

JUNE 10TH-16TH 2017

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The end of causality

TECHNOLOGY QUARTERLY: Civilian drones

Terror and the internet





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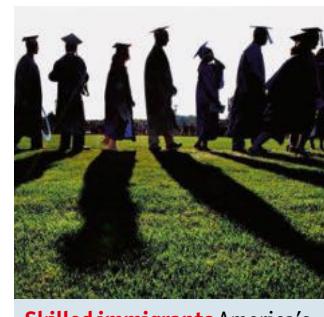
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Politics



Eight people were killed in **London** when three Islamists drove a van into pedestrians on London Bridge and then went on a stabbing spree in the trendy Borough Market neighbourhood. Almost 50 people were injured. The three attackers were killed within eight minutes by armed police, who were praised for their swift response. But questions were asked about why the men had been free to operate, given that they were already known to the intelligence services.

British voters went to the polls on June 8th, in the second general election in two years. Theresa May, the Conservative prime minister, had called it seven weeks ago to give herself a stronger mandate for negotiating Brexit. She framed the poll as a test of the strength of her leadership compared with a Labour Party adrift under Jeremy Corbyn. But the calm and composed Mrs May started to wobble as the campaign sparked to life in the final weeks. Results and analysis can be found at economist.com/ukelection2017.

Malta's incumbent Labour Party won a snap general election and another five-year term. Joseph Muscat, the prime minister, called the vote amid corruption allegations connected to the Panama Papers, which he denied.

After his victory in **France's** presidential election, Emmanuel Macron is on track to transform the face of the National Assembly. According to polls, La République en Marche!, a movement Mr Macron found-

ed just 14 months ago, will secure a parliamentary majority in an election. The first round is on June 11th, the second on June 18th.

Building a presence

In a new report, the Pentagon said that **China** was building fighter-sized hangars, fixed-weapons positions and other military infrastructure on three islands it has built in the South China Sea. It said that when complete, the facilities would enable China to base three regiments of fighters in the disputed Spratly Islands.

South Korea's new president, Moon Jae-in, suspended the deployment of THAAD, an American missile shield, for at least a year. China opposes the shield and has stepped up the pressure on Seoul recently, threatening sanctions.



More than 100,000 people in **Hong Kong** joined a candlelit vigil to mark the anniversary of the crushing of the Tiananmen Square protests in Beijing in 1989. On July 1st Xi Jinping is expected to pay his first visit to the territory as China's president, to mark the 20th anniversary of Chinese rule.

In India, raids by federal investigators on the offices of NDTV, an influential liberal television station, and on the homes of its founders were criticised by many in the press as an assault on free speech. The raids were carried out to gather evidence on an alleged outstanding bank loan, which NDTV said had been repaid years ago. It maintains that it is the victim of a political witch-hunt for its sceptical reporting about the government headed by the Hindu-nationalist Bharatiya Janata Party.

At least 19 people were killed in **Kabul** and another 90 injured when the funeral of the son of a prominent Afghan senator was targeted by bombers. The senator's son had died during protests calling for tighter security in the Afghan capital following the recent bomb near the diplomatic area, in which 150 people are now known to have died.

Tight margins

With most of the vote counted in the governor's race in the State of **Mexico**, which borders Mexico City, Alfredo del Mazo Maza, the governing Institutional Revolutionary Party's candidate, appeared to have defeated Delfina Gómez, from the left-wing Morena party. The election in Mexico's most populous state was a test of strength ahead of next year's presidential ballot. Morena alleges that the PRI bought votes and has demanded a recount.

Brazil's electoral tribunal began deliberations on whether to remove the country's president, Michel Temer, from office. Prosecutors say that he was re-elected as vice-president in 2014 with the help of illicit money.

Canada's government has said it will increase spending on defence by 70% over the next decade to C\$33bn (\$24bn) a year. That will raise the country's military budget to 1.4% of GDP from 1.2% now. The target for members of NATO is 2%.

Arab brothers



Saudi Arabia, Bahrain, the United Arab Emirates and Egypt all severed diplomatic relations with **Qatar**, and cut land, air and sea links with the

Gulf state. They accused it, without providing evidence, of supporting and promoting terrorism. Donald Trump tweeted his approval, perhaps forgetting that Qatar hosts a large American air base.

In a rare terror assault on Iran's capital, Islamic State (is) claimed responsibility for two attacks in **Tehran**, one at the Iranian parliament and one at the tomb of Ayatollah Khomeini, in which at least 12 people were killed.

American-backed Kurdish-led forces in Syria began an assault on **Raqqa**, the "capital" of is's so-called caliphate. The city has been encircled for weeks, but this is the first time the jihadists' opponents have entered the city limits.

South Africa unexpectedly slumped into recession after the economy contracted by 0.7% in the first quarter, after falling 0.3% in the last quarter of 2016. Economists had forecast a tentative recovery.

Think global, act local

More American states signed up to a "climate alliance" that aims to honour the terms of the **Paris accord** on climate change from which Donald Trump has withdrawn America. Mr Trump's decision to pull out of the agreement was roundly condemned. California, New York and Washington have created the United States Climate Alliance in response.

Mr Trump said he would nominate Christopher Wray to be director of the **FBI**. Mr Wray used to head the Justice Department's criminal division. The announcement came ahead of testimony to Congress from James Comey about why he was sacked by Mr Trump as head of the FBI.

An analyst working for an American spy agency was charged with leaking classified information to the media about Russian interference in the presidential election. She is the first person to be indicted for divulging secret files since Mr Trump became president. ►

Business

Santander, Spain's biggest lender, bought **Banco Popular**, a distressed rival, in the first test of a new scheme in Europe to bail out banks. The inability of Popular to reduce its pile of toxic debt led to a rapid decline in its share price. The Single Resolution Board, an independent agency of the European Central Bank, declared that Popular was about to fail, opening the way for a managed sale to Santander for €1 (\$1.10). The new scheme is designed to prevent taxpayers from picking up the tab for a bank rescue. Instead, some of Popular's bondholders have taken a hit and its shareholders have lost their shirts. In Italy, the government's plan to bail out **Monte dei Paschi di Siena** was approved by the EU.

More than 60 countries signed an agreement to clamp down on companies' **tax-avoidance** practices, such as shifting titular headquarters to low-tax jurisdictions. By some estimates the path-breaking pact, advanced by the G20 and OECD, could raise an extra 10% in tax revenues. America has not signed up, but the deal will affect its big multinationals, such as Amazon and Apple.

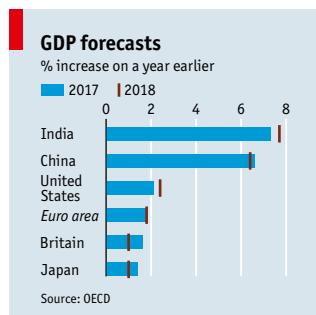
Trump air

Donald Trump proposed privatising America's **air-traffic control system**, calling for it to be put in the hands of a not-for-profit organisation outside government control. Mr Trump says this will improve air-traffic technology and reduce delays. He is supported by many big airlines, but whether his plan flies depends on winning over its opponents in Congress.

An electrical engineer contracted by **British Airways** to work at its data centre was blamed by the airline for causing a computer glitch that grounded all its flights. Willie Walsh, the chief executive of BA's parent company, said the engineer had disconnected the power and then turned it back on in an "uncontrolled fashion". But

IT experts are deeply sceptical that such a simple explanation accounts for the chaos. More may be revealed when an independent inspection delivers its conclusions.

American employers created 138,000 **jobs** in May, a lower number than economists had expected. The figure provided more food for thought for the Federal Reserve ahead of its policy meeting on June 14th. The central bank has dropped heavy hints that it will raise interest rates at the meeting, but one of the arguments for doing so is that the jobs market is overheating.



The OECD forecast that the **world economy** will grow by 3.5% this year, which would be the fastest pace since 2011. But the organisation downgraded its estimate of America's GDP growth rate to 2.1% from the 2.4% it projected in March. It

also said that although a modest cyclical expansion was under way worldwide, this would not be enough to sustain hefty improvements in living standards. In a separate report the World Bank predicted global growth of 2.7%.

Getting its house in order

Under fire for its management shortcomings, **Uber** has sacked 20 employees after an internal investigation carried out by a law firm reported its findings into claims of harassment. At least 90 other members of staff are either still being investigated, in workplace counselling or have received a warning. A separate report from a law firm led by Eric Holder, a former US attorney-general, into Uber's culture has been handed over to the board.

Five months after moving into **mobile gaming** by creating a division to focus on the business, 21st Century Fox agreed to buy Aftershock, a developer that is working on a game based on "Avatar", the world's highest-grossing film.

Research by PwC into **global media trends** revealed several firsts. It found that advertising revenue from the internet beat that from television last year;

that newspapers got more of their income from circulation than from ads; and that streamed music outstripped downloaded songs. This year it expects the proceeds from streaming videos on the web to overtake sales from DVDs.

Terry Gou, the chairman of **Foxconn**, a contract electronics manufacturer, said he had enlisted the financial backing of Amazon and Apple in a bid for **Toshiba's** chipmaking business, thought to be worth around \$20bn. That might help defuse stiff opposition to the bid in Japan, Toshiba's home, because of Foxconn's operations in China.

The voice: Siri v Alexa

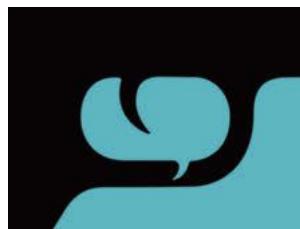
Apple unveiled the **HomePod**, a voice-activated speaker equipped with Siri, the virtual-assistant technology found on iPhones. HomePod is Apple's somewhat belated answer to Amazon's Echo smartspeaker (with Alexa voice-control) and Google's Assistant. At the launch, Apple played up HomePod's audio specifications, signalling that it expects the device to compete with top-of-the-range speakers made by Bose and others.

Other economic data and news can be found on pages 78-79



Terror and the internet

Tech firms could do more to help—within limits



THREE jihadist attacks in Britain in as many months have led to a flood of suggestions about how to fight terrorism, from more police and harsher jail sentences to new legal powers. But one idea has gained momentum in both Europe and America—that internet firms are doing the jihadists' work for them. Technology giants, such as Google and Facebook, are accused of turning a blind eye to violent online propaganda and other platforms of allowing terrorists to communicate with each other out of reach of the intelligence services.

It is only the latest such charge. The technology firms have also been condemned for allowing the spread of fake news and harbouring bullies, bigots and trolls in the pursuit of profit. In the past they were accused of enabling people to evade copyright and of hosting child pornography.

In all these areas, politicians are demanding that the technology giants take more responsibility for what appears on their networks. Within limits, they are right.

Shooting the messenger app?

For as long as there have been data networks, people have exploited them to cause harm. The French mechanical telegraph system was subverted in 1834 in a bond-trading scam that went undetected for two years. Cold-callers run cons by telephone. The internet, with billions of users and unlimited processing power, is the most powerful network of all. It was bound to become the focus of wrongdoers.

That does not mean it should be wrapped in red tape. Openness online is especially valuable because it allows “permissionless” innovation. Anyone can publish an article, upload a video or distribute a piece of software to a global audience. Freedom from the responsibilities that burden other media companies has served as a boost for a nascent industry.

But the days when the technology firms needed nurturing are long gone. In the past decade they have become the world's most valuable companies. As their services have reached deeper into every aspect of everyday life, online activity has gained more potential to cause offline harm. For every Spotify there is a WannaCry.

Technology firms complain that this combination of novelty and commercial success makes them a convenient target for politicians, some of whom seem to regard regulating the internet as a shortcut to solving complex social problems such as hate speech. Eager to protect their special status, technology firms have emphasised that online recruitment is only part of the terrorist threat. Besides, they say, they are platforms, not publishers, and that they cannot possibly monitor everything.

Yet the firms can act when they want to. Before Edward Snowden exposed them in a huge leak in 2013, they quietly helped American and British intelligence monitor jihadists. Whenever advertisers withdraw business after their brands ended up alongside pornographic, violent or extremist material, they respond remarkably quickly.

As with car accidents or cyber-attacks, perfect security is unattainable. But an approach based on “defence in depth”, combining technology, policy, education and human oversight, can minimise risk and harm.

Often, commercial self-interest gives an incentive for the technology companies to act. Although fake news is popular and engaging, and provides opportunities to fill advertising slots, it is bad for the technology giants' reputations. Accordingly, Google and Facebook are doing more to cut off fake-news sites from their advertising networks, build new tools to flag dubious stories and warn readers of them, and establish links with fact-checking organisations.

When self-interest is not enough, governments can prod the firms to tighten up—as German lawmakers have, threatening huge fines. Under a voluntary agreement with European regulators, the big firms have set a target of reviewing (and, when appropriate, removing) within a day at least 50% of content flagged by users as hateful or xenophobic. The latest figures show that Facebook reviewed 58% of flagged items within a day, up from 50% in December. For Twitter, the figure was 39%, up from 24%. (YouTube's score fell from 61% to 43%).

The strongest measure is new laws. In 2002, for example, Britain made internet service providers (ISPs) liable for child pornography if they did not take it down “expeditiously”. The ISPs used a charity to compile a list of blocked URLs that it updated twice daily. The charity works closely with law-enforcement agencies in Britain and abroad. Similarly, American lawmakers have clamped down on copyright infringement.

It's no longer 2005

As in the offline world, legislators must strike a balance between security and liberty. Especially after attacks, when governments want to be seen to act, they may be tempted to impose blanket bans on speech. Instead, they should set out to be clear and narrow about what is illegal—which will also help platforms deal with posts quickly and consistently. Even then, the threshold between free speech and incitement will be hard to define. The aim should be to translate offline legal norms into the cyber domain.

Before legislators rush in, they also need to think about unintended consequences. If internet firms are threatened with fines, they may simply remove all flagged content, just in case. Regulation that requires lots of staff to take down offensive posts will most hurt small startups, which can least afford it. Laws mandating cryptographic “back doors” in popular messaging apps would weaken security for innocent users. Bad actors would switch to unregulated alternatives in countries that are unlikely to help Western governments. They would thus become harder for the intelligence services to watch.

In the past, internet firms have tended to “build it first, figure out the rules later”. However, the arguments about terrorism and extremist content are a stark reminder that the lawless, freewheeling era of the early internet is over. Technology firms may find that difficult to accept. But accept it they must, as part of the responsibility that comes with their new-found power and as part of the price of their success. ■

Qatar

Donald does Doha

The Trumpian world order means a less stable Middle East



AMERICA'S president got on so well last month with King Salman of Saudi Arabia that he has embraced the monarch's foreign-policy goals. Sunni Saudi Arabia detests Shia Iran, its chief regional rival. So does Donald Trump. He also appears to share the Saudi view that the most egregious bankroller of terrorism in the Middle East is the tiny sheikhdom of Qatar. He applauded when, on June 5th, Saudi Arabia, Bahrain and the United Arab Emirates severed diplomatic ties with Qatar, as well as land, sea and air links. The Gulf states gave Qatari citizens 14 days to leave. Ludicrously, the UAE declared that anyone publishing expressions of support for Qatar can be jailed for up to 15 years. Mr Trump tweeted: "Perhaps this will be the beginning of the end to the horror of terrorism!"

Though tiny, Qatar matters. It is the world's largest producer of liquefied natural gas and an airline hub. It is also host to Al Jazeera, the nearest the Middle East has to an uncensored broadcaster (so long as it does not criticise the Qatari monarchy). It has good ties with Iran, with which it exploits a vast gasfield. It is supportive, too, of the (Sunni) Muslim Brotherhood, the most popular face of political Islam. All this makes Saudi Arabia hate it. The Saudi regime has tried in the past to bend Qatar to its will, but failed. Qatar hosts a large American airbase, which until now has made it feel safe. But with Mr Trump in the White House, nobody is now so sure.

No concrete reasons have been given for the blacklisting of Qatar. There is lots of chatter that wealthy Qataris fund terrorism. This accusation, which is also levelled at rich Saudis, is unproven, though the *Financial Times* reports that Qatar paid \$1bn to Iran and an al-Qaeda affiliate for the release of Qatari royals who were taken hostage while on a falcon-hunting trip

to Iraq. A billion-dollar ransom would buy a lot of explosives.

The spat has split the Gulf Co-operation Council, hitherto a force for stability in an unstable region. It may drive Qatar, as well as Kuwait and Oman, the other two members of the GCC, who pointedly declined to support the Saudi move, further into the arms of Iran. Tempers may eventually cool, but some observers worry that the price of Saudi Arabia backing down will be the muzzling of those pesky AlJazeera journalists.

Mr Trump's support for Saudi actions also damages America's credibility. It suggests that, under him, the superpower can abandon its allies after a brief chat with their enemies. "During my recent trip to the Middle East I stated that there can no longer be funding of Radical Ideology. Leaders pointed to Qatar—look!" tweeted Mr Trump on June 6th. The sober foreign-policy types who cling on in his administration are scrambling to downplay such undiplomatic words and calm tempers. Perhaps recognising his error, Mr Trump offered his services as a mediator the following day.

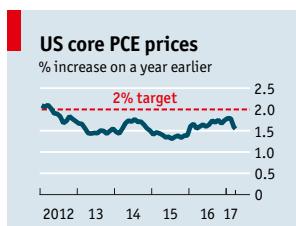
Now anything goes

Abdel-Fattah al-Sisi, Egypt's autocratic president, has also decided that Mr Trump is an American leader who will let him persecute his enemies without hindrance. On May 23rd, two days after the two men met and praised each other in Riyadh, Mr Sisi had a potential opponent arrested for allegedly making an indecent hand gesture at a rally five months earlier. On May 25th the government blocked access to the websites of *Mada Masr*, Egypt's leading liberal newspaper, and those of 20 other media outlets, including Al Jazeera and Huffpost Arabic. In Bahrain the authorities killed five people and arrested 286 more in a raid on the home of a Shia cleric; shortly after that, they dissolved the main secular opposition party. America would once have objected to all this. No longer—and that is a recipe for a less stable Middle East. ■

American monetary policy

Check yourself

The Federal Reserve should respond to lower inflation by holding interest rates steady



NO STATEMENT from the Federal Reserve is complete without a promise to make decisions based on the data. In each of the past two years, a souring outlook for the world economy prompted the Fed to delay interest-rate rises. And quite right, too. Yet if the Fed raises rates on June 14th in the face of low inflation, as it has strongly hinted, it would bring into question its commitment both to the data and also to its 2% inflation target.

The central bank has raised rates three times since December 2015 (the latest rise came in March). It is good that monetary

policy is a little tighter than it was back then. The unemployment rate, at 4.3%, is lower than at any time since early 2001. A broad range of earnings data show a modest pickup in wage growth. The Fed is right to think that it is better to slow the economy gradually than be forced to bring it to a screeching halt later, if wage and price rises get out of hand. The rate increases to date have been reasonable insurance against an inflationary surge.

But no such surge has yet struck. Unexpectedly low inflation in both March and April has left consumer prices no higher than they were in January. According to the Fed's preferred index, core inflation—that is, excluding volatile food and energy prices—has fallen to 1.5%, down from 1.8% earlier this year. It ►

► is now well below the 2% target.

Nor does a surge seem imminent. For a while, Donald Trump's promises to cut taxes and spend freely on infrastructure made higher rates appear all the wiser. But fiscal stimulus looks less likely by the week. Tax cuts are stuck in the legislative queue behind health-care reform, and Mr Trump's administration has tied itself in knots over whether it will increase the deficit. Meanwhile, the current "infrastructure week" in Washington may generate more headlines than proper plans.

Even so, the Fed is expected to go ahead and raise rates this month. The markets think there is a 90% probability of an increase of 25 basis points (hundredths of a percentage point).

It is possible that more inflation is coming. An economy that is stimulated will eventually overheat. The central bank may believe that low unemployment is about to cause inflation. But the truth is that nobody is sure how far unemployment can fall before prices and wages soar. Not many years ago some rate-setters put this "natural" rate of unemployment at over 6%; the median rate-setter's estimate is now 4.7%.

The only way to find the labour market's limits is to feel them out. Falling inflation and middling wage growth both suggest that these limits are some way off, for two possible reasons. First, higher wage growth could yet tempt more of the jobless to seek work (those who are not actively job-hunting do not count as unemployed). The proportion of 25- to 54-year-olds in employment is lower than before the recession, by an amount representing almost 2.4m people. By this measure,

which fell in May, joblessness is worse in America than in France, where the overall unemployment rate stands at 9.5%. Second, even the moderate pickup in wage growth to date might encourage firms to invest more, lifting productivity out of the doldrums and dampening inflationary pressure.

I like hike

Jobs growth in America has already slowed from a monthly average of 187,000 in 2016 to 121,000 in the past three months. That is enough to reduce slack in the economy, but only just. Slowing it still further is needless so long as inflation remains quiescent. It makes still less sense when you consider the asymmetry of risks before the Fed. If tighter money tips the economy into recession, the central bank has only a little bit of room to cut rates before it hits zero. But if inflation rises, it can raise them as much as it likes.

This asymmetry of risks extends to the Fed's credibility. Inflation has been below 2% for 59 of the 63 months since the target was announced in January 2012. Continuing to undershoot the goal would cast more doubt on the central bank's commitment to it than modest overshoots would.

For too long, hawks have made excuses for the persistence of low inflation. The latest is to blame new contracts offering unlimited amounts of mobile data, as if cheaper telecommunications somehow should not count. The Fed should keep its promise to base its decisions on the data, and leave interest rates exactly where they are. ■

Education in India

Letting 260m minds go to waste

India has made huge progress in getting children into school. Now it must teach them



IN 1931 Mahatma Gandhi ridiculed the idea that India might have universal primary education "inside of a century". He was too pessimistic. Since 1980 the share of Indian teenagers who have had no schooling has fallen from about half to less than one in ten. That is a big, if belated, success for the country with more school-age children, 260m, than any other.

Yet India has failed these children. Many learn precious little at school. India may be famous for its elite doctors and engineers, but half of its nine-year-olds cannot do a sum as simple as eight plus nine. Half of ten-year-old Indians cannot read a paragraph meant for seven-year-olds. At 15, pupils in Tamil Nadu and Himachal Pradesh are five years behind their (better-off) peers in Shanghai. The average 15-year-old from these states would be in the bottom 2% of an American class. With few old people and a falling birth rate, India has a youth bulge: 13% of its inhabitants are teenagers, compared with 8% in China and 7% in Europe. But if its schools remain lousy, that demographic dividend will be wasted.

India has long had a lopsided education system. In colonial times the British set up universities to train civil servants, while neglecting schools. India's first elected leaders expanded this system, pouring money into top-notch colleges to supply engineers to state-owned industries. By contrast, Asian ti-

gers such as South Korea and Taiwan focused on schools. Of late, India has done more to help those left behind. Spending on schools rose by about 80% in 2011-15. The literacy rate has risen from 52% in 1991 to 74% in 2011. Free school lunches—one of the world's largest nutrition schemes—help millions of pupils who might otherwise be too hungry to learn.

Pointless pampered pedagogues

However, the quality of schools remains a scandal. Many teachers are simply not up to the job. Since 2011, when the government introduced a test for aspiring teachers, as many as 99% of applicants have failed each year. Curriculums are over-ambitious relics of an era when only a select few went to school. Since pupils automatically move up each year, teachers do not bother to ensure that they understand their lessons. Overmighty teachers' unions—which, in effect, are guaranteed seats in some state legislatures—make matters worse. Teachers' salaries, already high, have more than doubled over the past two rounds of pay negotiations. Some teachers, having paid bribes to be hired in the first place, treat the job as a sinecure. Shockingly, a quarter play truant each day.

Frustrated by the government system, and keen for their children to learn English, parents have turned to low-cost private schools, many of which are bilingual. In five years their enrolment has increased by 17m, as against a fall of 13m in public schools. These private schools can be as good as or better than public schools despite having much smaller budgets. In Uttar ▶

► Pradesha the flight to private schools almost emptied some public ones. But when it was suggested that teachers without pupils move to schools that needed them, they staged violent protests and the state backed down.

India spends about 2.7% of GDP on schools, a lower share than many countries. Narendra Modi, the prime minister, once vowed to bump up education spending to 6%. However, extra money will be wasted without reform in three areas. The first is making sure that children are taught at the right level. Curriculums should be simpler. Pupils cannot be left to pass through grades without mastering material. Remedial "learning camps", such as the ones run by charities like Pratham, can help. So can technology: for example, EkStep, a philanthropic venture, gives children free digital access to teaching materials.

The second task is to make the system more meritocratic and accountable. Teachers should be recruited for their talents,

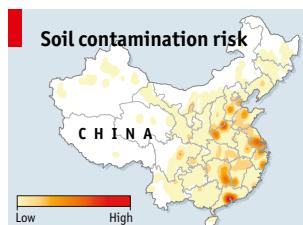
not their connections. They should be trained better and rewarded on the basis of what children actually learn. (They should also be sackable if they fail to show up.) The government should use more rigorous measures to find out which of a hotch-potch of bureaucratic and charitable efforts make a difference. And policymakers should do more to help good private providers—the third area of reform. Vouchers and public-private partnerships could help the best operators of low-cost private schools expand.

Mr Modi's government has made encouraging noises about toughening accountability and improving curriculums. But, wary of the unions, it remains too cautious. Granted, authority over education is split between the centre and the states, so Mr Modi is not omnipotent. But he could do a lot more. His promise to create a "new India" will be hollow if his country is stuck with schools from the 19th century. ■

Soil pollution in China

Buried poison

China would be a more convincing green champion if it did not treat pollution data as state secrets



AFTER Donald Trump said on June 1st that America would pull out of the Paris accord on climate change, many people congratulated China for sticking with it. With America on the sidelines, some see China as the leader of the fight against global warming—an idea that the Chinese Communist Party is eager to promote (see Banyan). Although it is the world's largest emitter of carbon dioxide, China has made a determined effort to cut back. It has burned less coal in each of the past three years. In 2016 it installed more wind-power capacity than any other country; three times as much as the runner-up, America. Some analysts believe that China's CO₂ emissions may peak in 2025, five years earlier than the goal it set in Paris. Yet it is premature to call China a champion of greenery.

Its air and water are notoriously foul. Less noticed, but just as alarming, much of its soil is poisoned, too. As our briefing explains the scale of the problem is hard to gauge, largely because China's government is so opaque. A soil survey conducted between 2006 and 2011 was at first classified as secret. Many of its findings are still not public, but one grim statistic has emerged: one-fifth of Chinese farmland contains higher-than-permitted levels of pollutants, some of which threaten food safety. This is bad news for a country that has 18% of the world's population but only 7% of its arable land. And it will be exceptionally costly and difficult to clean up. Soil just sits there, meaning that toxins linger for centuries.

Public alarm is growing. For evidence, ask any Chinese about "cadmium rice", which contains a heavy metal that, if ingested, can eventually cause kidney failure, lung disease and bone damage. Leaks from factories sometimes seep into paddy fields, and thence into rice-bowls. In 2013 the nation was horrified by a report that in Guangzhou, a southern city, nearly half of the rice tested by inspectors in restaurants and canteens was laced with cadmium. The story aroused a new awareness among citizens: that soil pollution was not just a local problem

in China, manifest here and there in the high mortality of "cancer villages", but a national threat, and that the government had been sparing with the truth about it.

The government is more forthcoming about air and water pollution. That is because these forms are usually more visible, making them harder to conceal. But it was not until 2013, after years of mounting public anger, that the government began to release real-time data for its biggest cities on levels of PM2.5, the finest of airborne poisons that lodge deepest in the lungs. A documentary on China's air pollution, released in 2015 by a Chinese journalist, was scrubbed by censors from Chinese websites after it attracted more than 200m views.

Blue-sky thinking

Officials are keenly aware of the public's anxieties. In 2014 the prime minister, Li Keqiang, promised that he would "resolutely declare war" on pollution. Last year the government unveiled an almost impossibly ambitious plan to make 90% of polluted soil usable by the end of the decade. In March Mr Li promised to "make our skies blue again"; PM2.5 levels would fall "markedly" this year, he said.

All this is welcome, but if China is to lead the world in the creation of a greener planet it must do more than build wind farms and erect solar panels. It must also come clean about the full extent of the problems it faces, and then demand no less from other countries. If the Paris accord is to succeed, transparency will be crucial—because pledges that cannot be verified are of little use in binding countries to a common cause.

One way for China to accomplish this would be for it to go beyond the letter of the Paris accord and allow international monitoring of its carbon emissions. At the very least Chinese officials should no longer remain so secretive about other kinds of pollution that pose an immediate threat to the lives of their own compatriots. Openness would enable the Chinese to understand the risks they face, and to hold officials to account for failing to stop polluters from poisoning them. Sunlight—something our readers in Beijing may only dimly remember—is the best anti-pollutant. ■

Two-state resolution

One can agree with the premise of your argument for "Why Israel needs a Palestinian state" (May 20th), while strongly disagreeing with the analysis explaining why a Palestinian state has not come about. The inadequate history you present not only unfairly places the majority of the blame on Israel, but also encourages a Palestinian narrative that continues to be the main obstacle to a solution.

Nowhere do you refer to Israeli initiatives—at Camp David in 2000, Gaza in 2005 and Annapolis in 2008—which could long ago have produced that desired state if not for Palestinian rejection and inaction. Add the Palestinian incitement against Israel, its funding of the families of terrorists and its refusal to negotiate throughout Barack Obama's presidency, and it should be no surprise that peace and a two-state deal remain a distant dream.

It takes two parties to make peace and the prospects for any resolution of the conflict have been damaged, delayed over the years by the Palestinian leadership and their continued refusal to accept the legitimacy of Israel as a Jewish state and their unwillingness to deal reasonably with the substantive issues.

When this finally happens, it will have a much greater impact than your skewed history in bringing the parties back to the table and allowing Israel to make the necessary concessions for peace.

JONATHAN GREENBLATT
National director
Anti-Defamation League
New York

You avoided the details of the run-up to the Six Day War. Israel's maritime channels to the Red Sea had been blocked. The UN peacekeeping force packed up its bags and left. President Lyndon Johnson was "neutral in thought, word and deed". I remember the fear and isolation we felt. Israel was on its own. Fifty years later, Israel has had a preview of a Palestinian state in Gaza, and

cringes at the prospect of replicating such folly on the West Bank. A bilateral agreement signed by any Arab leader today would be worthless in the event of a change of government in his country. Do you really blame Israel for hesitating to revise the status quo?

DAVID LEVINE
San Francisco

One alternative to two states is a confederation, consisting of three autonomous entities: Israel, Palestine and Jordan. A confederate structure offers a framework for reconciling sovereignty and the conflicting claims of the two sides, such as the right of Jewish settlement in all parts of Eretz Yisrael, simultaneously with the right of the Palestinian refugees to return to their homeland.

The confederation would include an Arab state administration possessing an Arab army. This would provide more balance than the two-states model, where an unarmed Palestinian state is expected to co-exist with the army of Israel. Jordan would gain direct access to the Mediterranean, thus expanding its economic horizons.

Dominated numerically by Muslims, the confederation would consist of two Arab entities and one Jewish one. To assure its chances of survival, the three parties would enter into internationally guaranteed agreements, including the right of residence. It would be economically viable, with natural resources such as gas and phosphates and an abundance of educated people.

To be stable, the confederation would be based on the principle of symmetry, which means that each party would have the right to favour its own residents but undertake to refrain from discriminating between the other two parties. Application of this principle to the seemingly incompatible claims of the Palestinians and Israelis on exclusive "right of return" suggests that realising both "rights" can be accommodated within the geographic confines of the original mandate granted to Britain by the League of Nations.

The outcomes are not self-evident. They would have to be acceptable to all parties. But a confederation is consistent with the ideas of equality, symmetry, economic viability and recognition of the basic rights asserted by each of the parties. These are qualities that the two-state solution cannot claim to possess.

SEEV HIRSCH

Professor emeritus
Tel Aviv University

The Singaporean way

I agree completely with Banyan that what has worked for Singapore may not work for others (June 3rd). But in explaining how foreigners misunderstand Singapore, Banyan added two misunderstandings of his own. First, we maintain racial calm in Singapore not to protect the Chinese majority but precisely the opposite: to protect the non-Chinese minorities, so that they can live secure and peaceful lives and be spared the atrocities visited on minorities in some other countries.

Second, the People's Action Party wins elections based on broad nationwide support, not gerrymandering. In the most recent general election in 2015, the PAP took 70% of the national vote and won all but one of its seats by at least 57% of the vote. The exception was a constituency which the PAP took back from the opposition without any boundary changes.

FOO CHI HSIA
High commissioner for
Singapore
London

The wild child of cinema

Has the "old guard" of Cannes forgotten the history of film? It seems so, judging from their response to Netflix ("Curtain call", May 27th). From live theatre to silent films, silents to talkies, black and white to colour, film has never stopped changing. The Old Guard of Cannes should get over it, or look forward to joining the Has-Been Guard. Take one of France's greats, François Truffaut. Banned from Cannes in

1958, he won best director in 1959, yet still had this to say: "Some day I'll make a film that critics will like. When I have money to waste."

SETH RUBINSTEIN
Singapore

History quiz

Charles Van Doren was mentioned in your obituary of Albert Freedman (May 6th). People were so interested in his performance on the "Twenty One" quiz show in the 1950s because he is the son of Mark Van Doren, who was one of the great English professors at Columbia University. Van Doren's students varied from Thomas Merton, a theologian and monk, to beat writers such as Allen Ginsberg and Jack Kerouac. Kerouac came to Columbia as a football player, but the story goes that after sitting in on one of Van Doren's classes he quit the team and wrote "On the Road".

WILLIAM POLLARD
Ocean City, New Jersey

GDP rocks!



So someone in China has written a musical tribute to GDP ("In the name of GDP", May 13th). Germany had such a song in the 1980s, too. It was called "Bruttosozialprodukt", performed by the band Geier Sturzflug. But in that case, it was a satire about the consumption frenzy.

PAUL MÜLLER
Schmerikon, Switzerland ■

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The bad earth

SHIQIAO, HUNAN PROVINCE

Contaminated soil is the biggest neglected threat to public health in China

TANG DONGHUA, a wiry 47-year-old farmer wearing a Greenpeace t-shirt, smokes a cigarette and gesticulates towards his paddy fields in the hills of southern Hunan province. The leaves of his rice plants poke about a foot above water. Mr Tang says he expects to harvest about one tonne of rice from his plot of a third of a hectare (0.8 acres) near the small village of Shiqiao. There is just one problem: the crop will be poisoned.

