damage.

For these reasons, both firms will probably try to reduce their dependence on China as a manufacturing location. Both are already looking to open more facilities in America and South Korea. Manufacturing costs are higher there than in China, despite the inducements both countries are offering chipmakers. That is the new reality chipmakers, and ultimately their customers, will increasingly face. ■



“芯”情不佳

韩国芯片制造商缓了一口气

但地缘紧张局势和中国发展本土芯片制造带来的压力将增加

对于韩国两大芯片制造商三星电子和SK海力士来说，今年是焦虑的一年。去年10月，美国限制向中国出口先进芯片制造设备，试图让中国无法为武器系统采购或生产芯片。这两家依赖中国为生产基地和市场的韩国企业获得了一年的豁免期，但它们还是为豁免到期后的日子忧虑不安。

10月9日，它们稍微舒了一口气。韩国政府宣布，通过与美国的“密切合作”，豁免将改为无限期。然而，中美科技战不可预测，中国也尝试扶持本国芯片制造商，意味着韩国最重要的产业可能仍需要把目光转向中国以外的地方。

2022年，芯片约占韩国出口总额的19%，高于其他任何产品。存储信息的存储芯片占芯片总出口的近60%，韩国公司在全球市场上的份额也大致是这个比例。在中国设厂是其雄霸市场的关键。三星的NAND芯片有40%在中国生产，SK有20%的NAND芯片和40%的DRAM芯片在中国生产。对这两家公司来说，中国都是个巨大的市场，分别占它们2021年销售额的16%和44%。因此，这次的豁免价值巨大，让它们能继续向自己的在华工厂输送零部件。

SK集团会长崔泰源表示“不可能放弃中国市场”。然而，即便获得无限期豁免，在中国生产芯片也可能变得更困难。延长豁免期的规则细节尚未公布，但假如其中限制了使用某类设备，韩国公司就可能在某个节点后难以再升级改造工厂。日本和荷兰对半导体技术的出口限制仍然有效，三星和SK海力士使用了这些技术。此外，公司若想要获得美国《芯片法案》（CHIPS Act，旨在鼓励半导体制造商在美设厂）提供的税收激励，就可能受制于该法案对在华扩产所设的限制。

中国对韩国芯片的需求也不确定。中国经济在新冠疫情后复苏乏力，半导

体公司因此积压了大量芯片，今年韩国半导体对华出口随之下降。而且中国一直在注资发展自己的半导体产业。所以，即使因美国出口管制被切断了与全球芯片制造设备供应链的联系，中国内存芯片龙头制造商长江存储也挺了过来。该公司今年将建成一座新工厂，以国产设备而非外国设备来生产。在韩国央行6月对韩国半导体企业的调查中，近56%的受访企业表示，不利的市场状况、中国的产业政策及其芯片产业的进步意味着韩国的出口水平不太可能恢复。

中美科技战的不可预测性造成了进一步风险。韩国官员喜欢说，这场争斗突显出美国 and 韩国相对亲密的关系。它也揭示了美国在制定产业政策时常不征求盟国意见。去年8月，美国推出了《通胀削减法案》（Inflation Reduction Act），鼓励电动汽车和电池制造商把供应链从中国转向美国，这尤其令韩国感到震惊。假如美国再出台类似的举措来阻碍中国半导体发展，三星和海力士可能将又一次面临连带损害。

出于这些原因，三星和海力士可能会减少依赖在华生产。两者都已开始考虑在美国和韩国开设更多工厂。尽管这两个国家都为芯片制造商提供了优惠条件，但美韩的制造成本仍高于中国。这就是芯片制造商——最终还有它们的客户——日益面对的新现实。■



Lithography lessons

Canon tries to break ASML's grip on chipmaking tools

Good luck with that

PURVEYORS OF CHIPMAKING tools seldom attract attention. Yet many investors' heads turned on October 13th, when Canon unveiled a new piece of kit. It is easy to see why. The Japanese company, which makes optical equipment, claims that its "nanoimprint" lithography machine can etch the very smallest transistors used in the most advanced microchips. Such feats have hitherto been the preserve of ASML, a Dutch manufacturer of lithographic tools. Canon hopes to eat further into ASML's business by eventually cranking out two-nanometre chips.

The possibility of breaking ASML's stranglehold on the supply chain for cutting-edge chips is intriguing. The firm has long enjoyed the biggest monopoly in the concentrated semiconductor industry. The world's three biggest chip manufacturers—Intel, Samsung and TSMC—depend entirely on its extreme-ultraviolet (EUV) technology to produce the cutting-edge microprocessors that go into smartphones and the powerful data-centre servers on which the computing cloud lives.

ASML's EUV rigs use high-powered lasers to etch electrical blueprints onto circular silicon discs. Canon's alternative, by contrast, directly stamps chip designs on such wafers using a patterned mould. In theory, this allows it to make more detailed patterns. And because it involves fewer steps and avoids the need for expensive lasers and supersmooth mirrors, it could be much cheaper than EUV lithography. ASML's share price dipped by more than 2% and Canon's rose by nearly as much on the nanoimprint news.

In practice, Canon has its work cut out. Dylan Patel of SemiAnalysis, a semiconductor-research firm, points out that nanoimprint lithography is

prone to defects because of the precision required to align wafers and moulds. The technique is also not yet effective in dealing with complex chip designs, including for processors used in artificial-intelligence models, that involve many layers of chemical deposits. Mr Patel predicts that Canon's tool will be used for making parts of memory chips, which have fewer layers, rather than for advanced "logic" chips, which process information rather than store it.

Even if Canon can overcome all these technical hurdles, chipmakers may be loth to replace their EUV kit with its machines. Chip fabrication plants (fabs for short) are highly standardised in order to minimise the share of chips that turn out faulty. Since ASML has long been the only game in town for cutting-edge chips, that standardisation means that fabs are being designed around its machines, which are the size of a double-decker bus. The fabs that chipmakers are currently busy putting up around the world will not suddenly switch to nanoimprint lithography. It may take five years for Canon's tools to be used in mass production, thinks Gaurav Gupta of Gartner, a research firm, and only once they have proved themselves.

One place where Canon could make headway more quickly is China. Since 2019 Chinese companies have been prevented by America's export controls from buying ASML's EUV machines, since they all rely on bits and bobs of American origin. It has also struggled to develop lithography machines of its own. The current American restrictions do not, however, explicitly cover nanoimprint technology. That leaves Canon free to sell it to customers across the Sea of Japan—at least for the time being and perhaps for longer. It is unclear whether the Japanese firm's machines include enough American know-how to ever fall under America's anti-Chinese strictures. Probably no necks craned more at Canon's announcement than those of national-security hawks in Washington and Beijing. ■



光刻经验

佳能试图打破阿斯麦对芯片制造设备的垄断

祝它好运

芯片制造设备的供应商很少引起人们的注意。不过当10月13日佳能推出一款新设备时，许多投资者都转头看向了它。原因很容易理解。这家制造光学设备的日本公司称，其“纳米压印”光刻机可以蚀刻在最先进的微芯片中使用的那种最小的晶体管。迄今为止，这样的创举一直是荷兰光刻机制造商阿斯麦（ASML）的专利。佳能希望最终能制造两纳米芯片，进一步抢占阿斯麦的业务。

阿斯麦在尖端芯片供应链上的垄断地位可能被打破，这件事非常有趣。在高度集中的半导体行业，阿斯麦长期享有最大的垄断地位。全球最大的三家芯片制造商——英特尔、三星和台积电——完全依靠它的极紫外（简称EUV）光刻技术来生产尖端的微处理器。智能手机以及计算云所在的强大的数据中心服务器使用这些微处理器。

阿斯麦的EUV设备是用高功率激光器将电子线路图蚀刻到硅晶片上。相比之下，佳能的替代方案是使用图案模具直接把芯片设计印制到这些硅晶片上。理论上，这让它可以制作更精细的图案。而且因为涉及的步骤更少，不需要昂贵的激光器和超光滑的镜片，价格可能比EUV光刻便宜得多。受纳米压印消息的影响，阿斯麦的股价下跌了超过2%，佳能的股价则上涨了近2%。

在实际操作中，佳能面临的难度不小。半导体研究公司SemiAnalysis的迪伦·帕特尔（Dylan Patel）指出，纳米压印光刻容易出现瑕疵，因为让硅晶片和模具对齐需要很高的精度。这种技术在处理复杂的芯片设计时还不太有效，包括人工智能模型中使用的处理器的设计，因为其中涉及很多层的化学沉积。帕特尔预测，佳能的设备将用于制造一部分层数较少的存储芯片，而不是先进的“逻辑”芯片，后者用来处理信息而不是存储信息。

即使佳能能够克服所有这些技术障碍，芯片制造商也可能极不情愿用佳能的机器取代它们的成套EUV设备。为了最大限度地降低缺陷芯片的比例，芯片制造工厂（简称晶圆厂）是高度标准化的。因为阿斯麦长期以来都是尖端芯片领域的唯一选择，这种标准化意味着晶圆厂是围绕阿斯麦的机器设计的，这些机器有一辆双层巴士那么大。芯片制造商目前在世界各地大举建造的晶圆厂不会突然转向纳米压印光刻技术。研究公司高德纳

（Gartner）的高拉夫·古普塔（Gaurav Gupta）认为，佳能的设备可能需要五年时间才会被用于大规模生产，而且它们必须首先证明自己的能力。

佳能有机会加速推进的一个地方是中国。自2019年以来，由于美国的出口管制，中国公司被禁止购买阿斯麦的EUV光刻机，因为这些机器都要依赖产自美国的部件。中国自主研发光刻机的道路也困难重重。而目前美国的限制并未明确包括纳米压印技术。这让佳能可以自由地把这一技术卖给日本海对岸的客户——至少目前是这样，也许还会持续更久。目前还不清楚这家日本公司的设备是否包含足够多的美国技术，以致日后也会落入美国对华限制措施的范围。在佳能发布新设备之时，恐怕没有谁的脖子伸得比华盛顿和北京的国家安全鹰派更长了。■



Free exchange

Israel's war economy is working—for the time being

The longer the conflict lasts, the greater the pressure

LESS THAN three weeks since Hamas plunged Israel into war, conflict is taking a toll on the country's economy. The shekel has sunk to its lowest level against the dollar in more than a decade, prompting Israel's central bank to sell \$30bn of foreign-exchange reserves to prop up the currency. The price of insuring the country's debt against default has rocketed. Firms from builders to restaurants have shut. On October 19th the finance ministry outlined plans to ramp up defence spending and provide for those pushed out of work. Four days later the central bank cut its growth forecast for the year from 3% to 2.3%.

Since war is not just fought by military forces, but also by economic ones, an important question hovers over all this activity. Can Israel withstand the economic pain? The country's clashes with Hamas since withdrawing from Gaza in 2005 do not provide much of a guide. In each case billions of shekels—a mere fraction of GDP—were spent on the military and repairs. The conflicts did not pose a threat to the country's economy, which has long had one of the highest incomes per person in the Middle East.

The scale of Hamas's attacks on October 7th, and the likely ensuing conflict, is therefore pushing economists to the history books. In 1973 the cost of weapons and drafting 200,000 army reservists for the Yom Kippur war brought Israel to the brink of financial collapse. The country's central bank reckons that, in 2002, a single year of intifada (Palestinian uprisings that ran intermittently from the late 1980s to the 2000s) cost 3.8% of GDP.

To dodge disaster, Israeli officials must face up to three challenges. The first is employment. There are not enough workers to support both the economy

and the war. Since October 7th the armed forces have mobilised more than 360,000 reservists, or 8% of the country's workforce—a bigger call-up than in 1973. Most have left jobs, producing an enormous hole in the economy. Worse, the recruits are some of Israel's most productive workers. Start-Up Nation, an Israeli charity, reckons that a tenth of tech workers have been called up. Workers in the industry are a quarter more productive than the average in the OECD club of mostly rich countries. By contrast, those in the rest of the economy are two-fifths less productive. Just a handful of reservists are from ultra-Orthodox communities in which employment is shunned.

There is another source of labour shortages. Many of Israel's low-skilled jobs are done by Palestinians from the West Bank, some 200,000 of whom work in either Israel or its settlements. But unrest in the West Bank means that many workers are not being allowed across the border, and they may begin to strike. During part of the second Palestinian intifada, which lasted from 2000 to 2005, missing Palestinian workers were one of the biggest brakes on Israeli growth, according to the IMF.

Moreover, there are few workers with which to replace reservists and Palestinians, since Israel's labour market is ultra-tight. According to the central bank, which has spent the past few months raising interest rates to cool the economy, unemployment is at 3.2%. Strict labour laws mean that firms can only hire temporary replacements for those on military duty—not an attractive option. Investors worry about capital flooding away from “Silicon Wadi” and back to its Californian namesake. Start-Up Nation reckons that 70% of tech firms are struggling to function. The risk is that, when the war finishes, there will be fewer jobs to which to return.

A second challenge for policymakers is the collapse of private consumption. Amid uncertainty and fear of repeat attacks, people have changed their consumption habits by staying at home. For nearly three

weeks, restaurants and shopping malls have been empty. Those with the workers to open have discovered there are few customers. Tourism, Israel's main business aside from tech, has screeched to a halt. Entire towns along the border with Gaza and Lebanon have been cleared out, putting a stop to economic activity. In order to support firms, all but the biggest businesses that suffer because of the war will receive covid-style grants to cover fixed costs. VAT payments have been deferred. Workers who used to toil in areas now deemed unsafe will get handouts.

That brings the final challenge for Israeli policymakers: managing the fiscal costs of conflict. Rescuing businesses, paying reservists and housing the population of entire villages in hotels will take its toll. An enormous increase in defence spending will be required in order to finance a ground invasion this year, and stock Israel with enough weapons to feel secure next year.

Israel's debt is currently at around 60% of GDP, a modest ratio for somewhere so rich. Even assuming that the war continues to the end of the year, it is forecast to rise to a mere 62%. The central bank has a healthy \$170bn of foreign-exchange reserves. On top of this, America will help, assuming that President Joe Biden is able to unlock the \$14bn he is asking for in military aid from Congress. Yet the longer the conflict continues, the more risks will grow. In 2024 Israel's primary deficit is forecast to jump from 3% of GDP to 8%. The country's economy had been on the rocks before Hamas's attack. The government's revenues were down by 8% in September, after a tough first eight months of the year. Now the cost of borrowing is rising and the tax base is crumbling. A longer war will mean more destruction, and reconstruction will not come cheap.

| *Now or never*

The government will not be able to pay its way for ever, which is one reason why a chorus of local politicians insists that a ground invasion of Gaza

ought to proceed straight away. Although, in the next few months, households and firms will receive generous financial support, conflict is draining labour, capital and expertise from Israel's economy faster than it can be replaced. Other economies may have withstood far greater damage in pursuit of military victories in the past, but that will be little consolation to those forced to bear the costs in Israel this time around. ■



自由交流

以色列的战时经济暂时还能应付

冲突持续越久，压力越大

哈马斯把以色列拖入战争不到三周，战事已对该国经济造成打击。以色列谢克尔兑美元汇率跌至十多年来新低，促使以色列央行出售300亿美元的外汇储备以支撑谢克尔。该国债务违约保险的价格也直线上升。从建筑商到餐馆，企业纷纷停业。10月19日，以色列财政部宣布计划增加国防开支并为失业者提供生活补助。四天后，该国央行把今年的经济增长预期从3%下调至2.3%。

战争打的不仅是军事实力，也是经济实力，因此这一切战事之上就有了一个重要问题：以色列能否承受住经济上的痛楚？自2005年撤出加沙地带以来，以色列与哈马斯冲突不断，但对评估这次战争的影响并没有多少指导意义。以往每次冲突花费数十亿谢克尔（仅占GDP的很小一部分）的军事和维修开支。这些冲突并未对以色列的经济构成威胁，其人均收入长期位居中东地区前列。

哈马斯在10月7日发动的袭击规模很大，加上很可能引发后续冲突，促使经济学家深入历史。1973年，“赎罪日战争”的军备和征召20万预备役军人的开支把以色列推向了财政崩溃的边缘。据以色列央行估计，单2002年这一年“巴勒斯坦起义”（从上世纪80年代末至本世纪初不断爆发的巴勒斯坦暴动）就耗掉了3.8%的GDP。

要躲避灾难性后果，以色列官员必须直面三大挑战。首先是就业。以色列没有足够的人力兼顾经济和战争。自10月7日以来，军方已动员36万多名预备役军人，占全国劳动力的8%，征召规模超过了1973年。大多数人离开了工作岗位，给经济造成巨大缺口。更糟糕的是，这些新兵属于以色列最富生产力的劳动者。据以色列慈善机构创业国度（Start-Up Nation）估计，十分之一的科技业员工被征召入伍。相比成员主要为富裕国家的经合组织（OECD）的平均水平，以色列科技业员工的生产率要高出四分之

一，而其他经济部门的生产率却要低五分之二。只有极少数预备役军人来自抵制就业的极端正统派犹太人社区。

劳动力短缺还有另一个原因。以色列的许多低技能工作由来自约旦河西岸的巴勒斯坦人承担，其中约有20万人在以色列或犹太人定居点工作。但约旦河西岸爆发动乱意味着许多工人被禁止跨境，他们也可能开始罢工。据国际货币基金组织（IMF）的数据，在2000年至2005年发生第二次巴勒斯坦起义期间，巴勒斯坦工人紧缺是以色列经济增长的最大障碍之一。

此外，由于以色列的劳动力市场极度吃紧，几乎没有劳动者可以替代预备役军人和巴勒斯坦人。该国央行过去几个月一直加息以求让经济降温，其数据显示目前以色列的失业率为3.2%。严格的劳动法让企业只能雇用临时工来替代服兵役的员工，而这不是什么有吸引力的选项。投资者担心资本会从以色列的“硅溪”涌回美国加州的“硅谷”。据创业国度估计，该国有70%的科技公司都在苦苦支撑。风险在于，战争结束时，供人们回来就业的岗位会减少。

政策制定者面临的第二个挑战是居民消费的崩溃。事态不确定以及对反复袭击的忧惧让人们改变了消费习惯，选择待在家中。近三周以来餐馆和购物中心空空荡荡，即便有员工可继续营业也没了顾客。旅游业是以色列在科技业之外的另一个主要产业，现在已迅速停摆。与加沙和黎巴嫩交界地带的城镇被整体清空，经济活动戛然而止。为支持商家，因战事遭受损失的企业（最大的企业除外）都将获得类似疫情时的补助以支付固定成本。增值税的缴纳也已延期。以前在如今被视为不安全地区工作的工人将获得救济金。

这给以色列的政策制定者带来了最后的挑战：管理战事的财政成本。救助企业、支付预备役军人的工资以及把整个村庄的居民迁入酒店将要付出成本。要在今年为地面进攻提供资金并在明年为以色列储备足够的武器以确保安全，将必须巨幅增加国防开支。

以色列现在的债务约占GDP的60%，对像它这样的富裕国家而言，这个比

例不算高。即使战争持续到今年年底，这一比例预计也不过上升至62%。以色列央行拥有1700亿美元的充足外汇储备。而且美国也会提供帮助，前提是总统拜登的140亿美元军事援助计划能获国会批准。然而冲突持续时间越长，风险就越大。据预测，2024年以色列的基本赤字占GDP比例将从3%跃升至8%。在哈马斯发动袭击之前，以色列的经济就已经岌岌可危，经过今年前八个月的艰难日子，9月的政府收入下降了8%。如今借贷成本在上升，税基在崩溃。战事拉长将意味着更多破坏，而重建的成本不会便宜。

| 就是现在

以色列政府不会永远应付得了这庞大开支，这也是该国一批政客坚持认为应立即对加沙发动地面进攻的原因之一。尽管在接下来的几个月里居民和企业将获得慷慨的财政支持，但战事正导致以色列经济的劳动力、资本和专业技能快速流失，无法及时补充。过去，其他经济体为求军事胜利可能经受了更大得多的破坏，但对这一次以色列被迫承受代价的人来说，这并没有什么安慰作用。■



Sleepy heads

Why do people sleep? And other unanswered questions

A new book, "Mapping the Darkness", explores the active world of sleep research

Mapping the Darkness. By Kenneth Miller. Hachette Books; 432 pages; \$32.50. Oneworld Publications; £18.99

BIRDS DO IT. Bees do it. People do it, though often less than they would like to. Owls do it in the daytime. Even *Caenorhabditis elegans*, a primitive roundworm made up of a few thousand cells, does something that looks an awful lot like it. Sleep is an ancient, universal experience.

But partly because it is so commonplace, for a long time sleep was a subject that scientists had not woken up to. It is only in the past half-century or so that it has attracted the attention of dedicated researchers. A new book from Kenneth Miller, a science journalist, sets out to chronicle the field's short but fascinating history.

The book is organised around the life and hard work of four scientists. The patriarch of the field is Nathaniel Kleitman, whose presence looms largest. A Jewish man born in what is now Moldova, he emigrated to America in 1915, escaping Russian pogroms before setting up a pioneering sleep-research programme at the University of Chicago.

The early pages of the book, before there is much in the way of established science to describe, are the weakest. A good deal of time is spent on biographical details and pen portraits of the world through which Kleitman moved. But the story soon picks up. It roams from the discovery of rapid-eye-movement (REM) sleep and circadian rhythms—the biological clocks that govern humanity's days—to the effects of sleep deprivation (which can be fatal, at least in lab animals). It also probes the purpose, if any, of

dreams.

Underlying it all is a sense of psychology's slow maturing as a science. New technologies such as electroencephalographs, which monitor electrical activity in the brain, have offered practitioners the ability to study brains directly, rather than trying to infer what they are doing from the behaviour of their owners.

Mr Miller has a good eye for a great scientific story. One of Kleitman's best-known experiments involved spending 32 days in a dark cave as he worked to shed light on the limits of the body's inbuilt circadian clock. The author is happy to show research as it is really done, indignities and all.

One section describes a more modern, quantitative sort of circadian-rhythm research that took place in a purpose-built facility in a Bavarian village. The lab sported two apartments, with no window or clocks to clue their occupants into what was happening outside. Test subjects lived there for weeks, free to wake and doze whenever they liked—but never free from the rectal thermometers that were attached to wall sockets by long cables.

There is a serious side, too. Shift work interferes with the body's internal clocks and raises the risk of illness, including heart disease and diabetes. Mr Miller explains medicine's slow recognition of sleep apnea, a common affliction, and the damage it can inflict. It is caused by the airway repeatedly collapsing during sleep. Sufferers endure hundreds of episodes of oxygen deprivation every night (the characteristic gasping and snorting comes when a bodily reflex forces sleepers to take a desperate breath of air).

If left untreated, sleep apnea can lead to crippling exhaustion or worse. Mr Miller relates the case of a brother and sister who both suffered from the condition. The brother was eventually cured by having a small hole cut in his throat, but years of oxygen deprivation at night had caused irreversible

brain damage in his sister.

Discoveries often lead to new questions in turn. That is why neat, tidy endings are hard to achieve in science books; this one is no different. Despite all the progress of the past 50 years, scientists are still unsure what sleep is for. The fact it is so widespread suggests it is vital. But why evolution would see fit to produce animals that must spend large amounts of their time insensate and unable to respond to threats is still a mystery researchers are trying to solve. For anyone curious about asking the right questions, however, Mr Miller's book is a good place to start. ■



嗜睡

人为什么要睡觉？以及其他关于睡眠的未解之谜

新书《黑暗地图》探究活跃的睡眠研究领域【《黑暗地图》书评】

《黑暗地图》，肯尼斯·米勒著。阿歇特出版社；432页；32.50美元。
Oneworld出版社；18.99英镑。

这件事鸟儿会做。蜜蜂会做。人也会做，尽管往往做得不如所愿。猫头鹰在白天也做。即使是秀丽隐杆线虫——由几千个细胞组成的原始蛔虫——也做一种看起来极相像的事。这就是睡觉，一种古老而普遍的经验。

但是，在某种程度上正是因为睡眠太过司空见惯了，很长一段时间里科学家都没有察觉到这个课题。只是在过去约半个世纪里，它才引起了研究者的潜心钻研。科学记者肯尼斯·米勒（Kenneth Miller）的新书记录了这个领域短暂但迷人的历史。

本书围绕四位科学家的人生与辛勤工作展开。该领域的奠基人是纳撒尼尔·克莱特曼（Nathaniel Kleitman），他的影响最为深远。他是犹太人，出生于现在的摩尔多瓦，1915年为躲避俄国人的大屠杀而移居美国，之后在芝加哥大学设立了开创性的睡眠研究项目。

本书的开头部分最为单薄，因为还没有什么成熟的科学研究可以讲述。大量篇幅花在了人物生平细节和对克莱特曼经历的描述上。但故事很快就加快了节奏。从发现快速眼动期和昼夜节律（支配人类日夜的生物钟），讲到睡眠剥夺的影响（至少对实验动物可能是致命的）。它还探究了做梦的目的（如果有的话）。

在这一切的背后，读者可以感受到心理学作为一门科学的缓慢成熟。脑电图仪等监测脑电活动的新技术让研究人员可以直接研究大脑，而不是试图通过大脑主人的行为来推断大脑的活动。

米勒善于发现精彩的科学故事。克莱特曼最著名的实验之一就是在一个黑

暗的洞穴里待了32天，试图揭示人体内的昼夜节律时钟的极限。作者乐此不疲地展示研究工作的真实过程，包括各种令人难堪的细节。

其中一节描述了在巴伐利亚的村庄一个专门建造的实验设施里进行的更现代、更定量的昼夜节律研究。这个实验室有两套公寓，没有窗户，也没有时钟，里面的人无法获知外界状况。受试者在那里住了几个星期，可以随时醒来或睡下，但始终插着直肠温度计，长长的电线将这些温度计连接到墙上的插座。

书里也有严肃的一面。倒班工作会干扰人体的内部时钟，增加患上心脏病和糖尿病等疾病的风险。米勒解释了医学界如何缓慢认识到睡眠呼吸暂停这种常见疾病及其可能造成的伤害。它是由睡眠中气道反复塌陷造成的。患者每晚都要忍受数百次缺氧（当身体本能反射迫使睡眠者拼命呼吸空气时，就会出现特有的喘息和鼾声）。

如果不及时治疗，睡眠呼吸暂停会让人疲惫不堪，甚至更糟。米勒讲述了一对兄妹的病例，他们都患有睡眠呼吸暂停。哥哥最终通过在喉咙上开一个小孔而被治愈，但多年的夜间缺氧对妹妹造成了不可逆的脑损伤。

科学发现往往又会引发新的问题。这就是为什么科学类书籍鲜有干净利落的结尾，这本书也不例外。尽管过去50年来取得了长足进步，但科学家仍不清楚睡眠到底有何用。睡眠如此普遍，表明它极为重要。但是，为什么进化要让动物必须花费大量时间失去知觉、无法对威胁做出反应——这仍然是研究人员试图解开的谜题。不过，对于任何有兴趣提出正确的问题的人，米勒的书都是一个很好的起点。■



Crypto's future

Will Binance come over to the light side?

With FTX crushed, CZ must decide whether to go along with regulation

“THE LUKE SKYWALKER and the Darth Vader of crypto.” That is how Michael Lewis, author of “Going Infinite”, a recent book about the rise and fall of Sam Bankman-Fried, founder of FTX, a now-bankrupt crypto exchange, is supposed to have described the intense rivalry between his subject and Changpeng Zhao (pictured), the boss of Binance, a rival firm.

Until Mr Bankman-Fried’s exchange collapsed with an \$8bn hole in its balance-sheet, the analogy seemed apt. The two men controlled the two largest crypto exchanges in the world. Both were known by acronyms: “SBF” and “CZ”. Young, talented and seemingly in favour of playing nice with regulators, SBF was something of a wunderkind, and CZ was his shadowy foil. Keen to avoid being pinned down by national laws, his exchange was based “nowhere”. Binance had long been under investigation for possible money-laundering and criminal-sanctions violations by America’s justice department. CZ had invested in FTX before the two turned on each other. Then SBF publicly goaded CZ about his legal problems, and a tweet by CZ probably helped set off the run on FTX.

Now, with FTX out of the picture and SBF on trial, charged with various kinds of fraud, which he denies, CZ looks a lot like the last man standing in crypto. Binance utterly dominates crypto trading (see chart). A whopping 40-50% of it by volume takes place on the platform. The big question, which CZ discussed in an interview with The Economist in Bahrain on October 11th, is how Binance will now evolve.

For as long as crypto exchanges have existed, financial laws have been ill-suited to them. Given the nature of the assets that are traded, they are in

effect hybrids of exchanges, brokers and settlement firms. If crypto exchanges were largely unregulated that was at least partly because few laws had been written to govern them.

But, in the wake of FTX's collapse, the situation is starting to change. Legislators and regulators around the world are rushing to pen new laws or crack down on the industry. This has two big implications for exchanges. First, regulators want to make sure that they are not mishandling or improperly using customer funds, as FTX did. Second, they want to ensure that exchanges are not facilitating financial crimes.

CZ insists that customers can trust his exchange. "There are so many ways" Binance is structured differently to FTX, he says. The firm has met heavy redemption requests from clients, including in choppy markets. He points out that the Securities and Exchange Commission (SEC), America's financial regulator, spent a long time investigating Binance for this kind of misconduct. The regulator could provide "zero evidence" that Binance was commingling user funds, says CZ, "which actually helps us to prove that we don't do it." Other complaints by the SEC, including that the company issued securities without a licence, are still to be heard in court.

Yet it is the second requirement that might turn out to be trickier for Binance. In December Reuters, a news service, reported that prosecutors at America's justice department were split on whether or not to charge the firm with money-laundering or sanctions violations. According to Bloomberg, another news service, Binance withdrew its application to become a licensed exchange in Singapore in 2021, where it was based at the time, in part owing to its inability to comply with strict anti-money laundering rules. The SEC quotes evidence from a former employee, who admitted that the company thought it was an "unlicensed securities exchange" and "did not want to be regulated, ever".

CZ dismisses this as “private chat by an ex-employee”, and adds it “was not the right thing by far”. He notes that Binance is “the most licensed crypto firm in the world”, with permission to operate in 18 countries across Asia, Europe and the Middle East (its American arm operates in 44 states). Binance now appears to be playing nice with various authorities. A spokesperson confirms that in recent days it has frozen “the small number of accounts” soliciting donations in support of Hamas, to comply with international sanctions laws.

The test for the firm now will be in Europe. America is cracking down on crypto, and is unlikely to pass new laws soon. By contrast, European legislators have written a “Markets in Crypto-Assets” or “MiCA” framework, which entered into force in June. Exchanges can keep operating under existing licences until 2026, unless refused under MiCA, which will require strong policies against money-laundering and terrorist financing. CZ says that, in addition to such policies, a full licence means that authorities look at “your wallet infrastructure, your security, your customer support policies, your refund policy. They look at your whole business.”

A crypto exchange can no longer argue that it cannot comply with national rules because they do not exist. Failing to meet Europe’s standards would reveal that Binance does not want, or is unable, to follow even clear laws. In “Star Wars”, Yoda warns Luke Skywalker that it is easier to amass or wield power by turning to the Dark Side. It is harder to operate in the light. ■



加密货币的未来

币安会转向光明面吗？

FTX垮台后，赵长鹏必须决定是否接受配合监管

“加密货币界的卢克·天行者和达斯·维达。”据信迈克尔·刘易斯（Michael Lewis）在新作《走向无限》（Going Infinite）中这样形容山姆·班克曼-弗里德（Sam Bankman-Fried）和赵长鹏（见上图）之间的激烈对抗。班克曼-弗里德是已破产的加密货币交易所FTX的创始人，刘易斯这本书以他为主角，记叙了他的成败起落；赵长鹏是其对手公司币安（Binance）的掌门人。

在班克曼-弗里德的交易所因资产负债表出现80亿美元的窟窿而倒闭之前，这个比喻看起来很贴切。这两人掌控着全球最大的两家加密货币交易所。他们均以名字首字母缩写广为人知：“SBF”和“CZ”。SBF年轻有才，看上去认同要与监管机构友好相处，有点少年得志的味道。而CZ好像是他暗淡的陪衬物。为免受辖区国家法律的约束，CZ的交易所“无处可寻”。币安一直被美国司法部门调查，怀疑它存在洗钱和违反刑事制裁的行为。CZ曾投资FTX，后来两人反目成仇。SBF公开指责CZ的法律问题，而CZ发布的一条推文很可能推动触发了FTX被挤提。

现在，随着FTX退出舞台，SBF被控多项欺诈行为（他拒不认罪）而受审，CZ似乎成为了加密货币界的终极悍将。币安完全称霸加密货币交易（见图表）。按交易量计算，多达40%至50%的交易都是在该平台上进行的。10月11日，CZ在巴林接受本刊采访时谈到，现在的首要问题是币安将如何演变。

自加密货币交易所诞生以来，现有金融法规一直对它们不太适用。从被交易的资产的性质来看，它们实际上是交易所、券商和结算公司的混合体。如果说加密货币交易所在很大程度上不受监管，至少部分原因是政府少有专门的立法来监管它们。

但是，在FTX崩塌后，情况开始改变。世界各地的立法机构和监管机构纷纷针对该行业制定新法律或开展打击行动。这对加密货币交易所两大影响。首先，监管机构希望确保这些交易所不会像FTX那样不当处理或挪用客户资金。其次，他们想确保交易所不会助长金融犯罪。

CZ坚称客户可以信任其交易所。他说，币安的架构与FTX“有太多不同之处”。该公司满足过客户大量赎回的要求，包括在强烈波动的市场上。他指出，美国的金融监管机构证券交易委员会（SEC）花了很长时间调查币安是否存在此类不当行为。但SEC拿不出“任何证据”证明币安有混用用户资金，CZ说，“这实际上帮助证明了我们的清白”。SEC对币安的其他指控（包括未经许可发行证券）尚待法庭审理。

然而对币安而言，第二项要求可能更加棘手。12月，路透社报道称，美国司法部的检察官在是否起诉该公司洗钱或违反制裁的问题上存在分歧。另一家新闻机构彭博社称，币安于2021年撤回在它当时总部所在地新加坡申请运营交易所牌照，一定程度上是因为该公司无法遵守严格的反洗钱规定。SEC引用了币安一名前雇员提供的证据，他承认币安自认是“无牌证券交易所”，而且“永远不想被监管”。

CZ驳斥这不过是“一名前员工的私下言论”，并称这“远非事实”。他指出，币安是“全球牌照获取最全的加密货币交易所”，被获准在亚洲、欧洲和中东的18个国家开展业务（其美国分公司在44个州开展业务）。现在，币安似乎在努力向各地当局卖乖。其发言人证实，近日，为遵守国际制裁法，币安冻结了“少量为支持哈马斯而募捐的账户”。

该公司如今面临的考验在欧洲。美国正在打击加密货币，短期内不大会通过新法律。相比之下，欧洲立法机构已制定了名为《加密资产市场监管法案》（MiCA）的法律框架，已于今年6月生效。加密货币交易所可在现有许可牌照下继续运营到2026年，除非按该法案的要求被喊停——该框架要求交易所严格的反洗钱和反恐怖主义融资政策。CZ说，除了这些政策外，要获得全面牌照还意味着当局会考察“你的钱包基础架构、安全性、客户支持政策、退款政策。它们会全面考察你的整个业务”。

加密货币交易所不能再辩称自己之所以不合规是因为没有相关政府法规可遵循。如果不能符合欧洲的标准，那就显示币安是不愿或无法遵守明确的法律。在《星球大战》中，尤达警告卢克·天行者，转向黑暗面更容易积累或运用力量。在光明面运营会更为困难。■



Bartleby

How big is the role of luck in career success?

Lubar: lucky beyond all recognition

LUCK PLAYS a big and often unacknowledged part in career success, starting in the womb. Warren Buffett has talked of winning the “ovarian lottery” by being born in America when he was, and being wired in a way that pays off in a market economy. Good looks are associated with higher pay and a greater chance of being called to interview in hiring processes. Your experience of discrimination will reflect your circumstances of birth.

The early way-stations in a career are often marked by chance: a particularly encouraging boss, say, or an assignment that leads you off in an unexpected but defining direction. Luck can affect the pathways of the most rational-minded professions. A paper published in 2022 by Qi Ge of Vassar College and Stephen Wu of Hamilton College found that economists with harder-to-pronounce names, including within ethnic groups, were less likely to be placed into academic jobs or get tenure-track positions.

Names can work against economists in other ways. Another study, by Liran Einav of Stanford University and Leeat Yariv, now of Princeton University, found that faculty with earlier surname initials were more likely to receive tenure at top departments, an effect they put down to the fact that authors of economics papers tend to be listed alphabetically.

Performing well can be due to luck, not talent. In financial markets, asset managers who shine in one period often lose their lustre in the next. The rise of passive investing reflects the fact that few stockpickers are able persistently to outperform the overall market. The history of the oil industry is shot through with stories of unexpected discoveries. A recent paper by Alexei Milkov and William Navidi of the Colorado School of Mines

found that 90% of industry practitioners believe that luck affects the outcome of exploration projects. The authors' analysis of 50 years of drilling on the Norwegian Continental Shelf concluded that the differences in success rates between individual firms were random.

There is a long-running debate about whether luck affects executives' pay. A recent paper by Martina Andreani and Lakshmanan Shivakumar of London Business School and Atif Ellahie of the University of Utah suggests that it does. The academics looked at the impact of a big corporate-tax cut in America in 2017, an event which resulted in large one-off tax gains and losses for firms that were based on past transactions and that could not be attributed to managers' skills. They found that larger windfall gains led to higher pay for CEOs of less scrutinised firms; tax losses did not seem to affect their earnings. Lucky things.

Just as some people blindly believe that merit determines success, so it is possible to get too hung up on the role of chance. CEOs may well be rewarded for luck but slogging to the top of companies involves talent and hard work. Although some have argued that entrepreneurs are simply people fortunate enough to have a large appetite for risk, skill does matter. A paper from 2006 by Paul Gompers of Harvard University and his co-authors showed that founders of one successful company have a higher chance of succeeding in their next venture than entrepreneurs who previously failed. Better technology and greater expertise reduce the role of chance; the average success rates in oil exploration, for example, have gone up over time.

But if luck does play a more important role in outcomes than is often acknowledged, what does that mean? For individuals, it suggests you should increase the chances that chance will work in your favour. Partners at Y Combinator, a startup accelerator, encourage founders to apply to their programmes by talking about increasing the "surface area of luck": putting

yourself in situations where you may be rejected is a way of giving luck more opportunity to strike.

An awareness of the role that luck plays ought to affect the behaviour of managers, too. Portfolio thinking reduces the role of luck: Messrs Milkov and Navidi make the point that the probability of striking it lucky in oil exploration goes up if firms complete numerous independent wells. If luck can mean a bad decision has a good result, or vice versa, managers should learn to assess the success of an initiative on the basis of process as well as outcome.

And if the difference between skill and luck becomes discernible over time, then reward people on consistency of performance, not one-off highs. Mr Buffett might have had a slice of luck at the outset, but a lifetime of investing success suggests he has maximised it. ■



巴托比

运气在事业成功中扮演多大角色？

有一种幸运，超乎你的想象

事业能否成功，运气起着很大的作用，尽管这一点往往得不到承认。其实运气在娘胎里就开始起作用了。沃伦·巴菲特（Warren Buffett）曾说过，他赢得了“卵巢彩票”，当年得以出生在美国，性情禀赋也契合市场经济，能为他带来回报。相貌出色意味着更高的薪水，在招聘过程中也更有可能会获得面试机会。你受歧视的经历会反映出你的出身背景。

职业生涯起步阶段的小节点往往是由偶然性促成的，比如遇到了一个特别爱鼓励人的老板，或者负责的某个任务意想不到地决定了你的职业发展航向。就算是在最讲求理性的行当，个人前途也可能受运气影响。瓦萨学院（Vassar College）的葛琪（Qi Ge，音译）和汉密尔顿学院（Hamilton College）的斯蒂芬·吴（Stephen Wu，音译）在2022年发表的一篇论文发现，名字难念的经济学家获得学术职位或终身教职的可能性更小，就算在本族裔内部也是如此。

姓名还可能在其他方面对经济学家产生不利影响。斯坦福大学的利兰·艾纳夫（Liran Einav）和现在供职于普林斯顿大学的莉亚特·雅利夫（Leeat Yariv）进行的另一项研究发现，姓氏首字母排名较靠前的教师更有可能在王牌院系获得终身教职，他们认为原因是经济学论文作者的名字往往是按字母顺序排列的。

表现出色也可能是因为运气好，而不是才华过人。在金融市场上，在某个时期大放异彩的资产管理人往往到了下一个时期就失去光彩。被动投资的兴起反映出很少有选股者能够持续跑赢大盘。在石油产业的历史中，意外探明矿藏的故事比比皆是。科罗拉多矿业学院（Colorado School of Mines）的阿列克谢·米尔科夫（Alexei Milkov）和威廉·纳维迪

（William Navidi）近期发表的一篇论文发现，90%的行业从业者认为运气会影响勘探项目的结果。两位作者分析了挪威大陆架上50年间的钻探工

作后得出结论：各个公司之间成功率的差异是随机的。

运气是否会影响高管的薪酬呢？这一点一直有争议。伦敦商学院的玛蒂娜·安德里亚尼（Martina Andreani）和拉克什曼南·西瓦库马尔（Lakshmanan Shivakumar）以及犹他大学的阿迪夫·埃拉希（Atif Ellahie）近期发表的一篇论文表明确实如此。几位学者研究了2017年美国大幅削减公司税的影响。这项举措让企业或是获得了一次性的大额税务收益，或是遭受了一大笔损失——视企业过去的交易情况而定，与管理者的能力并无关联。他们发现，较少受审核的公司的首席执行官因更大笔的意外之财获得了更高的薪酬；税收损失似乎并没有影响他们的收入。真是些幸运的家伙。

正如一些人盲目地相信真才实学决定成功，也可能有人会太过强调偶然性的作用。首席执行官们固然可能因运气而获益，但登上公司最高位仍需要才干和苦干。尽管有些人认为企业家只不过是足够幸运，生就了过人的胆量，但才能的确重要。哈佛大学的保罗·龚帕斯（Paul Gompers）及合著者在2006年发表的一篇论文中指出，一家成功公司的创始人再度创业时，成功的几率要高于之前失败过的企业家。更精良的技术和更深厚的专长降低了偶然性的作用，比如石油勘探的平均成功率就已随时间的推移而上升。

但是，如果运气在决定成败中的作用确实比通常认为的更重要，那人们需要做些什么？对于个人来说，这意味着你应该多多创造机会，让机遇在想帮你时不至于鞭长莫及。创业加速器Y Combinator的合伙人在鼓励创业者申请其项目时，用的一个说法是增加“运气的表面积”：让自己多置身于可能遭到拒绝的情形中，这样好运气才能有更多机会降临到你身上。

认识到运气的影响应该也会影响管理者的行为。投资组合思维弱化了运气的作用，比如米尔科夫和纳维迪就指出，如果公司多打油井，在石油勘探中撞大运的可能性就会增加。如果运气可能意味着糟糕的决策也能带来好结果（或者反过来），那么管理者就应该学着在评估某个方案成功与否时既看结果，也看过程。

假以时日，如果技能和运气之间的差异变得清晰可辨，那么就应该根据一贯的表现而不是一时的高光来给人以奖赏。巴菲特可能一开始确实有一点运气的成分，但他成功的投资生涯表明，他把运气的作用发挥到了极致。





Waterworlds

Tuvalu plans for its own disappearance

Is a country still a country if it sinks?

FOR OVER three decades the Pacific island country of Tuvalu has implored industrialised countries to cut their greenhouse-gas emissions. For over three decades global temperatures have ticked up. Tuvalu's government warns that its territory could slip underwater by the end of the century. "It's a matter of disappearing from the surface of this Earth," Kausea Natano, the prime minister, said in September. So Tuvalu is now asking a different question: how can it continue existing if that happens?

Mr Natano's government has amended the constitution to assert that the country will exist "in perpetuity" even if its landmass does not. The new wording, which came into effect on October 1st, will not on its own change very much. Under international law, a country must have a physical territory and permanent population. But no one has considered what happens if climate change strips a state of those qualities, says Bal Kama, a lawyer who advised the government on its constitutional changes. Tuvalu hopes that if other vulnerable countries follow its lead, international law could change.

The government talks about turning Tuvalu into a "digital nation" that could provide services and preserve cultural traditions online even were its people dispersed to other countries. It speculates about creating a 3D version of its islands that web users could ramble around. All these plans raise more questions than answers.

The government is especially keen to make explicit that it would expect to retain its claim on the waters surrounding present-day Tuvalu. Combine the "exclusive economic zones" (EEZs) that stretch 200 nautical miles

(370km) from their coasts, and Pacific island countries have rights to fish and mine an area of ocean bigger than Africa (see map). Leaders fear that they will lose those rights—and a tuna industry worth billions—if any or all of the islands that make up their territories disappear.

So Tuvalu's constitutional change states that its maritime boundaries would endure with its statehood. The government wants neighbours to accept that its EEZ will exist forever. Other Pacific governments have also mapped their maritime zones and passed laws asserting that rising sea levels will not affect their EEZs. It is not yet certain that Tuvalu will go under. But its government is readying the rafts. ■



未来水世界

图瓦卢为本国消失做准备

一个沉没的国家还是国家吗？

三十多年来，太平洋岛国图瓦卢（Tuvalu）一直恳请工业化国家减少温室气体排放。三十多年来，全球气温一直在上升。图瓦卢政府警告称，到本世纪末，该国国土可能会被水淹没。“这是一个从地球表面消失的问题。”该国总理纳塔诺9月表示。所以现在图瓦卢提出了另一个问题：如果这种情况发生，该国如何继续存在？

纳塔诺政府已经修改了宪法，坚称该国将“永久”存在，即使国土不复存在。修改后的宪法于10月1日生效，新的措辞本身并不会带来太多改变。根据国际法，一个国家必须有实体领土和永久居民。但没有人考虑过气候变化导致一国丧失这些特质后的场景，律师巴尔·卡马（Bal Kama）说。卡马为图瓦卢修宪提供了建议。图瓦卢希望其他受气候变化威胁的国家能效仿它的做法，这样国际法就有可能改变。

图瓦卢政府谈到把该国变为一个“数字国家”，这样即使国民分散到其他国家，也能在线上为其提供服务、保留文化传统。它考虑为其岛屿生成一个3D场景，网络用户可以在其中漫步。所有这些计划带来了更多问题而非答案。

图瓦卢政府特别想要明确的是，它预期保留对如今图瓦卢周边海域的权利。算上距其海岸线200海里（370公里）以内的“专属经济区”，太平洋岛国有权捕鱼和采矿的海域比非洲还大（见地图）。领导人担心如果领土中的某些或全部岛屿消失，他们会失去这些权利，还有价值数十亿美元的金枪鱼业。

所以图瓦卢的修宪申明它的海洋边界会与它的国家地位一起继续存在。图瓦卢政府想要邻国接受它的专属经济区会永远存在。其他太平洋岛国也绘制了它们的海洋区域，并立法声明海平面上升不会影响它们的专属经济

区。图瓦卢会不会被淹没尚不确定，但该国政府正在准备救生筏。■



Selling your sole

Why young consumers love Birkenstocks

The ancient German sandal-maker goes public

IN THE BLOCKBUSTER “Barbie” film, the Birkenstock is more than a shoe. It is a symbol of the real world not run by girls. It is introduced as a deliberately drab antithesis of Barbie’s perfect stiletto. By the film’s end the titular blonde is wearing the cork sandal—with the hallmark double-strap in her signature pink—as she walks into her new life, no longer a doll but a woman ready to put her best foot forward.

Barbie is not the only one swapping heels for contoured soles. So are real-life youngsters. Birkenstock’s revenues have doubled in the past three years, to \$1.4bn. Almost half of last year’s sales came courtesy of buyers in their 20s and 30s. Some of that is down to clever product placement—social-media mentions of Birkenstocks reached a record high in July around the time of the “Barbie” premiere. A lot more has to do with a post-pandemic fashion for all things casual and comfortable, especially among Millennials and Gen-Zs, which has boosted sales of other ungainly casual-chic footwear, such as furry Ugg boots or Croc sandals.

What is cool with the kids proved hot with some investors. On October 10th Birkenstock raised \$1.5bn in an initial public offering (IPO) on the New York Stock Exchange, valuing the firm at around \$9bn.

Although Birkenstocks are far from beautiful—German children forced to wear them to school in the 1980s bemoaned their ugliness—their maker has managed to turn itself into an aspirational brand. It has collaborated with Dior, a high-fashion brand controlled by LVMH, a French luxury behemoth, to make \$1,100 mules. It probably helped that L Catterton, a private-equity firm which bought a majority stake in 2021, is backed by

LVMH. The family holding company of LVMH's boss, Bernard Arnault, said it would buy up to \$325m-worth of Birkenstock shares in the IPO and nominate one of Mr Arnault's sons to its board.

Perhaps owing to the influence of its luxury backers, Birkenstock has no plans to increase production capacity; ever since Johann Adam Birkenstock started making shoes in 1774, the company has insisted on maintaining almost all its production in Germany (only some of the cork soles are made in Portugal). Engineering scarcity by limiting output is a time-honoured strategy for high-end brands that peddle exclusivity. Their couture-pocketed customers tend to be insensitive to price rises.

Birkenstock has managed to push up prices a bit in the past few years, but revenue growth also came from increased shipments. It is unclear how much more expensive it can make its sandals without putting off its customers. Investors are already watching their step. Its share price slipped by 13% on its first day of trading. ■



换鞋底

年轻消费者为什么爱勃肯鞋

古老的德国凉鞋制造商上市了

在大热影片《芭比》里，勃肯鞋不仅仅是一双鞋。它是不由女孩掌控的现实世界的象征。它被强调为一种单调乏味的款式，与芭比精致完美的细高跟鞋形成对比。在影片的结尾，这位金发女主角穿上这款软木凉鞋——那标志性的双绑带是芭比粉色的——走进了新生活，她不再是一个洋娃娃，而是一个准备好全力以赴施展所长的女人。

把高跟鞋换成波状鞋床的平底鞋的不止芭比。现实生活中的年轻人也是如此。勃肯鞋的营收在过去三年里翻了一番，达到14亿美元。去年它近一半的销售额是拜二三十岁的买家所赐。这在一定程度上要归功于巧妙的产品植入——社交媒体上对勃肯鞋的提及在7月《芭比》首映前后达到了创纪录的高点。疫情后全面追求休闲和舒适的时尚是一个很大的因素，尤其是在千禧一代和Z世代中。这推动了其他笨笨丑丑的休闲时尚鞋的销售，比如毛茸茸的UGG靴子或Croc洞洞鞋。

小年轻们觉得酷的东西在一些投资者眼中就是热门。10月10日，勃肯鞋在纽约证券交易所完成IPO，融资15亿美元，公司估值约为90亿美元。

尽管勃肯鞋跟漂亮沾不上边——上世纪80年代，德国孩子们被迫穿着勃肯鞋上学，哀叹它们的丑陋——但勃肯鞋的制造商已经成功地把自己变成了一个令人向往的品牌。它与法国奢侈品巨头路威酩轩集团（LVMH）旗下的高级时装品牌迪奥合作，推出售价1100美元的联名款。由LVMH支持的私募股权公司L Catterton在2021年收购了勃肯鞋的多数股权，这可能有所帮助。LVMH老板伯纳德·阿尔诺（Bernard Arnault）的家族控股公司曾表示会在IPO中购买总价值高达3.25亿美元的勃肯鞋股票，并提名阿尔诺的一个儿子进入公司董事会。

也许是受奢侈品投资方的影响，勃肯尚无扩大产能的计划；自1774年约翰

• 亚当·勃肯斯托克（Johann Adam Birkenstock）开始做鞋以来，该公司一直坚持几乎全部生产都在德国进行（只有部分软木底在葡萄牙生产）。通过限制产量来制造稀缺性，是兜售专享权的高端品牌一个历史悠久的策略。它们那些穿着高定服装的客户往往对价格上涨不敏感。

过去几年里，勃肯鞋成功地把价格推高了一些，但其收入的增长也来自出货量的增加。目前还不清楚在不吓跑顾客的情况下，它能把这些凉鞋的价格提高到多少。投资者已经在小心迈步了。其股价在上市首日下跌了

13%。 ■



Golden Goldin

Claudia Goldin wins the Nobel prize in economics

Her work has overturned assumptions about gender equality

ON THE MORNING of October 9th the National Bureau of Economic Research circulated a working paper to economists around the world entitled “Why Women Won”. In the paper, Claudia Goldin of Harvard University documents how women achieved equal rights in American workplaces and families. Rather fittingly, a few hours later, Ms Goldin was announced as the winner of this year’s economics Nobel prize, for advancing “our understanding of women’s labour-market outcomes”.

Having been the first woman to be granted tenure at Harvard’s economics department, Ms Goldin is now the third woman to have won the subject’s Nobel prize. Taken together, her research provides a comprehensive history of gender labour-market inequality over the past 200 years. In telling this history, she has overturned assumptions about both historical gender relations and what is required to achieve greater equality in the present day.

Before Ms Goldin’s work, economists had thought that economic growth led to a more level playing field. In fact, Ms Goldin showed, the Industrial Revolution drove married women out of the labour force, as production moved from home to factory. In research published in 1990 she demonstrated that it was only in the 20th century, when service-sector jobs proliferated and high-school education developed, that the more familiar pattern emerged. The relationship between the size of Western economies and female-labour-force participation is U-shaped—a classic Goldin result.

Ms Goldin’s research has busted other myths, too. Lawrence Katz, her colleague and husband, marvels at her ability to trawl archives to fill gaps in the historical data on women’s work. Simple statistics, such as the

female employment rate, were mismeasured because when surveyed, women might respond “I’m a housewife”, notes Ms Goldin, even if they managed the family business. Once corrected, the employment rate for white married women, for example, was 12.5% in 1890—five times greater than previously thought.

Her findings also showed that the gender wage gap narrowed in bursts. Women’s wages rose relative to men’s in 1820-50 and then again in 1890-1930, before shooting up in 1980-2005 (see chart). What drove these bursts? The initial two came well before the equal-pay movement and were caused by changes in the labour market: first, during the Industrial Revolution; second, during a surge in white-collar employment for occupations like clerical work.

For the third and most substantial drop, in the late 20th century, Ms Goldin emphasises the role of expectations. If a young woman has more say over when and whether she will have a child, and more confidence that women can work in a wide range of jobs, she may invest more in the future, such as by staying in school for longer. In work published in 2002 Ms Goldin and Mr Katz detailed the example of the contraceptive pill, which was approved in 1960, and gave women more control over decisions about children. Between 1967 and 1979 the share of 20- and 21-year-old women who expected to be employed at 35 jumped from 35% to 80%.

Expectations also matter for employers. Although the pay gap narrowed in the early 1900s, the portion driven by discrimination, rather than job type, grew. An important factor, says Ms Goldin, was changes in how payment was decided. Wages used to be tied to output—how many clothes were knitted, for instance. But after industrialisation, workers were increasingly paid periodically, in part because measuring an individual’s output became trickier. Therefore more ambiguous factors grew in importance, such as ideas about how long a worker would stay on the job. This penalised

women, who were expected to quit when they had children.

Since around 2005 the wage gap has hardly budged. Here Ms Goldin's work questions popular narratives that continue to blame wage discrimination. Instead, in a book published in 2021, Ms Goldin blames "greedy" jobs, such as being a consultant or lawyer, which offer increasing returns to long (and uncertain) hours.

She explains how such work interacts with the so-called parenthood penalty. "Let's say there are two lawyers, equally brilliant," explains Ms Goldin. Once children arrive, "they realise that they both can't work these gruelling hours." Women spend more time raising children, which is why the gender pay gap tends to open up after a first child. Both partners could take on less demanding jobs, but then the couple would earn less as a unit, she explains.

Ms Goldin's research holds lessons for economists and policymakers. For the former group, it shows the importance of history. Ms Goldin's prize is the first economics Nobel awarded for work largely in economic history since Robert Fogel, her former adviser, triumphed in 1993. Before Ms Goldin's research, many academics considered questions about historical gender pay gaps to be unanswerable because of a paucity of data. Yet she has repeatedly demonstrated that digging through historical archives allows researchers to credibly answer big questions previously thought beyond their reach.

For policymakers, Ms Goldin's research demonstrates that fixes for gender inequality vary depending on time and place. In early 20th-century America, companies barred married women from obtaining or retaining employment. A policy response came with the Civil Rights Act of 1964, which banned such behaviour. Today, wage gaps persist because of greedy jobs and parental norms, rather than because of straightforward employer

discrimination. In the past, Ms Goldin has suggested more flexibility in the workplace could be a solution to the problem. Perhaps working out how to achieve it will be her next act. ■



戈尔丁金曲

克劳迪娅·戈尔丁获得诺贝尔经济学奖

她的研究推翻了有关性别平等的假设

十月九日上午，美国国家经济研究局（National Bureau of Economic Research）向全世界的经济学家发表了一篇工作论文，题为《为什么女性赢得了权利》（Why Women Won）。在这篇论文中，哈佛大学的克劳迪娅·戈尔丁（Claudia Goldin）论述了美国女性如何在职场和家庭中获取了平等权利。非常应景的是，几个小时后，就传来了戈尔丁获得本年度诺贝尔经济学奖的消息，获奖理由是增进了“我们对女性劳动力市场结果的理解”。

戈尔丁是第一个获得哈佛经济系终身教职的女性，现在她又是第三位获得诺贝尔经济学奖的女性。总的看来，她的研究全面展现了过去两百年劳动力市场上性别不平等的历史。在讲述这一历史时，她推翻了两方面的假设：历史上的性别关系，以及在今天争取更多平等需要做什么。

在戈尔丁之前，经济学家曾认为经济发展带来了更平等的环境。实际上，戈尔丁的研究显示，工业革命把已婚女性赶出了劳动市场，因为生产从家庭转向了工厂。在于1990年发表的研究中，她展示了只有到了服务业岗位激增和高中教育得到发展的20世纪，我们更为熟悉的模式才开始出现。西方经济体的规模和女性劳动参与率之间的关系是一条U型曲线——这是戈尔丁的经典成果。

戈尔丁的研究还打碎了其他一些迷思。她的丈夫劳伦斯·卡茨（Lawrence Katz）也是她的同事，对她查阅档案资料填补女性就业历史数据空缺的能力惊叹不已。女性就业率等简单的统计数据并不准确，因为在调查中，女性可能会回答“我是家庭主妇”——戈尔丁指出——哪怕她们是在管理家族企业。如果加以修正就会有不同结果，比如已婚白人女性的就业率在1890年是12.5%，是之前认为的五倍。

她的发现还显示，性别工资差距的缩小是阵发性的。1820年至1850年，女性工资相对男性工资出现上升，然后1890年至1930年再次上升，到1980年至2005年间大幅上升。是什么推动了这些阵发性的上升？前两次远在同工同酬运动发起之前，是由劳动力市场的变化造成的：第一次是在工业革命期间；第二次是在办公室文员等白领就业激增的时期。

对于20世纪末出现的第三次也是最重要的一次上升，戈尔丁强调了预期的作用。如果一个年轻女性对于自己何时和是否生育子女有更多决定权，并且对女性有宽广的就业面更有信心，她就可能对未来投入更多，比如延长在校学习时间。戈尔丁和卡茨在2002年发表的研究详细阐述了避孕药的例子，避孕药于1960年被批准使用，让女性更能够掌控生育子女的决定。从1967年到1979年，20和21岁女性中预计自己在35岁仍然就业的比例从35%上升到80%。

预期对于雇主也很重要。尽管男女工资差距在1900年代初缩小，但因歧视而非工作类型导致的那部分差距却在扩大。戈尔丁说，一个重要因素是决定工资的方式。工作过去是和产出挂钩——比如编织了多少件衣服。但在工业化以后，越来越多的工人是领取定期工资，这在一定程度上是因为衡量一个人的产出变得更为困难了。因此更模糊的因素变得更为重要，比如推断一个工人会在岗位上做多久。这对女性不利，因为雇主预期她们会在生育子女后离职。

自2005年以来，男女工资的差距几乎没有变化。对此，戈尔丁的研究质疑了依旧责怪工资歧视的流行说法。在2021年出版的一本书中，她把问题归咎于“贪婪的”工作，例如咨询顾问或律师，在这些工作中，长时间（且不规律的）工作会得到更高回报。

她解释了这些工作与所谓的“育儿惩罚”之间的关系。“让我们假设有一对律师夫妇，两人同样有才华。”戈尔丁解释说。一旦有了孩子，“他们就认识到没法让两人都那么长时间地工作了”。女性花更多时间照料孩子，这是性别工资差距往往在第一个孩子出生后扩大的原因。父母两人可以都去做不那么辛苦耗时的工作，但这样一来家庭的总收入就会减少，她解释说。

戈尔丁的研究为经济学家和政策制定者提供了启示。对于经济学家，这些研究显示了历史的重要性。戈尔丁的获奖是诺贝尔经济学奖在罗伯特·福格尔（Robert Fogel）于1993年获奖后首次颁给主要研究经济史的成果，福格尔曾是戈尔丁的导师。在戈尔丁的研究之前，很多学者认为历史性别工资差距的问题是无解的，因为相关数据太过稀缺。然而她一再证明，从历史档案中挖掘数据能让研究人员令人信服地回答那些之前被认为是他们无法解答的重大问题。

对于政策制定者来说，戈尔丁的研究证明性别不平等的解决方法因时因地而异。在20世纪初的美国，公司禁止雇用或留用已婚女性。《1964年民权法案》（Civil Rights Act of 1964）禁止了这种做法，给出了政策上的应对。今天性别工资差距依然存在是因为“贪婪的工作”和育儿常规，而不是简单的雇主歧视。在过去，戈尔丁曾提出更灵活的工作安排可能是解决这一问题的一个办法。也许，探明如何实现这种灵活度会是她的下一幕精彩演出。■



Green light

How carbon prices are taking over the world

A quarter of global emissions are now covered, and the share is rising fast

IF GLOBAL WARMING is to be limited, the world must forget fossil fuels as fast as possible—that much almost everyone agrees upon. How to do so is the complicated part. Economists have long favoured putting a price on carbon, a mechanism Europe introduced in 2005. Doing so allows the market to identify the cheapest unit of greenhouse gas to cut, and thus society to fight climate change at the lowest cost. Others, including many American politicians, worry that such schemes will provoke a backlash by raising consumer costs. Under President Joe Biden, America is instead doling out hundreds of billions of dollars to turn supply chains green.