Egrets and damselflies chomp lazily on fish and insects in the humid valley below the paddy fields. But just beyond this rural scene lurks something discordant. Mr Tang points to a chimney around 2km away that belches forth white smoke. It belongs to the smelting plant which he blames for bringing pollution into the valley. Cadmium is released during the smelting of ores of iron, lead and copper. It is a heavy metal. If ingested, the liver and kidneys cannot get rid of it from the body, so it accumulates, causing joint and bone disease and, sometimes, cancer.

Hunan province is the country's largest producer of rice—and of cadmium. The local environmental-protection agency took

samples of Mr Tang's rice this year and found it contained 50% more cadmium than allowed under Chinese law (whose limits are close to international norms). Yet there are no limits on planting rice in polluted areas in the region, so Mr Tang and his neighbours sell their tainted rice to the local milling company which distributes it throughout southern China. Mr Tang has sued the smelter for polluting his land—a brave act in China, where courts regularly rule in favour of well-connected businesses. His is an extreme case of soil contamination, one of the largest and most neglected problems in the country.

Soil contamination occurs in most countries with a lot of farmland, heavy industry and mining. In Ukraine, for example, which has all three, about 8% of the land is contaminated. A chemical dump in upstate New York called Love Canal resulted in the poisoning of many residents and the creation of the “superfund”, a federal programme to clean up contaminated soil. But the biggest problems occur in China, the world's largest producer of food and of heavy industrial commodities such as steel and cement.

China's smog is notorious. Its concentrations of pollutants—ten or more times the World Health Organisation's maximum safe level—have put clean air high on the political agenda and led the government to curtail the production and use of coal. Water pollution does not spark as much popular outrage but commands the attention of elites. Wen Jiabao, a former prime minister, once said that water problems threaten “the very survival of the Chinese nation”. China has a vast scheme to divert water from its damp southern provinces to the arid north.

Dishing the dirt

Soil pollution, in contrast, is buried: a poisoned field can look as green and fertile as a healthy one. It is also intractable. With enough effort, it is possible to reduce air or water pollution, though it may take years or decades. By contrast, toxins remain in the soil for centuries, and are hugely expensive to eradicate. It took 21 years and the removal of 1,200 cubic metres of soil to clean up the Love Canal, a site covering just 6.5 hectares.

China's soil contamination is so great that it cannot adopt such a course (see map on next page). The country is unusual in that it not only has many brownfield sites (contaminated areas near cities that were once used for industry) but large amounts of polluted farmland, too. In 2014 the government published a national soil survey which showed that 16.1% of all soil and 19.4% of farmland was contaminated by or ➤

►ganic and inorganic chemical pollutants and by metals such as lead, cadmium and arsenic. That amounts to roughly 250,000 square kilometres of contaminated soil, equivalent to the arable farmland of Mexico. Cadmium and arsenic were found in 40% of the affected land. Officials say that 35,000 square kilometres of farmland is so polluted that no agriculture should be allowed on it at all.

Stick in the mud

This survey is controversial. Carried out in 2005-13, it was at first classified as a state secret, leading environmentalists to fear that the contamination might be even worse than the government let on. Not everyone, however, is as pessimistic. Chen Tongbin, head of the Institute of Geographic Sciences and Natural Resources Research in Beijing, thinks the figure of 19.4% is too high. Based on local studies, he says 10% is nearer the mark. Even that would be a worrying figure, given that China is trying to feed a fifth of the world's population on a tenth of the world's arable land. The conclusion seems to be that China's soil pollution is widespread and that information about it is disturbingly unreliable.

There are three reasons why the contamination is so extensive. First, China's chemical and fertiliser industries were poorly regulated for decades and the soil still stores the waste that was dumped on it for so many years. In 2015, for example, 10,000 tonnes of toxic waste was discovered under a pig farm in Jiangsu province in the east of China after a businessman proposed plans to build a warehouse on the plot and tested the soil. In 2004 construction workers on the Beijing metro suddenly fell ill when they started tunnelling under a site previously occupied by a pesticide factory.

New environmental regulations have sought to crack down on chemical dumping but they do not seem to do enough. Since 2008 new plants have had to be built in special chemical-industry parks, where oversight is supposed to be stricter. At the end of May, Greenpeace, an environmental NGO, took samples from the wastewater, soil and air of one such park, in Liangyungang in Jiangsu. It discovered 226 different chemicals. Three-quarters of them are not subject to hazardous-chemical regulations in China,¹⁶ are definitely or probably carcinogenic to humans and three are illegal.

Making matters worse is the astonishing "safety" record of the chemical industry. Between January and August 2016, China suffered 232 accidents in chemical factories, such as leaks, fires and explosions—almost one a day. Since around a fifth of these factories are in China's most productive agricultural areas or near rivers used for irrigation, many of the spilled chemicals end up in fields. Chemical fac-

tories are not the only culprits. About 150km from Mr Tang's village, in a town called Chenzhou, part of a lead and zinc mine collapsed in 1985, flooding nearby farms with arsenic, a by-product of mining. Arsenic concentrations in the soil were 24 times the legal limit 30 years later.

The second big problem is that land is being poisoned by "sewage irrigation". Wastewater and industrial effluent are used in increasing amounts for irrigation because there is not enough fresh water to go round. In the north of China there is less water available per person than in Saudi Arabia, so farmers use whatever they can get. China produces over 60bn tonnes of sewage a year and in rural areas only 10% of it is treated. Most of the sludge goes into lakes and rivers, and thence onto fields.

A study in 2014 found that 39 out of 55 areas using sewage irrigation were contaminated by cadmium, arsenic and other poisons and that the accumulation of heavy metals in intensively irrigated areas was rising. An earlier study from 2010 found that water along 18% of the length of China's rivers was too polluted for use in agriculture. It is used anyway.

To make matters worse, the soil is bearing the burden of the excess use of fertiliser and pesticide, which has increased as China's demand for grain has risen. Since 1991 pesticide use has more than doubled and the country now uses roughly twice as much per hectare as the worldwide average. Fertiliser use has almost doubled, too. In 2012 a survey by the Institution of Nutrition and Food Safety reported that in 16 provinces 65 pesticides were detected in food, though whether this was the result of

overuse by farmers, illegal dumping by factories or some other reason is not clear. The most common pesticides were present in all the main foodstuffs.

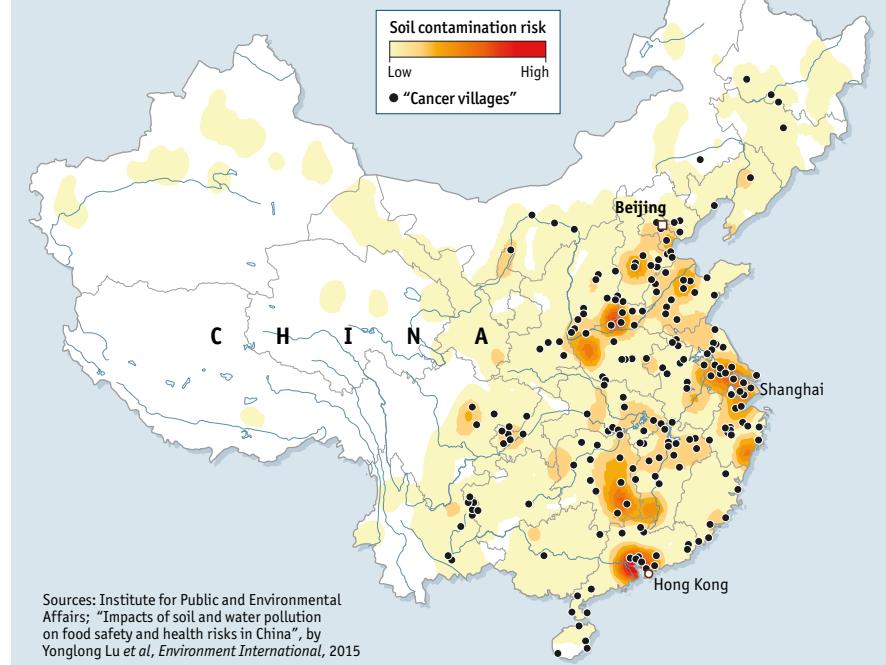
Third, soil pollution is affecting more people than it used to because of economic change and urbanisation. Twenty years ago, most chemical and pesticide plants were built far from cities and although their pollution hurt soil, crops and farmers, it did not directly affect city dwellers. Since then, China has experienced the largest urban expansion the world has ever seen and once-remote factories are now surrounded by houses and shops. As the economy switches from heavy industry to services, many factories are closing down or relocating.

Covering a lot of ground

A case in Changzhou in Jiangsu province showed what can happen next. In early 2016 students at a newly opened campus of the Changzhou Foreign Language School began complaining of headaches, skin rashes and a strange smell. Hundreds fell ill, some with lymphoma. The campus, it turned out, had been built next to a dump owned by three chemical companies that had closed in 2010.

The land had been acquired by the local government and cleaned up by a specialist firm that spread a heavy layer of clay over the top. Alas, the clay leaked. A survey in 2012 found that levels of chlorobenzene, a solvent, were 80,000 times the permitted limit. In May 2016 two NGOs took the chemical companies to court, blaming them for the pollution. The court threw the case out, leaving the plaintiffs with huge ►

What lies beneath?





► costs. As in so many cases, the pollution had been buried for decades but was unearthed by economic change.

The harm caused by soil pollution is as grave as might be expected. Heavy metals are exceptionally bad for food safety and human health. In 2002 China's ministry of agriculture conducted one of the few nationwide food tests to look for such heavy metals; it found that 28% of the rice samples it took had excess lead and 10% had excess cadmium.

In 2015 a survey by Yonglong Lu of the Research Centre for Eco-Environmental Sciences in Beijing and others in *Environment International*, a scientific journal, counted hepatitis A, typhoid and cancers of the digestive tract among the health hazards of eating contaminated food. The authors also suggested that there may be a link between soil pollution and China's "cancer villages", 400-450 clusters with unusually high levels of liver, lung, oesophageal and gastric cancers. In 2006 a Chinese environmental NGO took urine samples from 500 residents of Zhuzhou, an area of Hunan province with several such villages; 30% of those tested showed elevated levels of cadmium and 10% needed specialist treatment.

That alone should have rung alarm bells for China's rulers. In addition, several other effects are pushing the problem of polluted soil slowly up the ladder of political concerns. Politicians are becoming increasingly concerned about public opinion. Alarm at reports of cadmium rice and other contaminated foods is growing. Nor do local governments want a repeat of the Changzhou case, which became a public controversy last year.

The law of sod

Politicians also worry about the impact that contamination has on agricultural yields. Poisoned soils are less productive. The ministry of environmental protection said in 2006 that grain yields had fallen by 10m tonnes as a result of soil contamination. It did not specify what period this referred to but in 2006, China's total grain output was just under 500m tonnes, so

pollution could have reduced the harvest by 2% below what it might otherwise have been. With the total amount of arable land falling as a result of urbanisation and soil erosion (see chart), China cannot afford to contaminate what is left. The national government is obsessed with feeding China's 1.3bn people and anything that reduces grain yields is a matter of concern.

Lastly, soil contamination adds to the difficulties that local governments face in acquiring land to build on. A large part of local-government finance depends on officials taking over land on the edge of cities (sometimes forcibly) and leasing it to property developers who build the new houses and offices that China requires. Without this moneymaking activity, many provincial and county governments would go bankrupt. In 2014 a working group of the Communist Party revealed that 12 provinces had run out of land for construction. So when contamination reduces the amount of land for leasing or forces cities to build on polluted brownfields, it hurts local governments.

As a result, the attitude of authorities—especially the national government—has begun to shift from indifference to concern. In 2011 the environment ministry announced a five-year plan to cut heavy-metal emissions in the worst-affected areas by 15% from what they were in 2007 by the end of 2015. It said that three-quarters of the targets had been met by the end of 2014. That year the legislature stiffened penalties for polluters. Last year the national government issued a ten-point plan that aims to make 90% of contaminated farmland safe by 2020, defines different soil types and lays out steps to be taken to stabilise soil quality for each one. This year the legislature has said it will clarify who is responsible for soil pollution in the past and codify into Chinese law the "polluter pays" principle.

This spate of rulemaking is welcome, but it is only a start. As in many countries, health, food safety, water pollution and soil contamination are all dealt with in China by different regulatory agencies, which do not always co-operate. There has been no nationwide health survey to track the effect of soil contamination. And most of the soil-improvement plans lack teeth because they depend for enforcement on local officials, who are often in cahoots with the local polluters.

Efforts to clean up polluted soil have so far been modest because, without a proper law, it is not clear who should pay for them. China has nothing like America's "superfund". Nor could it afford to eradicate contaminants entirely by, say, washing the soil and treating it with bacteria. London did this when preparing the site, formerly an industrial area, for the 2012 Olympic games: it cost £3,000 (\$3,900) per cubic metre. Cleaning China's 250,000 square kilo-

metres to the depth of one metre to the same squeaky-clean standard would in theory cost \$1,000 trillion—more than all the wealth in the world. Even a less thorough clean up would cost more than China could afford.

Instead, the country has piecemeal projects. It has tested a method of using chemicals to fix heavy metals in the soil but the results have been disappointing. Researchers also worry about controlling pollution by adding more chemicals. To reduce rice contamination, plant scientists have bred a hybrid variety that absorbs less cadmium. Mr Tang was offered some but rejected it because the yield was low.

The Chinese have experimented with growing willow trees, which absorb cadmium, and poplars, which do the same for lead, to clean up its fields. This works—but the fields cannot be used for crops in the meantime. Typically the treatment of poisoned brownfields consists of spreading layers of clay or concrete over the affected areas, as happened in Changzhou, but this often just pollutes the water table beneath. Gao Shengda, the secretary of the China Environmental Remediation Industry Association, admits that the country lacks the experience and technical skills to stabilise its polluted soils.

Serf and turf

At the end of May Mr Tang's case came to court. The judge found that the pollution was indeed leaking from the industrial site. He admitted the fields were polluted. But he said that Mr Tang had not proved that one had caused the other and threw out the case. Mr Tang has launched an appeal. While he waits, he and his neighbours trudge back daily to their fields to look after the poisoned rice, which is almost ready for harvest. ■



Mr Tang calls for assistance



Indian schools

Now make sure they can study

JAIPUR

More Indians than ever attend school, yet few of them are learning much

ON THE ground floor of a primary school in Jaipur in the state of Rajasthan, five dozen pupils wait for the lunch break. The school has three teachers, but two of them are absent. One is "off sick" and the other, the head teacher, left at noon, explaining that she has "work to do". No child is learning much. Thick poetry textbooks sit open before pupils who struggle to read simple sentences.

Upstairs is different. Rekha Gurjar, an instructor from Pratham, a charity, asks children to come to the blackboard and read a line of text. She asks questions, and hands shoot up. By adjusting the curriculum to a level pupils understand, Pratham's high-intensity "learning camps" help teach basic Hindi and maths in 40 days. "You have to start where children are," says Rishi Rajvanshi, head of the charity's office in Rajasthan, "not where you wish they were."

About 260m children attend school in India, more than in any other country. Enrolment has risen steadily over the past two decades, helped by legislation such as the Right to Education (RTE) Act of 2009, which makes school compulsory up to the age of 14. Attendance at secondary school (69% of eligible children) lags behind that, say, of China (96%). But primary-school enrolment is nearly universal.

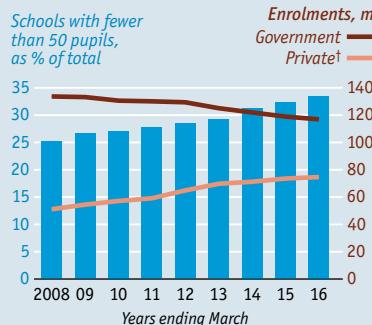
Learning is not. Half of fifth-grade pupils (ten-year-olds) cannot read a story designed for second-graders, according to

Pratham. Just a quarter can do simple division. "Where we have failed miserably is translating schooling into learning," says Yamini Aiyar of the Centre for Policy Research, a think-tank in Delhi.

The consequences of failure are profound, if hard to measure. How well pupils do in school is associated with higher wages and faster economic growth. India will not fully take part in the Programme for International Assessment (PISA), an influential global test, until 2021. But 15-year-olds in the states of Himachal Pradesh and Tamil Nadu did do the test in 2009. A rough analysis of those results puts them five years of schooling behind pupils in Shanghai and other high-performers in East Asia.

The state's shrinking schools

India, elementary schools*



Source: U-DISE *6- to 15-year-olds †Officially registered

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The Indian children are a lot poorer yet poverty explains only part of the gap.

More teachers showing up would help. About a quarter are absent when they should be at work. Pay is not the problem: a public schoolteacher's salary is often more than ten times the local median. Indeed, many Indian applicants bribe school boards to get a job, which they treat as a sinecure rather than a career. Then there are generous allowances for "sick leave", often taken as holiday. Political work is one cause of absenteeism. Teachers can spend several weeks a year urging voters to support their political patron. Their unions are, in effect, guaranteed representation in the upper houses of some state legislatures.

And yet more teachers turning up might not make much difference. India's 17,000 teacher-training institutes are low-grade degree shops. Few trainees are taught how to manage a class. Learning from other teachers is hard, in part because schools are so small. Under RTE, every village must have a primary school within one kilometre. This helps explain why a third of Indian schools have fewer than 50 pupils—and why, as country people migrate to the city, more than 5,000 schools have no pupils at all. With 35% more pupils than China, India has four times more schools.

By law, pupils are automatically shoved up to the next grade each year. So teachers have little incentive to help them grasp the curriculum. A study in 2016 suggests that the knowledge of sixth-grade pupils in a poor area of Delhi is $2\frac{1}{2}$ grades below what the maths syllabus expects of them. By ninth grade the gap is $4\frac{1}{2}$ grades.

For some, money is the answer. India spends 2.7% of GDP on schools, less than other developing countries, such as Brazil. Two-fifths of schools lack even electricity. But much of the budget is not spent, or is ►

► spent badly. School funding increased by 80% from 2011 to 2015, according to analysis of eight states' budgets by Geeta Kingdon of University College London, yet test scores have fallen. Education in India is a "concurrent" responsibility, shared between federal and state governments. But officials at neither central nor state level are accountable for academic outcomes. Data on student achievement are collected manually, if at all.

Some reformers are trying to improve the public system. A programme in Haryana, established in 2014, has reversed declining literacy in the state through regular assessment and more relevant curricula. In Delhi, the city government has doubled spending on schools and recruited "mentor teachers" to help others teach at the right level. Pratham is running learning camps in 5,000 schools in 19 out of India's 36 states and union territories. Yet although these changes are welcome, their ambitions are limited to helping children grasp just the basics.

Richer parents are opting out of public education: nearly half of urban children and a fifth of rural ones attend private primary schools. From 2010-11 to 2015-16, enrolment in public schools fell by 13m while the number in private establishments rose by more than 17m.

A study published in 2013 found that pupils at low-cost private schools in the south-eastern state of Andhra Pradesh achieved the same scores in maths and Telugu (the local language) as pupils at government-run schools. Yet because private teachers are paid a lot less than public ones, they produced these results for a third of the cost. Privately educated pupils also did slightly better than their peers at public schools in tests in English, Hindi, science and social studies.

Encouraged by such results, reformers are trying to expand and improve private schools. Punjab and Rajasthan, for example, are trying "public-private partnerships" where, like charter schools in America, schools are run by private outfits but are funded by the government. Voucher schemes, meanwhile, have been piloted in Delhi, Uttar Pradesh and Madhya Pradesh, among other places.

Yet there are limits to what such reforms can achieve. Teachers' unions fiercely oppose vouchers. Public-private partnerships are hamstrung by a lack of big operators able to ensure consistency and scale. And even if private schools are better, many are still horrendous.

So some people are looking to technology to transform education. To date, much of India's "ed tech" sector has been in the business of selling software to help rich children pass exams. But schemes such as EkStep, funded by an IT tycoon turned philanthropist, Nandan Nilekani, are trying to improve education for all. EkStep is build-

ing a platform that connects pupils with third parties, including newer software providers aiming squarely at a mass market. It hopes to provide better learning materials, at school or at home. EkStep wants to reach 200m pupils within five years.

Ambition on that scale is needed. But in the end even technological fixes will have to be part of a broader change among Indian policymakers. The government of Narendra Modi, the prime minister, has said it will undertake some reforms. It has suggested amending the law to add commitments about the quality of education. Pra-

kash Javadekar, the minister for human resources, has pledged to increase accountability for outcomes in both public and private schools.

Still, the central government has promised much more than it has delivered. A new strategy for education, due in the next few months, has been subject to delays. Though it should have some sensible ideas, it is unlikely to upset the unions much. That is a shame. And with more than 20m Indians reaching school age every year, such caution amounts to a huge waste of talent. ■



Pakistan's Khyber Pakhtunkhwa

Emergency treatment

PESHAWAR

A cricketer's party has improved services, but may not hold on to power next year

“THEY are getting away with murder,” says Khalid Masud, director of the Lady Reading Hospital in Peshawar, the largest in a province long racked by insurgency. Dr Khalid was not talking of the Pakistani Taliban or other extremist groups, but of his own doctors. Of the 45 senior consultants at the hospital, many pop in for no more than an hour a day if at all. Then they leave for their private clinics, taking with them those patients who can afford to pay. Patients without money can die before they see a specialist at the 1,750-bed facility. Such is the state of public health care for the 27m residents of Pakistan's mountainous, troubled border region of Khyber Pakhtunkhwa.

Things may be changing, though. A recent law seeks to pin wayward doctors to their official place of work. Only a handful have reappeared at the notorious Lady Reading. But about 60 are back at work at

another Peshawar hospital nearby.

That reform is possible in Khyber Pakhtunkhwa is down to improved security following the army's anti-Taliban campaign in 2014. Better government has helped too. In elections in 2013 the Pakistan Tehreek-e-Insaf (PTI) party of Imran Khan gained control of the province after breaking the national stranglehold of the two traditional rivals, the Pakistan Muslim League-Nawaz (PML-N)—which is in power nationally under the prime minister, Nawaz Sharif—and the Pakistan Peoples Party (PPP), currently the opposition in Islamabad, the capital.

Ahead of an election due to be held in 2018, Pakistanis wonder how far the PTI has fulfilled its promise to do two unusual things: run a clean government, and transform hospitals and schools. The evidence is clear on corruption. Ministers no longer drive about arrogantly in motorcades a dozen vehicles long. The PTI's term has ►

seen little scandal. And the party has ended a free-for-all in which provincial assembly members could appoint friends and family to public-sector jobs (many of the 119,000 teachers could hardly read or write). Federal handouts to the provinces have increased, and in Khyber Pakhtunkhwa money is at last ending up where it is meant to.

The PTI now wants to see locals flocking to use public services. It has certainly made schools more appealing: the party has appointed 40,000 more teachers, rebuilt institutions blown up by the Taliban and furnished others with toilets and electricity. Teacher absenteeism has fallen. But the PTI's claim that about 100,000 students have chosen to switch from private to public schools is based on dodgy data. There are other bones to pick. In 2013 the PTI allowed its coalition partner, the Jamaat-e-Islami, an Islamist group, to remove pictures in textbooks of women without a veil, among other measures.

The diagnosis is less mixed when it comes to health care. The PTI has employed many more medical staff, raising the ratio of doctors per 1,000 people from 0.16 to 0.24. It has also begun, albeit far from smoothly, to roll out a comprehensive health-insurance card for poor families. All this has had an effect. The number of operations in public hospitals has doubled since 2013; inpatient cases have risen by half as much again. Such change comes despite objections from special interests that lose out from reforms. Pharmacists broke the shelves of a new drug dispensary at one Peshawar hospital, so incensed were they by its offering medicine at the wholesale price.

Yet the PTI may struggle to win a second term in 2018. One problem is excessive promises. Mr Khan, who broke into politics after a stellar career as a cricketer, pledged a "tsunami" of change. But it took his inexperienced party two years to get a handle on government, and many of its reforms so far, according to Faisal Bari of LUMS university, need much longer to get entrenched. Some of its more notable improvements are hardly photogenic. It is one thing for people gleefully to take selfies in front of a new flyover in Peshawar, another to do the same in front of new toilets in a rural girls' school.

That Mr Khan himself appears to have lost interest in the province does not help. He aspires to national office and spends much of his time heckling the prime minister, who is under investigation for corruption. The PTI is starting to look more like the established parties. Having long mocked rapid-transit bus lanes, a favourite pork-barrel project of such parties, as a costly distraction from public-sector reform, the PTI is now building one of its own in Peshawar. It is said to be the country's most expensive, per kilometre, yet. ■

Veneration in North Korea

Follow my leader

SEOUL

Old playbook, new propaganda

FEW could hope to rival the engineering feats of Choe Song Chon. One was a device to hoist a 45-tonne red metal flame atop the Juche Tower in Pyongyang, the showpiece capital of North Korea; the pillar, named after the country's chunky state ideology, was built with 25,550 blocks of granite—one for each day to the 70th year of Kim Il Sung, the country's founder and eternal president. Other exploits were the city's May Day Stadium, the world's biggest, and a 22-metre bronze statue of Kim outside his mausoleum.

So it was only fitting that Kim Jong Un, Kim's grandson, who took power in 2011, should send flowers to Mr Choe's funeral on May 28th. Among North Korea's prominent architects, Mr Choe helped build the props to make Pyongyang less a city for people to live in than a gigantic stage upon which to glorify the Kim dynasty.

After American bombs flattened Pyongyang during the Korean war, Kim Il Sung remodelled his capital on Moscow's master plan from the 1930s. Kim died in 1994. His son and successor, Kim Jong Il, penned a witty treatise calling for statues of his father to play "the leading role" in urban planning. Only after Kim Jong Il's own death in 2011 did he too begin to appear in the statuary, starting with him and his father astride mythical horses.

The news, then, that the first big monument to Kim Jong Un would be unveiled in August beside the pristine caldera lake atop the sacred Mount Paektu, on the border with China, caused a stir among re-

gime-watchers—though this one will be dedicated to all three Kims. The Kim family claims ties to Mount Paektu—Kim Jong Il is said to have been born on its snowy slopes (he was actually born in Russia). It follows other fresh attempts at cult consolidation: portraits of the three generations of Kims, each standing on Mount Paektu, have appeared as triptychs in museums. Work on mosaic murals of Mr Kim, to be displayed in each province, is under way. Appearing by himself on such a scale would be a first.

These exercises in idolisation follow an old manual, says Oh Gyeong-sup of the Korea Institute for National Unification in Seoul, South Korea's capital. The most junior Mr Kim made his debut on a postage stamp within days of his father's death. Last October a documentary film on his rule was first broadcast. New twin statues of Kim Il Sung and Kim Jong Il across the country emphasise his lineage. Unlike his grandfather, the young Mr Kim has no anti-Japanese revolutionary exploits to advertise—not, like his father, any birth myth.

Instead, he emulated his grandfather early on, from suit to hairstyle. State media often present him as the "father of the people". In February Moranbong, a state-approved all-girl rock band that was formed in 2012, released a hit entitled: "We Call Him Father".

Mr Kim is now making his youth part of his appeal too, says Tatiana Gabroussenko, an expert on the North's propaganda. His pet architectural projects, such as water parks and department stores, are aimed at the growing middle class. Nowhere is his message of material progress clearer than in the capital, an unending building site. In April Mr Kim cut the ribbon for the opening of Ryomyong Street, a cluster of new high-rise apartments, shops, restaurants and pharmacies. He, rather than its architects, is portrayed as the mastermind behind its design—just as his father was for the Juche Tower. ■



No one cuts ribbons more brilliantly than Kim Jong Un

Cambodian elections

The grip starts to slip

PHNOM PENH

A strong showing for the opposition in local elections

THE day after Cambodia held its five-yearly local elections, both sides could claim some kind of victory. The ruling Cambodian People's Party (CPP) celebrated because, according to preliminary results—which both sides appear to accept—it won 1,162 of the country's 1,646 communes. But the opposition Cambodia National Rescue Party (CNRP) did remarkably well, increasing the communes it will now control more than tenfold, from 40 to 471. Unofficial totals suggest that it won 46% of the popular vote, up from the 30% the opposition won in 2012. The CPP eked out a slim majority with 51%. Voter turnout was an impressive 89.5%. Final results will not be released until June 25th.

As a general election looms next year, the results have given cheer to the CNRP. Yim Sovann, a party spokesman, notes that in the past the opposition's share of the vote in national elections outpaced its local showing by 15 percentage points. On that pattern, he says the CNRP—formed when two opposition parties merged and appeared on the ballot in 2013—should get three-fifths of the votes in 2018, winning power for the first time.

Yet hang on. Even if the opposition wins, the CPP may not cede power. Hun Sen, the country's strongman, has been in charge since 1985, making him one of the longest-serving leaders in the world. The CNRP believes that the ruling party rigged the 2013 election, in which the CNRP appeared to fare well. Since then Mr Hun Sen has led a broad crackdown on dissent and civil society. Opposition parliamentarians have been beaten. One critic, Kem Ley, was murdered (a crime Mr Hun Sen condemned).

Though the election itself was largely peaceful, during the campaign Mr Hun Sen threatened to "eliminate 100 or 200 people", and warned that "war will happen" if his party loses. His defence minister threatened to "smash the teeth" of protesters. Naly Pilorge, who heads LICADHO, a Cambodian human-rights watchdog, alleges that soldiers were trucked out to vote in contested rural communes, village chiefs told people whom to vote for, and some polling stations barred observers and counted ballots behind closed doors.

Much now rests on how the CNRP handles its new influence. The party pursued a risky strategy: Kem Sokha, its boss, vowed to boost commune budgets from the current average of \$57,000 a year to \$500,000,

Press freedom in Japan

Bristling with indignation

TOKYO

A government that leans on the media takes offence at being scolded

IF YOU had to pick someone to ruffle feathers, it would hardly be David Kaye, the UN special rapporteur for freedom of expression. A soft-spoken American law professor, Mr Kaye has prodded Japan to address concerns about the independence of its media. His report, which he presents to the UN's Human Rights Council this month, triggered a peppery riposte from the hurriedly created Academics' Alliance for Correcting Groundless Criticisms of Japan, a group of uptight university professors. Mr Kaye's alarm should be directed toward his own country, they fumed.

The official reaction was scarcely more measured. Sanae Takaichi, the communications minister and no liberal, declined to meet the rapporteur. Koichi Hagiuda, the deputy chief cabinet secretary, said Mr Kaye's findings were based on "hearsay". Just before Mr Kaye arrived in Tokyo to brief the government, a draft of his report was leaked to the *Sankei Shimbun*, an ultra-conservative newspaper.

per. It took offence at this finger-wagging by a foreigner.

Most governments give short shrift to rapporteurs, politely listening before ignoring their recommendations, which in any case are non-binding. But Japan bristles. A letter last month by Joseph Cannataci, a UN-commissioned expert on the right to privacy, questioned the merits of a new bill to guard against conspiracies, supposedly needed in the fight against terrorism; that sparked a blistering row. Mr Cannataci's assessment was "extremely unbalanced", said Shinzo Abe, the prime minister, and "hardly that of an objective expert". Two years ago the government angrily challenged a rapporteur's claim of widespread amateur prostitution among Japanese schoolgirls keen to have money for branded goods. A year earlier it rejected UN censure of its stingy system for asylum-seekers.

Japan's inability to rise above such slights smacks of a national inferiority complex, says Kaori Hayashi of the University of Tokyo. The government insists that foreigners are ignorant of how things work in Japan but is hopeless at explaining why the country is uniquely different, she says. It still smarts about a UN report in 1996 that condemned Japan's wartime military brothels. Radhika Coomaraswamy, a special rapporteur on violence against women, called for an apology and compensation for women herded into those brothels. Japan has repeatedly tried to have the report pulled, without success.

Tension is inevitable in the relationship between governments and rapporteurs, Mr Kaye insists. The mistake, he says, is assuming that reports are hostile rather than opportunities for public debate. The 46 professors who signed the statement accusing him of "unfair and biased views" preferred to shoot from the sidelines. If they felt so strongly, he says, why didn't they meet him face-to-face?



equivalent to around a fifth of the national budget. Yet the CPP controls that budget. Mr Yim Sovann gingerly describes this arrangement as "linking campaign promises to national elections"—in other words, trusting voters to understand that the pledge will be fulfilled only if the CNRP wins next year.

That may prove challenging. A small party allied with Mr Hun Sen has already vowed to open communal offices "to pro-

vide consultation to people to demonstrate" against communal leaders who fail to carry out their campaign promises.

Mr Hun Sen's star may be fading, particularly among young Cambodians sick of one-party rule. But do not expect him to go gently into that good night. "We're glad nothing violent happened on election day," says Ms Pilorge. There was a lot of intimidation beforehand, however, she says; and she expects a lot more in future. ■



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For daily analysis and debate on China, visit
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Chinese politics

Xi's nerve centre

BEIJING

The president wields power through a growing network of shadowy committees

DONALD RUMSFELD, a former American defence secretary, once delighted policy wonks everywhere by distinguishing between “known unknowns”—things we know we don’t know—and “unknown unknowns”. China’s political system is a known unknown. We know about the Communist Party and government but not much about how their leaders interact.

China’s system of government also contains something which is closer to an unknown unknown. This is the role of “leading small groups” (*lingdao xiaozu*): shadowy committees that often eclipse the power of more public political structures. For years, it was not even known how many there were, how often they met, who was in them or what they did. The situation is hardly clearer today. But research conducted by a Chinese scholar and two analysts at a German think-tank called the Mercator Institute for China Studies (MERICS) provides fresh insight into the groups and their make-up. It suggests that Xi Jinping, the country’s president, is using them in a new way.

Officially, the role of leading groups is to co-ordinate the work of the party and the government that serves it. Every country needs to keep the bits of its ruling system together; the bigger the system, the more it needs co-ordinating. China’s twin-engined arrangement is unusually extensive, so leading small groups have been an impor-

tant feature of its politics since 1958, when the first one was set up.

Such committees can get out of control. The Cultural Revolution small group, created in 1966 and later run by Madame Mao, almost took over the country at one point. They also tend to proliferate and have to be cut back. According to Alice Miller of Stanford University, there were 44 groups in 1981, 19 in 1998 and 29 in 2009. They cover everything from Taiwan and Hong Kong to internet security, the legal system and “preserving stability”. Some provinces have their own small groups. Guangdong, in the south, for example, has one to promote manufacturing.

Zhou Wang of Nankai University in Tianjin says there are three kinds of group. The most important type formulates policy, such as the one for foreign affairs. Most of these date from the 1950s; they conduct research before big decisions are taken. Next is the sort that has a specific task and that will, in theory, cease functioning when the task is complete. Examples include groups dealing with the Three Gorges Dam (full operation of which began in 2012) or poverty alleviation (Mr Xi has set a target of eradicating extreme poverty by 2020). Last, there are short-term groups to deal with emergencies.