Yet, remarkably, the rest of the world is beginning to look more European—with carbon prices spreading in countries both rich and poor. Take Indonesia, the world's ninth-biggest polluter. Although it releases 620m tonnes of carbon-dioxide equivalent a year, with almost half its soaring energy consumption coming from coal, the country has green ambitions. On September 26th, at the launch of its first carbon market, Joko Widodo, the president, talked up its prospects as a hub for the carbon trade, and local banks duly snapped up credits from a geothermal-energy firm. The country also introduced an emissions-trading scheme in February, which requires large coal-fired plants to buy permits for emissions above a threshold.

In short, even in countries better known as polluters than green leaders, things are shifting. By the beginning of 2023, 23% of global emissions were covered by a carbon price, up from just 5% in 2010. The spread will only accelerate over the coming years as more countries come round to the advantages of carbon pricing, and schemes expand their reach. According

to the IMF, 49 countries have carbon-pricing schemes, and another 23 are considering them. On October 1st the EU launched a groundbreaking policy under a dreary name. The “carbon border adjustment mechanism” (CBAM) will, by 2026, start to levy a carbon price on all the bloc’s imports, meaning that European companies will have a strong incentive to push suppliers around the world to go green.

The spread of carbon prices is happening in three ways. First, governments are creating new markets and levies. Indonesia is one example. If all goes to plan, its market will eventually be combined with a carbon tax. In April Japan launched a voluntary national market for carbon offsets, which will work alongside an existing regional cap-and-trade policy in Tokyo. Participants, accounting for 40% or so of the country’s pollution, will have to disclose and set emissions targets. Over time the scheme will become stricter, with auctions of carbon allowances for the energy industry due to begin in 2033. Meanwhile, Vietnam is working on an emissions-trading scheme to be established in 2028, in which firms with emissions above a threshold will need to offset them by buying credits.

Second, countries that already have established markets are beefing up their policies. In September China’s National Climate Strategy Centre announced that its emissions-trading scheme, the largest in the world, will move from focusing only on the carbon intensity of coal power plants, to focusing on both their intensity and total emissions. The scheme will also be linked with a dormant carbon-credit market, allowing power plants to meet obligations by purchasing credits for renewable power, planting forests or restoring mangroves. Australia, which scrapped its original carbon price in 2014, has reformed a previously toothless scheme known as the “safeguard mechanism”. Since July industrial facilities that account for 28% of the country’s emissions have had to reduce them by 4.9% a year against a baseline. Those that fail must buy offsets, which trade at a price of around \$20 a tonne.

The final way that carbon markets are spreading is via cross-border schemes. The EU's programme is by far the most advanced. In CBAM's pilot phase importers of aluminium, cement, electricity, fertiliser, hydrogen, iron and steel will need to report "embodied emissions" (those generated through production and transport). Then, from 2026, importers will have to pay a levy equivalent to the difference between the carbon cost of these emissions in the EU's scheme and any carbon price paid by the exporter in their domestic market. Free permits for sectors will also be phased out, and the housing and transport industries will be brought into the market.

Many of these schemes will take time to have an impact. Lots in Asia are flimsy, with prices set too low to lead to substantive change—well below the EU's current price of around €90 (\$95), which is itself only approaching climate economists' estimate of the social cost of carbon. For instance, half the coal plants covered by China's emissions-trading scheme face a negative carbon price, meaning that they are in effect paid to burn the dirty fuel, since their emission intensity is below the national average, says Lauri Myllyvirta of the Centre for Research on Energy and Clean Air, a think-tank. The scheme, he notes, also fails to create an incentive to shift from coal to other sources of power.

Across the world, activists criticise the ability of companies to use offsets to indulge in what they term "greenwashing", where firms falsely present themselves as environmentally friendly. Some schemes also struggle to prove that they have led to emissions reductions. Last year a team of academics, led by Andrew Macintosh of Australian National University, argued that reforestation used as carbon credits in Australia's scheme either did not happen or would have happened irrespective of payments for offsets. An independent review has since recommended changes to how the scheme works.

Yet even carbon-pricing programmes that are limited will still help change behaviour, for the simple reason that they encourage the monitoring of emissions. After its launch two years ago, China's emissions-trading scheme was dogged by fraud, with consultants alleged to have helped firms fake coal samples. A crackdown was announced by officials earlier this year, who are now satisfied with the quality of the data. Despite the absence of a carbon price, American firms also face incentives to monitor emissions. President Biden has proposed a rule that all businesses selling to the federal government must disclose emissions and have plans to reduce them. Many large firms have set voluntary net-zero targets as part of their marketing efforts. Apple, the world's largest, has pledged to make its supply chain entirely carbon neutral by 2030.

Industrial firms around the world now face a still greater incentive to accurately track their carbon footprints: CBAM. The EU's ultimate goal is to tackle "carbon leakage". Before CBAM's introduction, Europe's carbon price meant that domestic industries faced an extra cost compared with those in countries with less ambitious decarbonisation plans. This gave importers an incentive to source material from abroad, even if such inputs were dirtier. To compensate for this, the EU handed out permits to industrial producers. These will now be phased out as CBAM is phased in.

During the pilot phase, CBAM simply presents an extra hurdle (or a "non-tariff barrier") for exporters to the bloc. To comply, European firms must report the embodied emissions of their imports. If such data do not exist, importers must use reference values provided by the EU. In order to nudge foreign companies to change their behaviour and prove that their emissions are lower, these are based on the emissions of the dirtiest firms in the bloc.

Carbon border tariffs may themselves start to multiply. In Australia the government recently announced a review into "carbon leakage", which will

examine such an option. In 2021 America and the EU paused a trade dispute, begun by President Donald Trump, by starting negotiations on a “Global Arrangement on Sustainable Steel and Aluminium”. America wants the two trading partners to create a common external tariff on polluting steel producers. Since it does not have a domestic carbon price, such a policy would break the World Trade Organisation’s rules. But if the EU and America do not come to an agreement, the Trump-era tariffs and the EU’s retaliatory measures will be reinstated.

There is a domino effect to carbon pricing. Once an industry is subject to a carbon price, affected businesses will naturally want their competitors to face the same rules. Therefore owners of coal power plants will lobby to ensure that gas power plants operate on a level playing field. Governments in exporting countries also have an incentive to ensure that their domestic firms pay a carbon price at home rather than a tariff abroad. If Asia’s factories are pressed to reduce their emissions anyway by schemes such as CBAM, then its governments are leaving money on the table by not levying a carbon price of their own.

| *Getaway cars*

The question is whether the dominoes will fall sufficiently quickly. Almost no emissions-trading schemes are aimed at emissions from residential property or cars, for instance, where consumers would really feel the pain. In choosing to introduce carbon-pricing schemes, and then to make them broader and more muscular, policymakers have most economists firmly on their side—and are proceeding much faster than is commonly realised. Yet future policymakers will have little choice but to make such measures even more intrusive if they want to minimise the effects of climate change. For that to happen, they will have to win over voters, too. ■



绿灯行

碳定价如何征服世界

目前它已覆盖了全球四分之一的碳排放，而且这一比例还在快速上升【深度】

要想限制全球变暖，世界必须尽快放弃化石燃料——这几乎是人类的共识。但困难之处在于如何做到。经济学家长期都支持欧洲在2005年推出的碳定价机制。给碳定价可以让市场找到减排成本最低的温室气体，从而让社会以最低的成本应对气候变化。包括不少美国政客在内的其他人则担心，这样的体系会因提高消费者成本而遭到抵制。在总统拜登的领导下，美国另辟蹊径，正拿出数千亿美元来打造绿色供应链。

然而，值得注意的是，随着碳定价在富国和穷国都得到推广，世界其他地区越发向欧洲看齐。以世界第九大排放国印尼为例，尽管印尼每年排放6.2亿吨二氧化碳当量，且它飙升的能源消耗几乎有一半来自煤炭，但该国仍不失环保雄心。9月26日，在印尼首个碳交易市场的启动仪式上，总统佐科大谈它作为碳交易中心的前景，多家本地银行也适时从一家地热能公司争相购买碳信用额。今年2月，印尼还启动了一个碳排放交易机制，要求大型燃煤发电厂在排放超过阈值时必须购买碳排放许可。

简而言之，即使在那些更多以排放国而非环保先锋知名的国家，情况也在发生变化。到2023年初，碳定价覆盖了全球23%的温室气体排放，而2010年时这一比例仅为5%。随着更多国家开始认识到碳定价的好处，以及这类机制扩大覆盖面，未来几年碳定价的推广只会加速。根据国际货币基金组织的数据，目前已有49个国家建立了碳定价体系，另有23个国家正在考虑中。10月1日，欧盟推出了一项开创性的政策，名字很枯燥，叫“碳边境调节机制”（CBAM）。该机制规定，到2026年，将开始对欧盟所有进口商品征收碳排放费，这会让欧洲企业有强烈的动机去推动其全球供应商变得环保。

目前碳定价以三种路径传播。首先，各国政府正在打造新的碳市场以及开征新的碳税。印尼就是一个范例。如果一切按计划进行，印尼的碳市场最

终会与碳税协同起来。今年4月，日本启动了一个全国性的自愿碳补偿市场，该市场将与东京现有的地方性“总量管制与交易”政策并行。该市场的参与者——约占日本排放的40%——必须公布并设定排放目标。随着时间的推移，该体系将更加严格，能源行业碳排放配额的拍卖预计将于2033年开始。与此同时，越南正在打造碳排放交易体系，预计2028年上线。在该体系中，超过排放阈值的公司需要通过购买碳信用额来抵消排放。

其次，已经建立了碳市场的国家正在升级政策。今年9月，中国的国家气候战略中心宣布，它的碳排放交易体系（规模为全球最大）将从只关注燃煤发电厂的碳排放强度，转向同时关注它们的碳排放强度和总量。该体系还将与一个不活跃的碳信用市场打通，允许发电厂通过购买可再生能源、植树造林或红树林恢复等碳信用额来履行义务。澳大利亚在2014年废除了其原有的碳定价，改革了此前缺乏效力的名为“保障机制”的体系。从今年7月开始，占澳大利亚排放量28%的工业设施必须参照基准线，每年将排放量减少4.9%。未能达标的企业必须购买碳补偿，其交易价格约为每吨20美元。

丨 突破边界

碳市场扩大的最后一个路径是通过跨境体系。欧盟的方案显然最为先进。在CBAM的试行期，铝、水泥、电力、化肥、氢气、钢铁等的进口商将需要申报“隐含碳排放”，即生产和运输过程中产生的排放。之后，从2026年开始，进口商必须支付一笔税费，补足这些排放在欧盟机制中的碳成本与出口商在其国内市场支付的碳价格之间的差额。一些行业的免费排放许可也将被逐步取消，住房建设和交通运输行业也将被纳入碳市场。

这些机制中有很多尚需时日才能产生影响。亚洲的很多机制都很薄弱，无法带来实质性的变化，因为它们的碳价格定得太低——远低于欧盟目前约90欧元（95美元）的价格，而90欧元的价格也只是接近于气候经济学家估计的碳排放的社会成本。例如，中国碳排放交易体系所覆盖的燃煤发电厂中有一半因排放强度低于全国平均而面对负碳价，意味着它们在燃烧污染燃料时实际上得到了补贴，智库能源与清洁空气研究中心（Centre for Research on Energy and Clean Air）的劳里·米利维尔塔（Lauri

Myllyvirta) 表示。他指出，该机制也未能刺激从煤炭转向其他能源。

在世界范围内，环保活动人士批评一些公司利用碳补偿来尽情“漂绿”，假扮自己是环境友好企业。一些机制也难以证明自己确实促进了减排。去年，由澳大利亚国立大学的安德鲁·麦金托什（Andrew Macintosh）领导的一个专家小组认为，在澳大利亚的碳定价机制中，那些被用作碳信用的重新造林要么并没有实施，要么就是实施了也和购买碳信用来抵消排放并无关系。此后的一份独立审查报告对该机制的运作方式提出了改革建议。

然而，即便是有限的碳定价体系也有助于改变行事方式，原因很简单——它们鼓励对排放进行监控。中国的碳排放交易体系自两年前启动以来，弄虚作假屡见不鲜——据称有咨询公司帮助企业制作虚假煤样。今年早些时候，官员们宣布打击此类行为，他们现在对数据质量感到满意。尽管美国没有碳定价，但美国的公司同样有动力监控排放。总统拜登提出了一项规定，要求所有向联邦政府出售产品的企业必须公开碳排放量，并制定减排计划。许多大公司主动设定了净零排放目标，作为营销活动的一部分。全球最大的公司苹果就承诺，到2030年让自己的供应链完全实现碳中和。

现在，一个更有力的激励措施促使世界各地的工业企业精准追踪自己的碳足迹，那就是CBAM。欧盟的最终目标是解决“碳泄漏”问题。在CBAM推出之前，欧盟的碳价格意味着与那些脱碳计划不够雄心勃勃的非欧盟国家相比，欧盟内的行业面临着额外的成本。这变相鼓励了进口商从欧盟外部采购原料，即使这些原料排放更高。作为补偿，欧盟向工业生产商发放了排放许可。随着CBAM的逐步实施，这些许可将被逐步取消。

在试行期，CBAM对于向欧盟出口的出口商来说，只是增加了一个额外障碍（又称“非关税壁垒”）。要符合其要求，欧洲公司必须报告其进口产品的隐含碳排放量。如果没有这类数据，进口商必须使用欧盟提供的参考值。为了鼓励外国公司改变其行事方式并证明自己减少了排放，欧盟提供的参考值是基于欧盟内部污染最严重企业的排放量而制定的。

碳边境关税可能会开始在各处出现。澳大利亚政府不久前宣布对“碳泄漏”

发起审查，届时将考察碳边境关税方案的可行性。2021年，美国和欧盟暂停了一场由时任总统特朗普发起的贸易争端，就“全球可持续钢铝协议”展开谈判。美国希望能与欧盟这个贸易伙伴一道对高污染的钢铁生产商征收共同对外关税。由于美国没有国内碳定价，这样的政策将违反世贸组织的规则。但如果欧盟和美国不能达成协议，特朗普时代的关税和欧盟的报复性措施就会恢复。

碳定价会产生多米诺骨牌效应。一旦一个行业受制于碳定价，受影响的企业自然会希望其竞争对手也要面对同样的规则。因此，燃煤发电厂的老板会进行游说，以保证燃气发电厂在同样的条件下经营。商品出口国的政府也有动机确保本国企业在国内支付碳价格，而不是在国外支付碳关税。如果亚洲的工厂反正都要在CBAM等体系的推动下减少排放，那么其政府若不自己实施碳定价，就等于白白放弃了获取最大优势的机会。

| 逃亡汽车

问题是多米诺骨牌倒塌的速度够不够快。例如，几乎没有针对住宅或汽车排放的碳排放交易体系，因为这会让消费者直接感受到痛苦。在决定推出碳定价体系，以及随后的扩大覆盖面、加大力度的过程中，政策制定者得到了大多数经济学家的坚定支持——而且他们的推进速度比人们普遍意识到的要快得多。然而，如果未来的政策制定者想要把气候变化的影响降到最低，他们将别无选择，只能进一步加大这些措施的干预力度。要做到这一点，他们还必须赢得选民的支持。■



Demography

Large parts of Asia are getting old before they get rich

Even poor countries must start planning for an ageing population

A BULGE IN A country's working-age population is a blessing. Lots of workers support relatively few children and retired people. So long as the labour market can absorb a surge of job-seekers, output per head will rise. That can boost savings and investment, leading to higher economic growth, more productivity gains and developmental lift-off. Yet for countries that fail to seize this opportunity, the results can be grim—as many developing countries may soon discover.

Consider Thailand. It is rapidly greying. In 2021 the share of Thais aged 65 or over hit 14%, a threshold that is often used to define an aged society. Soon Thailand will, like Japan, South Korea and most Western countries, see a dwindling supply of workers and, without extraordinary measures, flagging productivity and growth. Yet unlike Japan and the rest, Thailand, with a GDP per person of just \$7,000 in 2021, is not a developed country. It has got old before it has got rich. When Japan had a similar portion of oldies, it was roughly five times richer than Thailand is today.

This is a big obstacle to Thailand's future development. To protect its ageing citizens, many of whom are poor, Thailand's government will have to spend more on health care and pensions. This will make it harder to invest in productivity-boosting skills and infrastructure. And where Thailand goes, many developing countries will follow. In Asia, where the problem is most advanced, Indonesia and the Philippines are also likely to become aged societies at lower income levels than was the case in the rich world. Sri Lanka, where the average income is a third lower than Thailand's, will become aged by 2028.

Countries that age before growing rich have failed to seize their demographic opportunity, or aged out of it too rapidly, or suffered both problems. Between 1960 and 1996 (just before the Asian financial crisis), Thailand's economy grew at an average annual rate of 7.5%. That was impressive, but below Japan's double-digit clip in its boom years. Meanwhile, thanks to improving life expectancy and other factors, Thailand has aged fast. The share of oldsters in its population doubled, from 7% to 14%, in two decades. It took Japan 24 years to undergo the same change, America 72, and much of western Europe over a century.

Rapid ageing and slower growth are widespread in the developing world. Vietnamese are about half as rich as Thais and ageing even faster. India's economy has been one of the world's fastest-growing, yet not as fast as Thailand's during its boom. In the decade to 2020 India grew at an average annual rate of 6.6%.

One conclusion is that countries with a working-age bulge need to wring more growth out of it. India may never have a better chance than the present. Under Narendra Modi it has a strong, pro-business government, which is likely to win re-election next year. There is a consensus on the measures, including privatisation and looser foreign-investment rules, that could raise its growth rate. Such reforms would help India take advantage of Western efforts to shift supply chains out of China. If India needs a cautionary tale to justify action, it need look no further than its own rapidly ageing southern states. In Kerala 17% of the population is 60 or older.

Another conclusion is that developing countries need to start planning for old age earlier. They should reform their pension systems, including by raising retirement ages. They should nurture financial markets, providing options for long-term saving and health insurance. They should create conditions for well-regulated private social care. And they should try harder to increase female participation in the labour force; in India it is a

wretched 24%, half the global average. Getting more women into jobs would extend the demographic dividend and help deal with the fact that women live longer than men, but tend to have more meagre savings and pensions, and so are vulnerable in old age.

Finally, developing countries should learn from the errors of rich ones by taking a pragmatic view of immigration. Hard as this can be politically, it is often the easiest way to extend the transition. Building sites in Bangkok already throng with illegal Burmese immigrants. By formalising them, Thai politicians could usher them into more productive roles.

| *Dividend booster*

India provides a happier example of this. A continent-size country, its boom is fuelled by internal migration. Its last census, in 2011, counted 450m internal migrants. Many travel from the poor north to the more prosperous south and west, to seize new opportunities and, increasingly, to take up those being vacated by the south's ageing workers. It is an inspiring illustration of what relatively unfettered labour markets can do—and a lesson for Japan, Thailand and governments everywhere. ■



【首文】人口结构

亚洲大片地区未富先老

即使是穷国也必须开始为老龄化筹谋

一个国家劳动年龄人口激增是好事情。这样就有很多劳动人口供养相对较少的孩子和退休人员。只要劳动力市场能够吸收飙升的求职者，人均产出就会上升。这可以促进储蓄和投资，从而推动经济增长、提高生产率以及加速发展。然而，对于未能抓住这一机遇的国家来说，结果可能很严峻——许多发展中国家可能很快就会看到这一点。

来看看泰国。它正在快速老龄化。2021年，泰国65岁及以上人口占比跨过了14%这一通常被视为进入“老龄社会”的门槛。很快，泰国就会像日本、韩国和大多数西方国家一样面临劳动力供应减少，而如果不采取特别措施，将面对生产率和经济增长乏力。然而，有别于日本和其他国家，泰国不是发达国家，它在2021年的人均GDP仅为7000美元。它还没变富裕就已经衰老了。当日本的老年人口占比处于类似水平时，其富裕程度大约是今天泰国的五倍。

这是泰国未来发展的一大障碍。为了保护其变得老迈而有大批穷人的国民，泰国政府将不得不在医疗保健和养老金上投入更多资金。这会让政府更加难以在能提高生产率的技能和基础设施方面做投资。许多发展中国家都将步泰国的后尘。在问题最严重的亚洲，印尼和菲律宾看起来也将以低于富裕国家当年的收入水平步入老龄社会。斯里兰卡的平均收入比泰国低三分之一，它将在2028年步入老龄社会。

未富先老的国家要么没能抓住人口机遇，要么老龄化的速度过快，亦或两者兼而有之。从1960年到亚洲金融危机前夕的1996年，泰国经济以年均7.5%的速度增长。尽管这一增速很亮眼，但仍低于日本繁荣时期两位数的增长速度。与此同时，由于预期寿命的提高和其他因素，泰国老龄化的速度很快。20年间，泰国老年人占总人口的比例翻了一番，从7%增至14%。日本用了24年才经历了同样的变化，美国用了72年，西欧大部分国家用了

一个多世纪。

人口快速老龄化和经济增长缓慢在发展中国家普遍存在。越南的富裕程度只有泰国的一半，老龄化的速度却比泰国还要快。印度一直是世界上经济增长最快的国家之一，但其增速还是不及泰国繁荣时期的水平。在2010至2020年的十年里，印度的年均经济增速为6.6%。

由此得出的一个结论是，劳动年龄人口激增的国家需要想方设法从中谋求更多的经济增长。印度眼下机不可失。莫迪领导下的印度有一个强势的亲商政府，它很可能还会赢得明年的大选。印度国内对于私有化和放宽外国投资规定等可能提高印度经济增长率的措施已有共识。这样的改革将有助于印度利用西方正将供应链移出中国的机会。如果印度需要一个警世故事来证明其行动的正确性，只需要看看自己迅速老龄化的南部各邦。在喀拉拉邦（Kerala），60岁及以上人口的比例已经达到了17%。

另一个结论是，发展中国家需要更早开始为老年社会做规划。它们应该改革养老金制度，包括提高退休年龄。应该培育金融市场，提供长期储蓄和医疗保险方面的多种选择。它们应该为规范的私营社会照护创造条件。它们还应该更努力地提高女性的劳动参与率——在印度，这一比例只有可怜的24%，是全球平均水平的一半。让更多女性就业将扩大人口红利，并有助于应对一个现实问题——女性通常比男性寿命更长，但储蓄和养老金却比男性少，因此在老年时很容易陷入困顿。

最后，发展中国家应该记取富裕国家的前车之鉴，对移民问题采取务实的态度。尽管这可能会遇到政治上的阻力，但这往往是延长过渡期最简单的方法。曼谷的建筑工地上已经充斥着来自缅甸的非法移民。泰国的政客或许可以通过向他们提供正式身份把他们引向更富生产力的工作。

| 人口红利助推器

印度在这方面提供了一个更积极的范例。印度的国土面积相当于一个洲的大小，它的繁荣就是由国内移民推动的。印度上一次人口普查是在2011年，当时统计总共有4.5亿国内移民。许多人从贫穷的北部前往较繁荣的

南部和西部以把握新机会，同时也越来越多地填补了南部日益年迈的劳动力留下的空缺。这一令人鼓舞的例子说明相对不受限的劳动力市场大有可为——这对于日本、泰国乃至世界各地的政府都是一个启示。 ■



The Economist Film

What drives Elon Musk? - Part 2

Having shown how to make space flight cheap and how to make electric cars sexy, he's decided that he can solve anything.



经济学人视频

马斯克的驱动力是什么？（下）

在展示了如何让太空旅行更便宜、让电动车更性感之后，他认为自己可以解决任何问题。



Where the wild things are

From myth to art, bears have long captivated people

A new book tells the story of eight bear species and their travails

Eight Bears: Mythic Past and Imperilled Future. By Gloria Dickie. W.W. Norton; 272 pages; \$30 and £25

WHEN MICHAEL BOND wrote his first draft of “A Bear Called Paddington” in the 1950s, he described his hat-clad protagonist as hailing from “darkest Africa”. Bond’s literary agent, Harvey Unna, liked the story but spotted an error: no bears lived in Africa. “Children either know this or should know this,” Unna wrote, adding that, “There are plenty of bears in Asia, Europe and America, and quite a few on the stock exchange.” Bond changed Paddington’s origins to “darkest Peru”, modelling him on the spectacled bear from there.

Bears occupy a special place in myth and mind. Youngsters are read stories about Paddington, Winnie-the-Pooh and the three bears and are presented with stuffed teddies. Perhaps also because bears can stand erect on two legs, resembling humans, people have long felt drawn to them. Bears have featured in ancient paintings, constellation names (ursa major, otherwise known as the Big Dipper) and diplomatic negotiations. China’s parcelling out of pandas to allies has precedent: in 1252 King Haakon IV of Norway gave Henry III a polar bear, which spent its days swimming and fishing in the River Thames.

“Eight Bears” explores the wonder and friction that characterise the relationship between bruins and people. The author, Gloria Dickie, a journalist for Reuters, travels around the world, bringing readers on a riveting and unique sort of bear hunt. She dresses up like an “imprisoned smurf” to volunteer at a panda-research centre in China, ventures into

arctic temperatures to find polar bears in Canada, hikes in Peru in the hope of seeing Paddington's ilk and wanders through villages of India to meet people mauled by sloth bears, whose name belies their aggression.

There are just eight bear species, compared with 41 types of felines and more than 500 primates. This offers pleasant concision, but Ms Dickie's tone is sombre. Polar bears are not the only ones on thin ice; most bear species are threatened by habitat destruction and climate change. Pandas, for example, need to eat about 18kg of bamboo a day, but agricultural expansion imperils their food supply. Deforestation has destroyed the habitat of sloth bears (India's most deadly wild animal). During droughts they roam in search of water, sparking conflict with people, who pursue "revenge kills" after bear attacks.

Ms Dickie concludes that only three bear species are likely to thrive past the end of this century: American black bears, brown bears and pandas. (There are fewer than 2,000 pandas, but China has started to take panda preservation seriously.)

This book is about bears but also about people, revealing two opposing sides of human nature. One is people's cruelty. "Bear-baiting", in which bruins were tied up and forced to fight with dogs, was a popular sport in Britain, made illegal only in 1835. (Elizabeth I so enjoyed bear-baiting that she overruled Parliament's attempt to ban it in 1585.) Although outlawed in India in 1972, "bear dancing" has persisted. People kill mother sloth bears and kidnap cubs; they then bash out their teeth and sometimes use muzzles with nails, forcing them into a "dance of fear and desperation" that offers "the illusion of merriment".

Elsewhere bears are enslaved for their bile. In Vietnam (where bear farming is illegal) and China (where it is not), sun and moon bears are kept in cages. Bile is extracted from their gall bladders in a process akin to torture. The

resulting “liquid gold” is sold for its anti-inflammatory properties. Bears’ imprisonment is made all the more disturbing by their intelligence. Researchers have observed that black bears can distinguish between animals and even gauge numbers.

But people also have a more positive side. They are building systems that allow for co-existence, from bear “jails” (where creatures are sent if they come too close to population centres) to bear-proof garbage bins and lockers. Many people around the world are trying to save and improve bears’ lives, proving there is some beauty in this story of beasts and humans. ■



野兽家园

从神话到艺术，熊一直令人着迷

一本新书讲述了八个熊种的故事以及它们的困苦【《八种熊：神话般的过往与危险的未来》书评】

《八种熊：神话般的过往与危险的未来》，格洛丽亚·迪奇著。W.W.诺顿出版社；272页；30美元和25英镑。

当迈克尔·邦德（Michael Bond）在1950年代写作《小熊帕丁顿》（A Bear Called Paddington）的初稿时，他说这个戴着帽子的主人公小熊来自“最黑的非洲”。邦德的文学经纪人哈维·乌纳（Harvey Unna）很喜欢这个故事，但他发现了一个错误：非洲没有熊。“孩子们知道这个，或者应该知道这个。”乌纳写道。“亚洲、欧洲和美洲有很多熊，有不少是在证券交易所。”他补充说。邦德把帕丁顿的出生地改成了“最黑的秘鲁”，赋予了它秘鲁眼镜熊的形象。

在神话里和人们的心中，熊有着特殊的地位。孩子们从小就听帕丁顿、小熊维尼和三只熊的故事，收到毛绒泰迪熊作为礼物。或许是因为熊能像人一样两腿站立，人们一直对熊感到亲近。熊出现在古代绘画中、星座名字里（大熊星座，也就是北斗七星）和外交谈判中。像中国那样向友好国家“派发”熊猫的做法古已有之：1252年，挪威国王哈康四世（King Haakon IV）送给英格兰国王亨利三世一只北极熊，这只熊从此就在泰晤士河里游泳捕鱼。

《八种熊》（Eight Bears）探究了熊与人之间特有的奇妙关系和摩擦。作者格洛丽亚·迪奇（Gloria Dickie）是路透社的记者，她游历全球，带读者踏上了一趟扣人心弦的独特的寻熊之旅。她穿戴得像个“被关押的蓝精灵”，在中国一个大熊猫研究中心做志愿者；在加拿大走进北极的冰天雪地，寻找北极熊；在秘鲁徒步跋涉，希望能见到帕丁顿的同类；穿行在印度的村庄间，探访被懒熊咬伤的人，这种熊的名字掩盖了它们的攻击性。

世界上只有八种熊，而猫科动物有41种，灵长类动物有超过500种。这种简洁令人愉快，但迪奇却笔调沉郁。濒危的不只是北极熊，大多数熊种都面临栖息地被破坏和气候变化的威胁。例如熊猫，它一天要吃掉约18公斤竹子，但农业扩张威胁着它们的口粮供应。砍伐森林破坏了懒熊（印度最致命的野生动物）的栖息地。在干旱期，懒熊会到处寻找水源，引发了与人类的冲突，在被懒熊攻击后，人会进行“报复性杀戮”。

迪奇推断，只有三种熊能活过本世纪末：美洲黑熊、棕熊和熊猫。（世界上的熊猫不到2000只，但中国已开始认真保护熊猫。）

这本书是关于熊的，但也是关于人的——它揭示了人性的两面性。一面是人的残忍。“斗熊”是把熊拴起来，强迫它和狗打斗，这在英国曾经是一种流行的观赏性运动，直到1835年才被列为非法。（伊丽莎白一世非常喜欢斗熊，她在1585年驳回了英国议会禁止斗熊的提议。）尽管“舞熊”于1972年在印度被列为非法，但这种表演一直存在。人们杀死母懒熊，抢走懒熊幼崽，打断小懒熊的牙齿，有时还给它们戴上带钉子的嘴套，迫使它们“因恐惧和绝望而手舞足蹈”，给人以“欢乐的假象”。

在其他地方，熊因为它们的胆汁而被奴役。在越南（养熊是非法的）和中国（养熊不违法），人们以笼子圈养马来熊和亚洲黑熊，用一种近乎酷刑的方法从它们的胆囊中提取胆汁。由此得来的胆汁因其抗炎功效被誉为“液体黄金”出售。熊很聪明，这就更加让囚禁熊的做法令人不安。研究人员发现黑熊能够区分不同的动物，甚至还能计数。

但人也有好的一面。人们正在建立能实现人熊共存的系统，从熊“监狱”（当动物过于接近人类聚集区时，就会把它们送去那里）到防熊垃圾箱和储物柜等。世界各地有很多人在努力拯救熊，改善它们的生存状况，可见在人与兽的故事中还是有一些美好之处的。■



It's all academic

American and Chinese scientists are decoupling, too

That will be bad for both countries

THERE ARE lots of ways to measure China's rise. It is the world's second-biggest economy, its biggest manufacturer and its biggest creditor. In 2021 it passed another milestone. That year, for the first time, Chinese scientists published more papers than their counterparts in America or the European Union (see chart 1). It is not just the quantity that is improving. The Nature Index, run by the publishers of the journal of the same name, tracks contributions to the world's best-regarded health and natural-sciences journals. Chinese researchers rank first in the natural sciences, and second overall.

Cause for celebration, no doubt, in Beijing. In Washington, though, the news may have been less welcome. America increasingly dismayed by China's rise—and especially its growing scientific and technological prowess. Under Donald Trump, the previous Republican president, and Joe Biden, the current Democratic one, it has imposed tariffs, rules and subsidies designed to hobble China's high-tech firms while boosting its own. China has retaliated, moving against some big American tech companies. Twenty years ago, politicians endorsed globalisation and free trade. Now “decoupling”, national security and “friend-shoring” are the hot topics.

| *Conscious uncoupling*

Academia is not immune. New rules and chilly politics in both countries are making it harder for researchers to collaborate. In August America agreed on a temporary, six-month extension for a landmark scientific co-operation agreement signed in 1979. Several American politicians want the

deal scrapped entirely, claiming in an open letter that, by collaborating with Chinese researchers, America was “fuelling its own destruction.”

The strains can be seen in the figures. In 2020 the number of papers jointly written by American and Chinese researchers fell for the first time. It fell again the following year, the most recent for which data are available, though it is still rising for some other countries, such as Britain. The number of visas America awards to Chinese students and academics is down as well, to around a third of its peak in 2015 (see chart 2). Scientifically as well as politically, the countries are drawing apart.

The Science and Technology Agreement, as the 1979 pact is called, was the first bilateral treaty signed between America and China after they re-established diplomatic relations. Several landmark studies have come under its umbrella. A long-running project following 285,000 Chinese women, begun in 1983, helped demonstrate that folic acid could prevent spina bifida, a rare birth defect. These days folic acid is added to flour, bread, cereal and other staple foods; pregnant women are encouraged to take more. Co-operation in influenza research helps anticipate which strains of flu are likely to be dominant each year, improving vaccines.

Even superpower rivals can agree that medical research is a good thing. But China's advances in other areas of science, such as computing, materials science and AI, have made American policymakers uneasy. Critics argue that science in China has benefited from American academic transparency and know-how—but that China has not always returned the favour. Doubters also point to China's policy of “civil-military fusion”, in which the fruits of civilian research are scrutinised for any useful military applications.

China retorts that America's worries about national security have led to the unfair targeting of Chinese researchers at American universities. One

frequent target of complaint is the Department of Justice's "China Initiative", which ran between 2018 and 2022 and was designed to investigate alleged instances of Chinese technological espionage. But cases seem to have been thin on the ground. The initiative investigated at least 150 academics of Chinese origin, but managed to secure only a handful of convictions. Some were for less offences such as grant fraud.

Some of the investigations have become very public fiascos, as with the case of Gang Chen, a well regarded mechanical engineer of Chinese origin who is now at the Massachusetts Institute of Technology. Dr Chen was arrested in 2021. He spent a year on academic leave before all the charges against him were dropped. Other researchers have been sacked by their universities and found themselves on no-fly lists. Academics say the initiative led to an atmosphere of suspicion and mistrust.

China, meanwhile, has national-security concerns of its own, which can likewise impede co-operation. Rules introduced in recent years all but prohibit the export of many different kinds of data. Officials have banned the collection of genomic data by non-Chinese entities, for instance. Foreign social-science researchers are rarely given access to economic and social surveys without a friend in the government. The rules are vague, leaving even researchers keen to work with colleagues overseas unsure what they are allowed to share.

A cooling of ties will make life harder for both sides. Chinese academics will find it harder to get experience in American universities, which still dominate the world rankings in almost every subject. And because China is now a scientific power in its own right, with cutting-edge researchers in several fields, American science will suffer, too.

The benefits of collaboration are "significant," and benefit American institutions slightly more than Chinese ones, says Jonathan Adams, who

tracks academic information at Clarivate, a data provider. A study published in 2020 by Jenny Lee and John Haupt at the University of Arizona, found that, when papers co-written with Chinese scientists were excluded, the number of American publications in science and engineering fell slightly between 2014 and 2018.

| *Give me your brainy masses*

America's scientific pre-eminence has been built at least partly on its ability to attract the world's best. Before the pandemic around 16% of graduate students in science, technology, engineering and mathematics at American universities were Chinese. The grad students of today often become the professors of tomorrow. Like Dr Chen, many Chinese students choose to stay in America after completing their degrees. That is something America's leaders should be keen to encourage. ■



学术现实

中美科学家也在脱钩

这会落得两败俱伤

中国的崛起可以从很多方面衡量。中国是世界第二大经济体、最大的制造国和最大的债权国。2021年，中国到达又一里程碑。这一年，中国科学家发表的论文数量首次超过美国或欧盟同行（见图表1）。提升的不仅是数量。《自然》杂志出版方编制的自然指数（Nature Index）追踪全球最有声望的健康和自然科学期刊的投稿情况，显示中国科研人员在自然科学论文发表上排名第一，总排名第二。

毫无疑问，这在中国是值得庆祝的，但在美国，这消息可能就不那么令人高兴了。中国的崛起越发令美国沮丧，尤其是中国的科技实力日增。在前任共和党总统特朗普和现任民主党总统拜登治下，美国实施了关税、限制规则和补贴措施，目的是打击中国的高科技企业，同时扶持本国企业。中国做出报复，针对一些美国大型科技企业采取行动。二十年前，政客们支持全球化和自由贸易。而现在，“脱钩”、国家安全和“友岸外包”成了热门话题。

| 自觉脱钩

学术界也未能幸免。两国的新规和冰冷的政治关系令科研人员更难开展合作。8月，美国同意将1979年签署的一项具里程碑意义的科学合作协议暂时延长六个月。美国多名政客希望完全废除这一协议，他们在一封公开信中声称，美国与中国科研人员合作是在“为自己的毁灭推波助澜”。

紧张关系可从数据中读出。2020年，中美两国科研人员联合撰写的论文数量首次下降。第二年（有数据可用的最近一年）再次下降，但在英国等其他国家仍在上升。美国发给中国学生和学者的签证数量也在下降，仅为2015年高峰时的三分之一左右（见图表2）。无论在政治还是科研上，两国都渐行渐远。

1979年签订的《中美科技合作协定》（Science and Technology Agreement）是中美建交后签署的首个双边条约。多项具里程碑意义的研究在其框架下展开。1983年启动的一项长期项目追踪了28.5万名中国女性，帮助证明了叶酸可以预防脊柱裂这种罕见的先天缺陷。如今，叶酸已被添加到面粉、面包、谷物和其他主食中；孕妇被鼓励多摄入叶酸。流感研究方面的合作有助预测每年流感的流行毒株，改进疫苗。

即使互为竞争对手的超级大国也会赞同医学研究是件好事。但中国在计算、材料科学和人工智能等其他科学领域的进步却让美国的政策制定者感到不安。批评者认为，中国的科研进步得益于美国的学术透明和技术诀窍，但中国并不总是投桃报李。质疑者还指出中国的“军民融合”政策，也就是仔细审视民用研究成果，从中找到任何可能的军事用途。

中国反驳称，美国对国家安全的担忧导致在美国高校的华裔科研人员受到不公平针对。常引发不满的是美国司法部的“中国行动计划”（China Initiative）。该计划于2018年至2022年实施，调查涉嫌充当中国技术间谍的事件。但落实的案件似乎不多。至少有150名华裔学者被调查，但只有少数人被定罪，有的不过是经费欺诈等较轻罪名。

有些调查已成为公开上演的闹剧，例如陈刚案，他是一位备受赞誉的华裔机械工程专家，现就职于麻省理工学院。陈刚于2021年被捕，休了一年的学术假才摆脱所有指控。还有一些科研人员被所在大学解雇，并列入禁飞名单。学者们表示，这项计划导致了怀疑和不信任的氛围。

另一边，中国也有自己的国家安全顾忌，这同样会阻碍合作。近年来出台的规定几乎完全禁止出口许多不同类型的数据。例如，官方禁止非中国实体收集基因组数据。如果在政府部门没有熟人关系，外国社会科学研究人员鲜少能接触到中国的经济和社会调查。相关规定很含糊，即使是乐于与海外同行合作的科研人员也不清楚哪些信息可以分享，哪些不可以。

关系降温会使双方的日子都更难过。中国学者将更难在美国的大学取经，而美国高校在几乎所有学科的排名中都仍然名列前茅。而鉴于中国现在本

身也是个科学强国，在多个领域拥有顶尖研究人员，美国的科研也将受影响。

在数据提供商科睿唯安（Clarivate）追踪学术信息的乔纳森·亚当斯（Jonathan Adams）表示，合作的好处是“显著的”，而且对美国机构的益处比对中国的略微更多一些。亚利桑那大学的珍妮·李（Jenny Lee）和约翰·豪普特（John Haupt）在2020年发表的一项研究发现，如果剔除与中国科学家合撰的论文，美国在科学和工程领域发表的论文数量在2014年至2018年间略有下降。

｜ 把你的人才给我

美国在科学领域的领先地位至少在一定程度上是因为它能吸引世界顶尖人才。疫情前，美国高校里科学、技术、工程和数学专业的研究生约有16%是中国公民。今天的研究生往往会成为明天的教授。像陈刚一样，许多中国学生在完成学业后选择留在美国。这才是美国领导人应该热切鼓励的事情。■



Reboot successful

The lessons from Microsoft's startling comeback

A bold bet on AI could help it overtake Apple as the world's most valuable firm

“IT IS KINDA like the Nineties are back,” crowed Satya Nadella, the boss of Microsoft, at a product launch in New York on September 21st. He was referring to the glory days of the software giant, when its Windows operating system was ubiquitous, profits were soaring and revenues routinely grew by more than 30% a year. For a while Microsoft became the most valuable company in the world. But success bred complacency. By the early 2010s sales growth had slowed and profit margins had shrunk.

In the 2020s Microsoft enjoyed a new heyday. Mr Nadella has put cloud computing at the centre of the firm, rather than Windows, which has helped trim costs and boost profits. The company's operating margin has fattened from 29% in 2014 to 43%, the highest among America's biggest 50 non-financial firms by revenue. Investors seem happy. Since the prospect of tighter monetary policy triggered a sell-off in tech stocks in November 2021, Microsoft's share price has beaten all its big rivals bar Apple.

Now Mr Nadella is charging ahead with another bold reorganisation, this time around artificial intelligence (AI). Thanks in large part to its investment in OpenAI, the startup behind ChatGPT, Microsoft has become the go-to firm for AI tools. A year ago most observers would have said that was Alphabet, Google's parent company, or Meta, Facebook's parent. And AI may propel Microsoft higher still, helping it reclaim the crown as the world's biggest company from Apple. Its remarkable reinvention holds wider lessons for businesses.

One is to be paranoid. When Steve Ballmer took over from Bill Gates in 2000, Windows was sacrosanct at the firm. As a result, Microsoft failed to

exploit big shifts in technology, such as the emergence of the smartphone and cloud computing. It could have easily gone the way of Kodak or BlackBerry. But under Mr Nadella, who was painfully conscious of the company's laggardly status, Microsoft became hyper-alert to promising new technologies. That prepared it to move quickly on AI.

Another lesson is that firms do not need to do the inventing themselves. Microsoft has been adept at working out how to bundle and sell technologies created elsewhere. At the event in New York the firm launched "Copilots", ChatGPT-like assistants, for various software offerings. At their core sit the capabilities of OpenAI's tools combined with a cloud-computing business model pioneered by Amazon.

Microsoft now wants to apply a similar formula to its gaming business. It plans to combine its cloud technology with the gaming assets and expertise of Activision Blizzard, its acquisition of which seems more likely now that Britain's trustbusters have signalled that they are happy with the deal.

Compare this approach with that of invention-obsessed Google, which has made a cumulative operating loss of \$24bn in its moonshot "Other Bets" business since 2018. Amazon, too, has invested heavily in technologies that have sci-fi appeal, but have so far failed to win over customers. Three-dimensional screens for its smartphone were a flop, and take-up of its palm-scanning technology at its grocery stores is sluggish. Both it and Google have thrown money at delivery drones.

A final lesson is that exposure to the stockmarket creates the discipline needed to rein in founders. Mark Zuckerberg, the boss of Meta, has already lost \$40bn building his virtual-reality dreams and plans to spend even more. He can do this because dual share classes give him 61% of voting rights. Similarly the founders of Google, Sergey Brin and Larry Page, hold 51% of the voting rights at Alphabet, which may explain why the company

has struggled to thrive beyond search. Apple and Microsoft, by contrast, are older, no longer dominated by their founders—and far more valuable.

There are, inevitably, counter-examples. Sometimes a founder's obsession turns into a money-spinner. And too much paranoia can be a distraction. Yet Microsoft is the rare example of a behemoth that has already carried out one successful reinvention and—if its bet on AI pays off—could yet pull ahead further still. Its remarkable comeback is worth studying. ■



【首文】重启成功

微软强势回归的经验教训

对人工智能的大胆押注可能会帮助它超越苹果，成为全球市值最高的公司

“这有点像是回到了90年代。”微软老板萨蒂亚·纳德拉（Satya Nadella）9月21日在纽约的一个产品发布会上欢呼。他指的是这个软件巨头的辉煌岁月，当时Windows操作系统无处不在，利润飙升，收入惯常以每年超过30%的速度增长。微软一度成为全球市值最高的公司。但成功孕育了自满。到2010年代初期，微软销售增长放缓，利润率缩水。

本世纪20年代，微软迎来了新的全盛期。纳德拉将云计算而不是Windows定为公司的核心，帮助削减了成本并提高了利润。微软的营业利润率从2014年的29%上升到43%，是美国收入最高的50家非金融公司中最高的。投资者似乎很高兴。自2021年11月货币政策收紧的前景引发科技股抛售以来，微软的股价压过了除苹果以外的所有主要对手。

现在，纳德拉正在推进另一次大胆的重组，这次是围绕人工智能（AI）展开的。微软现在已成为人们使用AI工具的首选公司，这在很大程度上要归功于它对ChatGPT背后的创业公司OpenAI的投资。若回到一年前，大多数观察人士会说这个领域的首选公司是谷歌的母公司Alphabet或Facebook的母公司Meta。AI可能会推动微软的地位继续攀升，帮助它从苹果手中夺回全球最大公司的桂冠。它非凡的重塑为企业提供了广泛的经验教训。

其一是忧虑多疑。当史蒂夫·鲍尔默（Steve Ballmer）在2000年从比尔·盖茨手中接过帅位时，Windows对微软来说是神圣不可侵犯的。因此，微软没能把握智能手机和云计算等科技领域的大转型。它本来很容易就会步柯达或黑莓的后尘。但纳德拉痛苦地意识到了公司的落后，在他的领导下，微软对具有前景的新技术变得高度警觉。这为它在AI上迅速行动做好了准备。

另一个经验是，企业并不需要自己去发明创造。微软一直擅长研究如何捆

绑销售别人创造的技术。在纽约的发布会上，公司推出了类似ChatGPT的助手“Copilots”，用于各种软件产品。其核心是将OpenAI工具的功能与亚马逊开创的云计算商业模式相结合。

微软现在想把类似的打法应用到它的游戏业务中。它计划将自己的云技术与动视暴雪的游戏资产和专业技术结合起来。英国反垄断机构已经传达出对微软收购动视暴雪乐见其成，这项收购现在看起来可能性更大了。

相比之下，痴迷于发明创造的谷歌自2018年以来在它列入“其他赌注”的“登月”项目上累计亏损了240亿美元。亚马逊也在具有科幻色彩的技术上投入了大量资金，但到目前为止还未能赢得客户。亚马逊智能手机的3D显示屏是个哑弹，它的手掌扫描技术在杂货店里的接受度也很低。这两家公司还都在无人机送货方面砸下巨资。

最后一个教训是，受制于股市能形成约束创始人所需的纪律。Meta的老板扎克伯格为构建他的虚拟现实梦想已经损失了400亿美元，而且还打算花费更多。他之所以能这么干，是因为双重股权结构赋予了他61%的投票权。同样，谷歌的创始人谢尔盖·布林和拉里·佩奇在Alphabet拥有51%的投票权，这或许可以解释为什么Alphabet一直难以在搜索业务之外蓬勃发展。相比之下，苹果和微软的历史更悠久，不再由创始人主导，价值也高得多。

当然，反例肯定是有的。有时候，创始人的痴迷会变成摇钱树。而忧思重重可能会让人分心。但微软是这样一个罕见的例子：一个庞然大物已经完成了一次成功再造，而且（如果它在AI上的押注得到回报的话）还可能进一步领先。它精彩的复出值得研究。■



A medical gold rush

Pharma's big push for a new generation of obesity drugs

Rivals to Novo Nordisk and Eli Lilly are piling in

FIVE YEARS ago Novo Nordisk was a boring Danish drugmaker whose diabetes medications were reliably profitable. The only time the company made headlines was when it was caught up in complaints about the high cost of insulin. Then in 2021 a trial of its diabetes drug, Ozempic (semaglutide), showed that people taking it lost weight. A great deal of weight—up to 15% of their body mass. Excitement about the drug has kept Novo Nordisk in the headlines. Its market value has nearly quadrupled in the past five years. Last month it reached \$444bn, handbagging LVMH, a purveyor of luxury goods, off its perch as Europe's most valuable company. Novo Nordisk's main rival, Eli Lilly, which has a similar drug called Mounjaro (tirzepatide), is worth \$522bn, more than four times what it was at the start of 2019.

It isn't just investors who are jubilant. Not long ago Morgan Stanley, a bank, estimated that global sales of such weight-management drugs could reach \$54bn annually by 2030. Now it puts the figure at \$77bn. By comparison, last year they raked in just \$2.4bn. The potential bonanza is attracting imitators. These include big pharma (for instance, Amgen, Boehringer Ingelheim and Pfizer), not-so-big pharma (Jiangsu Hengrui, Structure Therapeutics) and biotech startups (Carmot Therapeutics in California, Gmax Biopharm and Sciwind Biosciences in Hangzhou).

It is not the first time in pharmaceutical history that a class of drugs has been ignored, only to spur a gold rush when a successful medicine emerges. The arrival of Prozac (fluoxetine) in 1987 spawned many competitors, leading to the broad range of similar antidepressants available today. The weight-management newcomers will be hoping their drugs can,

like some of Prozac's rivals, improve on the first-movers.

One important improvement would be a drug that can be gulped down rather than injected, as Mounjaro and Ozempic's weight-loss version, Wegovy, need to be. Pfizer's needle-free option, danuglipron, is in the second phase of clinical trials (out of the necessary three). The company is expected to announce plans for further trials later this year.

A lot of effort is also going into limiting the drugs' side effects. The ones currently available make many people feel nauseous. That may lead some patients to stop taking them—a problem, given that their fat-suppressing effect wears off as soon as they are no longer administered. Novo Nordisk is experimenting with adding a hormone called amylin, which it hopes might make Wegovy more tolerable.

Efforts are under way, too, to make the drugs more effective and longer-acting. Work is going into testing whether they can help patients counteract compulsive behaviour other than overeating, such as alcoholism. And trials are being conducted to see whether they bring broader health benefits. One recent trial showed that Wegovy was able to reduce the risk of death from heart attacks, strokes and other cardiovascular causes by 20%.

Just how useful the drugs will prove beyond helping people lose weight remains unclear. Despite Wegovy's promising trial, Airfinity, a firm of analysts, recently calculated that 63 people would need to be treated with it over three years at a combined cost of \$1.1m to prevent one cardiovascular death. However, more data on the medical benefits of these drugs could also add to their perceived value.

This in turn would make them more palatable to those who foot the bill, such as public health-care systems or private health insurers. Those payers

are nervous about the high cost, particularly as the drugs must, in their current iteration, be taken indefinitely. In Europe prices range from €170 to €357 (\$180 to \$375) a month. In America the list price of Wegovy is about \$1,350 a month. Health insurers are cautious: so far only 40m of the 110m Americans with obesity have access to the drugs through their health insurance.

Raymond Stevens, boss of Structure Therapeutics, says that the long-run future of pricing remains hazy. Competition from firms like his could force prices down. On the other hand, innovations in delivery or tolerability could lift them back up. The short term is more predictable. Despite Eli Lilly's and Novo Nordisk's efforts to ramp up production, demand from an overweight world will continue to outstrip supply. That is a formula for healthy profits. ■



医疗淘金热

制药公司积极研发新一代减肥药

诺和诺德和礼来的竞争对手纷纷涌入

五年前，诺和诺德（Novo Nordisk）还是一家无趣的丹麦制药商，生产的糖尿病药物盈利稳定。唯一一次登上新闻头条是在人们抱怨胰岛素价格过高的时候卷入争议。接着在2021年，该公司对其糖尿病药物司美格鲁肽（商品名诺和泰）的一项试验显示，服用该药物的人体重减轻了，而且减得还不少——最多达到体重的15%。该药引发的兴奋让诺和诺德的新闻热度持续不减。它的市值在过去五年中几乎翻了两番，在9月达到4440亿美元，将奢侈品供应商LVMH从欧洲市值最高公司的宝座上挤了下来。诺和诺德的主要竞争对手礼来（Eli Lilly）有一款类似的药物替尔泊肽（商品名蒙扎罗），市值为5220亿美元，是2019年初的四倍多。

欢呼雀跃的不仅仅是投资者。不久前，摩根士丹利估计，到2030年，这类体重管理药物的全球年销售额可能达到540亿美元。现在它认为这个数字会是770亿美元。相比之下，去年的这类药物的销售额仅为24亿美元。大发一笔的前景吸引来了一批模仿者，有大型制药公司，如安进（Amgen）、勃林格殷格翰（Boehringer Ingelheim）和辉瑞；不太大的制药公司，如江苏恒瑞医药和硕迪生物（Structure Therapeutics）；还有生物技术创新公司，如加州的Carmot Therapeutics、杭州的鸿运华宁和先为达生物。

在制药史上，并不是第一次出现某类药物乏人问津，直到一种成功药物出现才引发一场淘金热的情形。1987年氟西汀（商品名百忧解）的问世催生出许多竞争者，今天便有了五花八门的类似的抗抑郁药物。体重管理药物的新来者希望自己的药物能像百忧解的一些竞争对手一样，在先发者的基础上取得进步。

一项重要的改进将是让药物可以口服，而不是像蒙扎罗和诺和泰的减肥版本Wegovy那样需要注射。辉瑞的danuglipron无需注射，正处于临床试验

的第二阶段（必须经过三个阶段）。该公司预计将在今年晚些时候宣布进一步试验的计划。

制药公司还下了很多功夫限制药物的副作用。很多人使用目前市面上的减肥药物后出现了恶心的症状。这可能会导致一些患者停药——这是个问题，因为一旦不再施用，它们的脂肪抑制作用就会逐渐消失。诺和诺德正在试验添加一种名为胰淀素的激素，希望以此提高Wegovy的耐受性。

制药公司也在努力使这些药物更有效、更长效。研究人员正在测试它们是否能帮助病人对抗暴饮暴食以外的强迫行为，比如酗酒。此外，目前进行的一些试验正在考察它们是否能带来更广泛的健康益处。最近的一项试验表明，Wegovy能够将心脏病发作、中风和其他心血管疾病导致的死亡风险降低20%。

除了帮助人们减肥外，这些药物究竟还有多大用处仍不得而知。尽管Wegovy的试验显示很有前景，但根据分析公司Airfinity近期的估算，要防止一例心血管死亡，就需要让63人接受这种药物为期三年的治疗，总费用为110万美元。然而，更多关于这些药物的医疗效益的数据也可能增加它们的感知价值。

这反过来又会使它们更容易让那些买单的人接受，比如公共医疗保健系统或私人医疗保险公司。这些支付者对高昂的成本感到忧虑，特别是就当前的版本而言，这些药物必须无限期服用。在欧洲，其价格从每月170欧元到357欧元（180美元到375美元）不等。在美国，Wegovy的标价大约是每月1350美元。医疗保险公司很谨慎：到目前为止，1.1亿有肥胖问题的美国人中只有4000万人能通过他们的健康保险买到这些药物。

硕迪生物老板雷蒙德·史蒂文斯（Raymond Stevens）说，定价的长期前景仍然不明朗。来自像他的公司这样的对手的竞争可能会迫使价格下降。另一方面，在药物递送或耐受性方面的创新可能又会使价格回升。短期倒是更容易预测。尽管礼来和诺和诺德都在努力提高产量，但在一个超重的世界里，供不应求仍将继续。这就是稳健利润的妙方。■



Schumpeter

Weight-loss drugs are no match for the might of big food

The world is as addicted to fattening foods as it is to fossil fuels

TO GET A sense of why periodic panics about the impact of weight-loss programmes on the food industry should be taken with a pinch of salt, sugar, butter and whatever else you fancy putting in your mixing bowl, go back 20 years to 2003. That was the year when Robert Atkins, the eponymous father of a popular diet, slipped on a sheet of ice in New York and died. The low-carb king was at the peak of his powers. One of his books, “Diet Revolution”, briefly outsold even “Harry Potter”. His message, not of abstinence but of indulgence in the finer things of life such as steak, bacon, eggs and cream, spread joy through the livestock pits of Chicago, and alarm through bakeries and confectioneries. Wheat prices fell. Unilever, an Anglo-Dutch food giant, blamed the Atkins diet for shrinking sales. Yet by late 2003 the craze had gone the way of its founder, snuffed out by a blend of boredom, bad breath and bad publicity. As one newspaper summed it up: “Atkins is toast.”