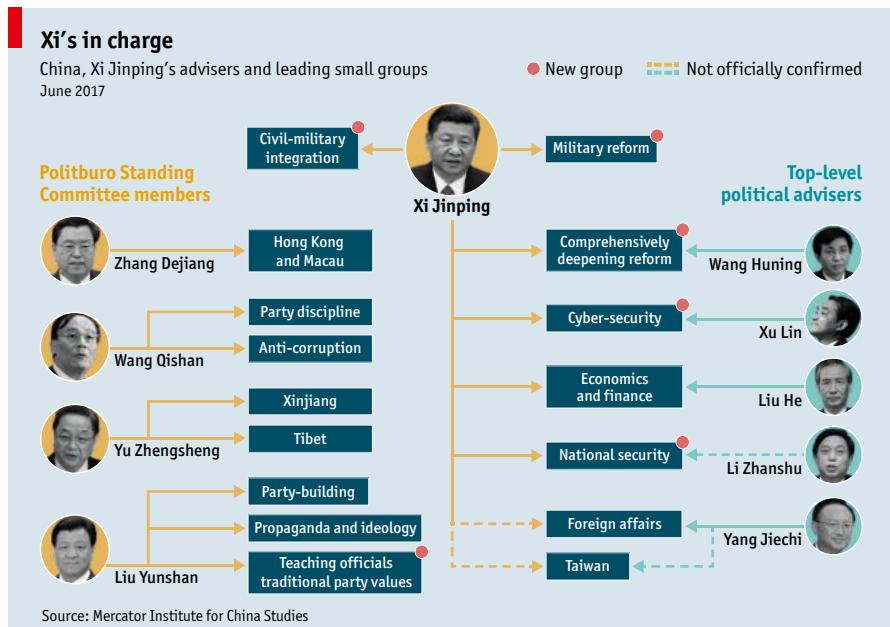
Under Mr Xi, the number of groups has risen. According to Jessica Batke and Matthias Stepan of MERICS, there were 45 lead-

ing small groups in May 2017. No fewer than 16 of them were set up by the president, even though, two years before he took over in 2012, the party issued guidelines saying there should be fewer new bodies. The president’s main innovation, though, has been to create what might be called supergroups. The most important is called the Leading Small Group for Comprehensively Deepening Reform (Mr Xi presided over its 35th plenary meeting on May 23rd; officials up and down the country have been holding meetings ever since to study its host of pronouncements). A sign of this supergroup’s status is that, unlike other groups, it has a network of its own, with subgroups in every province. It even has sub-subgroups in counties, two levels of administration down.

The reform group does more than assist co-ordination. It has a permanent secretariat (most others borrow officials on an ad hoc basis). It writes many of Mr Xi’s speeches and drafts party documents. The group seems to play a central role in formulating economic policy. It was involved, for example, in every stage of drafting the current five-year plan, which is supposed to guide China’s development until 2020.

The Peking order

Mr Xi uses such groups to advance his own authority. In the party’s pecking order, the body with the highest prestige is the Standing Committee of the Politburo. Its seven members were chosen five years ago, at the same time as Mr Xi was picked as leader: he was not in charge of selecting them. In contrast the small groups are packed with people who have worked with the president for years. MERICS believes that Li Zhanshu, the director of the party’s general office (ie, secretariat) and an ally of the president, leads a subgroup of ►



► the reform body and that he also serves on a new group overseeing national security. Liu He, Mr Xi's chief economic adviser, is the head of another reform subgroup and serves on the small group on finance. And so on (see chart).

By stacking the committees with his allies, Mr Xi has diluted the power of the Standing Committee's other members; they have to be mindful of their boss's proxy presence in the small groups they lead. The reform supergroup in effect usurps the authority of the prime minister, Li Keqiang, who is supposed to be in

charge of the economy (he is a deputy leader of the group, which Mr Xi chairs). Another supergroup, the national security commission, which Mr Xi set up in 2013 with himself as its chairman, ensures that he has the final say on such matters.

It is not clear whether Mr Xi will need to rely so much on these groups after a party congress which is due to be held later this year: the five-yearly meeting is expected to boost his power. But leading groups have long been a secretive part of an opaque political system. They have become central to the way Mr Xi governs China. ■

Media

All that's fit to print

Two bitter fights put the spotlight on an influential magazine

CHINESE media are not known for stirring up trouble. Their coverage of politics is almost uniformly tame. Business coverage is sometimes harder-hitting, but journalists still shy away from taking on powerful companies. One exception is *Caixin*, a financial magazine. It has a reputation for well-reported exposés, which have earned its editor, Hu Shuli, the widely used moniker of China's "most dangerous woman". Over the years she has made plenty of enemies. But until recently, she had never faced two prominent foes in public at the same time.

The first is Anbang, which in recent years has grown at warp speed to become one of China's biggest insurers. *Caixin* has published three separate cover articles

since 2014 examining the company's success. Like many analysts, it has pointed to the risks involved in Anbang's reliance on the sale of short-term insurance products to fund its long-term investments. The magazine has also raised questions about the company's shareholding structure. More explosively, *Caixin* wrote in its May 1st issue that Anbang had pretended to have more capital than it had—an allegation denied by Anbang.

Anbang has gone on the offensive since the publication of this latest article. It has released three statements, challenging details in the various reports and vowing to sue *Caixin* for reputational damage. It has also directed allegations of its own at Ms Hu: Anbang claimed that it was only after it

refused to buy advertisements in *Caixin* that the magazine turned on it. *Caixin*, which stands by its reporting and says it maintains a firewall between its newsroom and its commercial operations, has threatened Anbang with a lawsuit.

Caixin's second fight is with Guo Wengui, a billionaire living in self-imposed exile in America. Mr Guo has made headlines over the past few months with tweets and interviews laying out accusations of high-level corruption in China. Mr Guo has himself been ensnared in a graft inquiry: in April China asked Interpol to issue a global notice for his arrest.

Mr Guo has reserved special venom for Ms Hu. Mr Guo's troubles were widely reported in China in 2015 after a rupture with his business partner—but nowhere in as much detail as in *Caixin*, which documented his alleged business dealings and political connections. Mr Guo hit back by accusing *Caixin* of blackmail and adding the outlandish claim that Ms Hu, 64, had a child with his former business partner. *Caixin* and Ms Hu deny all allegations and are suing Mr Guo for libel.

One possible conclusion from all this is that *Caixin* is the rarest of things in China: a courageous media outlet, pursuing the truth in the face of intimidation. No evidence has been presented to support the allegations that it tried to extort cash for positive coverage. Less scrupulous Chinese journalists have done that, but Ms Hu and her team have won influence thanks in part to their reputation for being clean.

Nevertheless, there is also the cynical view of *Caixin's* critics that it is a pawn in a power war, going after select companies. In one statement Anbang accused Ms Hu of serving an unnamed "interest group". Mr Guo, less restrained, has named Wang Qishan, the official leading China's battle against corruption, as the force behind *Caixin*. But the notion that Chinese leaders need *Caixin* as a weapon stretches credulity. Mr Wang is more than capable of taking down businessmen such as Mr Guo without the help of journalists.

Strictly speaking, it is true that a powerful entity stands behind *Caixin*. Like all media outlets in China, its right to publish is conferred by having a "supervisory institution" as a formal backer (*Caixin's* is an official publishing house controlled by an advisory body to the national parliament).

It is also true that *Caixin* picks its targets, refraining, for instance, from digging into the wealth of senior leaders—a red line that Chinese media dare not cross. But it has pieced together stories about corrupt leaders after they have been placed under investigation; most journalists are wary even of doing that. Perhaps the best way of looking at *Caixin* is as a magazine that has mastered the art of the possible within the confines of China. It is dogged in its reporting but also pragmatic. ■

Banyan | Still shy of the world stage

America is creating a vacuum in global leadership. Does China really want to fill it?



EVEN analysts who make a living predicting a great shift of wealth, power and global leadership from the United States to China never anticipated the speed with which Donald Trump appears to be marginalising his homeland. Last week Mr Trump announced he would pull America out of the Paris accord on climate change. At an annual China-EU summit under way at the time, the president of the European Council, Donald Tusk, declared that China and Europe together would demonstrate "solidarity with future generations and responsibility for the whole planet". Others have gone further: it will be to China that the world will now turn for leadership on the issues that matter.

China appears to have advanced on other fronts. The Shangri-La Dialogue in Singapore, an annual talkfest on security, exists in part to showcase America's commitment to keeping the peace in Asia. Mr Trump's defence secretary, James Mattis, did his best at this year's event over the weekend to reassure Asian friends. Their chief concern is over the South China Sea, which China appears bent on turning into its own lake.

But though Mr Mattis's promises to expand American engagement in Asia were welcome, they did not dispel the perception that America is taken up with North Korea's nuclear threat (see Lexington), at the expense of the rest of the region. And America is run not by Mr Mattis but by an erratic man for whom "America First" may imply wrecking the world order that America itself built out of the ruins of the second world war. Amid doubts about America's commitment to the region, South-East Asian officials proposed that their countries' navies join China's to patrol the South China Sea, in which China has greatly expanded its presence through the construction and military reinforcement of artificial islands. It smacked, to some, of rolling over in the face of Chinese power.

Elsewhere, Chinese leadership seems to move from strength to strength. As *The Economist* went to press, China's own security grouping, the Shanghai Co-operation Organisation (SCO), which includes Russia and four Central Asian states, was preparing to welcome India and Pakistan as new members. Pakistan, an old ally of China's, is a natural inclusion. But India is a rival, so its nod to Chinese might is notable. The SCO's expansion reinforces China's ambitions for its "belt and road" initiative of infrastructure

spending that is intended to tie Asia to Europe, the Middle East and even Africa. Those who worry about Chinese power see the initiative as a gilded instrument of a new Chinese order.

This seeming tilt towards China owes little to its powers of attraction. It is more of a knee-jerk response to events in Washington: if that's what you do, Mr Trump, say those who have prospered under an American-led order, it leaves us with no choice but to turn elsewhere. But admire China's sense of timing. In January, even before Mr Trump's inauguration, China's president, Xi Jinping, speaking before the world's elites in Davos, presented his country as a champion of globalism and open markets.

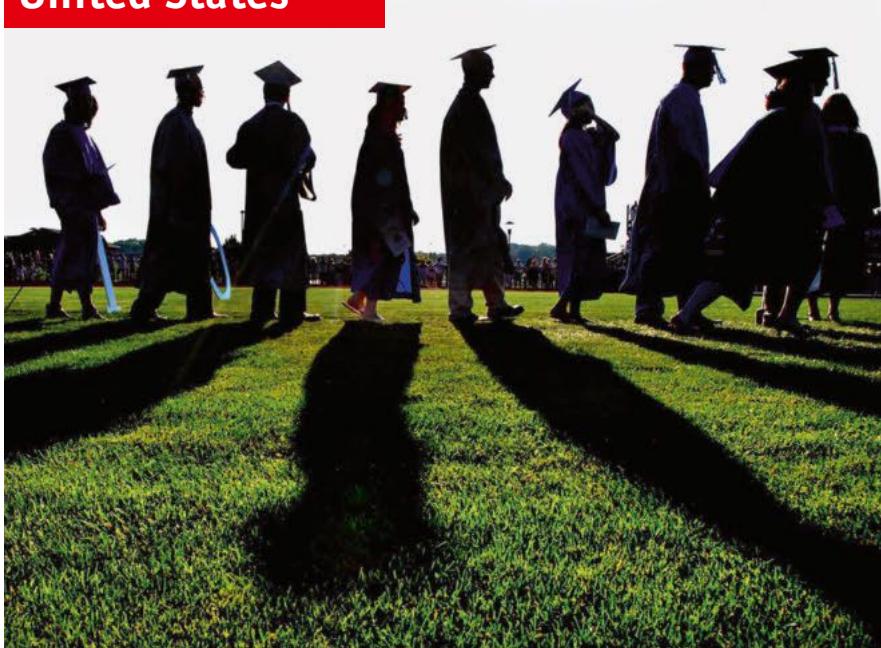
And yet: where China appears to be filling a leadership vacuum, there is often less than meets the eye. Climate change is one example. The world's largest emitter has done much to cut back on its discharge of greenhouse gases, installing more renewable capacity than any other country. Yet its own transparency and accountability over pollution and emissions still falls far short of the openness a world leader on climate change would need to adopt. Meanwhile, common cause between Europe and China has severe limits. As James Kynge of the *Financial Times* says, China's push to cut emissions is motivated by an environmental crisis at home, combined with hopes of conquering world markets for renewable energy. Europe wants to save the planet.

As for economic leadership, the EU-China relationship again reveals the limits. Mr Xi prises open markets, but many of China's own remain closed—and where foreigners may operate, the fear is of technology being stolen. That has led to European frustrations. Anger is growing over China's divide-and-rule tactics in separately wooing 16 poorer central and eastern European countries, using belt-and-road enticements.

With the addition of India and Pakistan, the share of the world's population who are citizens of SCO members will balloon to nearly half. Chinese officials proudly point out that the group will embrace three-fifths of the Eurasian land mass. But managing the newcomers' bickering could absorb China's energies, reducing the forum to little more than a talking shop about terrorism and trade. As for the South China Sea, China has been strangely quiescent since an international tribunal a year ago lambasted its territorial claims in the sea. It has been at pains to get on with neighbours it has disputes with, especially the Philippines and Vietnam.

No such thing as a small matter

Since at least the days of Napoleon, the world has been gasping at the scale of China's potential. China certainly knows how to play to that imagining. And the propaganda directed at its own people emphasises a return to historical importance every second of the day. Yet China is reluctant to push really hard on the outer boundaries of what it might hope to do. Just as it is browbeating neighbours over the South China Sea less than some had predicted, so, for all that it relishes being referred to as a leader in climate change, it is far from keen to take on a leader's responsibilities. And at Shangri-La, China didn't even send any senior leaders, merely what Washington works call "barbarian handlers": lower-level functionaries whose job is merely to parrot their government's line. Being a world leader involves being able to handle criticism on an international stage. China remains very unwilling to risk that. And the reason is simple: fear of how any slip-up might play at home. *Waishi wu xiaoshi*, goes the saying: there is no such thing as a small matter in external affairs. ■



Skilled immigration

Six degrees and separation

NEW YORK

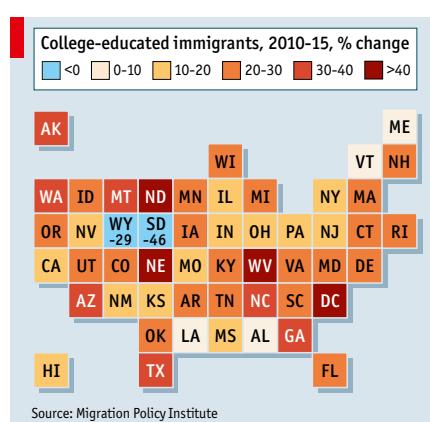
Immigrants are arriving better educated than ever before

JOSÉ ROMMEL UMANO, who is originally from the Philippines, moved to New York last autumn. He came on a family-reunification visa and joined his wife, who had been living in America for some time. This is a typical tale: America gives more weight to close family members when considering immigration applications than some other rich countries do. More surprising is that Mr Rommel Umano arrived with a master's degree from the University of Tokyo and 20 years of experience as an architect in Japan. Yet this, it turns out, is typical too. Nearly half of all immigrants who arrived between 2011 and 2015 were college-educated. This is a level "unheard of" in America, says Jeanne Batalova, co-author of the paper containing the finding published by the Migration Policy Institute (MPI), a think-tank.

One of Donald Trump's many executive orders instructed the Departments of Labour, Justice and Homeland Security to examine immigration rules. The president, whose hostility to illegal migrants is well-known, has also said that he would like to change the criteria for choosing legal ones, pointing to Canada or Australia as models for America to copy. In 1967 Canada became the first country to introduce a points system for immigration; Canada and Australia now both give priority to would-be migrants with degrees, work experience and fluent English (and, in Canada,

French). Some of the president's advisers think this more hard-headed system is better than America's family-centred approach. The doomed immigration bill from 2013 that died in the House of Representatives also reflected widespread enthusiasm for a points-based system.

Two things ought to temper this enthusiasm. First, Canada and Australia have concluded that pure points systems do not work well. A surprisingly high share of the people admitted this way ended up unemployed. Both countries have since changed their immigration criteria so that applicants who have job offers in their pockets may jump the queue. Second, migrants who move to America to join family mem-



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bers have become much better educated.

Of the more than 1m new green-card holders (or permanent residents) in 2015, the most recent year with numbers available, almost half were immediate relatives of citizens. A further 20% entered through preferences given to other family members. That left just 14% who were sponsored by companies, about the same share who first entered the country as refugees or asylum-seekers (a further 5% were lottery winners). Despite this bias towards families, the share of immigrants who arrived with degrees has risen from 27%, for those who arrived between 1986 and 1990, to almost half now.

America is not the only rich country to have seen such an increase. According to the OECD (a club of mostly wealthy countries), the number of college-educated migrants heading to member countries grew by 70% between 2001 and 2011. Recent migrants to America are as likely to be highly educated as those who move to Europe are. They still lag some way behind Australia and Canada, though.

The result is that America has switched from importing people who are, on average, less educated than the natives to people who are better schooled. Most states gained in college-educated immigrant populations between 2010 and 2015 (see map). Immigrants were more educated than Americans in 26 states. “This shift has gone unnoticed by the broader population and policymakers,” says Ms Batalova of the MPI. Many people have an outdated notion of who immigrants are, conflating them with the undocumented. The number of undocumented migrants has been falling, but even they are more likely to have a degree these days: the MPI reckons that a fifth of graduate immigrants are undocumented. Nearly a third of refugees

▶ have at least one degree.

One difficulty even educated migrants face on arrival is that employers do not always recognise foreign degrees and experience abroad. Antiquated licensing requirements and regulations also hurt. Upwardly Global, a charity which helps skilled immigrants translate their cvs into American, cites the example of a former Médecins Sans Frontières doctor from Botswana who worked as a waiter until he got help to navigate the system. As for Mr Rommel Umano, despite his years as an architect and two degrees, he had a hard time getting work in his profession in America. Needing money, he took a job loading boxes in a New Jersey warehouse two hours away from his home in the Bronx. The charity polished his cv and put him through mock interviews and in touch with his current employer, a construction firm. There, he says the work is pretty similar to what he was doing in Japan. ■

The FBI

Loyalty schemes

ATLANTA

Evidence from a former FBI boss—and a candidate to replace him

THE hotly anticipated appearance before the Senate Intelligence committee of James Comey, whom Donald Trump fired as the FBI's director last month, was scheduled to begin after *The Economist* went to press on June 8th. But his written statement, released the previous day, offered an explosive preview. In it Mr Comey related how, at a private dinner at the White House on January 27th, Mr Trump ominously advised him that many people wanted his job, explaining: "I need loyalty, I expect loyalty." Mr Comey added the small but telling detail that he received the invitation that very day—in other words, right after Sally Yates, then the acting attorney general, had told the White House that Michael Flynn, then the national-security adviser, was vulnerable to Russian blackmail and had been interviewed by the FBI.

That, in Mr Comey's words, was "a very awkward conversation". So was an encounter in the Oval Office on February 14th—the day after Mr Flynn got the boot. Then, said Mr Comey, the president told him: "I hope you can see your way clear to letting this go, to letting Flynn go." Mr Comey also gave his version of two subsequent phone calls. In one, the president described the investigation into Russian meddling in his election as "a cloud" and "asked what we could do to 'lift the cloud'." In what Mr Comey says was their last talk, Mr Trump is said to have admonished: "I

have been very loyal to you, very loyal". (In a bright spot for Mr Trump, Mr Comey confirmed he told the president he was not personally under investigation.)

Whatever else emerged at the committee hearing, for some of Mr Trump's critics his behaviour, as laid out by Mr Comey, amounts to obstruction of justice. In any event, the statement underscored the extraordinarily sensitive context of another development on June 7th: Mr Trump's announcement of his choice for Mr Comey's replacement. In what those critics saw as a bid to distract attention from the hearing, the president tweeted that he was nominating Christopher Wray, whom he called "a man of impeccable credentials".

In this febrile atmosphere, will others agree? Mr Wray is certainly a more palatable candidate than the various Republican politicians who were once under consideration, some of whom withdrew their names from the process. Many of them would have fuelled accusations that the bureau was in danger of being suborned. Instead Mr Wray is a former federal prosecutor and assistant attorney-general, who worked in the Justice Department during the fall-out from the September 11th attacks; he was also involved in the prosecution of Enron executives. He is currently a partner at King & Spalding, based in Atlanta and Washington, where he had worked before entering public service. (Ms Yates once worked for the same law firm.)

Still, Mr Wray's biography contains a few elements that Democrats will aim to scrutinise at his confirmation, in particular his association with Chris Christie, New Jersey's governor and a close ally of Mr Trump. Mr Wray represented Mr Christie in the matter of the closure of traffic lanes on the George Washington Bridge in 2013;



Christopher Wray, next man up

moreover he has made donations to assorted Republican candidates. Given his background, his path naturally crossed, too, with that of Robert Mueller, a previous boss of the FBI who—in the uproar that followed Mr Comey's firing—was appointed as special counsel to oversee its probe into possible collusion between Russia and the Trump campaign.

Precisely what relationship Mr Wray, as a Trump appointee, might have with Mr Mueller's team remains to be seen. But another detail in Mr Comey's recollections might catch Mr Wray's eye. After that excruciating encounter in the Oval Office, Mr Comey said that he asked Jeff Sessions, the attorney-general, to "prevent any future direct communication" between Mr Trump and him. Mr Sessions—whose relations with the president are also said to have deteriorated, in part because of his own recusal from involvement in Russia-related inquiries—"did not reply." ■

A Republican revolt

Brownback to black

CHICAGO

Has the Kansas experiment failed?

"WE HAVE gone too far to the right and are now swinging back to the centre," says Melissa Rooker, a Republican state representative. Ms Rooker was one of the moderate Republicans who on June 6th joined forces with Democrats in the state house to override a veto by Governor Sam Brownback. The bill in question aims to raise \$1.2 billion over two years by increasing income taxes and repealing a tax exemption for small businesses. In votes only a few hours apart, 49 of the 85 Republican members of the state house and 18 of the state's 31 Republican senators voted against the Republican governor.

The veto override's significance goes far beyond a tussle over the finances of an agrarian midwestern state. Mr Brownback is the poster boy for Laffer-curve enthusiasts who believe that lower taxes always boost growth. His radical business- and income-tax cuts, launched in 2012 and 2013, were a political and economic test of how far conservatives could push supply-side economics. Judging by the state of Kansas, the answer is not as far as they thought.

The selling points of Mr Brownback's tax cuts, explains Duane Goossen, a former Kansas budget director, were that they would spur growth, pay for themselves and make everyone across the socioeconomic spectrum better off. Five years later, none of these promises have come true. Kansas's economic growth has been slug- ➤



Sun sets on Brownback-onomics

► gish at best, the drop in state revenue has been steep and Mr Brownback was only recently toppled from his perch as the nation's most unpopular governor by New Jersey's Chris Christie. "The Kansas experiment did not work," states Mr Gooszen.

Defenders of Mr Brownback argue that Kansas would be doing much better now if he had been able to implement his reforms properly. He cut marginal tax rates (which discourage work and investment), but legislators did not let him close many loopholes to pay for the cuts, which meant that the state's revenue plunged much more than expected. "Kansas increased spending while taxes were cut," fumes Grover Norquist of Americans for Tax Reform, a lobby group. The low-tax crusader points instead to Florida, Arizona, Texas and Indiana to prove that tax cuts done right spur economic growth.

Though a Republican state for years Kansans did not want to move as far right economically and politically as Mr Brownback was trying to push them. Earlier this year almost two-thirds of respondents said in a "Kansas Speaks" survey by Fort Hays State University they felt Kansas was on the "wrong track". At the primary elections in 2016 moderate Republicans ousted many of the conservatives aligned with the governor.

The parliamentary newcomers, who account for about one-third of the Kansas legislature, helped to scupper Mr Brownback's tax agenda. In February lawmakers came within a few votes of overriding the governor's veto of a tax increase that would have raised more than \$1bn to help plug the budget shortfall. In March came another blow when the Kansas Supreme Court ruled that the state's spending on public education was unconstitutionally low. It may not come as a big surprise that the beleaguered governor is reportedly in talks with the Trump administration about a new job. ■

Puerto Rico

Admit one

SAN JUAN

The Commonwealth is poised to cast a symbolic vote for statehood

IN 1952 America granted self-rule to the Caribbean island of Puerto Rico, which it had obtained from Spain in 1898. Last year Congress in effect revoked that autonomy, by creating a control board capable of vetoing any item in Puerto Rico's budget.

The reversal was hardly an act of imperial gluttony. The island had issued \$70bn in debt, far more than its stagnant economy could hope to sustain. But because Puerto Rico is not a state, its public companies could not use the bankruptcy code used by insolvent borrowers like Detroit. That raised the spectre of a chaotic default.

In response, Congress passed a law with a tough trade-off. To obtain a bankruptcy-like proceeding that would shield the wayward island from its creditors, Puerto Rico had to relinquish control of its finances. Nonetheless, the policy bolstered the argument long made by proponents of both statehood and independence: that Puerto Ricans have no right to self-determination. "The creation of the control board took our status as a colony out of the closet," says Ana Rivera Lassén, a leader of the movement opposing the board. "It showed us what we really are."

Puerto Ricans now have the chance to demand a change. On June 11th the territory will hold a referendum on its status. In 2012, the last time islanders voted on the issue, the results were ambiguous. In a two-stage ballot, 54% said they opposed the status quo, and 61% of voters who made a selection picked statehood as their preferred alternative. But since a quarter of voters left the second question blank, just 44% of ballots actually supported statehood.

This time, there will be a single question with three choices: statehood, "current territorial status" and independence. Moreover, thanks to the austerity imposed by the control board—representing some 20% of total public spending by 2019—enthusiasm for the status quo has shrivelled. And because support for independence has always been scant—most Puerto Ricans treasure their American citizenship—many former believers in the Commonwealth now see joining the union as the least-bad option. Recent polls show that 60–70% of respondents expressing an opinion want Puerto Rico to become the 51st state. Moreover, leaders of the two parties opposed to statehood have called for a boycott, all but guaranteeing a robust majority among those that show up to vote.

Even a resounding victory for state-

hood would be mostly symbolic, however. For Puerto Rico to enter the union, Congress needs to pass a law admitting it. Even though the Republican platform of 2016 officially supported Puerto Rican statehood, it would not rush to add two senators and five representatives who would probably lean Democratic.

Moreover, even a future Congress might require another referendum. The Justice Department (DOJ) rejected Puerto Rico's first request for official recognition for the vote, citing concerns with the ballot choices and language. Although the pro-statehood governor, Ricardo Rosselló, modified the options and wording, he did not delay the vote to give the DOJ time to deliver a new verdict. Doing so would have postponed it until after budget cuts, when both he and his cause are likely to be far less popular. Mr Rosselló will not have long to celebrate his side's expected victory before he is saddled with the political costs of the colonial status quo. ■

Opioids and lawsuits

Ohio high

LOS ANGELES

How the pain pills were sold

IN 2016 a coroner's office in Ohio had to store corpses in refrigerated lorries for a week because residents were overdosing on opioids faster than their bodies could be processed. This year has been no better: the coroner borrowed space from a local funeral parlour to stow the dead. Largely because of opioids, Ohio has the third-highest drug-overdose death rate in the country. In a recent survey, four out of ten adults there reported knowing someone who has overdosed on prescription painkillers. Ohio blames opioid manufacturers. On May 31st the state government filed a lawsuit against a group of drug companies, accusing them of exaggerating the effectiveness of opioid painkillers while downplaying the risk of addiction.

Until the 1990s, doctors mostly reserved opioids for acute pain or easing suffering at the end of life. Around the middle of that decade, drug companies began a concerted marketing effort to convince doctors that opioid pills were also safe for treating chronic pain. Since then, addiction and deaths associated with prescription opioids have soared. The state of Mississippi, Santa Ana and Orange Counties in California, and the city of Chicago, among others, have recently filed complaints that similarly condemn drug companies for fuelling the opioid epidemic. The suits paint a startling picture of the companies' mar-

► keting strategies.

In 2014, the five defendants in the Ohio case spent \$168m promoting their products to doctors—twice what they spent in 2000. This allowed the companies to hire droves of sales representatives, who were deployed, as is usual in America, to hobnob with doctors at conferences and visit them in their offices. They doled out coupons for the drugs, as well as branded gifts. Purdue Pharma, one of the largest opioid manufacturers and maker of the popular OxyContin, was perhaps the most creative. When it introduced OxyContin in 1996, the company handed out soft toys in OxyContin t-shirts, branded fishing hats and a 1950s-music CD entitled “Get in the Swing with OxyContin”. An investigation by STAT, a health-news website, found that to convince a doctor with a sweet tooth to begin prescribing the drug, one salesman delivered a box of doughnuts and snack cakes arranged to spell OxyContin to his office.

In a strategy that the Ohio suit calls “borrowing a page from Big Tobacco’s playbook”, the pharmaceutical companies also recruited “key opinion leaders”—doctors and pain-treatment advocates identified as amenable to increasing the use of opioids for chronic pain. The companies paid these people to serve on advisory boards, give talks and hold continuing medical-education classes for other doctors. A report by the Government Accountability Office found that between 1996 and 2002 Purdue Pharma alone financed 20,000 such education programmes.

Most of the marketing practices detailed in the suits are not new, and opioid prescriptions have dropped off since 2011. The fact that local governments are suing now reflects their desperation, says Juliet Sorensen, of Northwestern University’s Pritzker School of Law. She believes that Ohio, Chicago and the others hope for an outcome similar to that in litigation against the tobacco industry. In the 1990s, 46 state attorneys-general sued the country’s largest tobacco companies over their marketing practices. The companies were forced to change their advertising methods and pay the states billions of dollars.

Opioids are more regulated than tobacco was, which could make cases against their manufacturers harder to win. The Food and Drug Administration approved the painkillers and their marketing; convincing a jury that the companies used “deceptive” advertising to increase sales could be hard. But even if the suits fail in court, they may still achieve other goals, says Timothy Lytton, of Georgia State University College of Law. Whereas the immediate aim of many local governments may be to recoup money spent on treating drug-overdose victims and addicts, Mr Lytton believes the ultimate objective of the suits is to force pharmaceutical companies to change their behaviour. ■

Climbing

Rock stars

DALLAS

A series of remarkable feats increases the appeal of a niche sport

MOST people get sweaty palms just staring up at the sheer granite bulk of El Capitan, a spectacular rock formation in California’s Yosemite Valley. Alex Honnold’s stayed dry as he ascended the 3,000-foot (900-metre) vertical wall on June 3rd, jamming his hands in cracks and pulling on edges barely big enough for fingertips.

That is just as well, for Mr Honnold could not afford any slips. He carried no kit other than painfully snug shoes, with soles made of the same sticky rubber that glues Formula 1 race cars to the tarmac, and a bag of gymnasts’ chalk strapped to his waist, to keep his fingers moisture-free. There was no rope to secure him if he fell, as there had been when he repeatedly rehearsed the route. After a four-hour display of sloth-like precision, power and preternatural poise, the 31-year-old safely made the summit, hiked back down to the valley, and phoned his mother. He then squeezed in a workout.

El Capitan had been climbed partnerless before, including by Mr Honnold. But never in the way he has, literally, taken to new heights. In 2011 an episode of “60 Minutes”, a current-affairs show, about his earlier “free solos” drew 17m television viewers. In climbing jargon, “free” means using only rock formations for support, not rope-ladders or other paraphernalia clipped to pre-drilled bolts or wedged in cracks; “solo” signifies dispensing with protection. It is the sport at its purest. In Yosemite, the cradle of American climbing, Mr Honnold has reached its pinnacle. Praise from fellow

climbers was matched only by relief at his safe return.

The exploit marks the latest in a series of milestones for “sport climbing”. This is to clambering up monkey bars what mountaineering is to hiking, a natural human pursuit pushed to extremes. In 2015 two other Americans, Tommy Caldwell and Kevin Jorgeson, made the front page of the *New York Times*, and got a congratulatory tweet from Barack Obama, for establishing a free (but not solo) passage up the Dawn Wall, El Capitan’s blankest stretch, after years of attempts. Last year climbing on artificial walls was included in the line-up for the Tokyo Olympics in 2020, part of a wider effort to rejuvenate the games.

This has cemented climbing’s place in the sporting mainstream, in America and elsewhere. Google invited Mr Jorgeson to give a motivational talk to employees; Mr Honnold can expect similar offers. Climbing gyms have mushroomed around the globe in the past decade, making the pastime safer and more accessible to city dwellers. Millennials, keener on experiences than possessions, have piled in.

Sporty children who may once have pursued gymnastics now often pick climbing instead. Some start as young as five, leading to dizzying leaps in performance. In November Adam Ondra, a wiry 24-year-old Czech regarded as possibly the best climber ever to fondle rock, repeated the scramble up the Dawn Wall, assisted by his father, after just a month of practice.



Alex Honnold rehearsing at El Capitan

Lexington | Clear and present danger

America's message to China: either you stop North Korea building nuclear missiles, or we will



ALL serious governments think, hard, about unthinkable horrors. For America, China and other Asia-Pacific powers, few potential events are as grim to contemplate as a war involving North Korea, or that country's violent collapse.

There are reasons why the world does not seek to topple North Korea's impetuous young leader, Kim Jong Un. For one, his regime—a Stalinist take on a feudal monarchy, funded by mafia-like criminality around the globe—keeps artillery pieces and rocket-launchers aimed at the South's booming capital, Seoul, 35 miles from the border between the two Koreas. To convey the costs of that conflict, American experts recall the grimmest examples of urban destruction in Chechnya, and imagine evacuating millions of civilians from Seoul and its suburbs, under fire.

Chinese leaders have their own nightmare scenario: the chaotic fall of the Kim regime, sending millions of refugees into north-eastern China as a race begins for control of the North's nuclear arsenal. In the medium term, China's government fears a unified, pro-Western Korea on its border. The jumpiest Chinese imagine gum-chewing Marines and American spy stations rising on the Korean banks of the Yalu river, yards from China—despite discreet assurances that America has no intention of enlarging its military footprint in Asia, should Korea peacefully reunify.

Seoul's vulnerability as a hostage city helps to explain why both Republican and Democratic administrations have spent years hoping that diplomacy and economic pressure will dissuade North Korea from building nuclear weapons. To date, these hopes have been in vain. Chinese leaders also fear the destabilising effects of North Korea's weapons programmes, and have signed up for somewhat tighter sanctions. But in their internal hierarchy of horrors, the Kim regime's collapse frightens them more. As a result China has, until now, been willing to consider all forms of sanctions except those painful enough to work.

Chinese officials, who struggle to meet senior North Koreans, continue to insist that they have limited political leverage over the Kim regime. That is sophistry: China has unrivalled economic power over North Korea, including a stranglehold on its energy supplies. China also continues to claim that an anti-missile defence system recently installed by America in South Korea, THAAD, undercuts China's ability to deter external threats. That

is a nonsense to which Americans reply, if you want THAAD gone, deal with North Korean nukes.

Something big has changed. In developing intercontinental ballistic missiles (ICBMs) that could hit American cities, and repeatedly testing them, the Kim regime directly threatens the American homeland. Yet in the upper ranks of the American government there are flickers of optimism, and they concern China. Perhaps its president, Xi Jinping, still fears instability on his border more than a nuclear-armed North Korea—American opinions are divided. But Team Trump is determined to convince Mr Xi that he has his hierarchy of horrors in a muddle. The new message: if China will not act to halt the North Korean missile threat, America will. As a result, it is North Korean ICBMs that threaten the very chaos that leaders in Beijing fear most.

On June 3rd James Mattis, the defence secretary, told the Shangri-La Dialogue, a gathering of Asian government leaders and military brass in Singapore, that North Korea's weapons programmes are a "clear and present danger" to America. Mr Mattis is a figure of rare credibility within the Trump administration, revered by his peers as a "warrior-monk"—a ferocious battlefield commander who carried works of Roman philosophy into combat, and prodded his officers to think hard about the ethics of killing. Still, his audience in Singapore was anxious as he began. Asian governments want to know whether Mr Trump, a man who seems more concerned with interests than values, might do a deal with China, trading help with North Korea for a Chinese sphere of influence. They fear that America will bluster, then look the other way as China builds airstrips and military bases on disputed reefs in the South China Sea. Mr Mattis tried to assure them that no such trade-off exists. He declared that America will not accept unilateral, coercive moves to change facts on the ground, and accused China of showing "contempt" for neighbours.

Cynics may remain sceptical, believing that Mr Trump is quite capable of a trade involving Chinese reef-grabbing for effective Korean sanctions. The best counter-argument within the American government is that such a binary trade-off would not be clever dealmaking. If possible, it is argued, America should avoid confusing the urgent (curbing North Korea) with the enduring (managing China's long-term rise within a rules-based order).

An appeal to self-interest

Following Dwight Eisenhower's dictum that "If a problem cannot be solved, enlarge it", the Trump administration hopes to engage China on a broader range of interests. There are, for instance, Uighur militants from western China with ties to extremist networks in Afghanistan, a country about which America knows a lot. North Korean cyber-attackers have used China as a base: America calls that an affront to Chinese sovereignty.

Mr Trump's affection for Mr Xi after a meeting at Mar-a-Lago, the American president's Florida country club—"I think I like him a lot, I think he likes me a lot," he said afterwards—may be more conditional than Asian allies fear. Mr Trump is said to feel that he received personal assurances about unprecedented Chinese pressure on North Korea. If disappointed, he has a whole tough-on-China agenda left over from his presidential campaign.

All-out war may be unimaginable. But if North Korea continues to sprint for ICBMs, America's appetite for risk will rise sharply, and military options will gain a harder edge. China has for too long tolerated North Korean provocations in exchange for stability on its borders. Time to choose. ■



Haiti

A time to sow

DESDUNES, ARTIBONITE VALLEY

A new president has a chance to try out fresh ideas for a country desperately in need of them

SWIVEL, clank, scoop, dump. On the outskirts of Desdunes, a town in Haiti's fertile Artibonite valley, three enormous excavators sink claws into the banks of the muddy Duclos canal. Arching across it, their slender hydraulic arms uproot small trees and drag them through the clay-coloured water as they gouge out mud from the canal bed. They deposit the glistening sludge, mixed with tall grasses, on their side of the channel, forming a neat ridge. Bored-looking policemen lounge in the shade of palm trees, ostensibly to deter thieves from stealing the machines' batteries. Blue-grey herons stand to attention; cows and horses graze. Ahead of the excavators, the canal is a mere incision through the fens. Behind lies the result of their work: the canal looks wide enough to accommodate a battleship. Naked boys dive in, seeking respite from the Caribbean sun.

The Artibonite is Haiti's rice basket, capable of producing enough grain for the whole country. The rice grows in standing water, which requires irrigation and drainage. By 2015, marshes had colonised so much of the canal that its waters had stopped flowing. The fields surrounding Desdunes have since lain fallow, costing farmers four harvests. "Whenever people see these excavators, they start dancing," says Samson Demosthene, the crew's pot-bellied foreman. "Nothing makes them happier." When the work is done, the val-

ley will come back to life.

The dredging fulfils a promise by Jovenel Moïse, Haiti's president since February, who has vowed to make rural areas more productive. That he is actually trying to keep this promise is startling in a country notorious for bad government. Haiti's long-run economic record is atrocious. In countries that were as poor as Haiti in 1981, GDP per person rose by half on average by 2012; in Haiti it dropped by 40%. After an earthquake in 2010 that killed more than 200,000 people and cost 120% of GDP, foreign governments and NGOs donated \$10bn, about 150% of GDP. But donor fatigue has set in and aid has dwindled to the flow rate of the unexcavated Duclos canal. Even the hurricane that devastated Haiti's south-western peninsula in October brought only a drizzle of money.

Haiti has not emerged from the shadow of the earthquake: amputees are disconcertingly common on the streets of Port-au-Prince, the squalid, chaotic capital; 50,000 people remain in tent cities. Mr Moïse governs from the rump of the presidential palace, whose stately central dome collapsed and has not yet been rebuilt. Nonetheless, he is the first president since 2010 who can move beyond a single-minded focus on reconstruction to devise a new long-term development strategy for the poorest country in the Americas. "I have to deliver results so that people understand that politics is

relevant to their lives," he says.

Mr Moïse ran in a protracted election beginning in 2015 as the candidate of the Shaved-Head Party, so named because both he and the previous president, Michel Martelly, sport gleaming pates. Mr Martelly's pre-presidential career was as a *compas* singer known as Sweet Micky. His political heir has an earthier moniker, Banana Man; he is a planter from Haiti's remote north-western peninsula. After leading in the first round of a presidential election, Mr Moïse waited over a year to take office because the electoral commission ruled the ballot invalid owing to accusations of fraud. In the re-run last November, in which just a fifth of the electorate participated, he was elected with 56% of the vote, buoyed by support from the hinterlands.

A new crop of ideas

So far, he has focused on what he knows best: the needs of the countryside. "We have to feed the people first," he says. "That's why agriculture is my priority." But growing more rice and bananas will not lift Haiti out of poverty. Mr Moïse is casting about for new ideas in a country where few policies have worked as intended.

One source of fresh thinking bore fruit just after he took office. The Copenhagen Consensus Centre (ccc), an NGO, completed a study of potential policies in Haiti. With C\$2.5m (\$1.9m) from the Canadian government, the ccc commissioned dozens of experts to score and rank a wide range of proposed initiatives by their return on investment. After a year of research, the ccc presented its findings to Mr Moïse in Port-au-Prince last month.

It has detractors. Its founder, Bjorn Lomborg, irks climate-change activists by arguing that some efforts to reduce carbon emissions are a waste of money (though he ➤

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▶ favours a carbon tax). Some critics accuse him of using shoddy statistics, a charge he vigorously disputes. He is not responsible for the calculations that landed on Mr Moïse's desk, which are the work of independent economists.

The ccc's call for "prioritisation"—concentrating on policies that offer the biggest bang for the buck—should be well-suited to poor places like Haiti. It promises to guide governments with cold-hearted maths, no matter how unsettling the results might be. For example, among Haiti's woes is a cholera epidemic that was brought by UN peacekeepers in 2010 and has killed more than 10,000 people. It might seem wise to vaccinate the entire country. But Dale Whittington of the University of North Carolina at Chapel Hill found that delivering the full two doses of the vaccine to every Haitian would be both prohibitively expensive and of limited value, since the disease has trouble spreading once a minimum share of the population is resistant. He found that the highest return—a social "benefit-to-cost ratio" (BCR) of 5.9 to one—came from delivering a single dose to schoolchildren, whom the government can easily reach, and counting on the resulting "herd immunity" effects to reduce the spread of cholera.

In practice, such calculations are sensitive to researchers' choices and the quality of their evidence. Studies that incorporate estimates of positive knock-on effects or ignore negative ones yield higher BCRs than those that do not. The ccc's models tend to give generous scores to health projects, whose benefits are measured in "disability-adjusted life-years", and disappointing ones to the agricultural initiatives dear to Mr Moïse, whose benefits were simply assessed on the cash value of a crop.

However, raising the productivity of subsistence farming, as in the Artibonite valley, will also improve nutrition, an effect that some of the ccc's studies do not measure. And investments in health and education, particularly for children, may provide less value to a country than their BCRs would indicate if the beneficiaries emigrate as adults because they cannot find jobs. A full accounting of such interactions could significantly change the rankings. Similarly, distinguishing causation from correlation in social policy is an inexact science. All but one of the 85 evaluations in the ccc's report were either not based on randomised controlled trials (RCTs), the only way to prove that a policy under consideration will work, or sought to translate RCTs from other countries to the unique environment of Haiti.

Imperfect information is better than no information, the ccc argues. "What's important is not whether the BCR is [precisely] 2.3 or 0.9," says Brad Wong, its chief economist; the differences between the top and bottom of the rankings are big

enough to judge which policies are worthwhile. The policies the ccc endorsed most heartily do enjoy widespread support—and Mr Moïse is listening.

The highest BCR comes from fortifying wheat flour with iron and folic acid, which would prevent 150 infant deaths and 250,000 cases of anaemia a year for a trivial overall cost of \$5m (see chart). This practice is standard even in poor countries. Jamie Marks, who runs Les Moulins d'Haiti, a big flour producer, says his firm could add the micronutrients within months of the government specifying a formula. Mr Moïse said he found the value of wheat fortification the most surprising of the ccc's findings, and promised to require it within half a year. That alone could justify the cost of the ccc's research.

Another priority is training first responders. Haiti is prone to natural disasters: it has suffered four times as many as the neighbouring Dominican Republic relative to its area. Deforestation makes the country vulnerable to floods, and unregulated house-building in vulnerable areas makes them devastating. It would cost just over \$1m to provide first-aid instruction to volunteers across the country, which the ccc estimates would save 700 lives a year. Ensuring that they have access to vehicles and equipment would be more expensive, but valuable. Brazil, Venezuela and Cuba have donated nearly 100 ambulances to Haiti, but the government has not maintained them or equipped them with oxygen tanks and defibrillators. "They're like ghost ambulances," says Jean-Pierre Guiateau, the head of the Haitian Red Cross.

Easy wins like first-aid instruction are small-scale. Another recommendation would be transformative and far harder to achieve: reforming Electricité d'Haiti

(EDH), the creaking national power company. Expensive and unreliable electricity is one of the biggest obstacles to development. Consumption per person is a paltry 2% of the level in the Dominican Republic; the price is almost double. EDH only manages to charge for 30% of the power it generates. The rest is either stolen or lost to technical faults. Blackouts can last up to 15 hours. To keep the lights on intermittently, the government spends 10% of its budget to buy power for EDH generated at exorbitant prices by local firms.

Mr Moïse acknowledges that "there will not be any development without energy reform." He wants to replace EDH's costly contracts to buy electricity with public-private partnerships, which would be a step in the right direction. But implementing reform would require confronting EDH's powerful suppliers. Mr Martelly tried and failed. Such obstacles highlight the limits of the ccc's approach: no matter how good an investment may look, making it work requires competent government. The ccc did not calculate a payoff from developing better governance; its costs and benefits are hard to estimate. But its absence is modern Haiti's original sin.

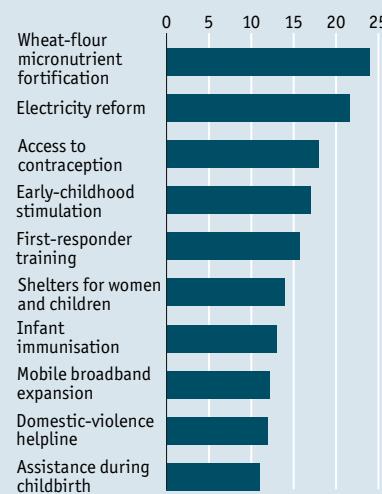
A sorry state

In a report published in 2015, the World Bank asked, "What makes Haiti Haiti?" Its first answer was succinct: "a social contract is missing between the state and its citizens." Since the dictator Jean-Claude Duvalier was overthrown in 1986, Haiti has had 18 changes of leadership, of which few were peaceful, democratic and undisputed. A small business elite has supported fragile governments in exchange for low taxes and oligopolistic control of key industries, keeping the economy uncompetitive and obliging the government to finance itself through regressive taxes on imports. Perennially short both of cash and professional civil servants, the state has failed to provide infrastructure, the rule of law and services such as health and education. The earthquake made the weak state even weaker, killing many civil servants and destroying their records. Most Haitians who have escaped poverty have done so by emigrating. Many of those who stay resort to crime. Violent protests are common, sometimes toppling presidents and starting the vicious cycle anew.

Mr Moïse agrees that a weak state is the main explanation for Haiti's 200-year-old poverty trap. To correct that, he says, Haiti needs political stability first of all. He wants to leave the country's "democratic apprenticeship" behind by enacting constitutional reforms to hold more elections at the same time. Currently, presidents, senators and lower-house deputies are elected on different cycles. Perhaps more contentiously, Mr Moïse would replace the cumbersome semi-presidential system,

A new breed of league table

Haiti, benefit-to-cost ratio per \$ of investment
Highest ranked programmes, 2017



Source: Copenhagen Consensus Centre

► which includes a prime minister, with a purely presidential one. He has plans to reform the civil service; he would replace ageing bureaucrats with energetic younger ones and set up a new training school. He is trying to improve the business climate, for example with legislation to cut the number of days needed to start a company from 97 to 30 and to allow employers to extend the work day by using shift labourers.

Some enterprises, unwilling to wait for a functional state, are taking matters into their own hands. Donald Trump's withdrawal from the proposed Trans-Pacific Partnership trade agreement provides a

business opportunity: Haiti's textiles will continue to enjoy privileged access to the United States. Investors from places like Taiwan are moving in. At Lafito, an industrial development 20km (12 miles) up the glimmering turquoise coast from Port-au-Prince, a consortium led by GB Group, a local conglomerate, is building a \$1bn state-within-a-state, with a 25MW power plant, a data centre for speedy internet access, a reservoir and desalination plant, and a container port. Eventually it will include housing and a teaching hospital.

So far, one of Mr Marks's flour mills and a cement plant are the only operations. But

Georges Sassine, who runs Lafito, says producers of apparel and motorcycles have more demand for factory space than he can accommodate. "The whole idea is to have Haiti itself not create problems," he says, gesturing towards squatters' homes on hillsides nearby.

In the Artibonite valley there is a bit more faith. The dredging of the Duclos canal has shown that the state can contribute to prosperity after all. Now farmers need ploughs and trowels, good seeds, access to credit and crop-storage facilities, say the leaders of a local farmers' association. Banana Man still has much to do. ■

Bello | The bogeyman of Mexico

Next year's presidential election will once again pit AMLO against tactical voting

IN RECENT months the fluctuation of the Mexican peso against the dollar has resembled an electrocardiogram during a panic attack. The currency fell some 15% after the victory of Donald Trump, who promised to scrap the North American Free-Trade Agreement (NAFTA) linking Mexico, the United States and Canada. The peso has since recovered, on mounting hopes that Mr Trump's administration will recognise the mutual benefit in NAFTA. But there is another nightmare troubling the currency markets: the notion that Andrés Manuel López Obrador, a left-wing populist who in some ways resembles Mr Trump, will win a presidential election a year from now.

After wobbling in May when polls suggested that Mr López Obrador's candidate might win the governorship of the State of Mexico, the biggest of four states to hold elections on June 4th, the peso gained 2.5% when preliminary results signalled a narrow victory for the ruling Institutional Revolutionary Party (PRI) of President Enrique Peña Nieto. That relief may be misplaced. Though final results may take weeks, overall the outcome gave Mr López Obrador, whom Mexicans refer to as AMLO, cause for cheer.

In the State of Mexico, which contains 13% of the national electorate and was once governed by Mr Peña, AMLO's candidate, Delfina Gómez, a teacher, gained 31% of the vote. The PRI won, with 34%, in a state it had never lost, but its vote was down by 28 percentage points compared with the last election in 2011. It clung on, according to its opponents and some analysts, only by large-scale vote-buying.

Mr López Obrador has thus reminded Mexicans that he remains a uniquely potent challenger. He has acquired a loyal following among poorer voters, especially in the centre and south, by railing



against a corrupt political system and a chronically mediocre economy, and by promising to review NAFTA and reverse the globalising economic policies Mexico has adopted in the past 30 years.

But he also gets in his own way. His messianism and unsubstantiated cries of fraud in past elections alienated former sympathisers in the middle class. After narrowly losing two presidential elections, he split from the centre-left Party of the Democratic Revolution (PRD) because of its support for Mr Peña's modernising reforms. In 2014 he set up the Movement for National Regeneration (Morena), whose sole purpose is to promote its leader.

AMLO heads most opinion polls for the presidential election. That is largely because of the flaws of his rivals. On the one hand, Mr Peña is widely reviled, mainly because of his failure to tackle violent crime and rampant corruption. Defeat in the State of Mexico would have been catastrophic for him; narrow victory there (and possibly in Coahuila, a smaller state) is not enough for him to impose his choice of candidate on his party.

On the other hand, the appeal of the

conservative National Action Party was diminished by the disappointing presidencies of Vicente Fox and Felipe Calderón between 2000 and 2012. Worse, the party is split between the presidential ambitions of Ricardo Anaya, its young general secretary, and Margarita Zavala, Mr Calderón's wife.

Nevertheless, it is far from inevitable that Mr López Obrador will win next year. What was once a three-party system has fragmented. The victor will be the candidate who is best at forging alliances. On that, AMLO has a mixed record. In the State of Mexico, had he struck a deal with his former companions in the PRD (whose candidate won 18%), Morena would have won with ease. But Mr López Obrador "wants subordination, not union", and is seeking "employees, not allies", a PRD leader complained.

Mexico's constitution does not allow for a run-off election. (Many political commentators believe that should be changed, but it probably cannot be in time for next year's contest.) In 2012 Mr Peña won with just 38% of the vote. His successor may need less than 30%. In the absence of a run-off, Mexicans vote tactically. Referring to the State of Mexico, Enrique Ochoa, the PRI's president, thanked "those who voted for us although we weren't their first choice". He went on: "Together we halted the advance of authoritarian populism" and "we will do so again successfully in 2018."

Whether the PRI can be the standard-bearer of such an anti-AMLO coalition next year is questionable. But someone can be. A successful candidate will need not just to argue that "Mexico does not deserve to be Venezuela," as Mr Ochoa put it, but also to present a vision of positive democratic change. Mexico still has a few months to find such a person.



Qatar and Saudi Arabia

A futile family feud

Its neighbours cut off tiny Qatar

TRIBAL feuding among the Al Thanis, Al Khalifas, Al Sabahs and Al Sauds has been the norm for centuries. From their beginnings in Nejd, the barren interior of the Arabian peninsula, they sparred for the best coastal spots from which to launch pirate raids into the Gulf. But even at the height of acrimony, they always observed unwritten rules of refuge and hospitality. When the tribes became states five decades ago, their people still travelled, lived and intermarried across lines in the sand. Their sheikhs might withdraw their ambassadors when tempers flared, but even when King Salman of Saudi Arabia went to war in Yemen in 2015, he let more than a million Yemenis in his kingdom stay.

For Gulf Arabs, the expulsion of Qatariis by Bahrain, the United Arab Emirates (UAE) and Saudi Arabia ordered on June 5th is more shocking than a declaration of war. It has torn up their code of conduct. With two weeks' notice to leave, Saudi husbands fear they might forfeit their livelihoods if they follow their Qatari wives. The queues at Qatar's only land border, with Saudi Arabia, already tail back for miles. The dunes have become barriers, preventing the entry of people and goods, including much of Qatar's food supply. Short-haul tourism has collapsed. The UAE has criminalised any expression of sympathy for Qatar, tweets included. Diplomatic ties have been severed, and air, land and sea links closed by the three neighbours, as well as by Egypt and Yemen.



Protruding like a sore thumb from the Arabian peninsula, tiny Qatar has long bugged its neighbours. But the explanations offered for the sudden, unprecedented closure seem inadequate. Only a fortnight beforehand, the Qatari emir had stood smiling alongside those who have now banished him. In a show of unity, they feted Donald Trump, the American president, in Riyadh. Saudi Arabia blames Qatar's involvement in terrorism, which to those recalling the role Saudi jihadists played on 9/11 sounds rich. Qatar's ties to Iran, too, irk Saudi clerics and kings, particularly the joint and expanding development of South Pars, the world's largest gasfield. But Kuwait and Oman are on similarly good terms with the Islamic Re-

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public, and Dubai, one of the UAE's seven emirates, provided the biggest back door into Iran when the world imposed sanctions on it.

The pretensions of Qatar's ruling Al Thani family to global grandeur have also vexed other rulers. The statelet has sought significance by offering a sanctuary to the Muslim Brotherhood, the Arab world's foremost Islamist movement. Diplomats found in Qatar a place in which to talk to Islamists, including Yousef Qaradawi, the Brotherhood's favourite preacher; Khaled Meshal, until recently the leader of Hamas, the militant Palestinian group; Abbassi Madani from Algeria; and several of the Taliban's leaders. A media empire led by Al Jazeera, a satellite tv channel, has for decades helped Qatar find a mass audience. It offered a platform to dissidents from across the region (except Qatar), giving voice to popular anger which erupted in the Arab spring of 2011. It then goaded revolutionaries to take up arms, and endorsed Islamists who stood in elections. Qatar bankrolled their campaigns and filled their coffers when they took power.

The Arabian peninsula is not big enough, however, to realise all its rulers' ambitions. Rivalries have grown as each struggles to create global shipping hubs, airlines, media arms, expeditionary forces and financial districts. A generation ago the Gulf was led by consensus-builders, whose prime concern was stability. But petrodollars, vast arsenals and Mr Trump's blessing risk turning their descendants into vainglorious autocrats with talents for inflaming, not compromising. Saudi Arabia's young deputy crown prince and de facto ➤

Writer wanted: The Economist is looking for a writer to cover the Arab world, based in Cairo. Candidates should send a CV, a cover letter and a 600-word original article that could run in our Middle East and Africa section to cairocorrespondent@economist.com. Deadline for entries is June 23rd.

► ruler, Muhammad bin Salman, it is said, likes to be called Alexander [the Great]. Their intelligence agents run amok, spreading dirt on each other, true or false. One of the triggers offered for the latest showdown is the revelation in Qatari-owned media of e-mails purportedly hacked from the account of the UAE's ambassador in Washington, Yousef Otaiba.

For now, the Al Thani's have the means to withstand the pressure. The sheikhdom is the world's biggest supplier of liquefied natural gas. Mr Trump might celebrate Qatar's come-uppance in tweets, but he must still consider the roughly 10,000 soldiers stationed there at al-Udeid, America's largest air base in the Middle East (though the Emiratis would prefer he move it their way). Egypt, which has also severed ties, knows that Qatar may retaliate by expelling its workers if it hinders Qatari exports through the Suez canal. Even the UAE worries that Qatar might shut off the gas pipeline supplying its domestic market.

But things can get much nastier. After Saudi Arabia closed Qatar's only land border, Iran offered to make up the shortfall. If Qatar drifts further into Iran's orbit, Gulf officials warn that more "punitive, economic measures" could follow. An attack, claimed by Islamic State, on Tehran's parliament on June 7th has heightened the tension: Iran is blaming Saudi Arabia, though without evidence.

There will be few winners. Airline embargoes harm tourism across all Gulf states, in the eyes of foreigners who cannot tell one sheikhdom from another, just when they are trying to diversify their economies. Investors already unnerved by Yemen's protracted war have further cause to fear Arabian instability. Mr Trump's recent proposal for an Arab NATO looks aborted. Plans for the Gulf Co-operation Council to forge a common foreign and economic policy lie in tatters. If only the world had a superpower focused more on diplomacy and less on selling weapons. ■

had already used travel bans, asset freezes and prosecutions to shut down groups they deemed troublesome. This is self-defeating, say activists. "No one is working with the victims [of human-rights abuses], so they may be easy to radicalise," says Mohamed Zaree of the Cairo Institute for Human Rights Studies. Mr Zaree himself has been charged with taking foreign funds and could face life in prison.

Egypt's vaguely worded laws are purpose-built for repression. NGOs must avoid such crimes as "destabilising national unity". Mr Ali was charged with "violating public morals", while others arrested recently are accused of "misusing social-media platforms". Some members of parliament want to make matters worse by forcing users of Facebook and Twitter to register with the government and further criminalising "insults" against the state.

The clampdown appears aimed at clearing the way for Mr Sisi to win re-election next year. Mr Ali, a former presidential candidate, was mulling another run. If convicted, he would be ineligible. He has little chance of winning anyway, but his campaign might raise issues, such as the islands transfer, that Mr Sisi would rather avoid. The president appears especially vulnerable to criticism over the economy. To clinch a loan from the IMF last year, the government imposed new taxes, raised the price of petrol and floated the Egyptian pound, which caused inflation to spike. "Ordinary people are getting squeezed," says Khaled Dawoud of the Dostour party, another target of the government.

One thing Mr Sisi can apparently count on is the backing of Donald Trump, America's president, who has hosted him at the White House and praised the way he "took control of Egypt". Mr Sisi, in turn, gushes that Mr Trump is "a unique personality that is capable of doing the impossible". Such displays of mutual admiration make ►

Egypt's crackdown

The punishments of Sisi fuss

CAIRO

Donald Trump's "fanatic" friend causes a stir by locking up more dissidents

THE fall of Khaled Ali has been as swift as it has been absurd. Last year Mr Ali filed a lawsuit against the Egyptian government over its plan to return two islands to Saudi Arabia. The deal, which many Egyptians saw as a shameful swap of land for cash, sparked rare protests against Abdel-Fattah al-Sisi, Egypt's president. So when the country's highest court blocked the transfer in January, Mr Ali and his supporters whooped it up outside the courthouse.

On May 23rd the state accused Mr Ali of making an indecent hand gesture during that celebration and, five months after the fact, arrested him. He is one of dozens of opposition figures detained in the past two months on similarly risible charges. The government has also blocked websites, raided homes and hobbled NGOs. Even before all this, Mr Sisi's repression was unprecedented. But with little protest from America or Europe, and with an election coming next year, the president has intensified his suppression of dissent.

The government says it is acting in the name of security. On May 26th gunmen killed 29 Coptic Christians on a bus south of Cairo, the latest in a series of attacks. But the repression is aimed at critics, not terrorists. The authorities have targeted democratic political parties, such as Bread and Freedom, run by Mr Ali, and activists who have criticised Mr Sisi online. Tens of thou-

sands of political prisoners sit in Egypt's jails—so many that the state has had to build 16 new ones. Only China and Turkey lock up more journalists. Yet, still fearful of the press, the government blocked several independent news websites last month.

Mr Sisi has also tightened his grip on NGOs with a new law that gives the government the final say over what they do and how they are funded. The authorities



You can't read all about it

► Egyptian activists nervous. "This is a disaster," says Mr Dawoud. "Sisi feels he has the green light from Trump."

Mr Trump's lack of interest in human rights, made clear at a summit in Saudi Arabia last month, is having effects elsewhere in the region. On May 23rd the authorities in Bahrain, a Shia-majority island that is run by Sunnis, killed five people and arrested 286 more in a raid on the home of a prominent Shia cleric. "The timing of this operation—two days after King Hamad's convivial meeting with President Trump—can hardly be a coincidence," says Nicholas McGeehan of Human Rights Watch, a pressure group. A week later the government banned the country's largest secular opposition group.

Yet autocrats emboldened by Mr Trump's support may not have a completely free hand. Mr Sisi waited months before signing the NGO law, in part due to pressure from American senators such as John McCain and Lindsey Graham. They now hope to make America's aid to Egypt conditional on improvements in human rights and democracy. ■

Al-Qaeda in the Arabian Peninsula

Yemen's other war

MUKALLA

A textbook operation against al-Qaeda now risks turning sour

SAFE behind multiple walls of sandbags at his airbase on Yemen's coast, a United Arab Emirates army commander points at a map of southern Yemen liberally covered in red. It indicates, he says, the reach of al-Qaeda in the Arabian Peninsula (AQAP) in March 2016. A second map, dated six months after his men marched ashore that month, has just a few red blotches left.

In a four-pronged attack, Emirati forces managed in a single day, without loss, to evict AQAP from Mukalla, one of Yemen's main ports and the capital of its largest province, Hadramawt. Soon after, the Emiratis took Zinjibar, a provincial capital 500km (300 miles) west of Mukalla, and Mansoura, its stronghold in Aden, the main southern port. Security at Yemen's gas terminal at Balhaf has been reinforced. "If we had not gone in, al-Qaeda would have held the south, and [Shia militias] the north, and Yemen would have been forever off the rails," says the commander, who is responsible for the UAE's 5,000-odd soldiers in Yemen. If only beating jihadists everywhere was as easy.

Though AQAP is still seen by some as al-Qaeda's most potent affiliate, its long arm looks shrivelled today. Its leaders still release videos appealing for lone wolves to

Travel in Africa

A dream of Schengen

It is still remarkably hard for Africans to get around their own continent

BY 2063, according to the African Union's (AU) rather long-range prediction, Africa will be "a continent of seamless borders". People, capital, goods and services will flow freely from South Africa to Tunisia and from Senegal to Somalia. Europe's frontier-free Schengen area may be creaking under the strain of migration and terror, but another will arise, this one encompassing a continent of more than 1.2bn people. Last year, with that goal in mind, the AU boldly introduced a single African passport. The first recipients were two of the continent's most powerful strongmen: Rwanda's president, Paul Kagame, and Chad's president, Idriss Déby.

For now, however, crossing borders remains a painful experience for most Africans. The World Bank estimates that intra-African trade is more expensive, all things considered, than trade in any other region. According to Anabel Gonzalez, senior director of a World Bank group on trade and competitiveness, one African supermarket chain reports that it spends \$20,000 every week to get import permits for meat, milk and other goods in one country alone; every day one of its lorries is held up at a border costs it \$500. On average, Africans need a visa to travel to 54% of the continent's countries; it's easier for Americans to travel around Africa than it is for Africans themselves. So far, the AU has issued its single African passport only to heads of state and senior AU officials.

But in the past year things have improved a little, according to a new report from the African Development Bank. Africans now need visas to travel to slightly fewer countries than they did in 2015, and 13 African countries now offer electronic visas, up from 9 the previous

strike America and its allies worldwide. But the last foreign attack it claimed, the massacre at Charlie Hebdo, a magazine in Paris, was more than two years ago. Even at its peak, it never looked very professional. Previous attempts to blow up synagogues or America-bound planes with printer-cartridges and booby-trapped underpants were botched. The sum of AQAP's successful foreign attacks since it was founded in 2009 can be counted on one hand.

The Pentagon says its drones have weakened AQAP. Barack Obama launched around 150 drone attacks on the terror group, wiping out its upper tier, including its best engineers. For the jihadists who

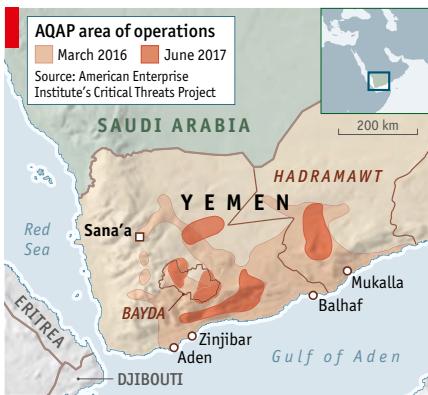


year. Ghana made the most progress: in 2016 the government announced that it would provide visas on arrival for citizens of every AU member state, while offering entirely visa-free travel to 17 African countries, including the 14 other members of the Economic Community of West African States (ECOWAS). The Seychelles is still the only country on the continent to offer visa-free access to all Africans. (An archipelago in the middle of the Indian Ocean, it is a haven for well-heeled tourists but hard to get to if you are poor.)

Elsewhere, progress has been patchy. Less than a quarter of African countries provide "liberal access"—meaning visa-free travel or at least visas on arrival—to all African citizens, and most of the continent's richest countries tend to be more restrictive. War-torn central Africa remains the most closed region; east and west Africa have opened up the most.

survive, getting out of Yemen to kill foreigners has grown harder, thanks to three years of war and the destruction of transport hubs.

Emirati commanders give most of the credit for forcing al-Qaeda to pull back to themselves. Their forces are well-equipped, and they have carefully wooed local support. Before the assault on AQAP in March, the Emiratis paid, armed, kitted and briefly trained 30,000 fighters. Many of AQAP's recruits were tribal hangers-on, who pragmatically hung up their Kalashnikovs after their leaders ran away from the advancing Emiratis. Whereas Aleppo (in Syria) and Mosul (in Iraq) lie in ruins, Mu-



▶ kalla is almost unscathed.

But AQAP's retreat might not make it less dangerous. Shorn of territory, it has gone back to being an amorphous and largely invisible network. Hiding in mountain ranges as inaccessible as Afghanistan's Tora Bora, its leaders still manage over \$100m in looted bank deposits, copious heavy weaponry ransacked from military bases, and multiple sleeper cells in cities which can be reactivated at any time. The war has created new opportunities for smuggling and protection rackets, which the jihadists undoubtedly exploit. Demand has also risen for guns for hire.

Few Yemenis would relish al-Qaeda's return. But given the mayhem now sweeping the south, the order they brought in their year-long rule of Mukalla appeals to some. After taking the port in March 2015, AQAP established a harsh but predictable judicial system. By contrast, their Emirati-backed successors have no courts to try prisoners. The jihadists were not conspicuously corrupt, say locals, with grudging respect. They paid civil servants' salaries, and were surprisingly flexible in their interpretation of sharia (Islamic law). Men were not forced to grow beards or stop work at prayer time. Male doctors persuaded clerics to let them operate on women, because they lacked female doctors.

UAE commanders now hope to secure Donald Trump's backing to stay in Yemen until their mission is accomplished. In the first five months of his presidency, Mr Trump has launched more strikes on Yemen than Mr Obama did in all of 2016, including one on the day after he took office. American boots are back on the ground, too, if in small numbers. To speed things up, the White House has eased restrictions on the authorisation of airstrikes.