Every decade brings something new to avoid. In the 1970s it was calories; in the 1980s, salt; in the 1990s, fat; in the 2000s, carbs; in the 2010s gluten and dairy. But this time is different, isn't it? The latest killjoys threatening the food, beverage and restaurant industries are not another dietary fad, but injectable medicines, such as Wegovy, approved in 2021 as an anti-obesity drug, and Ozempic and Mounjaro, anti-diabetes drugs used off-label for weight loss. Besides stimulating insulin production, the so-called GLP-1 medicines reproduce a feeling of fullness and suppress appetite in a way that has a similar effect in the food and drink aisles as dietary restraint, except people are less likely to cheat.

Investors in Novo Nordisk and Eli Lilly, which make the drugs, are

delighted. Those in the soft-drinks and snacking businesses, less so. In recent weeks the share prices of Coca-Cola and PepsiCo, as well as of retailers like Walmart and Costco, have swooned. Pundits were swift to link a big sell-off on October 6th to comments by a Walmart executive in America who revealed that, according to anonymised data, those who bought weight-loss drugs also purchased less food. It sounded like an echo of the Unilever scare from two decades ago. In all likelihood, it is a red herring.

It is easy to see why people are inclined to get carried away by the impact of “skinny pen” injections. Besides being a curse upon whom it falls, the economic consequences of obesity, from higher medical and insurance costs to lower workplace productivity, provide a compelling case for regulatory support for the drugs, as long as they are safe. Demand for GLP-1s is already exceeding supply; there are shortages of Wegovy and Ozempic, leading some pharmacists to make copycat versions.

The potential for disruption is huge. About 70% of Americans are obese or overweight, and by 2035 it is estimated that half the world will be; treatment could represent mountains of forgone calories. In some food categories, obesity is not just a consequence of unhealthy demand but almost a prerequisite; more than a third of what Americans call candy is eaten by mostly overweight people bingeing on many bars, bags and boxes each week. Theoretically, the sky could be the limit. According to Jefferies, a bank, even airlines would benefit from anti-obesity drugs if falling average passenger weights enabled them to burn less fuel.

Yet for now most of the projections are based on guesswork. More painstaking analysis has to include calculations not just of absolute obesity numbers, but of who is and is not eligible for insurance, people’s willingness to submit to treatment, the impact if the drugs have side-effects, the drop-out rates and the risk of regaining weight once off the

drugs. Alexia Howard of Bernstein, an investment firm, takes a stab at sifting through the fog of numbers to forecast that over the next five years, if one-tenth of American adults take the drug, overall calorie demand would fall by no more than 0.5% a year. As she says, that is hardly a “doomsday scenario”—though makers of processed foods and sweets may suffer worse than others.

The \$1trn-plus food industry, stalwarts of which have been around for generations, will not sit idly by and let someone else decide their fate. On October 10th Ramon Laguarta, PepsiCo’s boss, was the latest to play down the impact, saying that anti-obesity drugs were on the firm’s radar but were not expected to affect any of the long-term trends boosting its snacks business, such as urbanisation, busy lives and a growing middle class. The firm could, of course, “pivot” if necessary, he added. Other processed-food companies have noted that trends such as smaller pack sizes and healthier foods already align with GLP-1-style eating habits. And big food could use its influence to subtly raise concerns about the cost and safety of the new drugs. With such deeply entrenched incumbents, weaning the world off fattening foods is unlikely to be much easier than ending its addiction to fossil fuels.

| *Losing hearts and minds, not weight*

So why the stockmarket swoon? The best answer is that current conditions may be worse than the food-and-beverage industry likes to admit. PepsiCo’s third-quarter sales and profits beat analysts’ expectations, but mostly thanks to higher prices. Volumes fell by 2.5% compared with a year ago. This change signals a worrying cyclical trend. Consumers, who tolerated high prices during and after the pandemic, have been hit hard by inflation. With a cooling labour market, many Americans may soon face growing hardship. Though the well-off continue to splash out on fancy foods and restaurants, surveys suggest that the rest are buying more staples, cooking

from scratch at home, and using up their leftovers. Moreover, food companies are reluctant to recognise that they may have overexploited their pricing power.

This is not as eye-catching an explanation for weak share prices as a full-on assault on obesity. But for the next year at least, belt-tightening rather than girth may well be the biggest thing on consumers' minds. ■



熊彼特

减肥药难敌食品巨头之威势

全球消费者沉迷致胖食品，一如依赖化石燃料

对于担心各种减肥法会影响食品行业的周期性恐慌，得细细咂摸，明辨其味。欲知缘故，让我们回到20年前的2003年。那一年，发明了以自己名字命名的流行饮食瘦身法的罗伯特·阿特金斯（Robert Atkins）在纽约一处结冰的路面上滑倒，之后不治身亡。这位低碳饮食之王彼时正值影响力巅峰。他所著的《饮食革命》（Diet Revolution）的销量甚至一度超过《哈利·波特》。他宣扬的信息不是节制饮食，而是纵情享受牛排、熏肉、鸡蛋和奶油等更精良的食物，这给芝加哥的牲畜饲养场带去了喜悦，让面包店和糖果店惶惶不安。小麦价格下跌。英荷食品巨头联合利华把销售萎缩归咎于阿特金斯饮食法。然而到2003年末，这股热潮迎来了和其创始人一样的结局，人们受够了这个饮食法带来的无聊乏味、口臭熏天和负面报道，它很快销声匿迹。“阿特金斯完蛋了。”一家报纸盖棺论定。

每个年代都会出现要避免摄入的新东西。上世纪70年代是卡路里，80年代是盐，90年代是脂肪，2000年代是碳水，2010年代是麸质和乳制品。但这次不一样，对吧？威胁食品、饮料和餐饮业的最新扫把星不是另一种饮食时尚，而是注射药物，例如2021年获批的减肥药威哥维（Wegovy），以及超出说明书规定用于减肥的抗糖尿病药物诺和泰（Ozempic）和蒙扎罗（Mounjaro）。除了刺激胰岛素分泌外，这些GLP-1药物还能让人产生饱腹感，抑制食欲，这对食品和饮料行业的影响与节制饮食类似，只是这次减肥的人们不大可能作弊。

这些药物的制造商诺和诺德（Novo Nordisk）和礼来（Eli Lilly）的投资者喜不自胜。软饮料和零食业的投资者就不那么开心了。最近几周，可口可乐、百事，还有沃尔玛、开市客等零售商的股价大跌。10月6日股市出现大幅抛售，专家马上把这与沃尔玛的一名高管在美国发布的言论联系起来，他说无记名数据显示消费者在购买减肥药的同时会减少购买食品。听起来很像是二十年前联合利华那声惊呼的回声。但这十有八九是在混淆视

听。

不难理解人们为什么往往会被“瘦身笔”注射剂的影响牵着走。肥胖不仅对患者个人造成困扰，还造成各种经济后果，包括医疗和保险费用上升以至工作效率降低，为监管部门在确保这些药物安全性的前提下支持其应用提供了令人信服的理由。GLP-1药物现已供不应求；威哥维和诺和泰出现短缺，促使一些药商开始仿制。

这里有巨大的颠覆潜力。约70%的美国人患有肥胖或超重问题，到2035年，估计全球将有一半人有此类问题；治疗可能意味着大大减少摄入卡路里。就某些食品类别而言，肥胖不仅是不健康需求的后果，还几乎是一种先决条件；美国人称为糖果的食品中有超过三分之一主要由超重者消费，他们每周都暴食许多棒状、袋装和盒装糖果。从理论上讲，颠覆的潜力简直高上天了。杰富瑞（Jefferies）的研究显示，假如乘客平均体重下降能减少飞机燃料消耗，连航空公司也能从减肥药中获益。

然而，目前大多数预测都是基于猜测。更细致的分析不仅要计算肥胖者的绝对数量，还要考虑谁有医疗保险资格而谁没有，以及人们接受治疗的意愿、药物副作用的影响、停药率和停药后体重反弹的风险。投资公司盛博的亚历克西娅·霍华德（Alexia Howard）尝试拨开数字迷雾，她预测在未来五年，假如有十分之一的美国成年人使用减肥药，卡路里的总体需求量每年下降将不超过0.5%。正如她所说，这完全不是什么“末日情景”，不过加工食品和甜食的制造商所受的冲击可能要大于其他食品制造商。

食品行业的价值超过万亿美元，其中的中坚公司已传承几代人，他们绝不会无所作为，任由他人决定自己的命运。最新出来淡化所受影响的是百事老板拉蒙·拉瓜尔塔（Ramon Laguarta）。10月10日，他表示公司正关注减肥药的发展，但预计它们影响不了促进其零食业务发展的任何长期趋势，如城市化、忙碌生活，以及日益壮大的中产阶级。当然，必要时公司也可以“转向”，他补充道。其他加工食品公司则指出，更小的单位包装和更健康的食品等趋势已经与GLP-1式饮食习惯相契合。此外，大型食品公司可以利用自身影响力微妙地就新型减肥药物的成本和安全性提出质疑。

老牌食品公司如此树大根深，要摆脱致肥食品不比戒掉化石燃料的瘾容易多少。

丨 掉的是信心，不是体重

那为什么股市会暴跌？最佳答案是，当前的情况可能比食品饮料行业愿意承认的要糟糕。百事第三季度的销售额和利润超过分析师的预期，但主要得归功于价格上涨。其销量较去年同期下降了2.5%。这一变化预示着一种令人担忧的周期性趋势。消费者在疫情期间和之后忍受了高物价，已经深受通胀的冲击。随着劳动力市场降温，许多美国人可能会手头变紧。尽管富裕人群继续在高档食品上和餐馆里挥金如土，但调查显示，其他人正选择购买更多主食，在家自己动手烹饪，吃掉剩饭剩菜。此外，食品公司不愿承认可能已经过度利用了自己的定价权。

对于股价疲软，这番解释没有全面对抗肥胖的说法更抢眼。但至少在未来一年里，消费者最关心的可能是怎样勒紧腰带，而非怎么减腰围。■



Cranes, drains and automobiles

Will the auto workers' strike jeopardise Joe Biden's manufacturing boom?

A report from the front line of America's industrial revival

STANTON, TENNESSEE, looks like a place from a bygone age. The town hall quaintly resembles a 1960s grocery store. Next door is a cannery, where townsfolk use communal stoves to make soups and peach preserve for winter. For much of its history, Stanton's main source of income has been cotton farming, which was so depressed that many smallholders left.

Yet amid the cotton fields something remarkable is taking shape. Ford, one of America's three big carmakers, is setting up the biggest industrial complex in its history, including an electric-vehicle (EV) plant, a battery factory and a base for its suppliers, with an investment of \$5.6bn. A year after it broke ground thousands of acres have been covered with concrete and steel. Construction workers in high-vis jackets stomp into Suga's Diner, the only food joint in the 400-person town, for lunches of fried chicken and catfish. When Ford announced the project in 2021, the diner had a sign lamenting a shortage of chicken. Now a help-wanted sign points to a shortage of staff. "We are rushed off our feet," says Lesa "Suga" Tard, the owner.

It is a similar story in De Soto, Kansas. Its industrial activity was abruptly cut short decades ago when a munitions factory was mothballed. In April construction began on a \$4bn Panasonic battery plant, the largest investment in the state's history. Driving to the 9,000-acre (3,600-hectare) site in his pickup truck, Rick Walker, the mayor, points to diggers turning a country road into a four-lane highway, counts the cranes (nine of them) erecting the plant's second floor, and gushes about a giant solar farm due to be built nearby.

A drive over several days down parts of America's "auto alley", which stretches from the Great Lakes to the Gulf of Mexico, provides a glimpse of industrial history in the making. The country is in the grip of an investment boom in everything from semiconductor "fabs" to solar farms (see map). By late 2022 firms had announced a cumulative \$210bn of investments in EV and battery factories in America, up from \$51bn at the end of 2020, according to Atlas Public Policy, a data gatherer. This is already fuelling a boom in construction spending, which has doubled since the end of 2021.

Several factors explain what some are calling America's manufacturing renaissance. President Joe Biden claims much of the bonanza is the result of financial incentives in the CHIPS and Science Act, and the Inflation Reduction Act (IRA), two of his signature policies. State and local giveaways also help. So does the desire to outcompete China, as well as reshoring after the supply-chain chaos of the pandemic. In the case of car firms like Ford, which decided to build in Stanton before the IRA was passed, the fear is that unless they seize the initiative on electrification, they will lose their dominance of American carmaking to Tesla, the EV front-runner.

Given how attached Americans outside a few coastal cities remain to their gas guzzlers, the surge in EV and battery factories may seem like white elephants in the making. Whatever their commercial logic, the factories are already playing a role in national debates. The EV and battery plants are important points of contention in a strike against Detroit's big three carmakers, Chrysler (part of Stellantis, whose biggest shareholder part-owns The Economist's parent company), Ford and General Motors (GM). Ford has paused construction of a battery plant in Marshall, Michigan, until the labour dispute is resolved. Both Mr Biden and his predecessor and likely presidential rival, Donald Trump, visited Michigan last month to support the strikes.

The United Auto Workers (UAW), the trade union behind the strike, worries that the new plants will be hard to unionise. In fact there is little evidence of a full-blown migration of carmaking from the unionised north to the less union-friendly south. James Rubenstein of Miami University, in Oxford, Ohio, who studies the industry's geography, notes that non-American carmakers have been building factories in the south for decades. And now the old carmaking states are seeing as much activity as the new ones. GM's first contiguous EV-and-battery plant is in Detroit, close to the dilapidated and graffitied factories left over from the city's heyday. Ford's project in Marshall is a two-hour drive away. "Everyone's getting a pretty fair share of the largesse, both north of the Ohio River and south," says Mr Rubenstein.

The megaprojects may not, then, be reconfiguring America's large-scale industrial geography. But at the local level, their impact is extraordinary. They are sprouting up in left-behind places that for years waited in frustration for a manufacturing revival to arrive. These places have several things in common.

First, they long ago earmarked huge spaces of unproductive land for industrial development. Allan Sterbinsky, mayor of Stanton, says the town set aside 4,000 acres for this purpose decades ago; the state government even set up an office in Japan to promote it. Toyota, a Japanese car giant, made a few exploratory approaches. But it took Ford to ensure that the town's ambitions could at last be realised, he says. In Kansas, De Soto started drawing up plans to rezone 9,000 acres for development a decade ago.

| *Anyone up for a car pool?*

The second common feature is the availability of labour. Though many of the new factories are in rural backwaters, they have access to big pools of workers within commuting distance. Once up and running, Ford's operations are expected to employ 6,000 workers, about 15 times more than

Stanton's meagre population. A technical college on site will in time train future workers. For now, it will be fairly easy to find them in Memphis, which is about a 40-minute drive away, and which the car industry has hitherto overlooked. De Soto has 1.5m potential workers within a 30-minute radius, including Kansas City, so Panasonic should have no problem hiring 4,000 people, says Mr Walker.

The new factories will nevertheless contribute to further clustering in the American car industry—a third shared trait. This is helpful in order to minimise the cost of transporting heavy batteries. Ford will have SK On, its South Korean battery partner, on site in Stanton. It will also have car-parts suppliers, such as Magna, directly on its doorstep. Unlike the gigafactory in Nevada, where Panasonic has teamed up with Tesla, the Japanese firm's De Soto plant will supply more than one customer, and make different types of lithium-ion batteries.

The projects' dependence on copious sources of clean energy, meanwhile, makes them symbiotic with the proliferation of wind and solar developments nearby. The skyline along the Kansas prairies is thick with wind turbines, which generate almost half of the state's electricity. The Tennessee Valley Authority, a multi-state utility, is investing heavily in new solar and other forms of generation capacity to meet sharply rising electricity demand in the south because of projects like Ford's.

A few big bones of contention remain. One is the cost and efficacy of government incentives to promote the investment boom. Ford and SK, which are also building two battery factories in Kentucky, have conditionally been granted a \$9.2bn loan from the Department of Energy. They also hope to qualify for a battery-production tax credit under the IRA. Panasonic will reportedly receive \$830m in state-funded tax credits, as well as potential IRA support.

A new report by Ahmed Medhi and Tom Moerenhout, of the Centre on Global Energy Policy at Columbia University, calculates that the IRA tax credits provide savings of more than 30% for battery manufacturers, helping bridge the gap between the cost of producing batteries in America and China. However, their success in stimulating investments may make their fiscal costs higher than projected. They are also triggering “subsidy wars” with the European Union. Although they might boost factory towns, the subsidies come at a cost to the taxpayer, and in the long term could blunt the industry’s incentives to innovate. De Soto had to offer tax breaks and the like to lure Panasonic, which for many months kept its identity secret even from town officials so as not to tip off competitors.

Another concern is the environmental and social impact of investments. Companies want to develop greenfield sites in places where demand for labour is not too fierce. But that can stir hostility from locals who resist turning fields into factories and worry about pollution and overuse of local resources, even in the service of a “green revolution”. Some also fear that industrial development will destroy the traditional character of their towns, or increase living costs. At a café in De Soto, Kira Horn, a waitress, describes how at night the lights on the cranes, which work around the clock, make the site look “like a city”. Although people like her boss, who is also an estate agent, are already relishing the business and property boom, some of her young friends worry that it will price them out of buying homes.

Then there is the union challenge. Neither Kansas nor Tennessee is a union-friendly state. In contrast to GM, which has a unionised factory near Nashville, Tennessee, Ford’s workers at Stanton will not automatically be required to join the UAW. This has caused friction. In June the UAW’s president, Shawn Fain, blasted the Biden administration for lending money to the Stanton project without agreeing wage requirements up front.

Ford caught a breather on September 22nd when the UAW decided to expand its strike only at factories run by GM and Stellantis, saying it had made progress in negotiations with Ford. But the carmaker will be loth to give much ground on Stanton. Erik Gordon of the University of Michigan's Ross School of Business says that the revitalisation of American manufacturing will hinge on automation and labour. The Detroit carmakers' EVs will be uncompetitive if labour costs are too high, he says.

If America's entrepreneurial muscle is to be rebuilt and left-behind places revived, as the champions of local projects hope, these hurdles will need to be overcome. And Mr Biden's turn towards subsidies may bring with it economic costs for the country at large. But, though it is early days, the prospects for Stanton look encouraging. The presence of Ford's supply chain close to the factory floor is likely to lure more small businesses. The mayor's projections show that, as a result of Ford's investment, the town's population is likely to grow about 20-fold in just over a decade. Mr Sterbinsky is already securing investments in water, sewerage and other infrastructure to support the growth. He has toured southern states to learn how to turn sleepy places into creative hotspots that attract enterprising types. Stanton's genuine southern treasures, such as the cannery and Suga's Diner, are a good start. ■



起重机、排水沟和汽车

汽车工人罢工会危及拜登的制造业繁荣吗？

来自美国工业复兴前线的报道【深度】

田纳西州的斯坦顿（Stanton）像是一个来自久远过去的地方。市政厅古色古香，酷似1960年代的杂货店。隔壁是一家罐头厂，居民在那里用公共炉灶制作汤和过冬吃的蜜桃酱。在历史上的大部分时间里，斯坦顿的主要收入来源一直是棉花种植，但后来棉花种植业逐渐萧条，许多小农场主相继离开。

然而，在棉花田间一些引人注目的事物在渐渐成形。美国三大汽车制造商之一的福特公司正在建设其历史上最大的工业园区，包括电动汽车工厂、电池工厂和供应商基地，投资额达56亿美元。破土动工一年后，数千英亩土地被混凝土和钢材覆盖。这座400人的小镇里唯一的饭馆是甜甜餐厅（Suga's Diner），身穿醒目亮色工装的建筑工人中午在这里吃炸鸡和鲶鱼。当福特于2021年宣布该项目时，餐厅外的一则告示哀叹鸡肉缺货。现在，贴在那里的是一则招聘启事，显示人手短缺。“我们都忙到脚不沾地。”店主莱萨·甜甜·塔德（Lesa “Suga” Tard）说。

堪萨斯州的德索托（De Soto）也是类似的情景。几十年前，该市的工业发展在一家军工厂停止运营后戛然而止。今年4月，松下一座耗资40亿美元的电池厂开工建设，是该州历史上最大的一笔投资。市长里克·沃克（Rick Walker）开着一辆皮卡前往占地9000英亩（3600公顷）的工地，指着正在将乡间道路变成四车道高速公路的挖掘机，数着正在搭建工厂二楼的起重机（共有九台），滔滔不绝地介绍着附近即将建造的一座巨大的太阳能发电厂。

沿着从五大湖延伸到墨西哥湾的美国“汽车走廊”的一段行驶几天，可以一睹正在创造中的工业历史。从半导体“晶圆厂”到太阳能发电厂，美国的各个工业领域都在经历投资热潮（见地图）。数据收集机构Atlas Public Policy的数据显示，到2022年底，相关企业对美国电动汽车和电池工厂已

宣布的投资累计达到2100亿美元，而在2020年底时为510亿美元。这已经推动了一轮建筑支出激增——自2021年底以来翻了一番。

有几个因素可以解释一些人所说的美国制造业复兴。美国总统拜登声称，这些投资热情主要得益于他的两项标志性政策《芯片和科学法案》（CHIPS and Science Act）以及《通货膨胀削减法案》（IRA）中的财政激励措施。各州和地方的补贴也有帮助。在竞争中胜过中国的愿望以及在疫情导致供应链混乱后的制造回流也是原因之一。对于像福特这样在IRA法案通过之前就决定在斯坦顿建厂的汽车公司来说，它们担心的是如果不能抓住电动化的主动权，它们在美国汽车制造业的主导地位将被电动汽车领跑者特斯拉夺走。

考虑到在一些沿海城市以外的美国人依旧对燃油汽车非常依恋，电动汽车和电池工厂的激增看起来可能像是在搞华而不实的形象工程。无论其商业逻辑如何，这些工厂都已经在全国性的辩论中扮演角色。在针对底特律三大汽车制造商克莱斯勒（属于Stellantis，其最大股东持有《经济学人》母公司的部分股权）、福特和通用汽车的罢工中，电动汽车和电池工厂是重要争议点。福特已经暂停了在密歇根州马歇尔（Marshall）的一座电池工厂的建设，要等到劳资纠纷解决之后再复工。拜登和他的前任及可能的总统竞争对手特朗普上月都访问了密歇根州，对罢工表示支持。

组织罢工的全美汽车工人联合会（以下简称UAW）担心这些新建工厂很难成立工会。事实上，几无证据表明汽车制造业正从工会普及度高的北方全面面向对工会不太友好的南方迁移。在俄亥俄州牛津市的迈阿密大学（Miami University）研究该行业地理分布情况的詹姆斯·鲁宾斯坦（James Rubenstein）指出，几十年来，非美国汽车制造商一直在南方建厂。而现在，老牌汽车制造州与新兴汽车制造州的生产活动一样多。通用汽车的第一座电动汽车和电池联合工厂位于底特律，靠近该市在汽车制造业鼎盛时期遗留下来的满是涂鸦的废弃工厂。福特在马歇尔的项目距离这里两小时车程。“无论是俄亥俄河以北还是以南，每边得到的投资都不少。”鲁宾斯坦说。

因此，这些超大项目可能并没有在改变美国工业分布的地理大格局。但在地方层面，它们的影响却非同一般。这些项目纷纷落户多年来一直苦苦等待制造业复苏的衰落地区。这些地区有几个共同点。

首先，它们很早就划出了大片贫瘠土地用于工业发展。斯坦顿市市长艾伦·斯特宾斯基（Allan Sterbinsky）表示，该市几十年前为工业发展划出了4000英亩土地，田纳西州政府甚至在日本设立了办事处做推广。日本汽车巨头丰田探索性地前来打过一些交道。但斯特宾斯基说，是福特让该市的目标最终得以实现。在堪萨斯州，德索托十年前就开始对9000英亩土地重新规划，用于工业开发。

| 有人要拼车吗？

第二个共同特征是劳动力充足。尽管许多新工厂都位于偏远农村地区，但有大量工人在通勤距离内。一旦投入运营，福特工厂预计将雇用6000名工人，大约是斯坦顿目前区区400人口的15倍。厂区的一所技术学院以后还会培训未来的工人。目前，从距工厂约40分钟车程的孟菲斯

（Memphis）不难招到工人，这个地方此前一直不在汽车行业的视野中。沃克表示，德索托在30分钟车程半径内的堪萨斯城等地有150万名潜在劳动力，因此松下要雇用4000名员工应该没有问题。

尽管地处偏远，这些新工厂仍将有助于美国汽车行业进一步形成集群，这是第三个共同特征。这有助于最大限度地降低沉重电池的运输成本。福特的韩国电池合作伙伴SK On的电池工厂也将建在斯坦顿。麦格纳

（Magna）等汽车零部件供应商也将直接落户在福特的家门口。与松下和特斯拉在内华达州合作的超级工厂不同，松下在德索托的工厂将向多个客户供货，并生产不同类型的锂离子电池。

与此同时，这些项目将依赖当地丰富的清洁能源，这让它们与周边越来越多的风能和太阳能发电项目形成共生关系。堪萨斯大草原上遍布风力涡轮机，为该州提供了近一半的电力。跨州公用事业公司田纳西河谷管理局

（Tennessee Valley Authority）正在大力投资新的太阳能和其他形式的发电能力，以满足南部地区因福特等项目而急剧增长的用电需求。

仍然有一些重大争议点。一是政府促进投资热潮的激励措施的成本和效果。福特和SK在肯塔基州也有两家在建的电池工厂，并已获得美国能源部92亿美元的有条件贷款。它们还希望能够获得IRA规定的电池生产税收抵免。除了可能有IRA的扶持，有报道称松下还将获得8.3亿美元的州税收抵免。

哥伦比亚大学全球能源政策中心（Centre on Global Energy Policy）的阿哈迈德·迈赫迪（Ahmed Medhi）和汤姆·莫伦豪特（Tom Moerenhout）的一份新报告计算得出，IRA税收抵免为电池制造商节省了30%以上的支出，有助于缩小美国与中国在电池生产成本上的差距。然而，政府在刺激投资方面的成功可能会使财政成本高于预期，而且还引发了与欧盟的“补贴战”。尽管它们可能会促进工厂城镇的发展，但补贴出自纳税人的口袋，而且从长远来看可能会削弱该行业的创新动力。德索托必须提供税收减免等措施来吸引松下，以免向竞争对手走漏风声，松下在几个月里甚至对市政府官员都没有亮明身份。

另一个问题是投资对环境和社会的影响。这些公司希望在劳动力需求不太高涨的地方开发未开垦地。但这可能会激起当地人的敌意，他们拒绝将田地改成工厂，并担心污染和过度使用当地资源的问题，即使这些项目是为了推动“绿色革命”。一些人还担心工业发展会破坏自己城镇的传统风貌，或推高生活成本。在德索托的一家咖啡馆，女服务员基拉·霍恩（Kira Horn）说夜间不停工的起重机上的灯光让这片地带看起来“像一座城市”。尽管像她的老板（也是一名房地产经纪人的）这样的人已经开始享受商业和房地产所带来的繁荣，但她的一些年轻朋友担心这会让他们买不起房。

然后是工会的问题。堪萨斯和田纳西都是工会普及度较低的州。通用汽车在田纳西州纳什维尔（Nashville）附近的一家工厂成立了工会，与此不同的是，福特斯坦顿工厂的工人不会自动被要求加入UAW。这引起了一些摩擦。6月，UAW主席肖恩·费恩（Shawn Fain）炮轰拜登政府在没有事先同意工资要求的情况下就向斯坦顿项目提供了资金。

9月22日，UAW决定仅在通用汽车和Stellantis的工厂扩大罢工，它表示与福特的谈判取得了进展，这让福特松了一口气。但福特不会愿意在斯坦顿做出太多让步。密歇根大学罗斯商学院的埃里克·戈登（Erik Gordon）表示，美国制造业的复兴将取决于自动化和劳动力。他表示，如果劳动力成本太高，底特律汽车制造商的电动汽车就将失去竞争力。

如果要像本地制造项目的拥护者所希望的那样重建美国企业的实力，复兴衰落的地区，就需要克服这些障碍。拜登采用补贴政策可能会给整个国家带来经济成本。但斯坦顿的前景看起来令人鼓舞，尽管现在还处于发展早期。福特的供应链就铺设在工厂门口，可能会吸引更多小企业聚集。市长斯特宾斯基的预测显示，由于福特的投资，斯坦顿的人口可能在短短十年内增长约20倍。他已经争取到对供水、污水处理和其他基础设施的投资以支持人口增长。他走遍了南部各州，学习如何将沉寂小镇变成吸引雄心勃勃的人们的热土。罐头厂和甜甜餐厅这样斯坦顿真正的南方瑰宝是一个良好的开端。■



Schumpeter

So long iPhone. Generative AI needs a new device

Is this the twilight of the screen age?

WHEN A BEAMING Mark Zuckerberg took the stage in Menlo Park on September 27th to announce a new array of Meta products, the Facebook supremo may have buried the lead. He began talking about Quest 3, Meta's virtual-reality (VR) headset, which is understandable considering that his obsession with the metaverse is now inscribed in his company's identity. Techies, though, were more excited by what came later: an announcement that Meta, in combination with Ray-Ban, would soon launch smart glasses incorporating an artificial-intelligence (AI) virtual assistant. The specs will be able to see and hear, as well as answer their wearers' questions. With luck, they will not hallucinate.