Despite its success, the campaign against AQAP has critics. Some UAE officers wonder how long it will be before Yemenis view them as occupiers. Another fear is that AQAP's defeat might create space for Islah, the local offshoot of the Muslim Brotherhood, another Islamist movement against which the UAE is fighting. Instead of breaking al-Qaeda, Yemen's war could end up spreading it. ■

The Horn of Africa

Staying put

BALIGUBADLE

The hard life of Somali pastoralists

BARUUD ABOKOR has lived in Baligubadle for the past four decades. Before settling in this remote Somali town abutting the border with Ethiopia, he roamed widely. "I was master of myself," he says. "The economy was good and I had many animals." But over the years successive droughts, and war between the breakaway region of Somaliland that he inhabits and the central government down south in Mogadishu, have taken their toll. His herd of more than 100 sheep has shrunk to a dozen. Somaliland, like elsewhere in the Horn of Africa, has this year suffered from the worst drought in living memory. But Mr Abokor is staying put.

This makes sense. Since Baligubadle is only a couple of hours' drive south of Somaliland's capital, Hargeisa, food aid reaches the town without too much difficulty. His herd was too weak to travel elsewhere in search of grazing when, earlier this year, the drought was most severe. Baligubadle has man-made boreholes, which keep them alive even as the sun beats the dusty, parched streets. The town is a blessing for once-nomadic pastoralists like Mr Abokor. But its existence also helps to explain why pastoralism here is in the grip of a crisis that runs much deeper than drought.

Pastoral nomads—the animal herders who dwell in large numbers in the Horn of Africa—are hardy in times of water shortage. Being able to pack up and move live-



Nowhere to go

stock to fresh pastures gives them an advantage over sedentary farmers. But that mobility has shrunk. Two decades ago a nomadic pastoralist like Mr Abokor might have travelled as far as 500km (300 miles) each season, sometimes deep into neighbouring Ethiopia, says Ahmed Ibrahim of Candelight, a local NGO. Today most rarely move farther than 50km, except perhaps in times of emergency.

The spread of small towns like Baligubadle, with a school and a health clinic, is one important factor. So is restricted access to land. The vast rangelands stretching across Somalia are governed by a communal system of ownership known as the *xeer*. But the *xeer* was weakened in the 1990s with the collapse of the state during the country's civil war. Tracts of land which were once open for roaming have been fenced off by unscrupulous town-dwellers and wealthier herders.

The remaining land has been degraded by overgrazing. Somaliland now has almost no seasonal reserves, which are crucial for allowing pastures to lie fallow and recover, and which in the past were protected by guards. Vegetation is in desperate condition: the land that surrounds Baligubadle is all thorn bush and acacia trees. Much of the vitamin-rich grass that once covered it disappeared years ago.

These are problems felt by many of the roughly 23m pastoralists scattered across the Horn of Africa and Kenya. Soaring population growth in pastoral areas is putting ever more pressure on already dwindling resources. Rich commercial herders, some with animals numbering in the thousands, monopolise the best land. Mushrooming towns encroach on the ranges.

Attempts to address this have been half-hearted at best. Communal land rights are weak across the region. And governments tend to look unfavourably on mobility: social services, especially schools, are rarely designed to cope with it. Baligubadle's school is closed because its teachers have moved elsewhere, along with their animals. Pastoralist children are generally less educated than their sedentary peers, making it harder for them to find other jobs. Those who do settle in towns often find themselves destitute.

Pastoralism in the east African drylands persists despite such Malthusian pressures. In a harsh environment, many see it as the only way of staying alive. Repeated attempts to settle populations and introduce large-scale irrigated farming have a history of failure in the region, not least because they have often involved coercion.

In Somaliland less than a tenth of the land is reckoned to be suited to agriculture. So the choice is between carrying on as nomads, or getting educated and doing something completely different. Of his children's future, Mr Abokor says he hopes "their life will change". ■

The
Economist



TECHNOLOGY QUARTERLY | June 10th 2017
CIVILIAN DRONES

Taking flight





Taking flight

Most drones today are either cheap toys or expensive weapons. But interesting commercial uses are starting to emerge in the middle, says Tom Standage

STARTING a riot at a football match. Revealing an unknown monument in the desert near Petra. Performing at the Super Bowl. Sneaking drugs and mobile phones into prisons. Herding elephants in Tanzania. What links this astonishing range of activities? They are all things that have been done by small flying robots, better known as drones.

To most people a drone is one of two very different kinds of pilotless aircraft: a toy or a weapon. It is either a small, insect-like device that can sometimes be seen buzzing around in parks or on beaches, or a large military aircraft that deals death from the skies, allowing operators in Nevada to fire missiles at terrorist suspects in Syria. The first category, recreational drones aimed at consumers, are the more numerous by far; around 2m were sold around the world last year. The second category, military drones, account for the vast majority (nearly 90%) of worldwide spending on drones. But after a pivotal year for the civilian drone industry, an interesting space is now opening up in the middle as drones start to be put to a range of commercial uses.

Last year around 110,000 drones (technically known as unmanned aerial vehicles, or UAVs) were sold for commercial use, according to Gartner, a consultancy. That figure is expected to rise to 174,000 this year and the number of consumer drones to 2.8m. Al-

though unit sales of commercial drones are much smaller, total revenues from them are nearly twice as big as for the consumer kind (see chart, next page).

In "Drones Reporting for Work", published in 2016, Goldman Sachs, a bank, argued that drones are becoming "powerful business tools". It predicted that of the total of \$100bn likely to be spent on both military and civilian drones between 2016 and 2020, the commercial segment would be the fastest-growing, notably in construction (accounting for \$11.2bn), agriculture (\$5.9bn), insurance (\$1.4bn) and infrastructure inspection (\$1.1bn). Oppenheimer, another bank, predicts that the commercial market "will ultimately contribute the majority of UAV industry revenues".

The rise of commercial drones was made possible by three developments. First, fierce competition in the consumer market has made the machines much cheaper, more reliable and more capable than they were just a few years ago. "These are not military products that were downsized—these are consumer technologies that got better," says Brendan Schulman, head of policy at Da-Jiang Innovations (DJI), the Chinese firm that dominates the consumer-drone industry. DJI's bestselling Mavic, which costs \$999, can hold its position in light winds, detect obstacles and land automatically. At a company office in Shenzhen, Shuo Yang, one of the engineers who worked on the Mavic, ►

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Dario Floreano

REGULATION

Rules and tools

► proudly demonstrates that it can even respond to hand gestures to follow its owner around or snap a "drone selfie". And it folds up to fit into a backpack.

In many ways modern consumer drones are more advanced than far more expensive military systems, says Adam Bry of Skydio, a consumer-drone startup that is developing a rival to the Mavic. The best consumer models are now being redeployed for commercial use, often with little or no modification. As previously happened with smartphones, the fastest innovation is taking place in the consumer market and then being adopted by companies. And just as with smartphones, people who enjoyed playing with consumer drones realised it made sense to take them to work too, says Jonathan Downey of Airware, a startup that makes drone-management software. Even military users are beginning to pay attention to developments in the consumer market.

Second, the proliferation of consumer drones in America prompted regulation from the Federal Aviation Administration (FAA), which had repeatedly delayed introducing rules for commercial drones. "The flood of consumer vehicles forced the regulators to allow commercial use," says Chris Anderson of 3D Robotics, another drone startup. (Mr Anderson is a former editor-in-chief of *Wired*, and previously worked at *The Economist*.) A set of rules known as "part 107", issued by the FAA in August 2016, specifies the conditions under which drones can be used commercially; previously commercial use had been allowed only with a special waiver that was costly and time-consuming to obtain. The default thus switched from "commercial use is illegal" to "commercial use is legal under the following conditions". Many other countries follow the FAA's regulatory lead, so this cleared commercial drones for take-off not just in America but worldwide. Still, "the technology is moving so fast that the regulatory and legal frameworks are having a hard time keeping up," says Astro Teller of X, Google's semi-secret research laboratory.

Third, the industry underwent a shake-out as a crowd of jostling startups came to be dominated by DJI. Based in Shenzhen, where the world's technology firms go to develop and manufacture hardware, DJI outperformed both local and foreign rivals and now has about 70% of the consumer-drone market. It is valued at around \$8bn and has established itself as a global, premium brand with a reputation for quality and reliability, defying the stereotype of Chinese firms. Its consumer drones generally cost \$999 to start with and are subsequently discounted as new models appear. DJI also makes slightly heftier models specifically for commercial use; a fully equipped Inspire 2 costs around \$6,000.

Several rival dronemakers, including Autel, GoPro, Parrot and Yuneec, have announced lay-offs in recent months. Lily, a consumer-drone startup that attracted thousands of pre-orders, shut down in January. 3D Robotics laid off 150 workers and stopped making hardware altogether last year after its Solo drone failed to dent DJI's market share. Many drone startups concluded that in-

stead of competing with DJI on hardware, it makes more sense to complement its products by providing software and services for commercial users. "Everyone is moving to a model where we let DJI control most of the on-board stuff and we move all our innovation up the stack to the cloud," says Mr Anderson.

Pause for reflection

Having jumped, funding for drone startups is now maintaining a roughly stable altitude. In 2015 drone firms attracted \$479m in venture capital, up from \$149m the year before, according to CB Insights, a research firm; last year the total fell slightly to \$452m. Some investors had their fingers burned and were put off, says Peter Harrop of IDTechEx, a consultancy. "People are distracted by toy drones," he notes. But beyond the consumer market, a wide array of potential uses is emerging in construction, agriculture and other industries, as well as public safety.

More speculative uses are on the horizon. Amazon, Google and several startups are developing drones for delivering packages. Facebook is working on a giant drone to provide internet access in remote areas. Energy utilities are looking at generating power using high-altitude tethered drones that act as flying wind turbines. Tiny insect-like drones may one day pollinate plants; big ones might carry not just cargo but people in self-flying sky taxis.

This report will focus on the fastest-growing part of the drone business, namely the commercial market in between small, cheap consumer drones on the one hand and large, expensive military ones on the other. It will consider the evolving technology and the emerging opportunities, and examine the new challenges that drones pose for regulators. Having come from nowhere in just a few years, civilian drones are now taking flight. ■

Technology

Give and take

Originally a military technology, drones are now benefiting from rapid advances in consumer electronics

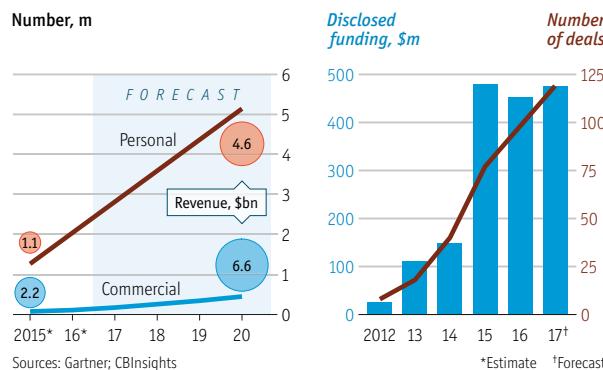
THE first drones were military. The use of pilotless flying machines as weapons dates back to the siege of Venice in 1849, when Austrian forces launched balloons laden with explosives against the city. But the origin of military drones is usually dated to the development of uncrewed, remote-controlled aircraft for use as targets by anti-aircraft gunners after the first world war. The first truly successful example was the de Havilland DH82B Queen Bee, which entered service in Britain in 1935 and seems to have been the inspiration for calling such aircraft "drones" (after stingless male bees); Germany's V-1 flying bomb was another early drone.

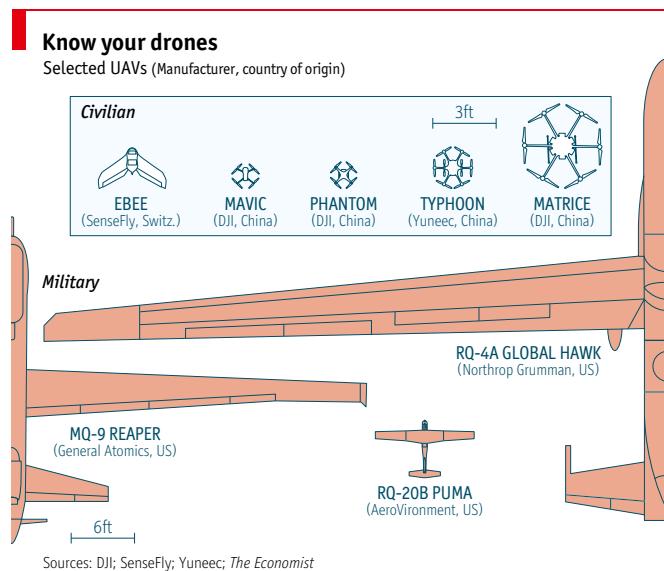
In recent years drones have become a vital component of air power. America's armed forces have a fleet of more than 11,000 drones, compared with just a handful in 2001. Peter Singer of the New America Foundation, a think-tank, says around 80 countries now have military drones, including about 20 with armed ones, either already in use or in development. But the vast majority are unarmed surveillance aircraft of various shapes and sizes.

At one end of the spectrum are small, hand-launched fixed-wing surveillance drones such as the Raven, Wasp and Puma, all made by AeroVironment, which fly either autonomously or under short-range remote control. The Raven, used by many countries' armed forces, is the world's most widely used military UAV, with around 20,000 units deployed; it can fly for up to 90 minutes. ►

Pointing skywards

Civilian drones, worldwide





► Larger drones like the Predator and Reaper can typically stay aloft for 12-20 hours and carry weapons. Biggest of all are long-endurance, high-altitude reconnaissance drones such as the Northrop Grumman Global Hawk, which can loiter over an area for 32 hours, longer than any human pilot.

Perhaps surprisingly, the recent rise of consumer drones owes little to military systems. Instead, it springs from two completely different technologies: hobbyists' radio-controlled (RC) aircraft on the one hand and smartphones on the other. Many people working in the drone industry started out flying small RC aircraft powered by tiny petrol engines, which were "annoying, messy and super-finicky", says Adam Bry of Skydio. The combination of brushless electric motors and lithium-polymer batteries, used in laptops and smartphones, allowed RC aircraft to be electrically powered, making them lighter, quieter and more reliable.

Cheap microcontroller chips, which allow a small computer to be squeezed into a box the size of a cigarette packet, led to the development of open-source autopilot software for fixed-wing hobbyist aircraft. Microcontrollers also provided the on-board brains for a new design of drone, with four or more helicopter-style rotors. By 2005 several research groups had figured out how a drone with four vertical-axis rotors could control its position and movement by adjusting the speeds of different rotors—much easier than controlling a traditional helicopter. "That enabled a completely new way for drones to fly around, hover and so on," says Dario Floreano, a roboticist at the Swiss Federal Institute of Technology in Lausanne.

But for all this to work, a quadcopter needed to know its orientation and direction of movement. Serendipitously, the price of accelerometers based on micro-electromechanical systems, used as tilt sensors in smartphones, had come down rapidly. Drones also borrowed small, cheap camera sensors and fast Wi-Fi chips from smartphones. Moreover, handsets loaded with suitable apps could be used as drone-control units, taking advantage of the phone's screen, radio and processing power. "Drones have really been riding the smartphone revolution," says Dr Floreano.

The stability of multirotor flight meant that small electrically powered aircraft

could suddenly be used in all kinds of new ways, beyond what was possible with small fixed-wing aircraft. Researchers were soon getting small multirotor drones to form amazing feats of agility. In a popular online video from 2013, Raffaello D'Andrea, a roboticist at the Swiss Federal Institute of Technology in Zurich, demonstrates quadcopters balancing broomhandles, carrying a glass of water without spilling a drop and returning ping-pong balls by hitting them in mid-air. Eight of Dr D'Andrea's drones, resembling flying lampshades, even perform in "Paramour", a Broadway show by Cirque du Soleil.

And for my next tricks...

Military drones are built to survive in demanding conditions, have special requirements (such as stealth capabilities or long endurance) and tend to be expensive. So although makers of military drones are keen to adapt some of their products for civilian use, commercial drones are more likely to be based on scaled-up consumer drones than on scaled-down military ones. Gartner estimates that military suppliers will capture just 10% of the commercial-drone market by 2020. The drones being put to commercial use now "are pretty much all consumer", says Mr Bry.

For their part, military types are paying increasing attention to consumer-drone technology, particularly for indoor use in urban combat. "We're interested in having something that can operate in a building, in a confined space," says a NATO spokesman. And as their adversaries adopt low-cost drones (Islamic State has used off-the-shelf consumer drones in Iraq for surveillance and to drop explosives), Western armed forces are trying to work out how to stop them reliably and inexpensively. A member of Britain's special forces says that a shotgun is currently the simplest method.

Military and consumer drones alike are being transformed by rapid progress in two cutting-edge areas of drone research: autonomy and swarming. If you automate away the need for a skilled operator, drones suddenly become much more useful. Military ones that do not require the oversight of a human operator can be radio silent and stealthier. Consumer ones can follow runners, skiers or cyclists and film them from above. Commercial ones can fly a specific, pre-planned path over a field, building site or quarry, avoiding obstacles as they gather data. Improved flight-control algorithms, more on-board processing power and progress in machine vision will allow drones to handle more decisions themselves, rather than relying on fallible or inexpert humans. Most existing drones simply move the pilot from the vehicle to the ground. The next generation of drones will not need pilots at all—just orders.

Greater autonomy also opens the way to swarms of drones ►



Churchill with the Queen Bee, the mother of all drones

► that act as a single unit. In a test carried out in October 2016 over California, 104 tiny fixed-wing Perdix drones, with a wingspan of 30cm, were launched from three American fighters and performed a series of manoeuvres. This is the shape of things to come, says Mr Singer. A swarm of small military drones might be released into a theatre of operations, spread out to look for targets and then collectively assign tasks to different drones within the swarm. When one target has been destroyed, the swarm can move on to another. Away from the battlefield, too, some tasks, such as search-and-rescue missions or mapping, might best be done by drone swarms. They are already used in entertainment: 300 Shooting Star drones, made by Intel, perform a regular light show at Disney World in Florida.

Getting swarms to collaborate, avoid collisions and cope with the odd failure is no mean feat. But as the technology advances, says Mr Singer, the prospect of autonomous military swarms is running into both ethical objections—there is no human “in the loop” to make life-or-death decisions—and cultural resistance from military types who want to retain a role for human pilots and traditional aircraft. (Tanks faced similar objections in the first world war, when they were initially seen merely as an adjunct to infantry.) Such constraints do not apply in the business world, however, where companies see ever more potential in drones as they become smarter, more numerous and more capable. ■

Commercial applications

Seeing is believing

Today's drones are mostly flying cameras. They are already being put to a wide range of business uses

PHOENIX DRONE SERVICES, operating from a business park on the outskirts of Phoenix, Arizona, is typical of the small firms that have sprung up in recent years to pursue the commercial opportunities around drones. Its founders, Mark Yori and Brian Deatherage, started off by building radio-controlled planes. To stream live video, they modified a baby monitor and attached its camera to a fixed-wing drone. These were the days of “crash, smash, rebuild and try again”, Mr Deatherage recalls. Then in 2011 they used a drone-mounted smartphone to take some pictures, for which they were paid \$200. “That’s a business,” Mr Yori concluded, and their company was born, one of the first permitted to operate drones commercially under a “section 333 exemption” granted by the Federal Aviation Administration.

In the company’s offices, fixed-wing and multirotor drones of various shapes and sizes hang on the walls like hunting trophies. A technician surrounded by tools and components tends to a half-built drone in a workshop area; a black DJI hexacopter sits on a table, poised like some giant insect. For years Mr Deatherage and Mr Yori built their own drones, and still use custom-built aircraft for some types of work. “In the beginning you had to be able to build and repair your own aircraft,” says Mr Deatherage, who has a computing degree and taught himself how to use the various tools to process the data from his drones.

Mr Yori likens the fast-moving drone business to surfing: “You always have to be ready to catch the next wave,” he says. There have already been several waves of enthusiasm for drones, as various industries have woken up to their potential and small firms have rushed to meet their needs. The introduction of the “part107” rules in America last year has removed the previously formidable

barrier to entry for commercial-drone operators. The industry is now looking for the most promising applications and trying to gauge how the market will evolve.

The first commercial use of drones (and still their main use for consumers) was to act as flying cameras. Over the past 150 years cameras have changed shape from bulky wood-and-brass contraptions to handheld devices and then smartphones. In many ways drones are the logical next step in their evolution. It is telling that GoPro, a company known for its indestructible action cameras, recently launched its first drone; and that DJI, the dominant maker of consumer drones, has acquired a majority stake in Hasselblad, an iconic Swedish camera firm. Using drones for photography is much cheaper than using manned helicopters. Aerial shots have proliferated on television in recent years, and are also popular with property agents and for dramatic wedding videos.

Eye in the sky

Paul Xu of DJI lists photography as one of five areas of opportunity for commercial drones, along with agriculture, construction, inspection, and public safety and other civil-government uses. Once you have a flying camera, there are lots of things you can do with it. Agriculture, and measuring the health of crops in particular, was identified early on as a promising market for commercial drones. Crop health can be assessed by taking pictures using special multispectral cameras which “see” more than the human eye. By measuring the relative intensity of colour in particular frequency bands, they can identify undernourished or diseased crops. This can be done by satellite, or by sending people into fields with clipboards, but drones can do it more cheaply. A GPS-equipped tractor can then precisely spray water, fertiliser or pesticides only where needed, increasing yields and reducing chemical run-off.

In a report published in 2013 the Association for Unmanned Vehicle Systems International (AUVSI), an industry body, identified precision agriculture as by far the most promising market for commercial drones. But enthusiasm for drones in agriculture has cooled lately. In part, that is because at the time of the AUVSI report most civilian drones were of the fixed-wing variety, ideally suited to flying over large areas; the rapid progress made since then by multirotor drones, which have a shorter range but can hover, opened up other markets that are now seen as more promising.

Encouraging farmers to adopt drones also proved harder than expected, notes Chris Anderson of 3D Robotics. The agricultural use of drones sounds good in theory—feed the world, save the planet—but is difficult in practice. The market is very fragmented and conservative, with many subsidies and distortions, and some

of the social goods that flow from using drones, such as reducing run-off of chemicals, do not benefit farmers directly. The agricultural market “is littered with struggling technology companies that have tried to break in”, says Jonathan Downey of Airware.

Mr Anderson believes that the most immediate opportunity lies in construction and related industries. Most big construction projects go way over budget and end in a lawsuit, he says. Mistakes made early on in a project may not be noticed until much later, and cost time and money to rectify. Buildings are designed in a flawless digital environment but must be constructed in the much messier real world. “It’s all an information problem,” says Mr Anderson. So the industry has been pursuing the idea of “reality capture”, using technology to measure buildings precisely during construction and track the use of raw materials on site to ensure that everything



Various industries have woken up to the potential of drones

► is going according to plan. Drones are ideally suited to the task. Thousands of aerial photographs are crunched into a 3D site model, accurate to within a few centimetres, called a “point cloud”, which can be compared with the digital model of the building. And safety worries that hamper the use of drones in other fields are kept to a minimum because construction sites are closed areas, workers wear hard hats, and drones fly within line of sight.

Andrew Kahler of John Deere, a maker of agricultural and construction machinery, explains how drones can also streamline the process of grading—preparing the ground for constructing a building, road or railway. This involves measuring the original topography, which by conventional methods might take several weeks for a large site; using bulldozers and other equipment to move large quantities of earth; then “fine grading” the site to within an inch or two of the desired final shape. The great benefit of drones, says Mr Kahler, is that they can carry out a topographic survey in half an hour, and the 3D model is ready the next day. That makes it possible to resurvey the site frequently and make any necessary changes. Mr Kahler’s company recently struck a partnership with Kespry, a startup, to provide drones and related software and services.

Keep away from the cliff edge

Drones are also useful farther up the construction supply chain, in mining and aggregates, says George Mathew, Kespry’s boss. Working out how much material is sitting in a stockpile in a mine or quarry usually involves taking a few dozen measurements with manual surveying equipment and then calculating the volume. A drone can measure the volume of dozens of stockpiles in a single flight, taking thousands of measurements that are turned into an accurate point cloud within an hour. As well as being far quicker and more accurate, it is also much safer. Falling off stockpiles is one of the industry’s biggest occupational hazards. Using drones to survey quarries and building sites also means human surveyors do not need to venture close to dangerous sheer drops.

Such is the interest in drones, says Mr Kahler, that he is asked about them at every site he visits. Customers are “ready and willing to jump into this technology”, he says. Sarah Hodges of Autodesk, which makes software used to design and model buildings, notes that drones are making it possible to digitise the construction industry, which has been relatively slow to adopt new technology. With a complex building like a hospital, being able to check that plumbing, heating and electrical systems are being installed correctly “is really transforming—it’s eliminating a lot of errors”. In China, she says, drones are being flown over building sites at night (which current American rules forbid) to measure progress made during the previous day and ensure that everything is going precisely to plan. Autodesk and others are also starting to use virtual reality and augmented reality to overlay digital models with real-world views.

Drones are attracting interest in a related field, too: the inspection of buildings and other infrastructure, such as pipelines, wind turbines, electrical pylons, solar farms and offshore platforms. At the moment, inspecting a roof for storm damage or checking the state of an electrical pylon involves sending someone up a ladder, which can be dangerous. “We are working with a lot of power companies,” says Mr Xu of DJI. His company has developed the Matrice 200, a drone specially equipped for use in harsh environments by adding features like backup batteries and GPS systems, magnetic shielding and weatherproofing.



Up in the air, down on the farm

But for utilities and other large companies to make the most of drones, they need to be able to integrate them smoothly with their existing computer systems and workflows. A single drone flight can generate as much as 100 gigabytes of data, says Anil Nanduri of Intel. Airware, which is working with large insurance companies in Europe and America, has developed a system that handles the whole process. The insurance company specifies what data it wants, and in what format, and Airware’s software generates a suitable flight plan. This is sent to an operator who uploads it into the drone, which gathers the required data completely autonomously. The results are then sent back, converted into the form needed by the claims assessor and a summary is delivered into the insurance company’s systems. What makes the insurance industry particularly attractive, says Mr Downey of Airware, is that it is highly concentrated: “By working with the top ten players you can target a pretty big proportion of the market.”

Inspection by drone will get even better with further automation, says Mr Xu. Some dream of “drone in a box” systems, where drones sit charging in weatherproof boxes in remote areas, popping out when needed to gather data entirely autonomously. The use of machine-learning systems to identify anomalies could automate the process even further. Kespry, which is also targeting the inspection and insurance market, has built a machine-learning system that can count hail strikes on a roof. “It’s mind-blowing for people in property and casualty insurance,” says Mr Mathew.

After a flood or an earthquake, drones are already used in search-and-rescue operations to sweep large areas for people who need help. By enabling relief workers to see the bigger picture, they allow relief efforts to be co-ordinated more effectively. After flash floods in Chennai, India, in December 2015, for example, the police used drones to locate and rescue around 200 people. A trial carried out in 2016 by Donegal Mountain Rescue in Ireland found that a drone could sweep an area for a missing person more than five times faster than a ground-based team of rescuers. In February four skiers in British Columbia, who got lost and ended up in the dark, were spotted and rescued with the help of an infra-red camera mounted on a DJI Matrice drone.

For police use, drones are a cheaper and quieter alternative to helicopters for monitoring crowds and can be used to create detailed 3D models to help investigators of traffic accidents. Journalists and environmental groups are also experimenting with drone-based photography. Fixed-wing drones monitor animal populations and detect and deter poachers in Kenya, Namibia, South Africa, Tanzania, Zambia and Zimbabwe; multirotor drones ►

► keep an eye out for sharks off Australian beaches.

As drones expand into all these areas, what shape will the industry take? Some drone startups took a “vertical” approach, focusing on specific industries and creating integrated drone hardware, software and services for particular applications, as Kespry does in mining. Others, like Airware, bet that hardware from different makers would become standardised around a single drone operating system that would run on a wide range of designs from different vendors, just as Google’s Android operating system powers most of the world’s smartphones. Some companies focused on making specific components, such as sensors, complete drone airframes, or software tools to analyse data from drones.

For the moment the commercial drone industry does not look remotely like the smartphone industry; instead, it is a mirror image of it. DJI so dominates the hardware side that its on-board software has emerged as the industry’s main platform. The leading software platform for drones thus belongs to a single company and is tied to its own hardware; it is what the smartphone industry would look like if Apple’s market share were 80% rather than 20%. An equivalent of Android for drones does exist—a free, open-source platform called Dronecode, used by 3D Robotics, Yuneec, Intel, Parrot and others—but DJI’s platform is more widely used.

Once it became apparent that DJI’s hardware and software was emerging as the standard, many drone companies switched their focus to building enterprise-grade software and services for specific industries—an area that DJI seems happy to leave to others, given that some companies might prefer not to hand over their data to a Chinese company. For software providers the vertical model is winning, as startups target clients in particular industries.

Start here

But how, in practice, will companies adopt drones? Initially, they may choose to pay drone-services companies to work for them on a job-by-job basis. Matchmaking services like Measure, DroneBase, Fairfleet and Airstoc have already sprung up to connect companies that want to get a particular task done by drones with small firms and individuals who can do it for them. DJI has a stake in DroneBase, and some makers of drone software, including Airware and DroneDeploy, operate similar services. But this may just be an interim solution. “Companies usually want to start by hiring a service provider,” says Mr Downey, “and then they see how easy it is, and realise they can do it themselves.”

Drone companies, for their part, have been forming partnerships with incumbent suppliers, notably in the construction industry, which already have access to a large customer base. Hence partnerships have been formed (many of them underpinned by an equity stake) between Kespry and John Deere, 3D Robotics and Autodesk, Airware and Caterpillar, and Skycatch and Komatsu.

Mr Xu of DJI reckons that more needs to be done to promote growth in the industry over the next five to ten years, so his company is fostering insurance, repair and financing services for drones that corporate customers are likely to want. With full automation some years away, it is also encouraging the training of drone operators. “We are transforming this from a hobby to a profession,” says Mr Xu. So far DJI’s training schemes, launched in June 2016 and outsourced to third parties, are available only in China. Each month 500-600 people are certified for particular kinds of drone operation, such as photography, pesticide spraying or infrastructure inspection. The company is also trying to assist startups that act as “UAV systems integrators”, helping companies in particular industries integrate drones into their business.

Thus many overlapping models and initiatives are competing to shape the future of the drone business. Mr Downey thinks that consolidation over the next five years will leave a couple of dominant providers in each industry. But in essence, all the commercial applications being pursued today use drones to gather data. As the machines become more capable, they will start moving things around, which will give rise to a vast range of new uses. ■

Future uses

Can drones deliver the goods?

The wait for cargo-carrying drones may be longer than expected

THERE is a striking disparity between the commercial applications drone companies are pursuing in fields like construction, inspection or agriculture and the public perception of commercial drones. Media coverage is dominated by one particular application: delivery. Experimental deliveries of parcels, pizzas and other items conjure up visions of skies abuzz with drones ferrying packages to and fro. But although delivery and logistics companies are interested in drones, many drone companies are not interested in deliveries. “It’s not on our immediate radar,” says Paul Xu of DJI.

Astro Teller, the boss of X, Google’s semi-secret research laboratory, is one of the lucky few to have received a delivery by drone. It was dispatched last September as part of a test carried out in Virginia by Project Wing, Google’s drone-delivery programme. Its machines come in a variety of shapes: some are “tail-sitters”, flying wings capable of flipping upright and hovering; others are fixed-wing drones augmented by vertical-axis rotors like those on a quadcopter. Both designs combine the benefits of a fixed-wing aircraft for efficient long-distance flight with those of a multirotor for hovering and vertical take-off and landing. When delivering a package the drones do not actually land but float above the recipient and use a winch to lower their cargo: in Dr Teller’s case, a freshly prepared burrito.

Receiving something by drone is “kind of magical”, he says, launching into an impassioned case for drone delivery. Imagine you had a magic elf that could bring you anything you asked for ►



Lunch has arrived

► within a minute or two, provided it could fit in a breadbin. You would no longer worry about what to take with you when going out. Nor would you keep common items, like batteries or perishable foodstuffs, on hand at home just in case you needed them. You might not need to own some rarely used objects at all if you could summon them when needed. Rapid drone delivery could thus accelerate the trend from ownership to access in the “sharing economy”, says Dr Teller. He claims delivery drones could be faster, quieter and more environmentally friendly than large delivery trucks. Project Wing now carries out experimental flights daily.

The technology giant most closely associated with delivery drones is Amazon. When its boss, Jeff Bezos, revealed his plans for drones in December 2013 on “60 Minutes”, an American television programme, they were widely assumed to be a publicity stunt. But Amazon is quite serious: it carried out its first trial delivery to a customer near Cambridge, England, last December—“13 minutes from click to delivery,” says Gur Kimchi, the head of Amazon’s drone effort. In March 2017 it conducted its first delivery demonstration in America, at a conference in Palm Springs. Like Google, Amazon is evaluating a range of different designs, all of which involve the drone lowering its package onto a target in the recipient’s garden or backyard. Logistics firms such as DHL and UPS, as well as some startups, are also looking at drone delivery.

But if widespread drone delivery is to become a reality, many technical and regulatory hurdles must be overcome. These include ensuring that drones do not fall and cause injury, and can land safely if something goes wrong; and preventing collisions with power lines, trees and other aircraft. Moreover, small drones have limited cargo-carrying capacity; not everyone has a garden or backyard; and deliveries require beyond-line-of-sight, autonomous operation, which requires special permission. So at least for now, many drone firms are steering clear. “It’s very challenging, and we do not want to promise something we can’t deliver,” says Mr Xu. “Delivery just bundles together all the hard problems,” says Mr Bry, who worked on Project Wing before leaving to found Skydio. He thinks it could take a decade to solve these problems.

One application where drone delivery may make more sense, and is already in use, is ferrying medical supplies to remote areas that are hard to reach by road. Zipline, an American startup staffed by veterans of Google, SpaceX, Boeing and NASA, began delivering medical supplies in rural Rwanda using fixed-wing drones in October 2016. It has an agreement with the government to deliver blood products to 21 transfusion clinics from two bases, the first of which is already serving five clinics. Zipline’s drones can fly 150km on a single charge and work in rain and winds of up to 30km an hour. They are launched using a catapult, fly below 150 metres (500 feet) and drop cargo packages weighing 1.5kg by parachute.

Rolling out the service means mapping the best routes for the aircraft, which fly autonomously, co-ordinating with military and civilian authorities, training clinic staff to receive cargo and reassuring the local communities along the route. Whether all this is economically viable, or just a publicity stunt by Rwanda’s tech-loving government, is unclear. But the company is talking to governments in other countries about operating similar services, focusing on medical deliveries outside urban areas. It hopes to change public perceptions of the word “drone”. Zipline’s Justin Hamilton says one of the firm’s engineers once told

The buzz about drones

United States, % polled June 9th-19th 2016

When, if ever, do you expect that companies might start to deliver mail or packages using a UAV or drone?*



Which of the following would you be most concerned about if a company were to deliver mail or packages using a UAV or drone?*



Do you agree or disagree that deliveries made with UAVs or drones would be safe?*



Source: USPS

*Unmanned aerial vehicle

him that he used to work on drones that drop bombs, “and now he builds drones that drop blood.”

Other startups say that drone delivery in urban areas is already possible—but using drones moving on the ground rather than in the air. Starship Technologies, based in Estonia, and Dispatch, based in California, have both developed wheeled, coolbox-sized drones that trundle along pavements to make local deliveries. Starship’s drones are being tested in several cities around the world, and Dispatch is about to begin tests in the San Francisco Bay Area. Both firms use a “partial autonomy” model, meaning that their drones can be remotely piloted for some or all of a route. As the drone approaches its destination, the recipient receives a smartphone alert, and when it arrives he uses his phone to pop open a lockable compartment to retrieve the cargo.

What if people steal the drone? Anyone who tries, says Stav Braun of Dispatch, has “just stolen a homing beacon”. A bigger concern, she says, is ensuring that the robot is courteous and people feel safe around it. But so far the response has been positive.

Instant gratification

Clement Jambou of Unsupervised.ai, a French delivery-drone startup, thinks the steps and kerbs of urban environments will be too difficult for wheeled robots to navigate, so his firm’s delivery drone has legs instead and resembles a dog. He may disagree with Dr Teller on the best way to set about it, but Mr Jambou has a very similar vision for fast, cheap drone delivery. For example, he imagines people renting rather than buying clothes, tools and other household items, dispatched by drone from a neighbourhood depot when needed.

Dr Teller, for his part, is confident that the technical and safety obstacles to flying delivery drones can be overcome. But it will be a gradual process involving “lots of data and demonstration” to satisfy regulators. “The magical elf won’t change the world unless it can go beyond visual line-of-sight, fly over people and have a small number of operators responsible for a large number of vehicles,” he says, none of which is allowed under current regulations. Google is working on making its drones resilient to the failure of a single rotor, battery or motor, the loss of GPS coverage and other potential problems. “We are building up evidence that we can do this safely,” he says. That will take a while, but Google expects its “moonshots” to take up to a decade to pay off. Work on Project Wing began in 2012.

The disagreement over the viability of delivery drones, then, is mostly a matter of timing. For companies that wish to put drones to work now, delivery is not a good bet. But for logistics companies it makes sense to start exploring the possibilities. The end result may well be a hybrid system of delivery trucks that arrive in a ►



► neighbourhood and disgorge flying and wheeled drones.

Deliveries are just one of the proposed uses of drones that seem speculative or impractical now but may become significant in future. Facebook, like Google and Amazon, is also investing in drones, but not for delivery: instead its drone, called Aquila, is a huge solar-powered machine intended as a communications relay, to extend internet access to parts of the world that lack connectivity. This will have health and educational benefits, the social-media giant says, but will also help it sign up more users. Aquila made its first test flight in June 2016. Facebook's boss, Mark Zuckerberg, explained in a blog post afterwards that his goal is "a fleet of Aquilas flying together at 60,000 feet, communicating with each other with lasers and staying aloft for months at a time", beaming internet access over wide areas.

Making all this work is a lofty goal. In November it emerged that the prototype Aquila had been substantially damaged on landing, triggering an investigation by flight-safety inspectors. And getting permission to fly such aircraft over any populated areas will not be easy. In January Google scrapped its own high-altitude communications-relay drone, Titan.

Dr Teller says that Google now sees more promise for extending internet access in high-altitude balloons; they are easier to keep airborne and much more lightly regulated than drones. Military drones such as the Global Hawk can already act as telecoms relays, so that part of the technology is proven; the challenge is to harness solar power to keep drones aloft for weeks or months, not

just a day or two. Large, lightweight UAVs can theoretically use solar power to remain in the air for weeks at a time; a prototype Zephyr drone, built by Airbus, Europe's aviation giant, stayed aloft for 14 days during a test flight in 2010.

High-altitude drones have also been proposed as a way to generate electricity, because strong winds blow more reliably well above the ground. Known as wind drones or energy kites, such drones are tethered so that cables can deliver the electricity back to the ground. Makani, a startup acquired by Google in 2013, reckons a single energy kite can generate 50% more electricity than a single wind turbine while using only 10% of the materials. Each Makani drone, which resembles a wing with eight propellers, weighs 11 tonnes, compared with about 100 tonnes for a comparable 600kw turbine. This approach is being pursued by other firms too, including Ampyx Power and Kite Power Systems, both backed by E.ON, a German utility. Tethered drones on a smaller scale are also being considered for indoor use in warehouses, where they might help with stocktaking. Flying indoors neatly sidesteps many regulatory problems, and supplying power via tethers does away with the need for recharging. But GPS cannot be used for positioning.

At the lowest end of the spectrum are insect-like drones, just a few centimetres across, that could be used for surveillance inside buildings, search and rescue, or even pollinating plants. Building very small drones is hard because the technology used in larger drones cannot simply be scaled down; different approaches are ►

Brain scan | Dario Floreano

A pioneer of evolutionary robotics borrows drone designs from nature

THE drones that most people are familiar with today are "very boring", declares Dario Floreano, head of the Laboratory of Intelligent Systems at the Swiss Federal Institute of Technology in Lausanne. He thinks that drones will come in a much wider range of shapes and sizes in future, and that nature will provide the inspiration needed to make them more agile, safer and more capable. "There is space for an enormous range of morphologies and sensing capabilities," he says, giving a slightly worrying example: vampire bats. As well as flying, they can also walk, jump and even run along the ground. Dr Floreano and his colleagues have built bat-like drones with folding wings, and locust-like ones that can jump and fly.

A pioneer in the field of evolutionary robotics, which borrows ideas from nature, Dr Floreano became interested in drones as a result of his work on insect-inspired vision systems. Curved compound "eyes", which (like insect eyes) can "see" in many directions, turn out to be useful in helping a drone sense its surroundings, navigate and avoid obstacles, for example. Dr Floreano's work on fixed-wing drones, with stabilisation and autopilot systems inspired by the way bees navigate, was spun off into a startup called SenseFly, now part of Parrot, a



French drone company. SenseFly's main product is a black-and-yellow fixed-wing mapping drone called eBee.

Birds are another inspiration. Dr Floreano's team recently published research on the benefits of adding artificial feathers to fixed-wing drones. By spreading its feathers, the drone can increase the surface area of its wing,

letting it trade speed for manoeuvrability. But not everything needs to be borrowed from nature. Flyability, another spin-out from Dr Floreano's lab, makes a "collision-tolerant" drone that resembles a flying spherical cage, for mapping and inspection in confined spaces.

These sorts of unconventional approaches enable drones to do things that existing designs cannot. Dr Floreano imagines search-and-rescue drones capable of perching on walls or landing on power lines, like birds, to survey their surroundings. This "multi-modal" approach could also increase the safety of delivery drones by allowing them to glide, land or perch if something goes wrong. Multirotor drones can carry a maximum of 30% of their total mass as payload, he notes, so to carry useful amounts of cargo they will have to be quite large and heavy.

At very small scales, fixed-wing and multirotor designs become less efficient, and insect-like drones with flapping wings may make more sense. Tiny drones could be used for virtual tourism, letting remote users "fly" around with the aid of virtual-reality goggles. In short, today's drone designs barely scratch the surface. "There is a huge range of shapes and sizes that we have to explore," says Dr Floreano. "Future drones may look very different."

needed. In a paper published in February in the journal *Chem*, Japanese researchers explained how insect-sized drones covered in hairs coated with a special gel picked up pollen from one plant and deposited it on another. They concluded that robotic pollinators might offer a remedy for the decline in honeybee populations.

Perhaps the most far-out proposal to date is to use drones to carry human passengers in self-flying taxis. This is harder than using drones for package delivery, because it raises safety concerns for people in the air, not just on the ground. EHang, a Chinese drone firm, hopes to test its one-person drone, which resembles a giant quadcopter with a passenger compartment, in Dubai in July. Other companies, including Airbus, Uber and Kitty Hawk, have proposed similar “flying car” drones. Dario Floreano, a robotics professor at the Swiss Federal Institute of Technology (see Brain scan, previous page), has been thinking about passenger drones as part of the European Union’s “myCopter” project. Packages, he says, can withstand sudden accelerations during flight that humans cannot, which makes path-planning and obstacle avoidance more difficult. And the limited energy density of batteries may restrict the range of passenger drones to intra-city hops.

It is a big leap from today’s drones to these sorts of uses. Trying to imagine how drones will evolve, and the uses to which they will be put, is a bit like trying to forecast the evolution of computing in the 1960s or mobile phones in the 1980s. Their potential as business tools was clear at the time, but the technology developed in unexpected ways. The same will surely be true of drones. ■

Regulation

Rules and tools

Regulation and technology will have to evolve together to ensure safety

MOVING bits around the internet is one thing; moving atoms around in the real world is something else entirely. In the two decades of the internet era, many world-changing technologies—web-publishing, file-sharing, online auctions, internet telephony, virtual currencies, ride-hailing—have raised new legal and regulatory questions. In each case, regulators had to work out the rules after the event: figuring out how libel law applies to the web, banning the sale of Nazi memorabilia, deciding whether Bitcoin is a currency, determining whether Uber drivers are employees or contractors, and so on. But drones are a different matter, because of the danger that flying robots pose to life and limb, and the existence of strict rules that govern the use of physical airspace. Their future will depend as much on decisions made by regulators as it does on technological advances. How will it play out?

Global policymakers are currently engaged in a “very interactive process of competition and co-operation”, says Greg McNeal, a law professor at Pepperdine University who advises the Federal Aviation Administration (FAA) on drone regulation and is co-founder of Airmap, a drone-software startup. Before the introduction of America’s “part 107” rules last August, Google’s Project Wing tested drones in Australia and Amazon in Canada, where the regulatory regimes were more accommodating. France’s relatively permissive regulation put it at the forefront of the agricultural use of drones. And in Britain a drone cluster has sprung up around an airport in Aberporth, in Wales, where drone-friendly regulations and facilities have been put in place. Now regulators in different countries are working closely together, attending each

other’s meetings and learning from each other, while also competing to attract drone startups. “It’s very good for the industry, because every nation wants to be a leader,” says Mr McNeal.

The FAA’s part 107 rules, providing for certification of commercial drone operators, are generally seen as a model by other countries. These rules, a decade in the making, allow operators with a remote-pilot certificate (obtained by passing a test costing \$150) to fly a drone for commercial purposes during the day, within line of sight, in uncontrolled airspace, and without flying over people who are not involved in operating the drone. Other countries have since followed America’s lead, and some are already going further: France and Switzerland allow some operation beyond visual line of sight, says Mr McNeal, and from 2018 Japan will permit it for delivery drones. In America the next set of proposed rules from the FAA, expected later this year, will deal with flight over people and remote identification of drones. Next year there will be proposals for the control of multiple drones by a single operator, “extended visual line of sight” operation over longer distances, and night operation. In 2019, says Mr McNeal, the FAA will propose its first rules governing flights without a visual line of sight, a crucial requirement for delivery drones.

Drone companies can already go beyond part 107 by obtaining special waivers from the FAA, provided they can show that the proposed operation can be conducted safely and meet some additional requirements. This offers a way to test new regulations before they are formalised. Such waivers impose additional safety requirements on drone operators: getting a waiver for night-time operation, for example, requires mounting a light on the drone that is visible three miles away, and providing night-flight training for operators. If all goes well, this could form the basis of a new rule, says Brendan Schulman, head of policy at DJI.

Flying over people raises additional problems. The FAA’s proposed rule, due out later this year, is expected to ask drone operators to show how they would mitigate the risk of injury to bystanders. The best way to do this, explains Mr Schulman, is to specify an acceptable level of risk, and then require dronemakers to show that their vehicles meet that standard. This might involve adding cushioning or parachutes to drones, or ensuring that they can still operate if some parts fail, or making them so small and light that they would cause little injury if they fell on someone.

An idea from Australia also deserves to be more widely adopted, he suggests: the creation of a special category for very small drones, allowing commercial operation without any certification. In Australia’s case this applies to drones weighing less than 2kg. Similar rules apply in Mexico and Canada, and are being considered in India and several European countries. In America all drones weighing less than 25kg are still treated the same. But broadly speaking, regulators are learning from a variety of approaches being tried in different countries.

Traffic lights in the clouds

To operate drones beyond visual line of sight and in large numbers, particularly in densely populated areas, will take not just extra rules but the establishment of new traffic-management systems, akin to air-traffic-control systems, to prevent drones crashing into each other or veering off course. Around 80% of consumer drones, including those made by DJI, Yuneec and Intel, already support “geo-fencing”, using technology provided by Mr McNeal’s company, Airmap. Its database of where drones are and are not allowed to fly is built into the software used to control them, working with satellite positioning to prevent an operator



Flying over people raises additional problems



In perfect formation

▶ from flying a drone too close to an airport, for example. Airmap's database can be updated in real time to keep drones away from unexpected events such as fires and other incidents.

But once drones are flying beyond their operators' line of sight, a more elaborate system will be needed to track large numbers of them and ensure they avoid each other and stay away from manned aircraft, says Parimal Kopardekar of NASA's Ames Research Centre. He is leading the development of a system called Unmanned Aircraft Systems Traffic Management (UTM), an automated traffic-management system for drones. Existing air-traffic-control systems are operated manually, with human controllers co-ordinating with human pilots during flight, but that will not work for unmanned drones flying in much larger numbers. The UTM system will be automatic, with drones filing requests to use particular flight paths with a local data exchange, which then coordinates all the movements. "The regulator only sets the rules and defines the exchanges, so it's a very different way of doing things from air-traffic control," says Dr Kopardekar.

Last year NASA carried out a trial of its UTM architecture across the United States which revealed several challenges, notes Dr Kopardekar. In particular, it turned out that fixed-wing and multi-rotor drones respond very differently when they encounter rising columns of air, called thermals. Fixed-wing drones "bounce around quite a bit, by a few hundred feet", says Dr Kopardekar, which means drones cannot be stacked too closely together. Route planning will, in short, require a detailed understanding of micro-climates and of the behaviours of different types of drones. Building the necessary systems will take a few years.

Where are you going?

The FAA plans to introduce the first rules around UTM from 2019. Drones will need to be equipped with "sense and avoid" systems and long-range radio to communicate with each other and with the data exchange. That also poses a challenge, says Jane Rygaard of Nokia, a maker of network equipment, because existing mobile networks are designed to work with users on the ground, not in the air. Networks will have to be augmented with antennae that point towards the sky. This technology already exists to provide in-flight connectivity to aircraft, but will have to be extended more

widely to take in drones as well.

And even once all these rules and tools are in place, not everyone will respect them. Some people may want to use drones for nefarious purposes. A range of anti-drone technologies is already being tested. Police forces in some parts of the world have trained birds of prey to attack small drones. Nets can also be used to trap them, either fired from bazooka-like launchers or dropped by other drones. America's Department of Defence holds an annual event called Black Dart at which various anti-drone technologies are evaluated. "The biggest surprise to military folks was how difficult it was to combat small drones," says Grant Jordan, the founder of SkySafe, an anti-drone startup, who worked on Black Dart a few years ago when he was in the air force. When the target is "tiny, very light and relatively slow", the assumptions of traditional air defence are all wrong, he says.

Big laser systems worked pretty well, he recalls, but are expensive and complex. Israel has used Patriot missiles to shoot down fixed-wing drones operated by Hamas, Mr Jordan says. By contrast, his firm disables drones by intercepting their control signals and video feeds. Examining the radio traffic to and from a drone makes it possible to determine what type it is, track it and if necessary take it over to disable it or force it to land. Anti-drone systems made by SkySafe, and rivals such as Dedrone and DroneShield, are being evaluated for military and government use and to police airspace around airports, stadiums and prisons (to prevent smuggling of phones, drugs and other items to inmates). But it is unclear who has the legal authority to stop drones that pose a threat to public safety, says Mr Jordan. Existing air-safety rules aim to protect passengers in aircraft; for drones, "the logic of these laws falls apart."

It is clear that the complexities of operating drones in large numbers have barely begun to be understood. As the first widely deployed mobile robots, drones already offer many exciting possibilities today, and no doubt other, as yet undreamed-of uses will follow in the future. Frank Wang, the founder of DJI, pictures people being followed around by tiny personal drones, like fairy sidekicks. Astro Teller of Google foresees delivery drones that can come up with any item on demand. And passenger drones might some day act as magic carpets, whisking people across cities from rooftop to rooftop.

Drones make the extraordinary power of digital technologies physically incarnate. But because they operate in the physical rather than the virtual world, exploiting the many opportunities they offer will depend just as much on sensible regulation as on technological progress. ■

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Emmanuel Macron's chances

A second French revolution

VILLEURBANNE

Mr Macron's party looks set to sweep to victory

JUMP IN!" yells Bruno Bonnell from behind the wheel of his rented minivan.

A tech entrepreneur more used to labs than leafleting, the local candidate for Villeurbanne in the upcoming parliamentary elections has never fought a political campaign in his life, and is having a blast. He has plastered a huge photo of himself and Emmanuel Macron, the French president, whose party he is standing for, on the outside of the van. "I love it," he grins, as he drives around the constituency, next to Lyon: "People recognise the photo, and they smile."

A second revolution is underway in France. On the back of the remarkable election in May of Mr Macron, who had never before run for election to any office, La République en Marche! (LRM), a movement he founded just 14 months ago, looks set to secure a parliamentary majority at the two-round legislative election, on June 11th and 18th (see chart). Only weeks ago, such a prospect looked slim. But almost everything Mr Macron has achieved so far has defied expectations. In constituencies across the country, enthusiastic political novices, such as Mr Bonnell, are preparing to transform the face of the National Assembly, and of French party politics.

Polls suggest that LRM could get 395-425 of the 577 seats. If so, this would be unprecedented for a new political movement. It would also be the biggest majority

achieved by any party since Charles de Gaulle founded the Fifth Republic in 1958. (The current record is held by Jacques Chirac, whose centre-right party won 365 seats in 2002.) "There's no longer any doubt about him getting a majority," says a Socialist former minister, whose own party is heading for a wipe-out. Its share of seats could plunge from 271 to a rump of just 25-35. The party that has governed France for the past five years could become all but inaudible in parliament, its representation barely bigger than that of Jean-Luc Mélenchon's Unsubmissive France, a far-left fringe group.

Amateur power

Mr Macron is hoovering up votes across the spectrum. Marine Le Pen's xenophobic National Front could improve its current tally of just two deputies to perhaps 15. Ms Le Pen stands a chance of securing her first

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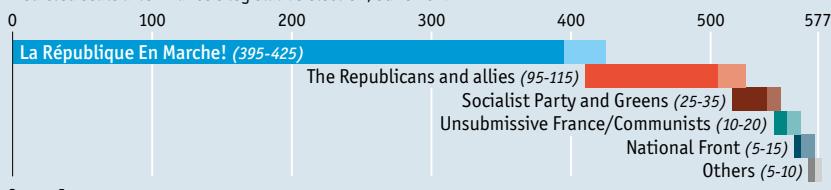
parliamentary seat in the northern ex-mining town of Hénin-Beaumont. But this would still be a disappointment for a party that had hoped to turn itself into a proper force of opposition. That role will fall to the centre-right Republicans, who are themselves heading for big losses. The Republicans had once expected to win both the presidency and a parliamentary majority. Instead, they could end up with little more than 100 seats, half their current share.

There could be some big-name casualties. Among those vulnerable is Najat Vallaud-Belkacem, a former education minister, who is running as the Socialist candidate against Mr Bonnell in Villeurbanne, an inner-city constituency well stocked with kebab shops as well as patisseries. A well-known figure nationally, she also cut her political teeth locally as an adviser to the mayor of Lyon, Gérard Collomb. But they have since parted ways. An early supporter of Mr Macron, Mr Collomb is now his interior minister, and turned up in Villeurbanne this week at a rally to drum up support for the 58-year-old Mr Bonnell. Polls suggest that the techie will win the run-off vote.

The Macron parliamentary revolution is not only about upsetting the old party balance, which has dominated France for 60 years, in favour of a new radical centre. ►

Marching forward

Predicted seats after France's legislative election, June 2017



It is also changing the face of French politics. Fully 251 of the 525 candidates LRM is fielding, which it selected from among 19,000 online applicants, have never run for elected office before, according to *Le Monde*, a newspaper. Half are women; the average age is 47. Like Mr Bonnell, some are entrepreneurs. There are also many teachers, civil servants and doctors, 11 farmers, two firemen, a hairdresser, an ex-professional golfer, a theologian, a mathematician and a female fighter pilot.

This astonishing democratic experiment is both refreshing, and a gamble. Some deputies with strong local roots

could yet resist the Macron mania. And those political novices who are indeed elected for LRM will have to learn fast. "I'm completely new to this world," laughs Mr Bonnell: "You have to be humble." Yet the French like the idea of turfing out the old guard, and seem ready to take the risk. "Let's give him a chance," says a voter in Villeurbanne who did not back Mr Macron in the first presidential round, but intends to do so at the legislative election.

A parliamentary majority for Mr Macron would be in line with tradition, whereby voters back the presidential winner. But it could also reflect widespread approval

for the firm yet dignified way Mr Macron has represented France since his election. His poll ratings are high. Fully 76% of voters judge his first diplomatic steps favourably. Adrien Taquet, the LRM candidate in the Paris suburb of Asnières and the brains behind the name “En Marche!”, says that, when he is out canvassing, voters spontaneously mention the president’s muscular handshake with America’s Donald Trump.

Mr Macron has already torn up the unwritten rules governing the French presidential elections. Now he looks set to rip apart those behind the party-political system too. ■

Obesity

Ravenously Hungary

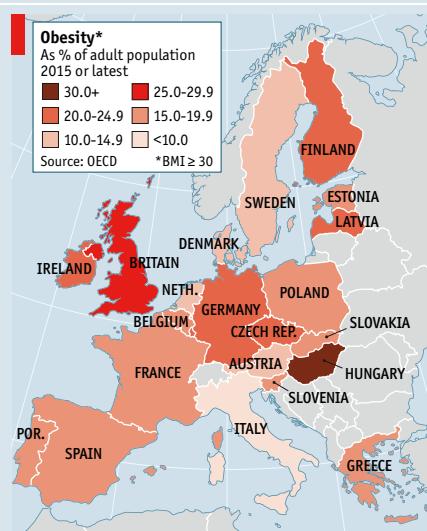
Taxes to trim waistlines are spreading across Europe

VISIT any culinary establishment in Budapest and some of the reasons why Hungary is the most obese country in Europe will soon become clear. In the coffee houses, you'll see *dobostorta*, a five-layer chocolate buttercream concoction topped with glazed caramel; *somloigaluska*, a chocolate and rum sponge cake; and *gesztenyepure*, a chestnut purée served with whipped cream. In markets you can buy slabs of fried dough covered in cheese, bread served with goose fat and lumps of lard and, of course, lashings of goulash.

According to new data released by the OECD, a club of mostly rich countries, almost two-thirds of Hungarians are overweight and nearly a third are obese. Hungarians eat fewer vegetables than most people in the rich world and more salt than any other EU state. Educated Hungarian men are at least as likely to be overweight as their unschooled male compatriots. Uneducated Hungarian women are 60% likelier to be obese than educated women; in slim Italy uneducated women are three times more likely to be obese. Hungarians' life expectancy is five years below the EU average: 76.

In 2011 Viktor Orbán, the prime minister, declared that those who “live unhealthily” would have to pay more tax. That year his government, led by the populist Fidesz party, introduced one of the broadest levies on unhealthy foods in the world. Dubbed the “chips tax” it applies to sugar, salt, fat, booze and energy drinks. The rate changes depending on the type of food: the tax adds 250 forints (\$0.91) to the cost of a litre of energy drink, for instance, and 500 forints to the cost of a kilogram of jam.

The policy has had some success. One review showed that 40% of manufacturers tweaked their recipes to use fewer



unhealthy ingredients. Another study found that consumers shifted to cheaper, often healthier products. Three years after the tax was introduced, the consumption of sugary drinks had fallen by a tenth, says Michele Cecchini, an analyst at the OECD. By 2015 the tax had generated 61.3bn forints to help cover the cost of public health care.

Other European countries are also attempting to trim waistlines by performing paysliposuction. In 2011 Denmark introduced a tax on saturated fats. Just 15 months later, however, as prices rose and Danes began popping over to Germany or Sweden to load up on lard, the policy was abandoned. In 2018 Britain (the second most obese country in Europe) will introduce a sugar tax that is expected to add 8p to a 70p can of Coke. Spain and Estonia have announced similar plans. Hungary's example may tip the scales in Europe's fight against fat. Hold the dumplings and pass the cucumber salad.

Welfare and migrants

A new Scandi model

STOCKHOLM

Immigration is changing the Swedish welfare state

AT THE height of the migrant crisis the Sweden Democrats, a populist anti-immigrant party, released a video. Over images of burnt-out cars and groups of homeless people it read: "No money. No jobs. No homes. No welfare. Welcome to Sweden." The message, like a previous video from the party in which burqa-clad women race ahead of an old Swedish lady to grab a share of public funds, was hysterical. But it touched on a real problem: large-scale immigration is putting a strain on Sweden's welfare system.

Sweden's welfare system
Sweden has long been admired for its blend of prosperity and social cohesion. Its model combines high taxes, generous welfare, collective bargaining, high educational standards and a reasonably free-market economy. The result is high living standards: the lowest wages, for example in hotels or restaurants, are far higher than minimum wages elsewhere in Europe says Marten Blix, a Swedish economist. Relative to other countries that have comparable data, Swedish men in manufacturing earn the highest minimum wage.

Aspects of this welfare state have long seemed unsustainable, with an ageing workforce and a recent rise in the number of sick-leave absences taken by employees. Some changes were made in the 1990s: the pension system is far less generous than it used to be, and much more school choice was introduced. But the influx of hundreds of thousands of refugees from Syria, Afghanistan and elsewhere in 2015 has put huge extra pressure on the system. To cope, Sweden needs to reform benefits, build more houses and boost the number of doctors and teachers outside big cities. If it does not, the country will struggle to absorb so many culturally dissimilar migrants—and anti-immigrant views may be-

Pressure cooker

Swedes who think that immigration is one of the three most important social issues, % polled



Source: SOM Institute, the University of Gothenburg

▶ come mainstream.

The government, led by the Social Democrats, has made a few tweaks to the welfare state. Previously, failed asylum-seekers would receive a cash benefit (of around 1,200 SEK, or \$140 a month) and housing; this was scrapped last year. On May 31st the government voted to limit paid parental leave for immigrants: previously, refugees could claim the full amount of paid leave (480 days per child under the age of eight). Now they can only do so if the child is under one year old. The benefit will also be limited in big families. (This change does not apply to Swedes.)

But these changes do not deal with the biggest problem: a rigid labour market which prevents unskilled workers from getting a foothold. As a result, Sweden has one of the largest gaps in employment between native and foreign-born workers. After nine years in Sweden, only half of immigrants have a job. Even after 20 years of residency, foreign-born workers are less likely than the native-born to have jobs. If they cannot work, they will not pay tax. This will undermine the welfare state both directly (because they will not pay for it) and indirectly (because locals may resent supporting so many foreigners). The only way that the newcomers will integrate and contribute is if they have jobs, and that probably means starting at the bottom.

For decades Sweden consciously tried to get rid of low-skilled service jobs, says Karin Svanborg-Sjovall, of Timbro, a free-market think-tank. "We are fanatics about equality here," she says. These jobs now need to come back to help newcomers. In March the LO, an umbrella body for blue-collar trade unions, indicated that it would accept lower wages for unskilled workers for a short period of time if they were also given the equivalent of a high-school education. So far nothing has happened.

A few local schemes have attempted to step in where the government has failed. In Landskrona, a town of 40,000 people near the southern tip of Sweden, a laundry was opened in May in order to employ low-skilled workers; previously, the washing would be shipped over to Copenhagen.

Around two-thirds of those employed there are foreign-born or refugees. "We have tried to create a market for 'simple jobs,'" says Torkild Strandberg, its liberal mayor. "We have begun delivering while others are talking."

Swedes are generally more sanguine than other Europeans about immigration. But a survey from the University of Gothenburg finds that the issue has become more fraught (see chart). Research by Clara Sandelind for Demos, a British think-tank, shows that talk of "Swedish values" is on the rise: they were mentioned 1,600 times in newspapers and blogs last year, up from 286 times in 2012. A recent poll put support for the Sweden Democrats at 24%, almost double their share of the vote in 2014. Centre-right and liberal parties, with an eye on the election next year, propose a benefit cap and tying benefits to schemes to promote integration. But without big changes the welfare system could buckle, and with it, Sweden's generous culture. ■

Italy's Mafia

The end of the boss of bosses

ROME

A dispute over how to deal with an aged "godfather" raises awkward questions

WHAT place, if any, has humanity in a fight with barbarism? On June 5th such a question was posed in an unusual fashion in Italy when the country's highest appeals court hinted that Salvatore "Totò" Riina should be freed to "die with dignity". As the head of the Sicilian Mafia, Cosa Nostra, Mr Riina is credited with ordering or committing several hundred murders, including those in 1992 of two of Italy's modern heroes, Giovanni Falcone and Paolo Borsellino, two anti-Mafia prosecutors.

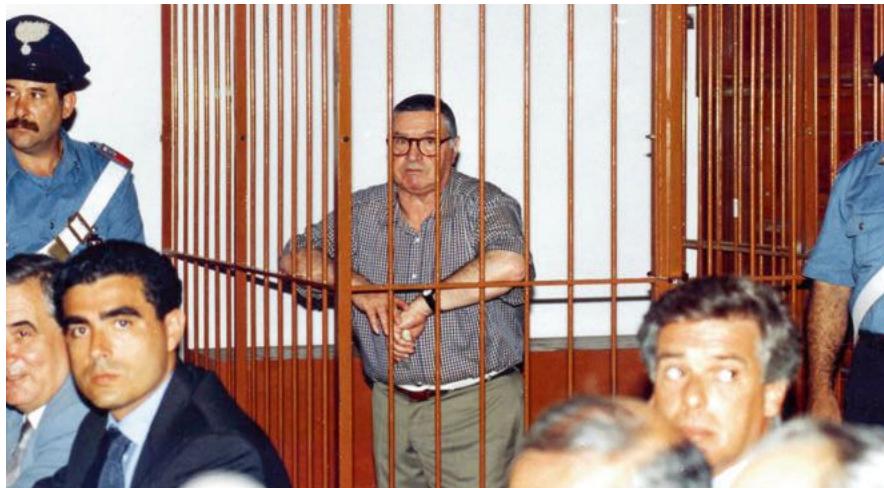
The judges said a lower court's rejection of an application for house arrest by Mr Riina (pictured) had not offered proof that he still posed a threat. The lower-court judges must now rewrite their verdict. If it is again judged unsatisfactory, the 86-year-old "godfather" could end his days in his home town of Corleone, in Sicily.

Also known as *la belva* (The Beast), Mr Riina is an exceptionally ferocious mobster. Under his command a 14-year-old boy was strangled before his body was dissolved in acid. After snatching the leadership of the Corleone "family", Mr Riina took on the established clans in the Sicilian capital of Palermo, sparking a Mafia war that cost several hundred lives. Once he was recognised as the undisputed chief of Cosa Nostra, he led it into a terrorist onslaught on the state, which culminated in the assassination of the two prosecutors.

Paolo Borsellino's brother, Salvatore, said the judges should "not even begin to think of a dignified death for an animal like Totò Riina". Relatives of the prisoner's victims sneered that Mr Riina had scarcely given their loved ones a dignified end. Though he has tumours on both kidneys, Mr Riina remains subject to the strict regime designed to ensure that Mafia bosses cannot escape or communicate with their subordinates outside. He attends court hearings that concern him via a video link, lying on a trolley bed.

Politicians are divided on the issue: the leader of the populist Northern League, Matteo Salvini, deplored the court's ruling; his party colleague, Roberto Maroni, a former interior minister, supported it. Several commentators protested that Mr Riina could receive adequate medical treatment in jail. Others questioned that; he is said to need an adjustable bed that cannot fit through the door of his cell.

Whether Mr Riina remains a threat depends in part on whether he is still Cosa Nostra's *capo di tutti i capi* (boss of all bosses). It was once widely thought that, ►



Caged Beast

► after his arrest in 1993, overall command passed to his associate, Bernardo Provenzano, and that since Provenzano's arrest in 2006 (he died last year) the supreme commander has been a godfather from Trapani, Matteo Messina Denaro. But Italy's chief anti-Mafia prosecutor, Franco Roberti, hinted at new evidence that Cosa Nostra's mobsters have never ceased to regard him as their chief, despite his long

spell behind bars.

Mr Roberti also noted that, despite the restrictions on him, Mr Riina had managed to issue at least one death threat from jail, against a prosecutor who has been probing claims that representatives of the government negotiated with Cosa Nostra. Another experienced anti-Mafia investigator, Nicola Gratteri, said: "A boss like Riina can even give orders just with his eyes." ■

from leaving home, but also to make him seem unpoplar.

The tactic failed. The protests in March were the largest since people took en masse to the streets 2011. This suggests that Mr Putin's efforts to make voters forget about the national malaise by rallying them around the flag are not working as well as he hoped. Even after he annexed Crimea and started a war in Ukraine, Russians are still gloomy.

The political mood has changed over the past six years. The protests in 2011 were good-natured, mostly in Moscow, led by journalists and artists and lacked political leadership. Now the protest is angrier, geographically broader and involves younger people, many of them teenagers. Their main grievance is that the government offers them no appealing vision of the future. Elena Omelchenko of the National Research University in Moscow argues that the protests demonstrated a "demand to bring moral order" back to Russia. Protesters complain of the injustice, hypocrisy and cynicism of daily life. "Corruption steals our future" is their slogan.

The new generation of protesters are hard for the Kremlin to win over. They eschew television in favour of YouTube videos and social media. Here, Mr Navalny has a clear advantage. He is banned from state television, but what of it? He rejects its output as propaganda and offers a digital alternative. His investigative film about the castles and yachts amassed by Dmitry Medvedev, Russia's prime minister, has been viewed over 22m times. It has also prompted an angry response from Alisher Usmanov, an oligarch, who is now suing Mr Navalny for defamation.