You can be dismissive of smart glasses. They have been hyped before. But lending Meta credibility this time is the fact that the same week OpenAI, the generative-AI pioneer, announced that its hit chatbot, ChatGPT, can now see, hear and speak, besides conversing by text. Moreover, it emerged that OpenAI was in talks with Sir Jony Ive, Apple's former designer, to create a new gadget for the AI era. What form it will take is still unclear. But if the idea is to build a new consumer-electronics device better suited to the back-and-forth of seeing, talking and listening AIs, there is a fair chance it will no longer be reliant on the touchscreen.

The smartphone has had a good innings. Yet you only need to talk to Sky, one of ChatGPT's new audio avatars, to feel the joy of freeing yourself from its tyranny. Your columnist got a taste when he asked Sky how she thought screens might eventually be replaced: Glasses? "Absolutely!" she enthused, "especially those equipped with augmented reality [AR] and AI". Asked whether this would be a good thing, she recommended two books that

explore the enormous impact that screens have had on modern life: “The Shallows: How the Internet is Changing the Way We Think, Read and Remember” by Nicholas Carr, an American writer, and “Screened out” by Jean Baudrillard, the late French philosopher. Then, when further prompted, she summarised each in crisp, insightful language with barely a moment’s hesitation. It wasn’t exactly Scarlett Johansson in “Her”. But it felt like having a Stanford University intellectual murmuring in your ear.

This is all rather refreshing. Just as the year-long excitement over “foundational” models and other mind-boggling bits of AI infrastructure has begun to fade, along comes the chance that gen AI, to use the industry shorthand, will unleash an onslaught of new consumer technology. Tech pundits are debating the best “form factor” for the chatbot era. Ben Thompson of Stratechery, a blog and podcast, puts it in epochal terms: “There is a hardware breakthrough waiting to happen just like the internet created the conditions for the smartphone breakthrough to happen.” The ability to talk and listen to chatbots makes Meta’s bet on AR glasses and VR headsets “drastically more compelling”, he writes.

Mr Zuckerberg was early to see this coming. He has ploughed a fortune into VR and AR despite misgivings from investors. He remains excited by the metaverse. This was clear from a remote interview he recently took part in with Lex Fridman, a podcaster, which used VR tools to make their virtual faces so lifelike they felt as if they were in the same room together. (As Mr Fridman quipped, it could reproduce realistic facial movements even from two famously inexpressive people.) And yet gen AI has so dramatically accelerated the use case for smart glasses, Mr Zuckerberg told another interviewer, that there is now “no question” they will be the bigger of the two markets. He likens AR specs to mobile phones and VR headsets to desktops. In both cases he appears to hope they will transcend screens, which he says inhabit “a completely different plane from our physical lives”.

The two-dimensional screen is not headed for the scrap heap yet. Incumbent technologies are always hard to dislodge. Meta's mobile apps such as WhatsApp, Facebook and Instagram, with their billions of users, still dwarf AIs like ChatGPT in terms of monthly visits, and they remain dependent on smartphones. As Mark Shmulik of Bernstein, an investment firm, notes, the smartphone era has never stopped people from using PCs. Moreover, it will not be clear until people start buying the smart glasses from the shops how compelling a product they are.

The business case for the all-seeing, all-hearing chatbots will also take time to emerge. OpenAI charges \$20 a month for access to its family of talking avatars; Meta's AI-infused smart glasses will start at \$299. Yet developing them is bound to be lossmaking at first. If there ever is a case for monetising them via advertisements or virtual shopping, that will probably take years. Meta's modus operandi, after all, is to launch a consumer product, scale it up and start making money from it only if it is adopted by the masses.

In the meantime, obvious safety concerns must be tackled. Consumer technology powered by AI is likely to be more immersive than social media, potentially making it even more isolating for some, or triggering unhealthy attachments. Mr Zuckerberg argues that AR and VR devices could help bring people together. But Mr Shmulik says investors will not want Meta to move too fast. "The last thing they need is another negative PR event where they are back in the cross hairs of regulators," he says.

| *Glasses half full*

For now Mr Zuckerberg, who this time last year was fighting fires on several fronts, looks prescient. That is largely thanks to gen AI. Meta's foundational model, LLaMA 2, has been an open-source hit and is underpinning the firm's consumer-tech ambitions. New devices such as smart glasses and headsets could eventually free Facebook and others from their dependence

on the iPhone, where Apple has hindered their ability to track data, hurting Meta's ad business. In a backhanded compliment to Mr Zuckerberg, Apple is launching its own high-end AR/VR headset. The iPhone-maker, too, may be sensing the twilight of the screen era. ■



熊彼特

再见了iPhone。生成式AI呼唤新设备

屏幕时代的黄昏已至？

当扎克伯格9月27日在门洛帕克（Menlo Park）登台，满面春风地发布Meta新产品系列时，这位Facebook掌门人也许多少是卖了个关子。他首先介绍的是Meta的虚拟现实（VR）头显Quest 3，这也可以理解，因为他对元宇宙的痴迷已经体现在了公司名字上。但接下来的消息才更让技术迷们兴奋：他宣布Meta将很快与雷朋（Ray-Ban）联手推出一款内置了人工智能（AI）虚拟助手的智能眼镜。这款眼镜不仅能看、能听，还能回答佩戴者的提问。幸运的话，它不会有“幻觉”。

也许你对智能眼镜的概念不屑一顾。毕竟它们以前就曾被炒作过。但这一次Meta也许值得关注，因为生成式AI的先驱OpenAI在同一周宣布，其炙手可热的聊天机器人ChatGPT除了能用文字对话外，现在也能看、能听、能说了。此外，有消息称，OpenAI正与苹果前设计师乔尼·艾维爵士（Jony Ive）探讨为AI时代打造一款新的小设备。至于是何种形态尚不清楚。但如果是想要开发一款新的消费电子设备，使其更契合能看、能说、能听的AI，那么它很可能将不再依赖触摸屏。

智能手机已经够成功了。然而，只要与ChatGPT最新的音频化身之一Sky交谈几句，你就能感受到摆脱被智能手机支配的喜悦。笔者就亲身体验了一下，问Sky她认为什么会最终取代屏幕：是眼镜吗？“绝对是的！”她兴奋地说，“特别是那些具备增强现实（AR）和AI功能的眼镜。”当被问及这会不会是件好事时，她推荐了两本书，主题都是屏幕对现代生活的巨大影响：美国作家尼古拉斯·卡尔（Nicholas Carr）的《浅滩：互联网如何改变我们思考、阅读和记忆的方式》（The Shallows: How the Internet is Changing the Way We Think, Read and Remember），以及已故法国哲学家让·鲍德里亚（Jean Baudrillard）的《屏蔽》（Screened out）。然后，在追问之下，她对这两本书做出了简洁精辟的总结，几乎没有片刻的犹豫。还不能说她完全就像电影《她》（Her）中的斯嘉丽·约翰逊

（Scarlett Johansson），但感觉就如同一位斯坦福大学的学者在你耳边轻声细语。

这一切都令人耳目一新。当对“基础”模型和其他令人匪夷所思的AI基础架构长达一年的兴奋之情开始消退之时，生成式AI又可能掀起新一波的消费技术浪潮。技术专家们正在争论什么才是聊天机器人时代电子设备的最佳“外形尺寸”。博客和播客网站Stratechery的本·汤普森（Ben Thompson）认为这具有划时代的意义：“正如互联网为智能手机这一突破创造了条件那样，一场硬件突破正在蓄势待发。”他写道，能与聊天机器人语音对话使Meta在AR眼镜和VR头显上的押注“说服力急剧增加”。

扎克伯格很早就预见到了这一点。他不顾投资者的疑虑，在VR和AR上投入了巨资。他仍然对元宇宙感到兴奋。在他最近参加播主莱克斯·弗里德曼（Lex Fridman）的线上访谈时这一点一目了然。这次访谈使用了VR工具，使他们的虚拟面孔栩栩如生，让人感觉就像两人同处一室一样。（弗里德曼打趣道，即使是两个出了名面无表情的人，也能逼真地再现他们的面部动作）。然而，扎克伯格在另一次采访中表示，生成式AI极大地加速了智能眼镜的应用场景，它的市场“毫无疑问”将比VR更大。他把AR眼镜比作手机，把VR头显比作台式机。他似乎希望这两个产品都能超越屏幕——他说屏幕占据的是“与我们现实具象生活完全不同的另一个位面”。

二维的电子屏幕并不会很快就被扔进垃圾堆。现有技术总是难以被整个驱逐出场。Meta旗下的WhatsApp、Facebook和Instagram等移动应用拥有数十亿用户，让ChatGPT这类AI的月访问量仍然相形见绌，而这些应用仍然依赖智能手机。正如投资公司盛博的马克·施穆利克（Mark Shmulik）所指出，在智能手机时代人们也从未停止使用个人电脑。而且，只有等到人们开始从商店购买智能眼镜之时，才能知道这种产品的吸引力到底有多大。

这种无所不见、无所不闻的聊天机器人的商业价值也需要时间来证明。要访问OpenAI那些能对话的虚拟化身，每月要花20美元；Meta的有AI加持的智能眼镜起价299美元。然而，开发这些产品在前期注定是亏损的。哪

怕真的可以通过广告或虚拟购物实现盈利，那也可能需要几年的时间。毕竟，Meta的惯用手法就是先推出消费产品，然后扩大规模，只有在产品获得大众采用后才开始赚钱。

与此同时，必须解决显而易见的安全担忧。与社交媒体相比，AI驱动的消费技术可能更具沉浸感，这可能会让一些人变得更加孤僻，或引发不健康的依恋。扎克伯格认为，AR和VR设备可以帮助人们走到一起。但施穆利克表示，投资者不会希望Meta走得太快。“他们最不希望看到的就是又发生负面公关事件，让他们再次被监管机构盯上。”他说。

| 眼镜有前景

去年此时，扎克伯格还同时在几条战线上奋力扑火，现在他却显得很有先见之明了。这在很大程度上要归功于生成式AI。Meta的基础模型LLaMA 2成了大热的开源模型，也为该公司实现消费科技的宏伟目标奠定了基础。苹果限制了Facebook和其他应用在iPhone上追踪数据，Meta的广告业务也因此受到打击，而智能眼镜和头显等新设备最终会让它们摆脱对iPhone的依赖。苹果正在推出自己的高端AR/VR头显，这对扎克伯格是一种间接的恭维。iPhone的制造商可能也察觉到了屏幕时代已近黄昏。■



A design for living

Some claim human lifespans can be lengthened indefinitely

Why not try a “country club for precision diagnostics” while you wait?

THERE IS A story about a blues musician who, when questioned on his 100th birthday about his decades of smoking and drinking, responded that if he'd known he was going to live so long, he'd have taken better care of himself. Bryan Johnson is that apocryphal bluesman's polar opposite. He has been taking care of himself for years to a degree as remarkable, in its way, as the deepest devotion to bourbon and bad choices. By sacrificing the now for the future, rather than the other way around, he turns disposable-soma theory on its head.

The daily regime which he and his many doctors have devised makes life in Biosphere 2 look sybaritic. A kilogram of vegetables, all before 11am, rigorous workouts lasting 45-60 minutes, and 100 pills, including metformin and rapamycin. His vital functions are subjected to the sort of continuous scrutiny more usually associated with laboratory animals. He says he is ageing at 69% of the normal rate.

Mr Johnson, who has been described as the most measured man in the world, can afford the team of medics, trainers and dieticians who minister to him because selling Braintree, an electronic-payments company which he founded, left him with a net worth of more than \$100m. For mere mortals, however, a range of less intensive options are available.

One is a distillation of Mr Johnson's accumulated experience, available on his website as “Project Blueprint”. Though he makes it available for free, he says implementing it could cost \$1,000-1,500 a month, including groceries, supplements, drugs and trainers.

For those on a budget, or who would prefer to have their hands held, an entry-level product at around a tenth of that price is offered by Tally Health, based in New York. Tally is the latest brainchild of David Sinclair, who led early research on sirtuins. Members get a quarterly cheek-swab test to check levels of epigenetic methylation, thus providing a Horvath-clock-like age to compare with a client's chronological age, and a daily supplement containing fisetin, quercetin, resveratrol, spermidine and alpha-ketoglutarate, a molecule involved in several biochemical pathways which seems to give lab mice longer, healthier lives.

| *Waiting in luxury*

For a more substantial fee, Human Longevity, in San Diego, offers customers full sequencing of their genomes and MRI scans of their bodies as well as a suite of other tests likely to leave them feeling like wired-up lab rats; for this they get a personal "longevity action plan" which the company will help them implement.

Human Longevity was founded in 2013 by Craig Venter, who, in the 1990s, ran a private rival to the Human Genome Project, and Peter Diamandis, a marketer, entrepreneur and all-round future-booster. Dr Venter later left, and though Mr Diamandis still has a stake in the business, his gaze seems to have shifted to a glitzier proposition. Fountain Life, his new venture, offers a similar package of goodies to that of Human Longevity, but with swimming pools and fluffy towels thrown in: "a country club for precision diagnostics", as it says in its marketing literature.

Mr Diamandis's stated vision of the future goes like this. For now, people should concentrate on not dying. Not dying is an obvious end in itself, but in this context it is also a means to a further end. Not dying gets the customer through to the moment when senolytic drugs are proved and approved and ageing curtailed. That in turn sees them through to the ultimate goal: age reversal via epigenetic reprogramming.

This approach can be traced to the ideas of Aubrey de Grey, a computer scientist with a remarkable beard who has been active in the field since the 1980s. Through entities like the Methuselah Foundation and concepts like SENS (Strategies for Engineered Negligible Senescence) he did much to shape modern ideas about life extension while also providing some succour to those who saw it as a weird fringe pursuit. (Mr de Grey was relieved of his position at the SENS Research Foundation in 2021 after allegations of sexual misconduct, all of which he denies). One of his pet ideas is “longevity escape velocity”, a future state where science is extending people’s lifespans by more than a year every year.

There is certainly room for scepticism about Mr Diamandis’s attempts to sell people an inside track to that longed-for day. Even if the science were to come good quickly, the time it takes for new medical treatments to be approved tends to be measured in periods that will challenge the physiology of Fountain Life’s more elderly customers. Excited talk of bringing AI to bear on the matter (Fountain Life makes a hoo-ha about its use) has yet to produce much of a pudding, let alone one that provides any proof.

Scepticism is increased by the number of defunct ideas and firms that litter the verges of the road to immortality. Human growth hormone, which is part of another nutrient-sensing pathway, was once promoted as having anti-ageing effects. Subsequent work on animals suggests using it might actually be counterproductive. The same may be true of some of the anti-oxidant approaches built on theories about mitochondrial-DNA damage.

The excitement over resveratrol guttered. Companies founded with much fanfare have lapsed into obscurity. Calico Life Sciences, a subsidiary of Alphabet, which was the Altos of its day in 2013, has fallen completely out of the conversation. Grand science projects born of entanglements between the very wealthy and the not entirely mainstream do not always end well.

Remember Biosphere 2.

A reasonable tendency to short-term scepticism, though, should not preclude medium-term open-mindedness. There is now a serious interest in understanding the biological underpinnings of ageing. There are treatments available which can almost certainly be used to extend healthspans, and possibly even lifespans, even though a lack of formal trial evidence makes it hard to see which of the touted options actually work. And there are promising lines of inquiry which may lead to bigger breakthroughs.

Evolution has no interest in seeing people live for ever, or even indefinitely. But that will not stop people trying. Whether it is feasible in practice is another thing altogether, for bodies contain trillions of cells that will need either rejuvenation or renewal. But less heroic measures towards smaller gains may yet yield fruit. And that alone is surely worth the effort. ■



生存设计

一些人说人类寿命可无限期延长

何不在等待时尝试一下“精确诊断乡村俱乐部”呢？【专题《长命百岁》系列之八】

据传有这样一位布鲁斯音乐家，在他100岁生日当天，有人问及他几十年来抽烟喝酒的习惯，他答说，早知道要活这么久，会把自己身体照顾得更好些。与这位多半是杜撰出来的蓝调音乐家截然相反的一例是布莱恩·约翰逊（Bryan Johnson）。他多年来照料自己的程度之极致，不亚于前者一头扎进波本威士忌和沉沦于各种糟糕选择。他为了未来牺牲现在——而不是反过来——以此彻底颠覆了“一次性躯体理论”。

约翰逊和他的许多医生制定的日常制度让“生物圈二号”里的生活都显得太过奢侈放纵。一公斤蔬菜——全部在上午11点之前吃掉；持续45到60分钟的严格锻炼；以及100粒药片，包括二甲双胍和雷帕霉素。他的生命机能受到一般对实验室动物才会做的持续监控。他说自己的衰老速度是正常水平的69%。

约翰逊被称为世界上被测量最多的人。他有能力负担由医生、培训师和营养师组成的团队为他服务，因为出售他创立的电子支付公司Braintree使他的净资产超过1亿美元。然而，对于一般人来说，仍有一系列强度较低的选择。

其一是约翰逊积累的经验的精华版，可以在他的网站上找到，名为“蓝图项目”。尽管他免费提供这个方案，但他说实施它可能每月要花费1000到1500美元，包括食品杂货、补充剂、药物和培训师。

对于那些预算有限或倾向继续观望的人来说，总部位于纽约的Tally Health提供了一种价格只有十分之一的入门级产品。这家公司是领导了对sirtuins蛋白的早期研究的大卫·辛克莱（David Sinclair）的最新发明。其会员每季度接受一次面颊拭子测试，检查表观遗传甲基化水平，由此得出一个类似霍瓦斯时钟的生理年龄来与实际年龄做比较，并每日摄入包含

非瑟酮、槲皮素、白藜芦醇、亚精胺和 α -酮戊二酸的补充剂。含有 α -酮戊二酸这种分子的几种生化通路似乎让实验室小鼠寿命更长也更健康。

｜ 在奢华中等待

位于圣地亚哥的人类长寿公司（Human Longevity）收取更高的费用，为客户提供基因组完整测序和身体MRI扫描，以及一系列可能会让他们觉得自己像被连了电线的实验室老鼠的检测。他们会换来一份个人“长寿行动计划”，该公司将帮助他们付诸实施。

人类长寿公司由克雷格·文特尔（Craig Venter）和彼得·迪亚曼迪斯（Peter Diamandis）于2013年创立。文特尔在1990年代经营着人类基因组计划的一家私营竞争对手，迪亚曼迪斯是一名营销人员、企业家和全面的未来推动者。文特尔后来离开了，迪亚曼迪斯仍持有该公司的股份，但他的目光似乎已经转向了一个更花哨显眼的项目。他的新企业“生命之泉”（Fountain Life）提供了与人类长寿公司类似的一揽子服务，还配备了游泳池和免费提供的蓬松柔软的毛巾——正如其营销文案中所说，“一个精确诊断的乡村俱乐部”。

迪亚曼迪斯对未来愿景的表述是这样的。眼下，人们应该“但求不死”。不死本身是一个不言而喻的目标，但在这里也是通向一个更远目标的手段。不死可以让顾客等到抗衰药物被证明有效和获批使用、衰老被遏止的那一天。这继而将帮助他们到达终极目标：通过表观遗传重编程逆转年龄。

这种策略可以追溯到奥布里·德格雷（Aubrey de Grey）的理念，这位留着惹眼大胡子的计算机科学家自1980年代以来一直活跃在该领域。通过玛士撒拉基金会（Methuselah Foundation）等机构和SENS（“掌控可忽略衰老策略”）等概念，他为塑造现代关于延长生命的观念贡献良多，但同时也给那些视之为古怪边缘追求的人们提供了材料（他因性行为不端指控而于2021年被解除了在SENS研究基金会的职务，他否认了所有指控）。他最热爱的概念之一是“长寿逃逸速度”：在未来某天，科学将能每年将人们的寿命延长超过一年。

迪亚曼迪斯试图向人们兜售通往这个令人向往的日子的有利位子，这当然有值得怀疑之处。即使科学进展很快，新疗法获批所需的时间往往会挑战“生命之泉”里那些更年老的客户的生理机能。关于让人工智能来影响抗衰进程的兴奋讨论（生命之泉围绕它大做文章）还没有产生多少看得见的果实，更别说到底有没有甜头的证明了。

已有许多创意和公司倒在通往不朽的道路两旁，怀疑情绪也随之增加。人类生长激素是另一种营养感应通路的一部分，曾被推崇为具有抗衰老作用。随后对动物的研究表明使用它实际上可能会适得其反。一些基于线粒体DNA损伤理论的抗氧化方法可能也会是这样的结果。

白藜芦醇引发的兴奋已经减弱。一些大张旗鼓开张的公司没了动静。Alphabet的子公司Calico Life Sciences在2013年之时就是今天的Altos，现如今已经完全退出了热门话题。超级富豪和偏冷门探索的结合催生的大型科学项目并不总有好结果。别忘了生物圈二号。

不过，对于短期结果的合理的怀疑倾向不应妨碍对中期的开放态度。眼下人们对于了解衰老的生物学基础产生了浓厚的兴趣。有一些已有的疗法几乎肯定可以用来延长健康年限，甚至还可能延长寿命，尽管由于缺乏正式的试验证据，还很难看出被吹捧的选择中哪些真的有效。还有一些有希望的研究方向可能会带来更大的突破。

进化无意寻求让人永远活着或无限期延长生命。但这不会阻止人们尝试实现它。在实践中是否可行则完全是另一回事了，因为人体包含数万亿个需要被逆龄或更新的细胞。但是，追求较小收益的不那么宏伟的措施仍可能收获成果。单凭这一点无疑就值得一试。■



Give us the tools

Fighting ageing requires properly equipped cells

Keeping the right proteins in the right amounts

A CELL'S MACHINERY is made almost entirely of proteins, each of them a chain of amino acids that takes on a particular shape when folded up. The shapes of some of them are designed to recognise other molecules, and sometimes to bring two different molecules together in a way that catalyses a reaction between them. Others are designed to cut DNA, RNA or other protein molecules into chunks. Long thin ones fit together to create the rods and filaments which give the cell structure its cytoskeleton; others make pores in membranes. But whatever has to be done, the protein has to be folded into the correct shape to begin with.

To a large extent most proteins fold themselves. Some, though, need help from other proteins, known as chaperones and foldases. In both cases things can go awry. Mutations in the genome or mishandling of RNA can lead to a protein chain having the wrong amino acid in one or more positions and thus folding up badly. Alternatively, the chaperones and foldases may themselves make a mistake. Not only will these misfolded proteins not work properly, they risk, if produced in large quantities, overwhelming a cell's repair and removal mechanisms.

The process that keeps a cell supplied with the right proteins in the right proportions and in peak condition is proteostasis. Impaired control of this process is detrimental wherever it happens, sometimes terribly so. Accumulations of misfolded proteins underlie several of old age's nastiest illnesses, including Alzheimer's and Parkinson's diseases. Misfolded proteins also cause the cataracts which, though treatable, remain a leading cause of blindness throughout the world.

The possibility of dealing with such conditions explains why fixing proteostasis is the core activity of Altos's campus in Silicon Valley. This is run by Peter Walter, who was, before Altos recruited him, one of those responsible for identifying what is known as the integrated stress response (ISR) in cells.

As its name suggests, the ISR reacts to many forms of stress, including starvation, infection and too much reactive oxygen. One of its main jobs is to make sure that they don't mess with the cell's proteostasis. If things get out of whack the ISR slows the rate at which proteins are being made, which lightens the load on the chaperones and foldases. If things go really off the rails, it presses the self-destruct button which sets apoptosis in motion.

| *Taking out the trash*

Altos's operational security makes it hard to say what if any progress Dr Walter and his colleagues are making. But the ISR is not the only approach to proteostasis. One alternative is microautophagy, a process which clears away damaged and superfluous proteins. Life Biosciences of Boston is dabbling in microautophagy alongside its work on epigenetic reprogramming.

Besides folding proteins up, chaperones also deliver their mistakes to bits of cellular machinery called lysosomes, which disassemble them so that their amino acids can be recycled. But this garbage-disposal system is yet another victim of disposable-soma theory, and thus another candidate for pepping up in later years. Researchers at Life Biosciences have found a molecule which, they claim, can do just that, and they are now in the early stages of testing its potential to curb frontotemporal dementia, Alzheimer's disease and retinal degeneration.

Alongside microautophagy sits macroautophagy, a big enough deal to have

a hallmark of its own. Like microautophagy, the macro kind delivers proteins that need to be broken down to lysosomes. The difference is that it uses a garbage truck called an autophagosome to get them there, one big enough to transport not just a bunch of proteins but even whole mitochondria. Genetic inhibition of autophagy accelerates ageing in laboratory animals. Its stimulation increases healthspan and lifespan.

One way to stimulate it is with a molecule called spermidine. This extends the lifespan of mice by up to 25%. Metformin, the type-2 diabetes drug being looked at for broader anti-ageing activity, also boosts autophagy. Rapamycin may do so, too. Biochemistry is a tangled web. It is perhaps not surprising that pathways which regulate what cells do according to the energy available might take an interest in the disposal of surplus proteins.

Other stimulants are less widely known. Retro Biosciences, the startup funded by Sam Altman of OpenAI, is looking at an autophagy booster known only as RTR-242 as a treatment for a disease of the muscles that it also declines to name.

The last of Dr López-Otín's hallmarks of ageing is chronic inflammation, now trendily and irritatingly often referred to as "inflammageing". Healthy inflammation is a response to tissue damage, pathogens or parasites. White blood cells heeding chemical cries for help from afflicted cells swoop in to clear out the damaged ones and fight back against the invaders. A side-effect of their doing this is that they cause swelling, thus increasing the pressure on their surroundings.

Cells experiencing genetic instability, senescence and poor communications with their microbiome also release such molecules, provoking inflammatory responses in places where they cause harm. Indeed, the threat posed by chronic inflammation is such that a high level of a molecule called IL-6, an indicator in inflammation, is predictive of all-

cause mortality in humans.

For inflammaging, there is no magic pharmaceutical bullet. Healthy living is the answer. Weight loss (for fat cells are sources of inflammation-provoking chemicals), exercise, sleep and eschewal of smoking and alcohol are all good ideas. And that, taken to extremes, is a pathway beaten by some of those who would like to cheat death for as long as possible. ■



必先利其器

对抗衰老需要装备良好的细胞

保持正确数量的正确蛋白质【专题《长命百岁》系列之七】

细胞的机构几乎完全由蛋白质组成：每个蛋白质都是一条氨基酸链，折叠时呈现出特定的形状。其中一些的形状旨在识别其他分子，有时将两个不同的分子结合在一起，从而催化它们之间的反应。其他的形状则用于将DNA、RNA或其他蛋白质分子切割成块。细长的蛋白质组装在一起形成杆和丝，为细胞结构提供细胞骨架；其他的则在膜上形成孔隙。但无论做什么，首先都必须将蛋白质折叠成正确的形状。

在很大程度上，大多数蛋白质会自行折叠。但有些需要其他蛋白质（称为“分子伴侣”和“折叠酶”）的帮助。这两种情况都可能出错。基因组突变或RNA处理不当可能导致蛋白质链在一个或多个位置出现错误的氨基酸，导致折叠得很糟糕。或者，分子伴侣和折叠酶本身也可能会犯错误。这些错误折叠的蛋白质不仅无法正常工作，而且如果大量产生，它们还有可能让细胞的修复和清除机制难堪重负。

以正确的比例为细胞提供正确的蛋白质并使之处于最佳状态的过程就是“蛋白质稳态”。对这一过程的控制如果受损，无论何时发生都是有害的，有时甚至非常严重。错误折叠的蛋白质的累积引发了多种最严重的老年疾病，包括阿尔茨海默病和帕金森氏症。错误折叠的蛋白质也会导致白内障，虽然可以治疗，但它仍然是全世界失明的主要原因之一。

对抗这类疾病的可能性解释了为什么修复蛋白质稳态是Altos硅谷园区的核心业务。该项目由彼得·沃尔特（Peter Walter）负责，在加入Altos之前，他是负责识别细胞中所谓的综合应激反应（ISR）的人员之一。

顾名思义，ISR对多种形式的压力做出反应，包括饥饿、感染和过多的活性氧。它的主要作用之一是确保这些压力不会扰乱细胞的蛋白质稳态。如果情况不正常，ISR会减慢蛋白质的生成速度，从而减轻分子伴侣和折叠

酶的负担。如果事情真的偏离轨道，它就会按下自毁按钮，启动细胞凋亡。

| 带走垃圾

Altos的运营安保使得我们很难判断沃尔特博士和他的同事们是否取得了任何进展。但ISR并不是获得蛋白质稳态的唯一方法。另一种方法是微自噬，这是一种清除受损和多余蛋白质的过程。波士顿的Life Biosciences公司在研究表观遗传重编程的同时也在涉足微自噬。

除了折叠蛋白质之外，分子伴侣还将它们折叠出错的蛋白质传递给细胞机器中称为溶酶体的部件，后者将这些蛋白质分解以便回收氨基酸。但这个垃圾处理系统是“一次性躯体理论”的又一个受害者，因此也是老年时的候选修补对象。Life Biosciences公司的研究人员声称发现了一种分子可以做到这一点，他们现在正处于测试它在抑制额颞叶痴呆、阿尔茨海默病和视网膜变性上的潜力的早期阶段。

与微自噬并存的还有巨自噬，这项功能的重要性足以使之被列为一个独立的衰老标志。与微自噬一样，巨自噬将需要分解的蛋白质传递给溶酶体。不同之处在于，它使用一种称为自噬体的垃圾车来运送，这种垃圾车足够大，不仅可以运输一堆蛋白质，甚至可以运输整个线粒体。自噬的基因抑制会加速实验动物的衰老。刺激它则可以延长健康年限和寿命。

刺激它的一种方法是使用一种叫做亚精胺的分子。这可使小鼠的寿命延长高达25%。二甲双胍是一种2型糖尿病药物，人们正在研究它是不是具有更广泛的抗衰老活性，它也能促进自噬。雷帕霉素也可能有这种作用。生物化学是一张错综复杂的网。所以也许不足为奇的是，根据可用能量来调节细胞行为的通路或许也可以参与处理多余的蛋白质。

其他刺激物则不太为人所知。由OpenAI的山姆·阿尔特曼（Sam Altman）资助的创业公司Retro Biosciences正在研究一种自噬增强剂用于治疗一种肌肉疾病。目前只知道这种增强剂被叫做RTR-242，该公司也拒绝透露是何种肌肉疾病。

洛佩斯-奥廷博士列出的最后一个衰老标志是慢性炎症，现在有点烦人的流行说法是“炎性衰老”（inflammageing）。健康的炎症是对组织损伤、病原体或寄生虫的反应。白细胞听到受影响细胞发出的化学求救信号，猛扑过来清除受损细胞并反击入侵者。这样做的一个副作用是会引起肿胀，从而增加周围环境的压力。

出现基因组不稳定、衰老以及和微生物群通讯不良的细胞也会释放此类分子，在它们造成伤害的地方引发炎症反应。事实上，慢性炎症所带来的威胁是如此之大，以至于一种叫做IL-6的分子的高水平（炎症指标）可以预测人类的全因死亡率。

对于炎性衰老，没有灵丹妙药。健康生活就是答案。减肥（因为脂肪细胞是引发炎症的化学物质的来源）、锻炼、睡眠以及戒烟戒酒都是好主意。而在这方面做到极致，是一些想要尽可能长时间地逃避死亡的人已经走过的一条路。 ■



You can't have everything

Older genomes have more dodgy genes

Can evolution's trade-offs be avoided?