Even though he rarely appears on television, most Russians recognise Mr Navalny. For now, they largely disapprove of him, having been told by their government that he is a criminal. But this could change: in the most recent parliamentary elections 52% of Russians did not vote. If even a quarter of these abstainers chose to believe Navalny's message that Russians can live better, the political landscape would shift dramatically, argues Leonid Volkov, the head of Mr Navalny's campaign.

Fight for the flag

Mr Navalny's task, for now, is to persuade people that he is a viable alternative to Mr Putin. To do so, says Mr Volkov, he must gain such a high profile that if he is not on the ballot, the election will not seem legitimate. To this end, he has called for an even larger rally, complete with flags, on Russia's independence day, June 12th, in 150 cities. Few Russians remember that the day both marks the anniversary of Russia declaring itself partially independent from the Soviet Union, and the election of Boris Yeltsin as Russia's first president. Mr Navalny is determined to refresh their memory. ■



Russia's opposition

The contender

MOSCOW

Still recovering from an acid attack, Aleksei Navalny continues to defy the odds

INSIDE a modern business centre in Moscow, of the kind that has mushroomed across Russia in the 17 years that Vladimir Putin had been in power, a team of 30-year-olds are making plans to replace the president with Aleksei Navalny, a 41-year-old former lawyer and anti-corruption crusader. Perched on the edge of white desks or lounging on red bean bags, Mr Navalny's team exude youthful confidence as they discuss last-minute preparations for a big rally. It all looks like a normal presidential election campaign. Indeed, Mr Navalny's staff have studied the methods of American candidates such as Donald Trump and Bernie Sanders. But this being Russia, nothing is what it seems.

For a start, the campaign for Russia's presidential election in 2018 has not yet begun. Once it does, Mr Navalny is unlikely to get on the ballot. A trumped-up conviction for embezzlement in 2013, though dismissed by the European Court of Human Rights, bars him from being registered. If that was not enough to put him off, he has already suffered a campaign of intimidata-

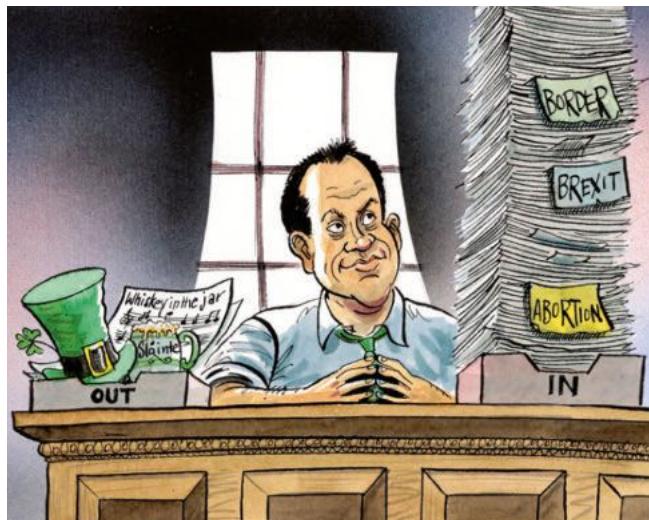
tion. On April 27th thugs threw green anti-septic mixed with acid in his face. The day your correspondent visited his election headquarters, Mr Navalny was in a clinic in Spain, having stitches removed after eye surgery to bring back his sight.

None of this is likely to stop Mr Navalny and his team, who claim to have seized the initiative. Over the past few months Mr Navalny has managed to mobilise volunteers, mostly through social media. His team boast they have opened 77 campaign headquarters in 65 regions. Such speed has caught the Kremlin by surprise.

On March 26th Mr Navalny brought thousands of people onto the streets in 90 Russian cities to protest against corruption. "The Kremlin did not expect Navalny to start making trouble until the Autumn," says Valery Fedorov, the head of VTSIOM, an opinion pollster. For now the government is trying to avoid further escalation. Physical attacks have mostly stopped. In the past Mr Navalny was pelted with eggs and tomatoes in nearly every town he visited. The aim was not simply to deter him

Charlemagne | A task for Gob Almighty

Leo Varadkar, Ireland's first gay leader, will find bigotry much less of a problem than Brexit



VARAD the impaler”, “Leo the Lion”, “Gob Almighty”. Any self-respecting Irish politician acquires a range of colourful nicknames, and those attaching to Leo Varadkar, whom parliament will, barring disasters, elevate to prime minister on June 13th, are nothing unusual. If none of them refers to the attributes that have earned Mr Varadkar global attention—that he is half-Indian, gay and, at 38, his country’s youngest-ever leader—that is testament to a society that has lost interest in the bigotries that marked public life in the not-too-distant past.

“Prejudice has no hold in this republic,” declared Mr Varadkar to a rapturous crowd at Dublin’s Mansion House on June 2nd, after winning the leadership of Ireland’s ruling, centre-right Fine Gael party. His rousing words satisfied outsiders seeking a good yarn about a country that decriminalised homosexuality only in 1993, but were atypical for a man who has been reluctant to use his minority status to advance his politics. Indeed, some Irish left-wingers sniffed hypocrisy from a politician who in his time has spurned such causes as gay adoption and once suggested paying unemployed immigrants to return home.

Mr Varadkar is both less and more interesting than that. His identity is not leashed to his politics in the manner of, say, Barack Obama, whose victory hinted at deliverance from America’s deepest trauma. In 2015 he came out as gay in the gentlest of fashions, during a radio interview a few months before Ireland became the first country to pass same-sex marriage by referendum. Comparisons to Emmanuel Macron, France’s fresh-faced new president, are also off the mark. Whereas Mr Macron single-handedly upturned France’s political establishment, Mr Varadkar has taken a familiar route to the top: schooled expensively in Dublin, he used the youth wing of Fine Gael as a springboard to local government, a seat in the parliament and a string of ministerial jobs after his party took office in 2011.

Articulate but sometimes awkward, Mr Varadkar is not wholly comfortable in the back-slapping world of Irish politics. Yet he secured his Fine Gael victory the old-fashioned way, quickly locking in support among his fellow MPs, whose votes counted disproportionately in the contest. His ministerial career, which includes stints running the big-spending departments of health and social protection, is unmarked by either triumph or catastro-

phe. What has distinguished him is a relaxed approach to ruffling feathers and a growing taste for ideological flexibility.

During the Fine Gael leadership campaign, for example, Mr Varadkar tacked right with a crackdown on welfare cheats, garnished with a Mitt Romney-esque jab at those “who believe they should be entitled to everything for free”. Some other proposals hint at a preference for the free market. Subsidies could be phased out for first-time homebuyers, while effective income-tax rates would be kept below 50%. In response Fianna Fail, the main opposition party, despairs Mr Varadkar as a “Thatcherite”. Yet that is not quite right either: he also speaks of a “new social contract” and promises an investment splurge, funded by more of a leisurely approach to debt-reduction.

The big question is how Mr Varadkar will tackle the daunting in-tray he inherits, from Ireland’s antediluvian health-care system to accusations of police corruption. A strong recovery after Ireland’s banking crisis may provide a tailwind, but non-economic tests lie ahead, too. Ireland’s constitutional ban on abortion is likely to be placed before voters next year. Mr Varadkar’s stated preference for a limited liberalisation may come close to the median Irish view, but he must tread carefully on an issue that, unlike gay rights, retains the power to divide. Mr Varadkar must also manage a minority government that Fianna Fail could bring tumbling down at any moment.

And then there is Brexit. The departure of Ireland’s main European trading partner from the single market will force difficult questions on this export-dependent economy. Yet more pressing is the threat to prosperity and peace posed by a possible “hard” border between the Republic and Northern Ireland, which will quit the European Union along with the rest of Britain. Mr Varadkar’s suggestion is to keep the north inside the EU’s customs union, an ingenious but unworkable idea that would in effect shift some border controls to the Irish Sea.

Hipster politics

In some respects—his instinctive pro-Europeanism, his friendliness to business—Mr Varadkar sits squarely in the contemporary Irish tradition. But his political style may mark something of a rupture. He feels no compulsion to indulge paddy-whackery by playing up to stereotypes of false bonhomie or to subsume politics under personal relationships. As one observer puts it, Mr Varadkar’s fellow EU leaders, whom he will meet at a summit in Brussels later this month, may have to get used to “that most unusual of things: a cold-blooded Irishman”.

So how might he leave his mark? After joining Mr Macron on the campaign trail in Paris in April, Mr Varadkar declared his allegiance to the view that the old left-right divide in politics is yielding to a fresh rupture between open and closed. A rethink of the way politics is conducted in Ireland might appeal to parts of an electorate badly served by parties that remain relics of the battle for independence from Britain in the 1920s. Here lies one possible course for Mr Varadkar’s premiership.

But failure cannot be ruled out. Mr Varadkar takes office under trying circumstances without the benefit of a popular mandate. If his rapid ascent hints at an instinct for calculation, on policy his fundamental views remain elusive. Flexibility will prove useful in navigating Brexit and Ireland’s domestic challenges. But if he is to meet the expectations some have heaped upon him, Leo the Lion will need to demonstrate deeper reserves of political steeliness than Ireland has yet demanded of him. ■



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Britons were voting as
The Economist went to press.
For continuing coverage of the
election see

Economist.com/ukelection2017



Terrorism

More money or more power?

Another attack sparks a debate on what police need to stop future atrocities

IF TERRORISM'S success is measured by its disruption of a city's way of life, the reaction of Richard Angell exposes the fanatics' failure. "If me having a gin and tonic with my friends and flirting with handsome men...is what offends these people so much, I'm going to do it more, not less," Mr Angell, an eyewitness to a terrorist attack on June 3rd, defiantly told the BBC.

The details of the attack are grimly familiar. Three men rammed a van into pedestrians on London Bridge before stabbing people in restaurants and bars around nearby Borough Market. Eight minutes after the first call to the emergency services, police shot all three dead, but not before the perpetrators had killed eight and injured dozens more.

It was Britain's third deadly terrorist attack in as many months. As after a similar incident on Westminster Bridge in March and the bombing of a concert in Manchester in May, Theresa May expressed her outrage. But she went further: the country "must not pretend that things can continue as they are. Things need to change."

One of those things, she said, is that extremism should be curbed online (see International section). Violent Islamist ideology should be more readily identified and squashed. And Britain's counter-terrorism strategy should be reviewed to ensure that law-enforcement agencies have the pow-

ers they need, including longer sentences for terrorism offences. She added that this could mean changing human-rights laws to restrict the movements of suspects and ease their deportation (two of the London Bridge plotters were foreign nationals).

Few experts think that Britain's police or security services lack powers. Theirs are as extensive as those of any Western counterpart, says David Anderson, a former statutory reviewer of the country's anti-terrorism legislation. Police can hold suspects without charge for up to 14 days, much longer than in most democracies. "Temporary exclusion orders", only one of which has been issued, allow the government to prevent Britons merely suspected of fighting with foreign terrorist groups from re-entering the country. "Terrorism prevention and investigation measures", also rare, impose curfews on and exclude from certain places those believed to be involved in terrorism, even if they have not been convicted. Police and intelligence agencies may access large quantities of personal data, subject to judicial permission.

Criminalising actions such as encouraging terrorism is intended to allow officers to intervene before more serious crimes take place, says Lord Macdonald, a former director of public prosecutions. During his time, at least, the wife of a terrorist who failed to report a plot was more

likely to be prosecuted than the wife of an armed robber. The sentences for some of those lesser crimes could perhaps be increased, he suggests, but the likelihood of getting caught is a bigger deterrent than the severity of the punishment.

At least one of the London Bridge assailants, as well as the Manchester and Westminster attackers, had in the past come to the attention of the authorities, before being put on one side. That has raised questions about whether the police and security services are overstretched. Jeremy Corbyn, the Labour leader, accused the prime minister of trying to protect the public "on the cheap". He is only partly right. The budget for counter-terrorism policing rose from £579m (\$750m) in 2010-11 to £633m in 2017-18. The intelligence agencies were given the go-ahead to recruit almost 2,000 extra officers in 2015, as the threat from Islamic State emerged.

But the general police budget has been slashed. The number of officers in England and Wales dropped from about 144,000 in 2010, when Mrs May became home secretary, to 124,000 in 2016. England and Wales have fewer police per person than countries such as France, Germany and Italy. The number of armed officers has fallen by about 700 from nearly 7,000 in 2010. After a spate of terrorist attacks in France in 2015, David Cameron, Mrs May's predecessor, ordered that their ranks be boosted. But that has proved hard. It is a dangerous job, subject to criticism and scrutiny.

Crime has been dropping steadily, so reducing officer numbers is reasonable. But the cuts have come as police face other pressures. Officers say that a squeeze on social services has left them spending more of their time dealing with people with mental-health problems, for instance. ►

► Neighbourhood officers build the relationships that lead to people sharing information on shady characters. But keeping their numbers up is expensive.

On efforts to combat extremism at its roots, Mrs May was most vague. Recent governments have struggled to define it. A tendency to conflate religious conservatism with the kind of fanaticism that feeds violence has undermined efforts to root out terrorism. This has sometimes frustrated Prevent, the government's counter-radicalisation programme. It is the only serious scheme of its kind in Europe, says Thomas Hegghammer, an expert on violent extremism. He argues that Prevent's structures and principles are sound, but that its intentions have been misunderstood. Muslims fear that it focuses on them alone, although in reality it targets extremism of all varieties, including the far-right.

It also needs to be more transparent, suggests Mr Anderson, making clear how success is measured, and should involve more young Muslims. Fixing its reputational problem is crucial. But that will not happen quickly. In the meantime, the plots will keep coming. ■

Negotiating Brexit

The hardest test

BRUSSELS

The new government faces big obstacles to securing a deal

THE next parliament will be dominated by Brexit. Formal negotiations are due to start in Brussels in the week of June 19th. Besides their sheer complexity, there are three big reasons why they are so daunting. The European Union is better prepared than the British; the gap between the two sides is widening; and the clock is ticking to March 2019, when Brexit is due to happen.

Preparations are clear in Brussels. The European Commission has a Brexit team, led by Michel Barnier, working under a negotiating mandate from the 27 other EU governments. The key Article 50 council working group, chaired by Didier Seeuws, is meeting twice a week. Officials liken the process to accession negotiations in reverse. That is not reassuring for Britain: as Charles Grant of the Centre for European Reform, a think-tank, notes, accession talks consist more of take-it-or-leave-it offers than real negotiations. And so far the EU 27 have proved both united and hardline.

In contrast, Britain seems ill-prepared, and not just because of the election. Eurocrats say they have spent much time debating Brexit with British officials, only to find this not reflected at political level. Mujtaba Rahman of the Eurasia Group, a consultant-

cy, reports that Brussels is confused even about whom it is negotiating with: the prime minister, the Brexit secretary or senior officials. That the talks will be conducted more or less in public, with even draft papers published in full, will make things trickier for London.

So will the widening chasm between the two sides. Within the EU, that is down to pressure from national capitals, not Brussels. One Eurocrat calls the negotiating guidelines "maximalist, even surreal". Yet it will be hard to change them. A good example is sequencing. The British want to talk about a trade deal from the outset, pointing out that Article 50 talks of "taking account of the framework for [Britain and the EU's] future relationship". But the EU insists that such talks can happen only after "sufficient progress" is made on the divorce terms. Mr Barnier's team will not be allowed to deviate from this decision.

Making sufficient progress will be testing because the two sides are so far apart on the three main divorce arguments. The first is protecting EU citizens resident in Britain and vice versa. All parties accept this in principle, and the British say it can be dealt with fast. Yet the details are fiendish; and the EU's demands give their citizens in Britain more rights than Britons, with full protection by the European Court of Justice (ECJ). No British government can agree to this, as even Labour's Brexit spokesman, Sir Keir Starmer, concedes.

The second problem is how to avoid a hard border with customs checks in Ireland. Again, all sides agree in principle. But since Britain is heading for a hard Brexit, leaving the EU's single market and customs union, it will be difficult to avoid a border in practice. Much agrifood trade takes place between north and south: what happens if a post-Brexit Britain no longer applies the EU's high (and rigid) phytosanitary standards, say?

Third and toughest is the money. On this, one Eurocrat talks of an unholy alliance of countries that are net contributors to the EU budget and those that are net recipients. The one thing all agree upon is to extract as much as they can from Britain. That is why the gross Brexit bill has mushroomed to as much as €80bn-100bn (\$90bn-112bn). No government in London would pay so much. Yet the notion that it might be possible to avoid numbers by merely accepting a methodology to calculate the bill will not work either; once the method is clear, it does not take a genius to work out the figures.

As one EU diplomat concludes, all this makes it unlikely that sufficient progress will be made by October, or even December. That could mean talks on trade starting only in February 2018. The idea that they can be concluded in a year is a fantasy. Eurocrats say the depth of the relationship makes a deal with Britain far more com-

plex than any others the EU has. They add that it will need ratification by national and some regional parliaments: a court ruling that a simple trade deal can be approved by a majority cannot apply to one that covers many services, regulatory standards and non-tariff barriers as well.

This point, plus the ticking clock, leads to another conclusion: the need quite soon to talk of transitional arrangements. Airlines, drugmakers and other businesses want assurances in early 2018 that their cross-border activities will not just cease in March 2019. Yet negotiating a transitional deal will itself be tricky. Another EU diplomat notes that its terms depend on whether it is a bridge to a future deal or a mere phasing-out. Moreover, the EU will surely insist on any transition keeping the status quo, including free movement of people, budget payments and the ECJ. That will be awkward for Britain.

The underlying mood may be unhelpful. Brussels is not impressed by talk of no deal being better than a bad deal, seeing the implied threat as empty since Britain would suffer the most. But there is still some concern that a post-Brexit Britain could undercut the EU in its social, fiscal and environmental practices. Most parties in the election have made promises not to do this, but the EU remains nervous.

Moreover, no party has faced what Anand Menon of the UK in a Changing Europe network calls the biggest question of all. As a new report from his group points out, a hard Brexit is predicted to cut Britain's annual GDP by a net 2.4%, and much more if immigration is curbed. Yet nobody has even begun to debate how to share out such a large future drop. Brexit negotiations may be tough, but living with lower incomes afterwards could be tougher. ■



Bagehot | The second eleven

The British political class is not up to the job



IT HAS been impossible to watch the general election without being haunted by a single question-cum-exclamation: surely Britain can do better than this? The best performer in the campaign, Jeremy Corbyn, the Labour leader, is a 68-year-old crypto-communist who has never run anything except his own mouth. Theresa May, the Tory leader, tried to make the election all about herself and then demonstrated that there wasn't much of a self to make it about. As for Tim Farron, the Liberal Democrats' leader, he looked more like a schoolboy playing the part of a politician in an end-of-term play than a potential prime minister.

Complaining about the quality of your leaders is an ancient tradition: Gladstone's older contemporaries no doubt moaned that he wasn't a patch on Pitt the Elder. George Osborne, a former Tory chancellor, has had an enjoyable election skewering Mrs May from the editor's chair at the *Evening Standard*, a London newspaper. But only four years ago that same organ was skewering Mr Osborne for his "omnishambles" Budget. And Britain's leadership problems pale compared with those of America, where Donald Trump crashes from one disaster to another.

Yet sometimes decline really is decline. Both Mrs May and Mr Corbyn want to extend the already considerable powers of the government, Mr Corbyn massively so. And both promise to lead Britain out of the European Union, a fiendishly complicated operation. Unfortunately, both candidates have demonstrated that they are the flawed captains of flawed teams. Mrs May broke the first rule of politics: don't kick your most faithful voters in the teeth for no reason. Mr Corbyn has stood out in part because his team is so mediocre. Diane Abbott, his shadow home secretary, stepped down the day before the election citing ill health, after a succession of disastrous interviews.

In 1922 Winston Churchill dubbed Bonar Law's coalition government the "second eleven" because so many top players, including Lloyd George, refused to serve in it. Today both major parties are fielding their second elevens—Labour because of the rise of the far-left and the Tories because of Brexit. On the left, three-quarters of Labour MPs have concluded that Mr Corbyn is not fit to run their party, either personally or politically, scuppering their chances of a front-bench position. On the right, Brexit has hollowed out the party. Several prominent Remainers (in-

cluding David Cameron and Mr Osborne) have retired, while several leading Leavers (such as Boris Johnson and Michael Gove) are seriously weakened. The Conservative Party chose Mrs May because she hadn't expressed any strong opinions about the most important question of her time.

There are also deeper reasons. For most of the 20th century British politics has enjoyed an embarrassment of riches. Britain's competing elites directed their most gifted offspring towards Parliament. The landed aristocracy sent Churchill and the Cecil clan. The business crowd offered Harold Macmillan and the Chamberlain dynasty. The trade unions put forward Ernest Bevin, Nye Bevan and James Callaghan. And the meritocratic elite sent intellectuals galore—so many, in fact, that the 1964–66 Labour cabinet contained seven people with first-class degrees from Oxbridge. (Mr Corbyn left school with two grade "E"s at A-level.)

There was plenty of dross among the gold, of course: Tory knights of the shires who didn't care about much except badger culling and Labour trade-unionists who were only there for the beer. But the gold shone brightly. And it was well distributed between the major parties, with the Tories mobilising the forces of property and Labour the workers and intellectuals. Today it is as if Britain's various elites have all decided, at exactly the same time, to stop sending their best people to Parliament.

It is harder to sell landed aristocrats to the people than it used to be. The trade unions are shadows of their former selves. But there is one big reason. Over the past 30 years politics has become a profession. Yesterday's tribunes of the people, or at least of the people's leading interest groups, have been replaced by professionals who make their livelihood out of politics. The trouble is, it turns out that politics is not a very attractive profession.

A sticky wicket

Most people crave two types of rewards: material (money and security) and psychological (esteem and fulfilment). Politicians don't get much of any of this. They have seen their salaries fall relative to the sort of jobs that their university contemporaries go into, such as banking, consultancy and the law. They endure horrendous workloads: constituencies to nurse, speeches to make and, if they are ministers, huge departments to run. They live with the possibility of having the rug pulled from under their feet by electoral misfortune or personal scandal. And the public treats them with a mixture of suspicion and contempt. The proportion of Britons telling pollsters that they almost never trust the government has risen from one in ten in 1986 to one in three today. The biggest reward for putting up with all this is nebulous: the sense that you are part of the whirl while history is being made.

There are a few things that can be done to slow the decline. One is to give more respect to age and experience in selecting MPs. Parliament is over-stuffed with young former aides. Selection committees need to pay more attention to candidates who have already succeeded in other professions. A second is to broaden the talent pool. Margaret Thatcher used the House of Lords to bring in business people such as David Young. Gordon Brown did the same to try to create an administration of "all the talents". The devolution of power to the cities may also provide another road to the top. If Britain embraces these and other ideas the electorate might face a more inspiring choice at the next election. But it is too late to do anything about the current mess: whoever wins the election, Britain will go into bat against Brussels with one of the weakest teams it has fielded in decades. ■



Terrorism online

Fighting the cyber-jihadists

Also in this section

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LONDON AND SAN FRANCISCO

Tech giants are under fire for facilitating terrorism. Though that is unfair, there is more they could do

AFTER last weekend's terrorist attack in London Theresa May, Britain's prime minister, declared that "enough is enough." She was not suggesting that some reasonable amount of terrorism had now been exceeded; rather, that extremism had been too readily tolerated in the past. She specifically criticised the big internet firms. "We cannot allow this ideology the safe space it needs to breed," she said, adding that Britain and its allies needed to "regulate cyberspace to prevent terrorist and extremist planning".

The threats Mrs May and other political leaders identify online are twofold. The first is the extremist material that spews from jihadist websites and chat-rooms and spreads across social media. The second is terrorists' ability to communicate via encrypted messaging apps. Together, they create an online echo chamber that amplifies anti-Western messages and helps propel a few individuals on their journey towards murder.

The three men who stabbed and rammed Londoners in the latest attack were not classic "lone wolves", radicalised online and invisible to the security services until they acted. They were part of a London-based group that supports Islamic State (is) and is linked to Al Muhajiroun, a banned Islamist organisation. At least one

of them was known to law enforcement. According to the Henry Jackson Society, a British think-tank, a quarter of all those convicted in Britain for offences related to Islamist terrorism between 1998 and 2015 were affiliated to Al Muhajiroun.

But evidence is emerging of the role the internet played in reinforcing the three men's extremism and helping them to plan their attack. One, Khuram Butt, had links to Mohammed Shamsuddin and Abu Haleema, two extremist preachers. The latter has a hefty following on YouTube and is thought to have been partly responsible for the online radicalisation of an Australian teenager convicted last year of plotting to behead a police officer. Abu Haleema was arrested on suspicion of encouraging terrorism, then released on condition that he stopped using social media to spread his views. His Twitter account was closed at the request of MI5, Britain's security service; YouTube is reported to have refused to take down his videos.

Mr Butt was also reportedly influenced by the online videos of Ahmad Musa Jibril, an American preacher and is recruiter, which YouTube still carries. According to the London-based International Centre for the Study of Radicalisation and Political Violence, more than half of a sample group of foreigners who had gone to Syria to fight

for IS followed Mr Jibril on Twitter.

The London attackers probably also used jihadist websites to help them plan. Instructional videos showing how to kill as many people as possible by driving into them are not hard to find. And judging by past attacks, the perpetrators may well have communicated through an "end-to-end" encrypted messaging app such as WhatsApp or Telegram.

Radicalisation superhighway

Fears that the internet is promoting and enabling Islamist terrorism are not new. But they have become sharper since 2014, when IS established its "caliphate" in parts of Syria and Iraq. It has put much more effort than its older rival, al-Qaeda, into creating sophisticated online propaganda, which it uses to recruit, promote its ideology and trumpet its social and military achievements. It puts as much attention into digital marketing as any big company, says Andrew Trabulsi of the Institute for the Future, a non-profit research group. "It's a conversion funnel, in the same way you would think of online advertising."

At first, IS's aim was to recruit foreign fighters to Syria and Iraq, where they would help build the caliphate. Around 30,000, including some 6,000 from Europe, heeded its call. But as the tides of war ➤

▶ have turned (western Mosul, its last big redoubt in Iraq, is about to fall, and Raqqa, its "capital" in Syria, is under assault by the American-backed Syrian Democratic Forces), it is turning its energies to creating mayhem in the West, in particular Europe. Through its various outlets, including *Rumiyyah*, an online English-language magazine, it is asking supporters not to travel to Syria or Iraq, but to kill people at home.

IS's media operation was portrayed in a report published in 2015 for the Quilliam Foundation, a counter-extremism think-tank in London. "Documenting the Virtual Caliphate" described an outlet that released nearly 40 items a day, in many languages, ranging from videos of battlefield triumphs and "martyrdom" to documentaries extolling the joys of life in the caliphate. Each wilayat or province of the caliphate has its own media team producing local content.

Unlike al-Qaeda, which aims its messages at individual terror cells, IS uses mainstream digital platforms to build social networks and "crowdsource" terrorist acts. Its Twitter supporters play whack-a-mole with moderators, setting up new accounts as fast as old ones are shut down. Some accounts broadcast original content; others promote the new accounts that replace suspended ones; others retweet the most compelling material.

When IS releases a new recruitment video, its supporters spring into action. Rita Katz of the SITE Intelligence Group, a Washington-based firm that tracks global terror networks, analysed what happened to "And You Will Be Superior", a 35-minute video released in March that follows suicide-bombers, from a doctor to a disabled fighter to a child. Translators, promoters, social-media leaders and link-creators joined together to promote it across the internet. One of these groups, the Upload Knights, creates hundreds of links daily across streaming and file-sharing sites. Ms Katz found that in the two days after the film's release, it distributed the video with 136 unique links to Google services (69 for YouTube, 54 for Google Drive and 13 for Google Photos).

Network effects

There is no doubt that the way IS uses the internet adds greatly to the fear that terrorists set out to foster. But security experts differ in their assessment of its overall impact. "If there is a message that resonates, it will get out there," says Nigel Inkster, a former intelligence officer now with the International Institute for Strategic Studies in London. What the internet has changed, he says, is the speed at which the message travels, and its ubiquity.

A counter-terrorism expert at Britain's Home Office agrees: "The internet has allowed the process of radicalisation to evolve, but it has not revolutionised it." Al-

though online jihadist content can trigger or reinforce radicalisation, it is rarely enough on its own. Creating a terrorist usually requires grooming through offline social networks that provide the camaraderie of shared purpose and the personal bonds which create feelings of obligation.

There is, however, broad agreement that the internet both amplifies the impact of terrorism and launches some disaffected youths on the path to jihad. The violent images they view desensitise them. Propaganda validates their extremist ideology, provides them with the support of a community and primes them to act by emphasising purification through sacrifice.

All this puts the big internet firms in a bind. They have no interest in helping users spread extremism, and already ban pro-terrorist content in their terms and conditions. But they have been slow to police



false news and extremist propaganda, lest they be accused of making editorial judgments about what can be shared on their platforms. They have mostly relied on reporting systems, whereby users flag extremist content and companies decide whether to remove it after reviewing it. This is cumbersome, slow and costly. Facebook recently announced that it plans to double its workforce of content moderators, hiring another 3,000.

In the 1990s, under pressure from governments, internet firms cleared most child pornography from their platforms. But it is easier to write a program that recognises an image of a child in a sexual act than one that can distinguish extremist content. An algorithm might spot and block images of beheadings, but that would censor some news articles and documentaries.

Mark Zuckerberg, Facebook's boss, has

said he wants to invest in artificial intelligence to root out terrorist propaganda, but that it will take many years to develop new tools. In the meantime, the social network and other platforms must rely on human moderators, who have to make difficult judgments. Facebook's guidelines, which were recently leaked, show how hard it is to distinguish posts that should be removed from those that are offensive but permissible. For example, posting "I'm going to destroy the Facebook Dublin office" is allowed, but posting "I'm going to bomb the Facebook Dublin office" is not, because it is more specific in suggesting a weapon.

Some firms are experimenting with new tactics. Jigsaw, a sister company of Google, has tested a "redirect method", showing ads and videos that counter IS propaganda to people who search for extremist material on Google and YouTube. Microsoft is trying something similar for its search engine, Bing. Last year Google, Facebook, Twitter and Microsoft agreed to work together on a database, where they mark terrorist content with a unique identifier. Other companies can spot tagged content and remove it from their own platforms. But the database is at an early stage and includes only the worst material.

Further progress will require joint action by internet firms and governments. Unfortunately, relations have been strained in recent years. The firms used to give some discreet help to authorities on both sides of the Atlantic, says a former British intelligence officer. But they stopped when their co-operation was revealed in the classified material leaked by Edward Snowden in 2013. Some of their customers were horrified to learn that their privacy, however notionally, was being compromised by what they saw as collusion with government spooks.

Commercial interests combined with west coast libertarianism to create a dialogue of the deaf. Security services accused firms of ignoring public safety and their legal responsibilities; Apple, Google and others retorted that what they were being asked to do was either impossible or would threaten their profits. After Mrs May's speech, some felt they were being scapegoated. "Politicians aren't blaming the car-rental companies for renting white vans, or telecoms firms for offering phone and internet services to bad guys, but they are blaming internet platforms for allowing them to do bad stuff," grumbles an executive at an American internet firm.

Even so, firms are waking up to the fact that if they do not find ways to work with governments, they will be forced to do so. They fear laws along the lines of one recently proposed in Germany that would see them fined vast sums unless they speedily remove any content that has been flagged as hate speech. They also have a growing commercial interest in cracking

► down on terrorist content, which hurts their brands and could cut revenue. In recent months some of YouTube's clients pulled their ads after realising that they were appearing next to extremist videos.

Quietly, co-operation between governments and internet firms is picking up once more. In Britain a specialist anti-terror police unit that trawls the web for extremist material removed 121,000 pieces of content last year with the help of some 300 companies around the world. Getting around encryption poses greater technical challenges. Weakening it would not be in the public interest, says Robert Hannigan, who ran GCHQ (Britain's signals-intelligence agency) until January this year.

The idea of forcing firms to put "back doors" into their software that authorities could use to spy on terrorists has been largely abandoned. It would make the software less secure for all its users, might violate free-speech protections in America and would anyway be impossible, since some messaging apps, including Telegram (developed by a Russian, Pavel Durov, now a citizen of St Kitts and Nevis) are beyond the reach of Western laws.

The authorities do, however, have other options. Once an intelligence agency has access to a target's phone or laptop, almost anything is possible. These devices' built-in cameras and microphones make them excellent for bugging. Or the spooks can install covert monitoring software to see what is being displayed on the screen and to log a user's keystrokes. Since messages must be decrypted before their recipients can read them, this makes it possible to bypass even the strongest encryption.

Governments and tech firms now broadly accept that they have a common interest in establishing global standards for exchanging data across borders. A bilateral agreement that Britain and America reached during Barack Obama's administration is before Congress and awaiting legislation. It would not permit Britain to get data on American citizens or residents; and access would be limited to targeted orders relating to the prevention or investigation of serious crime and terrorism.

This could become a template for other international agreements. In testimony before the Senate Judiciary Committee in Washington in May, Brad Smith, the president of Microsoft, argued for a change in the legal framework, which he said "impedes America's allies' legitimate law-enforcement investigations" and exposes American tech firms to potential conflicts of jurisdiction. Greater legal certainty, less confrontation and more co-operation between governments and firms will not drive jihadist propaganda off the internet altogether. But they should clear the worst material from big sites, help stop some terrorists—and absolve tech firms from the charge of complicity with evil. ■

The stabbing intifada

How to spot a lone wolf

SAIR

Israel may have lessons for the West

HIS last Facebook post was perhaps the only clue of Raed Jaradat's yearning for vengeance: it showed a Palestinian teenager lying dead with her headscarf soaked in blood and the message "Imagine if this were your sister." Dania Irsheid, 17, had been shot by Israeli security forces in October 2015 at the entrance to the Ibrahimi mosque (Jews call it the Cave of the Patriarchs) in Hebron. Police said she had tried to stab Israelis; Palestinian witnesses say she was unarmed.

The next day Raed, a 22-year-old accounting student from the town of Sair, near Hebron, went to a checkpoint nearby and stabbed an Israeli soldier in the neck before he, too, was shot dead. Later his 19-year-old cousin, Iyad, was killed during stone-throwing clashes with Israeli troops. Raed and Dania had never met but, at his funeral, their fathers said their children should be married "in Paradise".

Such is the rhythm of the Palestinian "stabbing intifada". Since its outbreak in late 2015, there have been hundreds of knife and car-ramming attacks against Israelis. If the violence has ebbed, it may be in part because the Israel Defence Forces (IDF) have become better at forestalling attacks. Israeli spooks reckon they have lessons to offer Western countries struggling to stop lone wolves.

One is that conventional intelligence organisations, even Israel's well-honed system, are designed to penetrate organ-



ised terrorist groups, so they struggle to spot imminent attacks by self-radicalised individuals or small groups. After reviewing the profiles of scores of attackers, IDF intelligence officers found they often acted on the spur of the moment. They were rarely linked to militant factions, and were not especially religious or poor. Many had a grievance: a son who felt unjustly treated, a brother who was disinherited, a bride who was beaten by her husband, and so on.