NUTRIENT-SENSING systems can be tuned up; senescent cells targeted for destruction; stem cells supplied afresh; epigenomes spruced up. For many of the hallmarks of ageing hope is in the air. But some are more refractory. Perhaps the toughest of all is genomic instability: the persistent accumulation of mutations. By middle age, to take an example published in 2018 by Philip Jones's group at the Wellcome Sanger Institute near Cambridge, England, the cells lining a human oesophagus will each have acquired mutations in an average of 20 genes.

Cells have surveillance and repair mechanisms to correct damage to their DNA. Mutations persist regardless, though, because evolution makes these mechanisms good enough, rather than perfect. The investment required to repair 100% of the mutations would cost the cell more than the damage it sustains to its DNA by letting some mutations slide. This explains the finding that when cells are placed in an environment where one sort of damage to DNA becomes more common, they give up on repairing other sorts; such repairs are no longer worth it.

The biggest risk comes from mutations which unleash the cell's innate capacity to reproduce without pause or purpose, thereby causing cancer. The body has various ways to react to such mutations; there is a whole set of tumour repressor proteins, of which the most well known are p53 and p16, and there are various ways for the immune system to swoop on the cells in which those safeguards are over-ridden. As a backstop, it also has the Hayflick limit, which gives cells only so many chances to reproduce.

Here again, life's trade-offs are at play. If anti-cancer measures were to be

relaxed, ageing might be less of a problem. Less p53 activity would make senescent cells less damaging; the p53 and p16 they leak into the environment cripples any nearby stem cells. Making it easier for cells to resume growth if necessary might allow the slow erosion of non-cancer-causing mutations to be offset, with the dead weight of somewhat clapped-out cells lessened and vigour returned. But the price of creating tissues better suited to growth and rejuvenation would be more cancers.

| *War of attrition*

Some think that price can be circumvented. Rejuvenation Technologies, of Mountain View, California (which like the similarly named and previously mentioned Rejuvenate Bio of La Jolla, California, counts Harvard's Dr Church among its backers), is planning to help cells extend their telomeres and avoid the Hayflick limit. They think telomere attrition (which Dr López-Otín and his colleagues see as important enough to qualify for a hallmark of its own) can be countered if cells make more of a vital sub-component of telomerase. To encourage them to do so they will use mRNA technology like that used in some SARS-CoV-2 vaccines.

Injected into tissues that need rejuvenation the mRNA would provide cells with a temporary ability to make this substance. Various studies have shown that pepping up telomerase increases both the lifespan and the healthspan of mice, with positive effects on insulin levels, neurological function and strength. The initial targets for Rejuvenation Technologies will be two forms of fibrosis, then cirrhosis of the liver.

In mice the approach also had an unlooked-for bonus: it perked up the mitochondria on which cells rely for the production of ATP, the molecule from which proteins get their energy. Why this might be is not clear; though mitochondria have small genomes of their own, they have no telomeres. But it is welcome, because mitochondria are something that ageing specialists have been interested in for decades.

Their initial interest was, it transpired, misplaced. It was based on the idea that the way in which mitochondria use oxygen to get energy out of metabolites exposed them to fearsomely reactive forms of oxygen at levels that damaged their genes. This damage due to “oxidative stress” was held to be a key aspect of ageing.

This turned out to be, at best, only partially true. Damage to mitochondrial genes does matter, but it seems to come about as a result of replication errors rather than reactive forms of oxygen. Those oxygen radicals do, though, have the potential to encourage inflammation—and because mitochondria, like many of us, get a bit more leaky as they age, over time that potential becomes reality. The cell’s systems for getting rid of clapped-out mitochondria also become less efficient over time, making matters yet worse.

Another link between mitochondria and ageing comes in the form of humanin, a short string of amino acids of the sort biologists call a peptide. It appears that as well as containing genes describing some full-size proteins, mitochondrial genomes also contain a lot of short DNA sequences that could describe peptides, and some of these peptides have now been isolated and studied.

Humanin normally becomes less prevalent as people age. But studies of centenarians show that their humanin levels stay high. Correlation, not causation; but interesting enough to justify some experiments. Those have found that nematode worms genetically engineered to have high humanin levels live longer. In April a review of humanin’s protective effects by researchers at the University of Sassari, in Italy, suggested that there could be a role for it in treating Alzheimer’s and Parkinson’s diseases, diabetes, obesity and inflammation. Another potential belle has come to the ball. ■



不可得兼

更老的基因组有更多不可靠的基因

进化的权衡可以避免吗？【专题《长命百岁》系列之六】

营养感知系统可以调校，衰老细胞可以定向清除，可以供应全新干细胞，也可以重整表观基因组。对于许多衰老标志来说，空气中弥漫着希望的气息。但它们中有些比另一些更难驾驭。也许最难攻克的是基因组不稳定——突变的持续累积。比如，英国剑桥附近的威康桑格研究所（Wellcome Sanger Institute）的菲利普·琼斯（Philip Jones）领导的团队在2018年发表的研究显示，到了中年，人类每个食道内壁细胞将有平均20个基因已发生突变。

细胞具有监视和修复机制来纠正其DNA受到的损伤。然而突变仍会持续存在，这是因为进化使得这些机制只是足够好，而非完美。如果百分百修复突变，细胞付出的代价要比放任某些突变而致DNA受损更高。这解释了为什么人们会发现，当细胞被置于一个某种DNA损伤更为普遍的环境中，它们会放弃修复其他类型的损伤——这样的修复已不再值得。

最大的风险在于那些解放了细胞固有的不停歇或无目的自我繁殖能力的突变，它导致了癌症。身体有多种方式对这类突变做出反应：有一整套肿瘤抑制蛋白，其中最著名的是p53和p16；对于被突破了这类防御机制的细胞，免疫系统有多种方式向它们发动突击。而作为最后的防线，它还有海弗利克极限，也就是只给细胞有限的繁殖机会。

在这里，生命的权衡取舍再度上演。如果抗癌措施放松些，衰老问题可能就不那么严重了。p53的活性越低，衰老细胞的危害就越小，因为它们泄漏到环境中的p53和p16会削弱附近的任何干细胞。在有必要时让细胞更易恢复生长可能会抵消非致癌突变的缓慢侵蚀，减轻衰老细胞的死气沉沉，恢复其活力。但创造更适于生长和更新的组织的代价将是更多的癌症。

一些人认为代价是可以规避的。加州山景城的Rejuvenation Technologies公司（和与本专题前文提到的名字相像的、位于加州拉霍亚市的Rejuvenate Bio公司一样，其资助者也包括哈佛大学的丘奇博士）正计划帮助细胞延长其端粒并避免海弗利克极限。他们认为，如果细胞制造出更多端粒酶的一种重要子成分，那么端粒损耗就可以被抵销（洛佩斯-奥廷博士及其同事认为端粒损耗非常重要，足以成为一项独立的衰老标志）。为促成细胞这样做，他们将使用在一些新冠肺炎疫苗中使用的那种mRNA技术。

将mRNA注射到需要恢复活力的组织中，就可为细胞提供暂时制造这种端粒酶子成分的能力。多项研究已经表明，增强端粒酶活性可以延长小鼠的寿命和健康寿命，对胰岛素水平、神经功能和力量都有积极影响。Rejuvenation Technologies的初步针对目标将是两种形式的纤维化，然后是肝硬化。

在小鼠身上，这种方法还显现了一个意想不到的好处：它增强了细胞赖以产生三磷酸腺苷（ATP，蛋白质从这种分子中获取能量）的线粒体的活力。原因尚不清楚：尽管线粒体有自己的小基因组，它们没有端粒。但这是人们喜闻乐见的发现，因为衰老专家对线粒体感兴趣已有好几十年了。

后来得知，他们最初的兴趣投错了地方。它是基于这样的想法：线粒体利用氧从代谢物中获取能量的方式使它们暴露于高度活性的氧中，其浓度会损坏它们的基因。这种“氧化应激”造成的损害被认为是衰老的一个关键方面。

事实证明，这充其量只是部分正确。线粒体基因的损伤确实要紧，但它似乎是由于复制错误而非活性氧造成的。不过，那些氧自由基确实有可能引发炎症，而由于线粒体和我们许多人一样会在上年纪时变得稍微更易“渗漏”，这种可能性就会逐渐变成现实。而细胞清除老弱线粒体的系统也会随时间推移而变得更低效，使情况进一步变糟。

线粒体与衰老之间的另一个关联在护脑素（humanin），这是一种氨基酸短链，生物学家称之为肽。线粒体基因组似乎除了包含描述一些全长蛋白质的基因外，还包含许多可以描述肽的短DNA序列，其中一些肽现已被分离和研究。

随着人们年龄的增长，护脑素通常会变得不再那么普遍存在。但对百岁老人的研究表明，他们的护脑素水平仍然很高。这里发现的是相关性，而非因果关系，但足够有趣而值得展开一些实验。研究人员已经发现，经基因改造而具有高护脑素水平的线虫寿命更长。今年4月，意大利萨萨里大学的研究人员综述了护脑素的保护作用，指出它可能会在治疗阿尔茨海默病和帕金森氏症、糖尿病、肥胖症和炎症方面发挥作用。又一个美人胚子来到了舞会上。■



Blood and guts

What the young can give to the old

Can gut microbes and blood be gifts of youth?

PAUL BERT, a pioneering 19th-century French physiologist, added a gruesome new procedure to laboratory experimentation: grafting mice together rather as a gardener grafts branches onto a tree. Part of the idea was to discover what qualities could be passed from one mouse to the other through the blood they now shared. In the 1950s such “parabiosis” experiments led to the suggestion that one such thing was youth. Older rats, after several weeks grafted to younger rats, showed signs of rejuvenation.

The experiments were widely ignored until new interest in the science of ageing brought them to light in the 2000s. Since then the phenomenon has attracted new interest among both scientists and a number of people who might charitably be described as chancers. Young-to-old transfusions of human blood plasma allow wealthy clients to take a punt on the blood of hard-up students.

There may be substances in young blood that help the old, such as taurine or humanin. However it seems quite likely that the effect seen in older rats owes more to the removal of detritus than an influx of the essence of youth. In 2020 Irina Conboy of the University of California, Berkeley, and her colleagues found that replacing half of an old mouse’s blood with just albumin, a blood protein, and saline solution had the same rejuvenating effect as young-mouse blood. Old blood may need filtering and dilution, not supplementing.

Intriguingly, blood is not the only thing which, if transfused between old and young animals, has an effect on how they age. Gut microbes do so, too.

A body's microbial inhabitants are not mere hangers-on; evolution has built them a role in their host's well-being. Gut bacteria liberate inaccessible nutrients from food and synthesise molecules their host cannot.

Some of the parabiosis experiments in the 1950s were aimed at discovering whether the microbiome of the old mouse would be rejuvenated by young blood. (It was not.) But taking poo (and the microbes it contains) out of the digestive tract of a young mouse and putting it into the gut of an older one seems to enhance both lifespan and healthspan in "progeric" mice engineered for early ageing.

A study of 9,000 individuals aged between 18 and 101 by a team of investigators at the Institute for Systems Biology, in Seattle, revealed three things about the ageing microbiomes in their guts.

First, in middle age people's microbiomes become increasingly dissimilar from individual to individual. Second, this process of increasing distinctiveness continues in healthy people as they get older but stops in those who are unhealthy. Third, in those aged 85 or more, lack of such distinctiveness is a harbinger of earlier death.

There are broad hints as to which microbes are the ones that matter. *Lactobacillus plantarum* both extends lifespan and alleviates cognitive decline in progeric mice. Its presence is also, intriguingly, boosted by calorie-restricted diets. Conversely, retention into old age of lots of bacteria of the genus *Bacteroides* is a known predictor of mortality. But the key message of the institute's studies is that an old-age-friendly microbiome is one well adjusted to its unique circumstances. More fundamental insights into how the microbiome adapts to its host, and vice versa, may be necessary before a road to an enduring old age through the gut can be established. ■



血液与肠道

年轻人能给老年人什么

肠道微生物和血液能成为青春的礼物吗？【专题《长命百岁》系列之五】

十九世纪法国先驱生理学家保罗·伯特（Paul Bert）在实验室实验中添加了一道可怕的新程序：把两只老鼠“嫁接”在一起，就像园艺工把树枝嫁接到另一棵树上那样。部分目的是要看看哪些特质可以从一只老鼠通过共享的血液转到另一只老鼠。在1950年代，这类“联体共生”实验带来了这样的提示：一个可转移的特质是青春。在被连接到年轻老鼠身上几周后，年长老鼠出现了返老还童的迹象。

这些实验少有人关注，直到本世纪头十年，人们对衰老科学产生的新兴趣使它们重见天日。自那时起，这种现象吸引了科学家以及一些或可被宽容地称为投机者的人们的新兴趣。年轻人给老年人输送的人血浆让富有的客户可以用拮据的学生的血液赌上一把。

年轻血液可能含有对老年人有帮助的物质，例如牛磺酸或护脑素（humanin）。然而，看起来很有可能的是，在老年老鼠身上看到的回春效果更多地要归因于垃圾的清除，而不是年轻精华物质的涌入。2020年，加州大学伯克利分校的伊琳娜·康博伊（Irina Conboy）和她的同事发现，仅用白蛋白这种血液蛋白加上盐水替换掉一只年老小鼠一半的血液，与使用年轻小鼠的血液来替换具有相同的回春效果。老龄血液需要的可能是过滤和稀释，而非补充。

有趣的是，血液并不是唯一一样在年老和年轻的动物间转移后会影响它们衰老进程的东西。肠道微生物也会。身体中的微生物不仅仅是寄居者，进化使得它们在宿主的健康状况中扮演角色。肠道细菌从食物中释放出难以获取的营养物质，并合成宿主自身无法合成的分子。

1950年代的一些联体共生实验旨在发现年轻的血液是否会让年老小鼠的微生物组减龄。（结果并没有。）但是，从年轻小鼠的消化道中取出粪便

（及其所含的微生物）放入更年长小鼠的肠道中，似乎延长了经遗传工程改造的“早衰”小鼠的寿命和健康寿命。

西雅图的系统生物研究所（Institute for Systems Biology）的一组研究人员对18岁至101岁的9000人的研究揭示了有关他们肠道中日益衰老的微生物组的三件事。

首先，到了中年，人与人之间的微生物组变得越来越不同。其次，随着年龄的增长，这种独特性增加的过程在健康人身上持续存在，但在不健康的人身上中止。第三，对于85岁或以上的人来说，缺乏这种独特性预示着更早死亡。

对于哪些微生物最为重要已有明显的线索。植物乳杆菌既延长了早衰小鼠的寿命，也减轻了其认知衰退。有趣的是，低热量饮食会增加植物乳杆菌的存在。相反，大量拟杆菌属细菌保留到老年是一个已知的死亡率预测指标。但该研究所的研究传达出的关键信息是，一个老龄友好的微生物组得要能很好地适应其所在的独特环境。或许我们首先必须对微生物组如何适应其宿主（反之亦然）有更为根本性的了解，方可建立一条由肠道通往不朽的道路。■



Of bowheads and borzois

Alternatives to the laboratory mouse

Researchers are looking at whales, sparrows and large dogs

IT IS ENTIRELY possible that at this point you, the reader, are thinking that a greatly enhanced lifespan would be there for the taking had you only had the good luck or foresight to have been born a laboratory mouse. So many things, after all, seem to extend their life's lease. If so, you should learn from the scepticism of Steven Austad of the University of Alabama, Birmingham.

Laboratory mice are very little help, he thinks, in understanding ageing in animals that have not gone through decades of inbreeding and which live in environments that offer more danger than that inflicted in experiments. Lab mice, he feels, are not just a poor guide to the wider world of animal ageing; they are barely even mice any more. They are, in a phrase coined by one of his colleagues, just "mouse-like objects".

This scepticism may, in part, come from the fact that Dr Austad took an unusually long and circuitous route to the lab. His first degree was in English literature; as well as making an abortive attempt to write the great American novel he has enjoyed employment as a taxi driver, a newspaper reporter and an animal trainer. The last job provoked an interest in zoology that led to academia.

With a maximum recorded lifespan of just over 120 years, human beings are at the upper end of the animal longevity scale. But there are a few that outdo them. At an estimated 200 years, bowhead whales are thought to be the longest-living mammals. Greenland sharks can manage double that. Giant tortoises are well-known mult centenarians. Among invertebrates, red sea urchins are reckoned to be able to clock up 100 years, a type of tube

worm called *Escarpia laminate*, 300 years, and ocean quahog clams, 500 years.

In-depth studies of bowhead whales and Greenland sharks obviously pose difficulties. Long-lived invertebrates may not have as much to say about people as one might wish. And working with true methuselahs, backboned or not, might mean working on their timescales, which would hardly be helpful.

As a compromise between longevity and fecundity Dr Austad proposes the house sparrow. In general, animal lifespans increase with size. But whereas wild mice live three or four months wild sparrows, similar in weight, can live almost 20 years. Understanding the physiological differences that grant these birds such long lives might, he reckons, lead to useful ideas for increasing the lifespans and healthspans of people, a species in which he is interested despite its basically domesticated nature.

Another off-kilter approach is to look at ageing not through the lens of animals that lead long lives in the wild, but of animals which lead shorter lives in domesticity. Big breeds of dog live less long than small ones; breeding them for size bred them for short lives, too. The mechanism by which that happened may be more tractable to study than most of those involved in ageing; selective breeding has changed relatively little of the dogs' genome. And turning understanding thus gathered into a treatment would unleash a flood of dollars and love from people who own Great Danes, Newfoundlands and the like.

That is what Celine Halioua, the founder of Loyal, a San Francisco startup, wants to do. She knows which pathway she wants to target and the company is getting a drug (details of which are not public) into trials. Animal trials are more easily done than human ones, and veterinary approval is far faster than medical approval. Dr Halioua's hope is that by

developing a life-lengthening supplement for big dogs she can provide Loyal with a reliable revenue stream quite quickly. With that she can fund her long-term goal, the extension of human life. And it should help with her other heroic ambition—to found a drug company people actually like, even love. What better first step than extra years with a best friend? ■



弓头鲸和苏俄牧羊犬

实验室小鼠的替代品

研究人员正在考虑鲸鱼、麻雀和大型犬【专题《长命百岁》系列之四】

本系列读到这里，你完全有可能在暗自寻思，如果运气好或是先知先觉地投胎成了一只实验室小鼠，你的寿命就可轻松大大延长。毕竟，很多东西似乎都延长了它们的寿命。如果是这样，你应该学习一下阿拉巴马大学伯明翰分校的史蒂文·奥斯塔德（Steven Austad）的怀疑态度。

他认为，要了解没有经历数十年近亲繁殖，且生活环境比实验中人造的危险更为危险的动物的衰老，实验室小鼠的帮助微乎其微。在他看来，实验室小鼠不仅不能很好地指导动物衰老这一更为广阔的世界，而且已经几乎算不上是老鼠了。用他的一位同事的话说，它们只是“类似老鼠的物体”。

这种怀疑可能部分源自于奥斯塔德博士来到实验室前走过的异常漫长而迂回的路。他的第一个学位是英国文学。他尝试写一部伟大的美国小说但失败了，还做过出租车司机、报社记者和驯兽师。最后一份工作激发了他对动物学的兴趣，并最终引领他进入了学术界。

人类的最长寿命记录120岁出头，处于动物寿命的上限。但也有一些物种超越了人。弓头鲸估计有200年寿命，被认为是最长寿的哺乳动物。格陵兰鲨可以达到这个数字的两倍。众所周知巨龟能活几百岁。在无脊椎动物中，红海胆的寿命被认为可以达到100年，一种名为Escarpia laminate的管虫寿命可达300年，而圆蛤可以活500年。

要深入研究弓头鲸和格陵兰鲨显然存在困难。长寿的无脊椎动物可能不会像你可能会希望的那样对人的情况有太多的启发。而且研究真正的长寿动物，无论是否有脊椎，可能意味着要按照它们的时间表工作，这几乎没有帮助。

作为长寿和繁殖力之间的折衷方案，奥斯塔德博士建议采用麻雀。一般来

说，动物的寿命随着体型的增大而延长。但野生老鼠可以活三四个月，而体重相似的野生麻雀却可以活近20年。他认为，了解赋予这些鸟类如此长寿的生理差异可能会为延长人类的寿命和健康寿命带来有用的想法——尽管人类基本上是靠家养的，但他对这种物种很感兴趣。

另一种不走寻常路的方法是，不通过在野外寿命较长的动物的视角来看待衰老，而是通过在饲养环境中寿命较短的动物的视角。大型犬的寿命比小型犬短；为了培育它们的体型也导致它们的寿命短。这种情况发生的机制可能比衰老涉及的大多数机制更容易研究，因为选择性育种对狗的基因组的改变相对较小。将由此获得的理解转化为治疗方法，将让拥有大丹犬、纽芬兰犬等大型犬的人们献出大笔金钱和爱。

这正是旧金山创业公司Loyal的创始人席琳·哈利欧阿（Celine Halioua）想做的事情。她清楚自己想要瞄准哪条通路，其公司正在将一种药物（其详细信息未公开）投入试验。动物试验比人体试验更容易完成，兽医批准也比医学批准快得多。哈利欧阿博士希望，通过为大型犬开发这种延长寿命的补充剂，可以很快为Loyal提供可靠的收入来源。这样她就可以为自己的长期目标——延长人类寿命——提供资金。这应该有助于实现她的另一个英雄般的抱负——创建一家人们真正喜欢、甚至热爱的制药公司。什么样的第一步能比得上和最好的朋友一起度过更多年呢？ ■



Don't be greedy

Eating fewer calories can ward off ageing

And various existing medicines may offer similar benefits

IN 1991 EIGHT volunteers sealed themselves into a huge greenhouse in the desert near Tucson, Arizona. They were part of an experiment seeking to discover whether a carefully curated selection of plants and animals could develop into a self-sustaining ecosystem: a “Biosphere 2” independent of “Biosphere 1”, aka the outside world.

In terms of proving grand ecological truths the Biosphere 2 experiments were something of a bust. As an illustration of what can happen when somewhat fringe-y science meets extreme wealth they were fascinating. There were fierce fallings-out on both sides of the glass. In 1994 Ed Bass, an oil dynast who had paid for the facility, threw out the management team and handed the reins to Steve Bannon, later a key adviser to Donald Trump. At the same time, though, there was what some took to be a breakthrough in the science of human ageing.

One of the eight biospherians was Roy Walford, a professor of pathology at the University of California, Los Angeles (UCLA). Research by Walford and others had shown that restricting what animals ate could significantly lengthen their lives. The lifespans of nematode worms, fruit flies, rodents and dogs could be extended as much as 50% by laboratory protocols which gave them a diet with all the nutrients they needed in terms of minerals, vitamins and the like but fewer calories than were seen as normal.

Biosphere 2 allowed him to test the theory on humans in no position to sneak off for snacks. With a daily intake of 1,750-2,100 calories (7,320-8,790 kilojoules) the biospherians, trim to begin with, all slimmed down. But after eight months their weight stabilised. Gaunt as they were, their energy

levels remained high. Blood tests showed physiological responses which matched those of calorie-restricted rodents with extended lifespans.

Some people have taken this as a reason to incorporate calorie restriction into their lives, as Walford did. But such diets, which go well beyond the sort of weight-restricting efforts to which any sensible person might aspire, are hard to maintain. That has provoked an interest in finding ways to get the benefits of calorie restriction without having to engage in it.

| *The garden of forking paths*

Calories are a measure of the amount of energy that cells can get from breaking food into its component chemical parts. The precise nature of that breaking down, and what happens with all the parts, is under the control of a range of signalling pathways which have the job of matching what the cell is doing with how much energy the organism needs and has available. Dysfunction in these nutrient-signalling pathways is one of the 12 hallmarks of ageing listed by Dr López-Otín and his colleagues.

If there is a general truth behind the success of calorie restriction, it is that when energy is on the scarce side, the nutrient signalling pathways in cells pay greater attention to what is going on and keep the cell in better shape. What is necessary if the same pathways are to be recruited without the calorie reduction is an understanding of what other cues can have the same effect.

The research would be both easier to do and easier to understand if these pathways all had distinct, clearly understood functions. Alas, this is not the case. Pathways frequently regulate more than one function, functions are frequently regulated by more than one pathway and the farthest-flung parts of pathways are often obscure. To make things yet less comprehensible, the proteins involved in the pathways have incredibly opaque names.

Take the MTORC1 pathway. The complex of proteins which gives it its name first came to attention because an immune suppressant called rapamycin has a strong effect on it: hence “mechanistic target of rapamycin complex 1”. That gives no real clue, however, to the fact that the signalling pathway in which MTORC1 sits is a complex set of controls and feedbacks designed to regulate metabolism in response both to the availability of nutrients (for example, glucose, which provides energy, and amino acids, from which proteins are made) and impediments to their use (for example, low oxygen levels).

The ambit of this regulatory power is broad; it influences the rate at which cells break down damaged internal structures (“autophagy”), the balance of their protein content (“proteostasis”) and the reproduction of their mitochondria, components responsible for turning the calories it receives into a form of energy its proteins can use. Autophagy, proteostasis and mitochondrial reproduction are three more of the 12 hallmarks of ageing.

| *Rap of ages*

What is more, rapamycin, the effects of which give MTORC1 its name, turns out to lengthen the lives of lab animals even though it curbs their immune responses. This has led some longevity enthusiasts to seek off-label prescriptions for it. But its side-effects, including anaemia and an insensitivity to insulin, make rapamycin ill-suited for widespread use. There is thus a search for “rapalogs” which provide the benefits of a tuned-up MTORC1 pathway without so many costs.

Another pathway which calorie-restriction studies have marked out as promising is named after a protein called AMPK (don’t ask). This regulates the production of ATP, a small energy-carrying molecule produced in mitochondria. When ATP levels fall, the AMPK pathway increases a cell’s sensitivity to insulin.

Metformin, a drug used to treat type-2 diabetes, does so by activating the AMPK pathway. Like rapamycin, it extends the lifespans of healthy mice. It does the same for diabetic humans. A study published in 2014 showed that diabetes patients treated with metformin enjoyed a decreased mortality rate, not just compared with patients who were not treated with it, but also with healthy controls who were not given the drug.

Not surprisingly, metformin is also used off-label, probably more widely than rapamycin. The American Federation for Ageing Research, a not-for-profit organisation, hopes soon to start a six-year, 3,000-person clinical trial to measure its effects in people from 65- to 79-years-old. The Targeting Ageing with Metformin (TAME) trial will see if metformin helps prevent cardiovascular disease, cancer and cognitive decline; it will also test the hypothesis that it reduces all-cause mortality.

A further set of medicines developed to treat diabetes but now used more widely are the GLP-1 receptor agonists. The best known, semaglutide (sold as Wegovy), has been specifically licensed in various places for use in people without diabetes who nevertheless need to lose weight. Whether they might live longer than someone of the same final weight who does not take one of the drugs is an open question. There are no published studies that show the drugs to have an effect on the lifespans of laboratory animals.

One thing that does do the job for lab animals is taurine, an amino acid widely used as a dietary supplement. According to a recent paper by Parminder Singh of the Buck Institute for Research on Ageing in Novato, California, and colleagues, in mice taurine increases lifespan by 10%; some of this seems to be due to nutrient signalling. But there are effects on four or five other hallmarks of ageing, too. Taurine levels drop with age in humans but, in those who live to be over 100, levels stay significantly higher.

Nutrient sensitivity may also be enhanced by a molecule called NAD⁺. Some enzymes—proteins which catalyse chemical reactions—require the presence of a small extra molecule to do their thing. NAD⁺ is such a “co-enzyme”. More than 300 enzymes need it to be present if they are to do their bit for the cell. And if you give mice more of it, they live longer.

Considering that NAD⁺ is so generous with its favours it is difficult to know exactly which of the enzymes it helps are responsible for delivering this effect. But one connection which looks particularly interesting is that with a set of proteins called sirtuins.

| *La vie en vin rouge*

Sirtuins came to prominence two decades ago when David Sinclair, who is now co-director of the Centre for Biology of Ageing Research at Harvard University, showed that stimulating their production prolongs life in a variety of laboratory animals. One form of stimulation is calorie restriction. But Dr Sinclair discovered a chemical alternative: resveratrol, a molecule found, among other places, in the skins of red grapes.

Dr Sinclair is by no means publicity-shy; his discovery saw a great deal of brouhaha. He founded a company, Sirtris, to produce resveratrol derivatives suited to the human body. The work did not amount to much. Sirtris, having been bought by GlaxoSmithKline, ceased to exist as a separate entity in 2013.

That might seem a cautionary tale. But it can also be seen as grounds for hope. Sirtuins got a lot of attention because there had been no similarly credible claims about longevity for some time. Their story set out a blueprint for looking into such things: a mechanism looked interesting, a molecule seemed promising, investigations were carried out, conclusions were drawn. Many more mechanisms and drugs are now being scrutinised in the same way. Some scepticism is warranted. But there is no reason to

believe that none of them will get results just because the few looked at so far have not. ■



不要贪吃

低热量饮食可以延缓衰老

而各种现有药物可能具有类似的功效【专题《长命百岁》系列之二】

1991年，八名志愿者将自己封闭在亚利桑那州图森附近沙漠中的一个巨大温室里。他们参与了一项实验，旨在探索精心挑选的一批植物和动物是否可以发展成为一个可以自我维持的生态系统：独立于“生物圈一号”（即外部世界）的“生物圈二号”。

就证明宏大的生态学真理而言，“生物圈二号”实验是失败的。作为一个当边缘科学遇到极端财富时会发生什么的例证，这些实验非常有趣。玻璃的两侧都发生了激烈的争吵。1994年，支付这一设施费用的石油大亨埃德·巴斯（Ed Bass）解雇了管理团队，把领导权移交给了史蒂夫·班农（Steve Bannon），后者后来成为唐纳德·特朗普的重要顾问。但与此同时，一些人认为其中取得了人类衰老科学的突破。

罗伊·沃尔福德（Roy Walford）是生物圈的八位居民之一，他是加州大学洛杉矶分校（UCLA）的病理学教授。沃尔福德和其他人的研究表明，限制动物的饮食范围可以显著延长其寿命。实验室方案为它们提供了含有矿物质、维生素等所有所需营养成分的饮食，但卡路里含量却比平常的惯例要少。线虫、果蝇、啮齿动物和狗的寿命可以由此延长多达50%。

生物圈二号让沃尔福德能够在没有办法偷偷溜走吃零食的人类身上测试这个理论。那些生物圈居民本来就很健康苗条，每天摄入1750至2100卡路里（7320至8790千焦）后全部都瘦下来了。但八个月后，他们的体重稳定下来。尽管瘦削，他们却精力旺盛。血液测试显示，他们的生理反应与那些被限制了热量而寿命延长了的啮齿动物的相当。

有些人据此认为应把限制卡路里纳入生活，正如沃尔福德所做的那样。但这种饮食方式很难维持下去，它远远超出了任何理智的人有志于付出的那种限制体重的努力。这引发了人们的兴趣，要去找寻无需真正限制卡路里

摄入就能获得其益处的方法。

| 岔路花园

卡路里是细胞将食物分解为化学成分所获得的能量的量度。这种分解的确切性质，以及各种成分发生了什么，都受控于一系列信号通路，这些通路的作用是将细胞所做的事与生物体需要和可用的能量相匹配。这些营养信号通路的功能障碍是洛佩斯-奥廷博士及其同事列出的12个衰老标志之一。

如果在热量限制的成功背后有一个普遍真理的话，那就是当能量匮乏时，细胞中的营养信号传导通路会更加关注发生了什么，并使细胞保持更好的状态。如果要在不减少卡路里的情况下激发相同的通路，那么就有必要了解哪些其他信号可以产生相同的效果。

如果这些通路都具有独特的、清晰易懂的功能，那么研究就会更容易进行，也更容易理解。可惜事实并非如此。通路经常调节不止一种功能，功能也往往由不止一种通路调节，并且通路最远端很可能是模糊的。更难以理解的地方在于，参与这些通路的蛋白质的名称也极为难懂。

比如MTORC1通路。它的名字所指的这种蛋白质复合物首次引起人们的关注，是因为一种名为雷帕霉素的免疫抑制剂对其具有很强的作用：于是就有了“雷帕霉素复合物1的机械标靶”。然而，这并没有提供真正的线索来指明这样一个事实，即MTORC1所在的信号通路是一组复杂的控制和反馈，旨在调节代谢以对营养物质的多少（例如，提供能量的葡萄糖和用来制造蛋白质的氨基酸）以及使用它们的障碍（例如，氧含量低）做出响应。

这种调节能力所涉广泛；它影响细胞分解受损内部结构（“自噬”）的速度、蛋白质含量的平衡（“蛋白质稳态”）以及线粒体的繁殖（线粒体负责将接收到的卡路里转化为蛋白质可以使用的能量形式）。自噬、蛋白质稳态和线粒体繁殖是12个衰老标志中的另外三个。

更重要的是，雷帕霉素（MTORC1 的名字来源于其效果）被证明可以延长实验动物的寿命，尽管它会抑制实验动物的免疫反应。这导致一些长寿爱好者寻求标签外处方。但其副作用，包括贫血和对胰岛素不敏感，使得雷帕霉素不适合广泛使用。因此，人们正在寻找雷帕霉素类似物（rapalog），它可以带来调节MTORC1通路的益处，而无需付出这么多代价。

热量限制研究提出的另一条有希望的通路以一种名为AMPK的蛋白质命名（别问是什么）。它调节三磷酸腺苷（ATP）的产生，这是线粒体中产生的一种携带能量的小分子。当ATP水平下降时，AMPK通路会提高细胞对胰岛素的敏感度。

二甲双胍是一种用于治疗2型糖尿病的药物，通过激活AMPK通路来实现这一目的。与雷帕霉素一样，它可以延长健康小鼠的寿命。它对糖尿病人也有同样的作用。2014年发表的一项研究表明，接受二甲双胍治疗的糖尿病患者的死亡率不仅低于未接受治疗的患者，甚至低于未接受该药物的健康对照组。

毫不意外，二甲双胍也有标签外使用，可能比雷帕霉素更广泛。非营利组织美国老龄化研究联合会希望很快启动一项为期六年、有3000人参与的临床试验，以衡量其对65岁至79岁人群的影响。二甲双胍靶向衰老（TAME）试验将了解二甲双胍是否有助于预防心血管疾病、癌症和认知能力下降；它还将检验它降低全因死亡率的假设。

另一套用于治疗糖尿病但现在使用更广泛的药物是GLP-1受体激动剂。最著名的是索马鲁肽（商品名Wegovy），它已在多个地方获得特别许可，可用于没有糖尿病但需要减肥的人。这些人是否会比最终体重相同但不服用某种这类药物的人活得更久还是个悬而未决的问题。没有已发表的研究表明这些药物对实验动物的寿命有影响。

对实验动物有效的一种物质是牛磺酸，一种广泛用作膳食补充剂的氨基

酸。根据加州诺瓦托市的巴克衰老研究所（Buck Institute for Research on Ageing）的帕尔敏德·辛格（Parminder Singh）及其同事最近发表的一篇文章，牛磺酸可使小鼠的寿命延长10%；其中一些似乎是由于营养信号传导所致。但它也会对其他四五个衰老标志产生影响。牛磺酸水平在人类身上随着年龄的增长而下降，但在活到100岁以上的人中，牛磺酸仍保持在高得多的水平。

NAD⁺分子也可以增强营养敏感度。一些酶（催化化学反应的蛋白质）需要一个额外的小分子才能发挥作用。NAD⁺就是这样一种“辅酶”。超过300种酶需要它的存在才能为细胞发挥作用。如果你给老鼠更多这种物质，它们就会活得更久。

考虑到NAD⁺的贡献如此之大，我们很难确切地知道它所帮助的哪些酶带来了这种效果。但看起来特别有趣的是与一组称为sirtuin的蛋白质的联系。

| 红酒生活

二十年前，现任哈佛大学衰老生物学研究中心联合主任的大卫·辛克莱（David Sinclair）发现，刺激sirtuin的产生可以延长多种实验动物的寿命。sirtuin遂声名鹊起。刺激的一种形式是限制热量。但辛克莱博士发现了一种化学替代品：白藜芦醇，一种在红葡萄皮等地方发现的分子。

辛克莱博士完全不介意公众关注——他的发现引发了轩然大波。他创立了Sirtris公司，生产适合人体的白藜芦醇衍生物。这项工作有些虎头蛇尾。Sirtris被葛兰素史克收购后，于2013年不再作为独立实体存在。

这似乎是一个警示故事。但这也可以被视为希望的理由。Sirtuins受到了很多关注，因为已经有一阵子没有关于长寿的可信度类似的说法了。他们的故事为研究此类事情制定了蓝图：一种机制看起来很有趣，一种分子似乎很有前途，进行研究，得出结论。现在正在以同样的方式审查多得多的机制和药物。一些怀疑是有道理的。但我们没有理由认为，仅仅因为迄今为止所做的少数研究尚未成功，它们中的任何一个都不会取得成果。■



Out with the old

Ageing bodies need to get rid of decrepit cells

Senolytics and cellular rejuvenation could hold the key

IN 1962 LEONARD HAYFLICK, then at the Wistar Institute in Philadelphia, now retired, made one of the most famous observations in the science of longevity: in laboratories, non-cancerous mammalian cells can reproduce themselves for only a fixed number of times before cell division ceases and they enter a state called senescence. For human cells, this Hayflick limit is 40-60.

Exceeding the Hayflick limit is not the only route to senescence; it can arise in other ways, too, including as a response to DNA damage. The body normally gets rid of these senescent cells either by triggering a genetic self-destruct sequence called apoptosis or by sending the immune system in to dismantle them. Both forms of housekeeping, though, become less efficient with age, allowing senescent cells to persist in a sort of zombie state that makes things difficult for the healthy cells around them.

James Kirkland of the Mayo Clinic, in Rochester, Minnesota, offers a daunting list of the things that go wrong in tissue where zombie cells accumulate. It includes inflammation, DNA damage, a form of tissue scarring known as fibrosis, disabling aggregations of protein and two of the hallmarks of ageing associated with problems in the MTORC1 nutrient-signalling pathway discussed in the previous article: poor proteostasis and damage to mitochondria. Experiments on mice suggest that senescent cells are involved in Alzheimer's disease; other work suggests they play roles in diabetes, fibrosis of the lungs, osteoarthritis, osteoporosis and several diseases of the eye.

Dr Kirkland is, however, undaunted. For it was he who, in 2011, pioneered

what has become an increasingly studied approach to the problem of cellular senescence. This is the development of drugs known as senolytics designed to kill senescent zombie cells.

His initial research discovered four already characterised molecules that looked promisingly senolytic: dasatinib, fisetin, navitoclax and quercetin. All four stimulate apoptosis, though not all by the same mechanism. They can all be taken orally and extend the lives of laboratory animals. Dasatinib is an anti-leukaemia drug available in America and Europe since 2006; navitoclax is currently in trials as a treatment for myelofibrosis, a bone-marrow cancer; quercetin (which is often added to dasatinib in cancer treatment) and fisetin, meanwhile, are natural substances that are found in fruits.

Dr Kirkland is one of the organisers of what is known as the Translational Geroscience Network. It has 14 centres across America and is running 81 clinical trials on compounds that could become drugs for age-related diseases, with the trials done in ways that seek to add to the understanding of ageing in general. About 30 of them are on potential senolytics, including three of the four on his original list. The idea, he says, is to conduct a lot of small trials in parallel, on different molecules and different target diseases. And, though he thinks there is only about a 25% chance of a successful senolytic drug emerging, he says that when he first started in the field he would have put the chances at 0.001%.

In 2020 a survey of the field by Nature, a journal, identified more than two dozen startups in the senolytic field. They use a broader range of approaches than those initially identified by Dr Kirkland. There are undoubtedly more companies, and more approaches, today. And there have already been disappointments. Unity Biotechnology of San Francisco, funded in early years by Jeff Bezos and Peter Thiel as well as the Longevity Fund, a venture-capital operation, went public in 2018 only to see its share

price collapse by two-thirds two years later when early trials of a senolytic aimed at osteoarthritis disappointed.

While Unity and other firms build weapons to fight senescence, another set of companies is looking at the Hayflick limit from the other side. Instead of searching for ways to kill cells that are over the limit, these cellular-rejuvenation companies are examining treatments aimed at keeping cells under it and helping them stay in fine fettle while they are there. Their targets are not cells that need to be removed, but organs the cells of which are failing to renew themselves as they should. The two approaches differ in other ways, too. The senolytic approach looks at drugs and supplements already available to try and find those that could help soon. Cellular rejuvenation, made plausible by recent developments in stem-cell science, is more radical and thoroughgoing; it needs, and attracts, those with deeper pockets.

The human body contains hundreds of different types of cell, each with the right properties for a particular sort of job. This differentiation is accomplished by having different sets of genes turned on and off in the different types of cell by means of various “epigenetic” modifications. Some are chemical alterations to the bits of DNA on which specific gene sequences are stored, others affect the proteins around which that DNA is wrapped, still others work in subtler ways. These sorts of epigenetic modification are vital. But the processes which drive and maintain them are another of those bits of life’s workings that get less effective with age. Indeed, the pattern of DNA methylation (a specific type of chemical change to one of the molecule’s genetic letters) can be used to diagnose the age of a cell.

Stem cells are reserves from which new specialised cells of various types can be made. When one divides, one of the two daughter cells sets off down a route of epigenetic specialisation which, a few generations on, will

produce a number of cells of specific types. The other daughter will remain a stem cell, ready to produce more daughters when required. In this way the hematopoietic stem cells in blood marrow, for example, can produce progeny from which all the different sorts of white blood cells are derived, as well as the oxygen-carrying red ones. To keep doing so for a lifetime, though, they need to divide a lot more than 40-60 times.

| *Factor analysis*

Allowing stem cells to keep going is the task of an enzyme complex called telomerase. The physical manifestation of a cell's progress, or descent, towards the Hayflick limit is found in structures at the end of its chromosomes called telomeres. Every time the chromosomes are copied to allow the cell to divide, the telomeres get shorter; after 40-60 divisions they are too short for the chromosome to be copied any more. In stem cells, though, telomerase is used between cell divisions to rebuild the chromosomes' telomeres, resetting the clock. But it does not do so perfectly. And, as time goes by, stem cells can pick up unwanted epigenetic markers, too. Stem cells diminish in number, in capacity, or both.

What if the exhausted cells could be pepped up, or replaced? In 2006 Yamanaka Shinya, of Kyoto University, and others showed that by administering a specific set of four "transcription factors", proteins that affect which genes are used as blueprints for proteins, they could strip the cell-type-specific epigenetic markers off the DNA in a cell and return it to the state of a "pluripotent" stem cell. That opened the prospect that these induced pluripotent stem cells, or iPSCs, if prodded with other chemicals or implanted in the relevant type of tissue, could be used to generate specific cell types on demand. More recently it has been shown that using a subset of those four proteins offers a way to rejuvenate cells to a lesser degree, not stripping them right back to the stem-cell state but nevertheless removing some of the apparently excessive epigenetic markings that come with age.

The biggest player in the cellular de-ageing business is a company called Altos Labs. It was founded in 2022 with \$3bn of initial capital from various sources, including Yuri Milner, a Russian-born billionaire. It has three campuses, two in California, the other in England, just south of Cambridge. To work in these the company has recruited some luminaries of the field. One such is Steven Horvath, who when at UCLA developed a way of predicting an animal's age based on the amount of methylation it has endured in parts of its DNA. Horvath's clock, as it is known, can be used to see if the age of cells is tracking the age of the animal they find themselves in, lagging it or leading it: in other words, whether the animal is ageing well or badly.

Altos plays its cards close to its chest; it is hard to say quite what approaches it is taking. But the field as a whole is faced with two options. One is to combat stem-cell exhaustion by making fresh stem cells in the lab and transplanting them in. The other is to try to rejuvenate tissues and organs in situ, by turning back the Horvath clocks in their cells a little way.

Dr Church at Harvard likes this latter approach, sometimes called transient or partial reprogramming. Researchers at Rejuvenate Bio, a firm in which he has an interest, have described using modified viruses to carry genes for three of the Yamanaka proteins into cells to be rejuvenated. In mice this reprogramming gives old tissues a fresh capacity for self-repair; subsequent damage is set right as efficiently as in young individuals. This has been shown to be true for skeletal muscle, nerve fibres, eyes, skin, hearts, livers and pancreases. It can even ameliorate loss of long-term memory. Rejuvenate's researchers have, however, gone further than that. Their experiment (admittedly not yet peer reviewed) showed that OSK treatment (so-called from the initials of the three Yamanaka proteins involved) can actually extend life in laboratory mice.

The trial in question, posted on a site called bioRxiv, which exists to

facilitate the early release of such un-peer-reviewed papers, reported a doubling of the remaining life expectancy of elderly mice given the treatment. Instead of living for less than nine further weeks they soldiered on for more than 18 (the mice were 124 weeks old when treated, an age equivalent to that of a human in their late 70s).

| *Nothing to offer but blood, nerves and T-cells*

Others exploring in-situ rejuvenation include Life Biosciences, in Boston, a recent venture of David Sinclair, the prophet of sirtuins. Its first project is an attempt to use partial reprogramming as a way to repair the damage glaucoma does to the neurons of the optic nerve. The firm's researchers have shown that the approach works on mice. AgeX Therapeutics of Alameda, California, uses a different set of rejuvenating transcription factors, identified by Michael West, one of its founders.

According to Joe Betts-LaCroix, boss of Retro Biosciences, the firm's researchers are looking into rejuvenating the immune system by reprogramming the stem cells which differentiate into blood cells, including the white blood cells which form one branch of that system, and those that turn into the T-cells found in another branch of it.

Some other firms, though, prefer the idea of stem-cell transplants, a branch of a field known as cell therapy. Application of the Yamanaka factors means it is now possible to make stem cells to order—including from a patient's own differentiated tissue, which will thus be recognised as friendly by the immune system and avoid the problem of rejection.

One of the leaders in this field is BlueRock Therapeutics, a subsidiary of Bayer that is based in Cambridge, Massachusetts. It says it has developed a way of making pluripotent human stem cells at scale and then tweaking them with further transcription factors to set them off on various paths that lead, eventually, to nerve cells, cardiac cells, immune-system cells and so

on.

Its initial target is Parkinson's disease, a condition caused by a loss of nerve cells in a region of the brain called the substantia nigra. This specificity and localisation makes Parkinson's an attractive target for cell therapy, and the firm has embarked on a phase-I clinical trial involving 12 people. If that and subsequent, larger trials work, BlueRock hopes the range of targets can be widened.

Bayer's involvement is a sign that big pharma has hopes for such approaches. So is a collaboration between Lineage Cell Therapeutics, of Carlsbad, California, and Genentech, a subsidiary of Roche, to develop a treatment for dry age-related macular degeneration, a cause of blindness. It is one of the places where the outsiderish field of lifespan and healthspan extension blurs with the medical mainstream; cell therapy is also a coming thing in cancer treatment, and pharma companies such as AstraZeneca are looking into it for tissue-restoration, too. Success in those fields could feed success in work on ageing—and vice versa. ■



老旧不再

衰老的身体需要除去衰败的细胞

返老药和细胞再生可能是破解的关键【专题《长命百岁》系列之三】

1962年，当时在费城的威斯塔研究所（Wistar Institute）工作（现已退休）的伦纳德·海弗利克（Leonard Hayflick）做出了长寿科学领域最著名的观察之一：在实验室中，非癌性哺乳动物细胞只能自我复制固定的次数，之后细胞就会停止分裂，进入一种“衰老”（senescence）状态。对于人类细胞而言，这一“海弗利克极限”为40到60次。

超出海弗利克极限并非通向细胞衰老的唯一路径；细胞衰老也可经由其他方式引发，包括作为一种应对DNA损伤的反应机制。身体通常用两种方式去除这些衰老细胞：激活称为细胞凋亡的一系列基因自毁程序，或派出免疫系统来清除它们。然而，随着年龄的增长，这两种形式的“房屋清扫”的效率都会降低，使得衰老细胞继续以一种类似僵尸的状态存在，给它们周围的健康细胞造成麻烦。

位于明尼苏达州罗彻斯特的梅奥诊所（Mayo Clinic）的詹姆斯·柯克兰（James Kirkland）列出了僵尸细胞聚积的组织中出现的令人生畏的一大堆问题。其中包括炎症、DNA损伤、一种称为纤维化的组织疤痕、蛋白聚集致功能失效，以及与本系列上一篇文章中讨论的MTORC1营养信号通路问题相关的两个衰老标志：蛋白稳态失衡和线粒体损伤。对小鼠的实验表明，衰老细胞与阿尔茨海默病有关。其他研究认为它们促成糖尿病、肺纤维化、骨关节炎、骨质疏松症和几种眼部疾病。

不过柯克兰博士并没有被吓退。正是他在2011年率先提出了一种解决细胞衰老问题的办法，如今研究这种方法的人越来越多。它尝试研发所谓的“返老药”来杀死衰老的僵尸细胞。

他的初步研究发现了四种已被表征的分子，看起来很有可能成为返老药：达沙替尼、非瑟酮、纳维托克和槲皮素。所有四种分子都会刺激细胞凋

亡，尽管机制不尽相同。它们都可以口服并延长实验动物的寿命。达沙替尼是一种抗白血病药物，自2006年起在美国和欧洲上市；纳维托克目前正被用于治疗骨髓纤维化（一种骨髓癌）的试验；槲皮素（在癌症治疗中常配合达沙替尼使用）和非瑟酮是可在水果中找到的天然物质。

柯克兰是转化老年科学网络（Translational Geroscience Network）的组织者之一。该组织在美国设有14个中心，正在对可能成为治疗年龄相关疾病的药物的化合物进行81项临床试验，试验方式的设计寻求增加对衰老的总体理解。其中大约30项在测试候选返老药，包括他最初罗列的上述四种中的三种。他说，总体思路是针对不同分子和不同目标疾病并行大量小型试验。尽管他认为成功发现一种返老药的几率只有25%左右，但他说自己刚开始这方面研究时会认为这个几率只有0.001%。

2020年，《自然》期刊对该领域的一项调查发现有二三十家创业公司在研究返老药。它们所用的方法不只是柯克兰最初确定的哪几种。毫无疑问，今天在这个课题上已经有了更多公司和更多方法。而且令人失望的结果也已显现。旧金山的联合生物技术（Unity Biotechnology）早年由杰夫·贝索斯和彼得·泰尔以及风险投资机构长寿基金（Longevity Fund）注资，于2018年上市，但两年后，它针对骨关节炎的一种返老药的早期试验结果令人失望，股价应声暴跌了三分之二。

在Unity等公司打造对抗细胞衰老的武器的同时，另一组公司正从另一面打量海弗利克极限。这些细胞再生公司并不寻找办法来杀死超出该极限的细胞，而是要把细胞维持在极限之下并帮助它们保持健康活力。其标靶不是需要清除的细胞，而是那些细胞无法正常更新的器官。这两种方法还有些其他的不同。返老疗法着眼于已有的药物和补充剂，尝试找到那些可以很快就帮上忙的。近期干细胞科学的进展则让细胞再生成为可能，这种方法更激进彻底。它需要且也在吸引财力更雄厚的参与者。

人体中有数百种不同类型的细胞，每种细胞的特性都适合担任某个特定类型的工作。这种分化是通过各种“表观遗传”修饰以在不同类型的细胞中打开和关闭各组基因来实现的。有些修饰是对储存着特定基因序列的DNA片

段的化学改变，有些是影响DNA所包裹的蛋白质，还有一些以更微妙的方式运作。这类表观遗传修饰至关重要。但驱动和维持它们的过程是生命运作机制中另一个随着年龄增长而变得不那么有效的部分。事实上，DNA甲基化（对DNA分子的遗传字母之一的一种特定化学改变）的模式可用于诊断细胞的年龄。

干细胞是可用于制造各种类型的新特化细胞的储备。当一个干细胞分裂时，两个子细胞中的一个会启动一条表观遗传特化途径，在几代后将产生一些特定类型的细胞。另一个子细胞将仍然是干细胞，准备在有需要时生成更多子细胞。例如，通过这种方式，骨髓中的造血干细胞产生的子细胞除了携氧的红血细胞外，还可从中衍生出所有不同种类的白血细胞。然而，若要终生继续这种生产，它们需要远超40到60次的分裂。

| 因子分析

让干细胞能继续分裂是一种名为端粒酶的酶复合物的任务。一个细胞向海弗利克极限靠近的具体表现可在其染色体末端的结构（“端粒”）中找到。每次染色体被复制以让细胞分裂时，端粒就会变短；经过40到60次分裂后，它们已经短到令染色体无法再复制了。但在干细胞中，端粒酶在两次细胞分裂的间隙被用来重建染色体的端粒，从而重置时钟。但它做得并不完美。而且，随着时间推移，干细胞也会出现预期外的表观遗传标记。干细胞的数量或能力会降低，或两者同时降低。

那如果耗尽的干细胞可以重生或更换呢？2006年，京都大学的山中伸弥（Yamanaka Shinya）等人表明，通过管理一组特定的四个“转录因子”（即影响哪些基因被用作蛋白质蓝图的蛋白质），他们可以将细胞类型特异性的表观遗传标记从一个细胞的DNA中擦除，把它恢复到“多能”干细胞的状态。这开启了新的前景：如果用其他化学物质刺激，或被植入相关类型的组织中，这些诱导性多能干细胞（iPSC）可用于按需生成特定的细胞类型。较近期的研究表明，使用这四种蛋白质的子集提供了一种在较小程度上恢复细胞活力的方法：不是将它们直接剥离回干细胞状态，而是擦除一些随年龄增长变得明显过多的表观遗传标记。

细胞逆龄领域里的最大参与方是Altos Labs。这家公司创立于2022年，其30亿美元的初始资本由多方提供，包括俄罗斯出生的亿万富翁尤里·米尔纳（Yuri Milner）。它有三个园区，两个设在美国加州，另一个位于英国剑桥南边。公司招募了一些该领域的名人进入园区，其中之一是史蒂文·霍瓦斯（Steven Horvath），他在加州大学洛杉矶分校时开发了一种根据某些DNA部分的甲基化程度来预测动物年龄的方法。这一“霍瓦斯时钟”可用来观察细胞的年龄是否与动物的年龄一致，是更年轻还是更老。换句话说，动物的衰老是慢是快。

Altos的研究对外保密，所以很难确切地说它在采用什么方法。但整个领域面临两种选择。一种是在实验室中制造新鲜干细胞并将它们移植入体内来对抗干细胞衰竭。另一种是把细胞中的霍瓦斯时钟稍微往回调一些，以尝试使组织和器官在原位恢复青春活力。

哈佛大学的丘奇博士喜欢后一种方法，它有时也称为瞬时或部分重编程。他有利益牵涉的Rejuvenate Bio公司的研究人员此前描述过用改良病毒将三种山中因子的基因携带到细胞中以恢复活力。在小鼠中，这种重新编程赋予了旧组织新的自我修复能力：之后的损伤可以像在年轻小鼠身上那样被高效修补。这已经在骨骼肌、神经纤维、眼睛、皮肤、心脏、肝脏和胰腺上得到验证。它甚至可以减缓长期记忆丧失。但Rejuvenate的研究人员已经走得更远。他们的实验（诚然尚未经过同行评审）显示，OSK疗法（这个名字来自三种山中蛋白质的首字母缩写）实际上可以延长实验室小鼠的寿命。

该试验发布在bioRxiv网站（该平台旨在方便此类未经同行评审的论文快速发布）。它报告称，接受治疗的老年小鼠的剩余预期寿命增加了一倍。它们本来只能再活9周不到，如今顽强坚持了超过18周（接受治疗时这些小鼠已经124周大，相当于人类70多近80岁的年龄）。

｜能奉献的唯有热血、神经和T细胞

其他探索原位再生的公司包括波士顿的Life Biosciences，这是由去乙酰化酶sirtuin的倡导者戴维·辛克莱（David Sinclair）近期创办的一家企业。

它的第一个项目是尝试使用部分重编程来修复青光眼对视神经的神经元造成的损伤。该公司的研究人员已经证明这种方法对小鼠有效。加州阿拉米达的AgeX Therapeutics公司则使用该公司创始人之一迈克尔·韦斯特（Michael West）发现的另一组能恢复细胞活力的转录因子。

据Retro Biosciences的老板乔·贝茨-拉克鲁瓦（Joe Betts-LaCroix）介绍，该公司的研究人员正在研究通过对干细胞重编程来恢复免疫系统的活力。这些干细胞分化为血细胞，其中一些是形成了免疫系统的一个分支的白细胞，还有一些则变成另一个分支中的T细胞。

不过，其他一些公司更喜欢干细胞移植的想法，这是“细胞疗法”领域的一个分支。山中因子的应用意味着如今干细胞有可能定制——包括使用来自患者自身的分化组织来定制，从而将使得移植的干细胞被免疫系统识别为友军而避免了排异问题。

这个领域里的先锋之一是拜耳的子公司BlueRock Therapeutics，总部位于麻省剑桥市。该公司表示，它已经开发了一种规模化制造多能人类干细胞的方法，然后用更多的转录因子调整它们，使它们走上各种不同的道路，最终通向神经细胞、心肌细胞、免疫系统细胞等。

它最初的目标是帕金森氏病，这种病症因大脑黑质区的神经细胞缺失引发。这种特异性和局部性使帕金森氏病成为细胞疗法一个具吸引力的标靶。该公司已启动一项12人参与的一期临床试验。如果这一阶段以及随后的更大规模试验取得成功，BlueRock希望能够将治疗扩展到其他目标疾病。

从拜耳的参与可以看出大型制药公司对这类方法抱有希望。加州卡尔斯巴德的Lineage Cell Therapeutics携手罗氏子公司基因泰克（Genentech）是另外一例，这两家公司要合作开发一种针对干性年龄相关性黄斑变性（导致失明的一个原因）的疗法。延长寿命和健康寿命这一外围领域和主流医学之间的界限变得模糊的地方不止于此：细胞疗法也是癌症治疗中即将出现的趋势，而阿斯利康等制药公司也在研究将细胞疗法用于组织修复。这

些领域的成功可以促成抗老研究的成功，反之亦然。 ■