Sometimes they were teenagers bullied at school who wanted to be admired as "martyrs"—Clark Kent becomes Superman, as one officer put it. Often they were so inept that they appeared to be trying to commit "suicide by IDF". And, as with teenage suicides, there was a pattern of copycat attacks, or at least a tendency of those close to a "martyr" to seek revenge. In Sair, for instance, 13 people have died since 2015 in attacks on, or confrontations with, Israelis.

These days IDF algorithms monitor the social-media accounts of young Palestinians to look for early-warning signs. These include "tripwire" terms such as the "sword of Allah" or "day of the sword", associated with the writings of past attackers. The IDF also monitors the activity of relatives, friends, classmates and co-workers of recent "martyrs".

The parents of those deemed suspicious might receive a telephone call or a visit from the Shin Bet security service, and their names could be passed on to the Palestinian Authority. Their phones are tracked to see if they meet other suspects, or leave their districts to move towards potential Israeli targets. In such cases, security forces detain the suspect.

How much of this could be applied in the West? Perhaps not much. Israel holds millions of Palestinians under occupation. Its security barriers restrict their movement and keep them segregated. The army can seal off restive areas, enforce curfews and impose punishments, such as the demolition of homes. In contrast, most Muslims in the West move and mix freely as full citizens. Israeli-style ethnic profiling and ubiquitous electronic surveillance would be neither possible nor desirable.

Still, cleverly fusing clues from social media with other information might help, as could early intervention to steer suspects away from possible violence. That means keeping would-be attackers online, where they can be watched. ■



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Business and clean energy

We've got the power

President Trump may not see the promise of clean energy. A lot of big business does

PITY America's big businesses. For years their efforts to reduce their carbon footprint were dismissed by environmentalists as "greenwashing". Now, after months trying to persuade a supposedly pro-business new president, Donald Trump, of the merits of staying in the Paris climate accord, he practically laughed in their faces by withdrawing on June 1st.

Executives fear the exit will do no good to America's—and by implication their—reputation. Not for nothing have more than 900 American firms and investors, including Amazon, Twitter, Target and Nike, put their names this week to a "We are still in" open letter to the UN. Its signatories pledge to help reduce the country's carbon emissions by 26% by 2025, in keeping with America's Paris pledge. That may be quixotic but is a rallying cry nonetheless.

Indeed, some American firms are taking climate change so seriously that they are surprising even former critics. Alongside energy-efficiency measures, the strongest evidence of their commitment is the number of new wind and solar projects that they are helping to build around the world. Companies are using power-purchase agreements (PPAs), in which they sign long-term contracts to buy clean electricity from firms that develop solar and wind farms at agreed prices, instead of buying the bulk of their power from utilities, which can rarely guarantee 100% clean

energy to their customers.

Utilities do sign clean-energy PPAs as well. But in 2015, more than half the country's wind-energy PPAs went to big companies hoping to take advantage of a federal tax credit before it was due to expire. Big business has by now spurred the worldwide development of a cumulative 20 gigawatts (GW) of wind and solar farms (see chart on left). That is four GW more than the entire onshore and offshore wind capacity of Britain.

Last year it was American IT firms such as Amazon and Google that led the way. They use clean energy to power their vast banks of servers (see chart on right). More

recently, enthusiasm is extending beyond tech firms to energy-intensive industries, including manufacturers. It is also moving from corporate headquarters to subsidiaries and suppliers, and from developed countries to emerging markets, where the costs of wind and solar energy are falling fastest. Some environmentalists now see businesses as allies, rather than adversaries, in the fight against global warming, and believe they could become strong forces behind the worldwide spread of clean energy. "There used to be rhetoric and little action," says Marty Spitzer, head of climate and renewable-energy policy in America for the World Wildlife Fund (wwf), a charity. "Now I see fundamental changes."

Take Anheuser-Busch InBev, for example. The world's biggest brewer, with brands ranging from Budweiser to Stella Artois to Corona, has a fair share of millennials among its tipplers, and many take environmental issues seriously. Electricity—used as part of the brewing process, for refrigeration, and so on—amounts to up to a tenth of its costs, says Tony Milkkin, the ➤

Making hay while the sun shines

Business power-purchase agreements (PPAs)

Worldwide, GW of capacity



Top PPA buyers, 2016, MW



*The Ivanpah solar plant, pictured, is not a PPA †To May 24th

► firm's chief sustainability officer. In March it set out to increase the role of renewables in generating power from 7% to 100% by 2025; as much as 85% will come via PPAs. "My generation, as a baby-boomer, looks at clean air and energy as infinite commodities. The generation coming up looks at it totally differently," he says.

Iberdrola, one of the world's greenest utilities (see box), is building a 220-megawatt wind farm in a blustery part of Mexico to supply AB InBev's largest brewery with clean electricity from 2019. That will add a hefty 5% to Mexico's renewable-energy capacity. The brewer expects other PPAs to follow in Argentina, Brazil, India, South Africa—and possibly China. Mr Milikin says the firm will "heavily negotiate" with its suppliers, such as those producing its aluminium cans and bottles, to encourage them to do likewise.

Other companies are even tougher. Walmart, the world's largest retailer, in March said it would require its own operations and those along its supply chain to reduce carbon-dioxide emissions by 1bn tonnes (it calls this "Project Gigaton") by 2030—the equivalent of taking 21m passenger cars off America's roads for a year. The announcement was welcomed by charities such as the WWF, which are helping Walmart's suppliers work towards the goal. Apple, maker of the iPhone, said in April that seven of its big global manufacturers have promised to power their Apple-related production with renewable energy by the end of next year. It is helping its suppliers improve energy efficiency, but also hopes to have brought 4GW of renewable power online by 2020, half of it in China.

Some multinationals are clubbing together to do deals. For instance, AkzoNobel, DSM and Philips, a trio of Dutch firms, have teamed up with Google to buy electricity generated from a co-operative-owned wind park in the Netherlands.

The buzz is spreading beyond the corporate stratosphere. Enel Green Power, one of the biggest sellers of PPAs, is close to developing wind energy in Morocco for local cement factories, steel firms and chemical companies, says Antonio Cammisecra, its boss. It will also build a clean-energy plant for a gold-mining project in South Africa. In Britain a startup, Squeaky Clean Energy, is hooking up small and medium-sized businesses with wind and solar farms in what it calls "peer-to-peer electricity".

Hervé Touati of the Rocky Mountain Institute (RMI), a clean-energy research outfit, believes the biggest incentive for businesses to do PPAs is to meet sustainability goals, which improve their public image and help attract customers, staff and investors. According to the WWF, almost two dozen of America's biggest firms have committed to becoming 100% renewable in the near future. Consumer-staples firms make the greenest promises. Fossil-fuel

Iberdrola

The storage question

A trailblazing utility bets against fully distributed energy

ONE of Ignacio Galán's early jobs as an engineer was to design lead-acid batteries for the milk floats that used to trundle around Britain's streets. So the 66-year-old Spaniard, who heads Iberdrola, one of the world's largest utilities, claims he has been thinking about the storage of electricity for his whole career. That is useful, because for the second time since he took over Iberdrola in 2001, the industry faces a fork in the road. This time round, the big debate in energy is about batteries and storage.

The first time, Mr Galán blazed the right trail. He made a prescient bet on renewable energy, turning Iberdrola into one of the world's biggest providers of onshore wind while at the same time underpinning returns with relatively safe, regulated electricity networks in America (Avangrid) and Britain (Scottish-Power). Some European peers, such as Germany's E.ON and RWE, took the opposite approach, prioritising conventional fossil-fuel-fired power plants in less regulated markets. In the past five

years, the Germans have been through near-death experiences, and have belatedly created stand-alone renewables and grid businesses. Iberdrola's share price has more than doubled.

The renewables revolution has, in turn, caused the latest dilemma, because intermittent sun and wind require ways of storing electricity as a backup. Battery firms like Tesla, as well as some utilities, see a mixture of rooftop photovoltaics, home-mounted batteries and electric vehicles as the way of the future, with power being stored locally and new business models emerging to manage customers' energy use remotely. But Mr Galán is sceptical that batteries can last long enough to handle intermittency, or that customers will care enough about distributed energy to make the domestic-battery business compelling. "I can't imagine saying to my wife that we have a choice between a new fridge and the latest Powerwall battery."

Instead, he believes there is more to be gained by using renewable energy to pump water up to hilltop reservoirs, and letting it flow downhill to produce hydroelectricity when needed. Iberdrola has already done this with its successful \$1.3bn Cortes La Muela project in Spain, completed in 2013. It is building a large pumped-hydro storage facility in northern Portugal. Mr Galán does not dismiss batteries altogether. But he thinks it would be better for utilities to deploy them to regulate the intermittency of electricity supply in substations, rather than putting them in homes.

His reservations about fully distributed electricity may be self-serving. If users buy batteries to help them cut loose from grids, network operators would have to raise prices to remaining customers, causing a "utility death spiral". Yet it is probable that centralised electricity will survive, especially in big cities. And do not write off Iberdrola's predictive powers. "They could see the future," says Antonella Bianchessi of Citigroup.



The way the wind's blowing

producers are, predictably, the laggards.

Economics is also a draw. In America the cost of procuring wind energy directly is almost as cheap as contracting to build a combined-cycle gas power plant, especially when subsidies are included, Mr Touati says. In developing countries, such as India and parts of Latin America and the Middle East, unsubsidised prices at solar and wind auctions have fallen to record lows.

Yet there are also complications with PPAs, which explain why their growth has been more fickle of late. The most straightforward are for renewable plants on a company's own property, because that saves the cost of grid-based transmission and distribution. But it is rare for a firm to have sufficient spare land in a suitably sunny or windy area.

More complex, and most common, are ►

► remote or virtual PPAs, in which a company agrees to buy an amount of wind or solar energy from a distant developer, which feeds it into the grid. The company receives an equivalent amount of energy from a utility, which gets paid as a middleman. Such bespoke transactions can require a bevy of lawyers, which can put off smaller firms.

The long-term nature of such PPAs is also a hindrance, because they lock in a price that can be costly if power prices do fall. Other options include buying renewable-energy certificates as evidence of clean-energy use, or entering into a green contract with a utility. These may not bring the same environmental kudos, however, because they might not lead to new wind and solar farms being built.

On the bright side, says Simon Currie of Norton Rose Fulbright, a law firm, non-pro-

fits such as the WWF and RMI are promoting “buyers clubs” that help bring firms together and standardise PPA contracts. They also press for regulatory reform in places such as China and some parts of America, where incumbent utilities block PPAs because they fear being disintermediated.

At a conference in Beijing on June 7th, the International Renewable Energy Agency, a global body, launched a survey of firms to find out how better to promote corporate PPAs in such places. At the same event, Google spoke of the regulatory hurdles it faces in expanding beyond the five countries where it has bought 2.6GW of PPAs since 2010. This month a pro-Republican alliance of big businesses will even press for carbon taxes and other clean-energy measures. With such powerful backing, the growth of renewable energy may one day win over even Mr Trump. ■

two do not just compete for passengers; each also tries to woo the other's drivers. In 2014 Uber's boss, Travis Kalanick, attempted to buy Lyft.

But Lyft's culture has turned out to be an asset. Uber's controversies, including Mr Kalanick being caught on video berating a driver, have helped its rival—particularly on America's liberal-minded west coast, where people are more squeamish about using a brand associated with sexism. Half of those who have switched to Lyft in America say that company reputation was the chief reason, says Survey Monkey, an online-polling firm.

On June 6th Uber said it had fired 20 employees after the conclusion of an investigation into sexual harassment (the result of a broader probe, led by a former attorney-general, is due soon). One venture capitalist who has backed Uber says he is embarrassed to be seen getting into its cars. It seems no coincidence that in April Lyft said it had raised another \$600m from investors, valuing the firm at \$7.5bn, around a third more than its previous mark.

That also reflects a change of mind among investors over the ride-hailing business. Having thought of it as a winner-takes-all market, in which one big company has a near-monopoly in each country, plenty now believe people will spend enough on transport for more than one player to prosper. Mr Zimmer, Lyft's co-founder, compares ride-hailing to the wireless-carrier market, in which several companies boast high-quality coverage and plenty of customers.

Offering good “coverage” in ride-hailing so that rides can arrive within a few minutes, of course, requires resources. “We're at the stage of building cell towers. That's expensive,” says Brian Roberts, Lyft's chief financial officer. But it may help the firm that it remains geographically and strategically focused. It has fewer distractions than Uber, which in addition to expanding globally is pushing into new business lines, like food delivery and trucking.

Lyft's strategy on self-driving cars is also distinctive. Uber is investing heavily to build its own autonomous technology, guarding against the chance that another service could come in without drivers and undercut it on price. But Lyft has opened up its network to other firms, including Waymo, a self-driving car unit that is Google's sister company (and which has accused Uber of stealing trade secrets).

Collaborating with others is better than building expertise in-house, Lyft reckons, because so much uncertainty surrounds the evolution of autonomous technology. This week Lyft announced another relationship, with an autonomous-driving startup called nuTonomy, which will start testing cars in Boston. There is a risk that Waymo and other partners may try to perfect their own self-driving technology with ►



Ride-hailing wars

Lyft's big lift

SAN FRANCISCO

America's number two ride-hailing firm has benefited from Uber's struggles

ONE firm's bad news is often another's good fortune. For years Lyft, an app that offers on-demand rides, was outdone by its seemingly unstoppable rival, Uber, which zoomed into new markets and grabbed a near-\$70bn valuation, the largest of any private American tech firm in history. Uber does not report a share price that would register its recent troubles, which include one investigation into alleged intellectual-property theft and another into its workplace culture. But that Lyft's market share in America has risen from 18% five months ago to 25% now (according to TXN Solutions, a data provider) is a gauge of the larger firm's crisis.

Lyft is far from a typical Silicon Valley company. Unlike Uber, it does not lust for world domination and it operates only in America. Nor does it take itself especially seriously. For years it identified its drivers by pink, fuzzy moustaches fastened to the front of cars, and encouraged riders to fist-bump their drivers and sit in the front seat (though it has now relaxed this etiquette to attract more customers).

Its founders, Logan Green and John Zimmer, put an early emphasis on being nice to drivers, for example by allowing people to tip through the app. Many in Silicon Valley viewed such cuddly behaviour as a sign that Uber would trounce it. The

Air travel

Roger, Tango Romeo...ump

The president wants to privatise air-traffic control

IN JUNE 1956 a TWA Constellation collided with a United Air Lines DC-7 over the Grand Canyon in Arizona, killing all 128 people on both aircraft. At the time it was the worst ever airline disaster. Struggling with outdated technology and a post-war boom in air travel, overworked air-traffic controllers failed to spot that the planes were on a collision course.

That crash led to the creation of a new body, which became the Federal Aviation Administration (FAA), in charge of running and modernising the world's biggest air-transport system. With that system again struggling to keep pace with demand, Donald Trump thinks it is time to privatisate America's air-traffic control service. This week the president outlined a plan to turn air-traffic control into a separate non-profit entity financed by user fees, instead of the present patchwork of taxes and grants. Shorn of its air-traffic responsibility, the FAA would become a safety body.

America's air-traffic system is vast, consisting of 14,000 controllers working in 476 airport-control towers that handle take-offs and landings, as well as in 21 "en route" centres looking after flights along the nation's airways. It has a good safety record, but elderly technology limits the number of flights that can be handled. This leads to delays and frustrated flyers. With passenger numbers set to grow from 800m a year to almost 1bn by 2026, the problem will only get worse.

Mr Trump believes that, no longer mired in a federal bureaucracy, the air-traffic service will become more efficient and better able to invest in technology. Many countries, including Australia, Britain and Canada, have privatised air-traffic services or turned them into state-owned firms. Nav Canada, a non-profit firm that has long managed Cana-

dian airspace, has costs per flight hour of \$340 compared with the FAA's \$450.

Replacing old radar-based methods with accurate satellite navigation and better digital communications is a particular priority. Aircraft using satellite navigation can be safely spaced more closely together, which permits many more planes to be in the air at the same time. Digital systems also provide data links to control centres and to other planes by regularly broadcasting an aircraft's identification sign, its position and course. This would allow "free routing", which means pilots can fly directly to a destination, rather than follow established airways, which often zigzag around.

The president's proposal might even speed a move towards "virtual" control towers in low-rise buildings, which can replace towers physically located at airports. The virtual versions are fed live video from airfield cameras. Proponents argue that they are both safer and around 30% cheaper to operate. Virtual towers can look after more than one airport. One in Norway is set to supervise 32 airports, some of them in remote areas.

The European Union reckons such innovations will allow three times as many flights to be handled in the region and save airlines some €9bn (\$10bn) a year. It also, optimistically perhaps, predicts that on average aircraft will land within one minute of their scheduled arrival time. That would count as a miraculous improvement for anyone, let alone America's weary airport warriors.

Mr Trump, though, may struggle to get the proposal through Congress. A similar plan got stuck last year, despite being backed by most airlines and the air-traffic controllers' union. At least the president can dodge the queues: Air Force One flights get special clearance.

► Lyft's data and then launch a competing ride-hailing network, but that seems a distant possibility.

In the immediate future Lyft may find it harder to keep differentiating itself. Uber has mimicked some of its successful tactics, such as tipping, and is overhauling its culture. Many ride-hailing drivers now work for both services, which means travelling in a Lyft car is no longer unique.

The fact that Lyft has won a quarter of the American market could help both firms' profits. In 2016 it lost around \$600m and Uber \$2.8bn. They formerly seemed likely to spend money fighting to the point

of "mutually assured destruction", says Vincent Letteri of KKR, an investment firm that recently put cash into Lyft (after declining to join in two previous funding rounds). Uber now accepts that Lyft is there to stay; it will have to rein in promotional spending if it wants to achieve healthy profits in America to pay for expansion abroad and to reassure nervous investors, says Mr Letteri. Lyft will have less need to spend heavily on subsidies for drivers and riders. It has stopped its practice of offering new customers \$50 in free trips to sign up. Lyft still wants to be nice, but has no wish to be taken for a ride. ■



Replica food in Japan

Sampuru chef

TOKYO

How sham food became a multi-billion-yen industry

GUESTS to the factory of Tsuyoshi Iwasaki are presented with a rasher of bacon. The succulent marbled sliver is branded with his name, title and e-mail address—an apt introduction to the owner of Japan's biggest manufacturer of replica food. At the headquarters of Iwasaki Co on the outskirts of Tokyo, racks of golden-brown gyoza jostle for attention with boat-shaped dishes of lustrous raw tuna, bowls of creamy ramen and a dozen pinkish scallops in iridescent shells. The acrid smell of resin and paints is the only hint that everything on show is utterly tasteless.

Most of these Japanese *sampuru*, from the word "sample", will go on display in restaurant windows, from fast-food outlets to *izakaya* (bars), throughout the east of the country, in the hope of luring hungry customers. A sister company, managed by Mr Iwasaki's brother, covers the western half of Japan. Together they make over ¥5bn (\$46m) in annual sales, and claim to account for four-fifths of Japan's food-replica market. Mr Iwasaki says they have no real competitors; sales at the next-biggest firm are one-tenth the size. Most are small workshops, many based in Gujo, a city in Gifu prefecture where the founder of Iwasaki Co, which started in 1932, was born.

The firm has a garnished founding myth. After Tsuyoshi Iwasaki's grandfather dripped candle wax on a tatami mat, he used it to reproduce an omelette dish with ketchup, based on one his wife made. The market for fakes was ripe: newly arrived ►

► Western dishes needed promoting and explaining to locals in the 1930s, as more people dined out. Traditional Japanese restaurants also switched from hanging *noren* curtains in their entrance-ways—which granted passers-by a peek at the food inside—to doors, creating demand for shop-front replicas that gave a true sense of dishes' presentation and size, says Mr Iwasaki.

Though wax counterfeits were used for decades, they lost their shape and faded quickly. Now most are made from ultradurable polyvinyl chloride (PVC). Designers go to restaurants to watch chefs prepare dishes. They come away with what Mr Iwasaki calls “an architect's sketch”, photographs and notes on textures, colours and consistency. At the factory, each bit of the dish is individually cast to create a silicone mould, into which the PVC is poured, baked and hand-painted or airbrushed, from the boiled-egg halves in a bowl of ramen to its noodles (string, coated with resin). These ingredients are then assembled into a display.

Trade secrets are jealously guarded in an industry that competes mainly on realism. Mr Iwasaki's team only mastered clear liquids a decade ago, with the discovery of a new material. Raw food, fish in particular, remains among the most challenging to mimic: designers proudly claim that it takes as long to master fake sushi—about a decade—as it does to become a sushi chef. Grains of rice are individually made and balls of it shaped by hand. For more convincing counterfeits, natural shells, spices and herbs are used with the plastics.

The hours spent crafting a replica determine its price tag, which can be up to twenty times the selling price of the original dish. But demand for them is wilting. Young people turn to food blogs for reviews of how dishes taste; hip retailers are using digital menus with appealing pictures. High-end restaurants snub plastic, no matter how appetising. The much longer shelf life of PVC replicas means many do not need to be replaced for years. Mr Iwasaki is looking to increase sales in new areas, including tourist trinkets and educational replicas for hospital patients that explain what foods to eat after an operation.

Food fads can still be lucrative: a boom in ramen has raised demand for distinct noodle shapes and sizes in a category of replica food that had been standardised. Chain restaurants, the biggest clients, are launching more seasonal variations. Owing to this turnover of menu items, more are hiring replicas: rentals account for 60% of Iwasaki Co's sales. Some 13,000 restaurants across the country pay a flat monthly fee—around ¥1,000 for a hamburger, for example—that includes refinements and updates to their display every three months. Iwasaki Co recycles some of the stale food for new displays, the beauty of working in a business of imperishables. ■

New retail techniques

Body language

Shoppers' emotions may help physical retailers compete with online ones

FOR eight months up to this April, a French bookstore chain had video in a Paris shop fed to software that scrutinises shoppers' movements and facial expressions for surprise, dissatisfaction, confusion or hesitation. When a shopper walked to the end of an aisle only to return with a frown to a bookshelf, the software discreetly messaged clerks, who went to help. Sales rose by a tenth.

The bookseller wants to keep its name quiet for now. Other French clients of the Paris startup behind the technology, Angus.ai, are testing it in research shops that are not open to the public. They include Aéroports de Paris, an airport owner; LVMH, a luxury conglomerate; and Carrefour, a chain of hypermarkets. In a test at a Mothercare shop in Tallinn, Estonia, software from Realeyes, an emotion-detection firm based in London, showed that shoppers who entered smiling spent a third more than others.

Simple video yields a lot of insight. But there are far more sophisticated and intimate ways of learning about emotions of shoppers. Thermal-imaging cameras can detect the heart rate. Wirelessly captured data from smartphone accelerometers can suggest when shoppers become fascinated (movement often stops) or are fretting over prices (a phone is repeatedly raised to search for cheaper products online).

For even more insights, shoppers are sometimes asked to don special kit,



In the mood for buying?

typically in exchange for a discount or other reward. Wearable “galvanometer” gadgets, for example, measure moisture and electrical resistance on hand skin to reveal arousal.

All of this could be a chance, some say, for bricks-and-mortar retailers to trim the advantage that data have long given online sellers. A race is on to work out how best to collect and use emotions data, be it to improve packaging, displays, music, or the content and timing of sales pitches, says Rana June, chief executive of a firm in New York called Lightwave. It measures shoppers' emotions for retailers, for malls, and for consumer-goods firms such as PepsiCo, Procter & Gamble and Unilever.

Not everyone is impressed. Some find it all a little creepy. Nielsen, a consumer-research giant, deems using technology to work out shopper emotions en masse too “avant-garde” for now, says Ricardo Gutiérrez, head of shopper insights at Nielsen Colombia in Bogotá.

But it is much cheaper than old-fashioned interviews. Nielsen charges roughly \$10,000 to interview 25 shoppers about three products. Angus.ai's service costs just €59 (\$66) a month per camera. For \$15,000 or so, iMotions, based in Copenhagen, gives retailers an EEG cap that detects brain activity, an eye-tracking headset that notes when an attractive object dilates pupils, and a galvanometer. iMotions' 150 or so consumer-goods clients include Mondelez International, Nestlé and Unilever, which use them in mock-up stores and real ones.

What's more, conventional market research can mislead. People typically “edit” verbal responses to make themselves sound rational, when purchases are often driven by subconscious emotions. The key is in tracking the unconscious things that shoppers do, says Jeff Hershey of VideoMining, a firm in Pennsylvania whose software also analyses store video. And surveys can also ask the wrong questions—such as how much people like a product when what really matters, notes Simon Harrop of BrandSense, a consultancy in Britain, is whether, say, it makes them feel attractive.

The notion of “retail therapy”, consumers driven to spend when they are feeling blue, is an obvious example of shopping's emotional side. Whichever store is first to work out how to spot mildly depressed customers could make a bundle.

Digital mapping

Car-tography

As mapping systems for autonomous cars emerge, a tangle of startup firms and new alliances vie with Google Maps

IN THE 1940S Jorge Luis Borges, an Argentine writer, wrote a short story about mapping. It imagines an empire which surveys itself in such exhaustive detail that when unfolded, the perfectly complete 1:1 paper map covers the entire kingdom. Because it is unwieldy and thus largely useless, subsequent generations allow it to decay into tatters. Great scraps are left carpeting the deserts.

In their capacity for up-to-the-minute detail, modern maps surpass even Borges's creation. By using networks of sensors, computing power and data-crunching expertise, digital cartographers can produce what are in effect real-time simulations of the physical world, on which both humans and machines can base decisions. These maps show where roadworks are blocking traffic or which street corners are the most polluted. Innovative products will make new demands of them. Drones need to know how to fly through cities; an augmented-reality game might need to know the exact position in London of Nelson's column.

Google is the giant of the consumer-mapping world. More than 1bn people use the Google Maps smartphone app every month. Rivals can still prosper by providing detailed directions in dense cities: CityMapper, for example, tells its users which exit to take in London's warren-like tube stations. But none can match Google's revenues. Local search ads allow firms to place adverts inside the search results of a person who is physically near their premises, along with maps showing their locations. And promoted pins permit businesses to highlight their own positions along routes that Google calculates for navigation—a pin for a Starbucks en route to Central Park in New York, say. Morgan Stanley, an investment bank, projects that such ads will generate \$1.4bn of revenue for Google in 2017, rising to \$3.3bn by 2020.

Yet the race to develop autonomous cars, which cannot run without guidance from machine-readable maps known as "splines" or "digital rails", could be a far bigger opportunity. Goldman Sachs, another investment bank, reckons that the market for maps for autonomous cars will grow in value from around \$2.2bn in 2020 to \$24.5bn by 2050 (see chart). Google's dominance in consumer mapping means it has a strong advantage in this emerging field (which will mainly accrue to Waymo, its autonomous-car spin-off). But it will not

Are we nearly there yet?

Market forecast for mapping in self-driving cars

\$bn

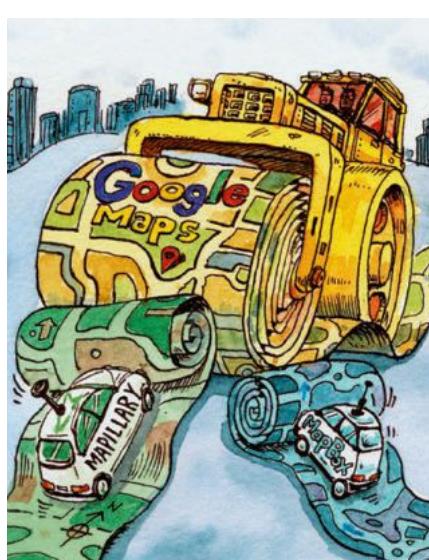


Sources: Goldman Sachs Global Investment Research; Morgan Stanley

have things all its own way. An assortment of other Silicon Valley giants, startups, carmakers and a few old-fashioned mapping firms, are fighting hard.

The inputs for digital mapping are threefold. First comes information about roads, buildings and so on. Such base maps have been commoditised. A British open-data repository called OpenStreetMap (and its cousin organisation, OpenAddresses), that is already widely used and has global data, provides the basics. Many new mapping businesses build on top of OSM data.

Imagery containing close-up detail of streets is the second main ingredient. In May Google said it had used an artificial-intelligence technique known as deep learning to scan 80bn photos, automatically identifying house numbers and the



names of streets and businesses. Its photos were gathered from its "StreetView" cars, which have trawled the planet capturing street imagery since 2007, at a vast cost.

This archive is a barrier to entry for other companies, but it may be tumbling. Mapillary, a Swedish startup which also uses deep learning to process imagery, has released a data-set of 25,000 street photos collected through its own sensor network. Its chief executive, Jan Erik Solem, says that Mapillary's fastest-growing business is providing data mined from those images to companies that are trying to build maps for autonomous cars. (Laser scanners and radar used by autonomous cars to navigate will add to the torrents of data.)

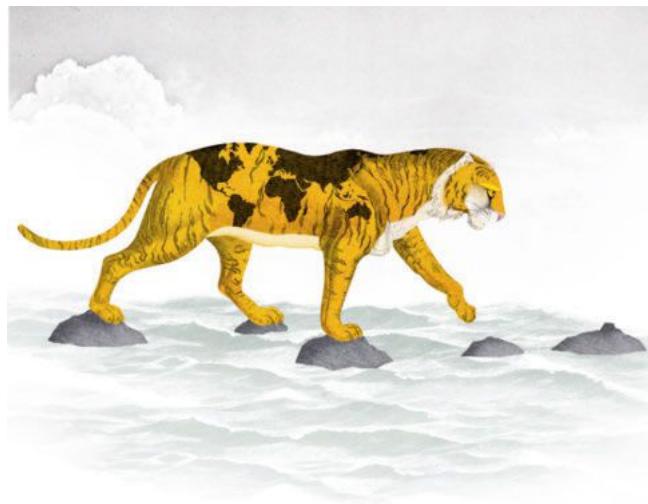
Large quantities of real-time GPS location data from people with smartphones in their pockets are the third important input. Google harvests such data from Google Map users as they move around the world. If it stops seeing data streaming off a street, for example, it is likely to mean that the road has been closed. Here, too, Google's defences are looking less impassable. Mapbox, a young firm based in San Francisco, has found another clever way to compete—a map-specific software-development kit (SDK) which any developer can install and use to present maps to users. When those users call up one of its maps, Mapbox receives anonymised location data. Mapbox's SDK is now in some 250m phones. Marc Prieleau, a mapping guru whom Mapbox poached from Uber, a ride-hailing firm, says the firm is gathering enough data in the Bay Area alone to redraw every road there ten times a day.

Google is also vying with a legacy mapping firm that has sold map data for car-navigation systems since 1985. Germany's three largest car companies, Daimler, Volkswagen and BMW, bought HERE, based in Chicago, for €2.8bn (\$3.1bn) in 2015. In December a Chinese and Singaporean consortium including Tencent, an internet giant, and NavInfo, a mapping firm based in Beijing, took a 10% stake in it. HERE will provide Tencent with digital maps of China. It will get access to location data from WeChat, Tencent's popular chat app, connecting it to a sensor network the scale of which rivals Google's. The firm has also joined forces with Shenzhen-based DJI, the world's biggest drone-maker.

America's big three car companies, General Motors, Ford and Fiat Chrysler, have also invested heavily in digital mapping through AI startups and in partnerships with ride-hailing firms and with TomTom of the Netherlands, another older mapping firm. Google is hard to avoid, though: Fiat Chrysler has joined Waymo's self-driving programme in Phoenix, Arizona and will use the search giant's mapping data. And whoever ends up winning most sway over cartography, Borges's everything map is no longer imaginary. ■

Schumpeter | Crossing the river

Chinese companies have a weak record abroad. They must do better



CONSIDERING the size of China's economy, it seems inevitable that its firms will eventually play a huge role on the world stage. Yet China Inc's adventures abroad in the past 15 years have been a mixed bag. Thousands of small deals have taken place, some of which will succeed. But of the mergers and acquisitions that have been worth \$1bn or more, it is a different story. There have been 56 abandoned deals, 39 state-backed acquisitions of commodities firms at frothy prices, and, lately, wild sprees by tycoons scooping up trophies such as hotels and football clubs.

Some deals defy any conventional logic. Last month HNA, an airlines-and-tourism conglomerate from Hainan, said it had bought a 10% stake in Deutsche Bank, having earlier considered buying a Landesbank. The Chinese firm, which runs a beach-volleyball tournament in Beijing, appears to think it can consolidate Germany's fragmented banking industry—the financial equivalent of bringing peace to the Middle East. If China Inc is to realise its potential abroad, it needs a more credible approach.

The experience of Britain, and then America, in the 20th century suggests that economic hegemons control a disproportionate share of the world's stock of cross-border corporate investment. Today China's slice is only 4%, below its 15% share of global GDP and its 13% share of total stockmarket value. Its leaders want firms to go faster. If companies don't globalise, China won't become powerful, argues Wang Jianlin, boss of Dalian Wanda, a property firm, and China's richest tycoon, in his autobiography.

In their hurry, Chinese firms have made mistakes. Deals worth \$1bn or more account for two-thirds of activity by value since 2005. Of these about half fall into three problematic categories. First, acquisitions by state-controlled groups of natural-resources firms. The aim was to secure access to raw materials but many deals were badly timed, with high prices paid at the peak of the commodity cycle between 2010 and 2014. CNOOC, an oil firm, for example, has written off part of its \$17bn acquisition in 2012 of Nexen, a Canadian oil firm.

The second difficult category consists of acquisition sprees by leveraged conglomerates, financed by debt or by the funds that policyholders entrust to these firms' insurance subsidiaries. Four such companies—HNA, Dalian Wanda, Fosun (based in Shanghai) and Anbang—have spent \$100bn on assets that include luxu-

ry hotels, a Portuguese bank, a Russian gold mine and a yacht-maker. It is hard to see industrial logic behind the purchases. Fosun and HNA, which disclose their accounts, have eye-watering ratios of debt to gross operating profit of 8 and 13 times respectively. In the last category are outright flops: \$230bn of deals worth \$1bn or more have collapsed because the buyer or the Chinese government got cold feet, or because of a hostile reception abroad. As a result Chinese buyers are seen as unreliable.

Other countries have been on foreign M&A benders: in 1989-90 Japanese companies bought a Hollywood studio and the Rockefeller Centre and in 2005-15 Indian firms splurged overseas. But China is different. It is much bigger. And its firms' weaknesses abroad reflect the unique problems of its economy at home.

State-controlled firms are the most financially undisciplined. They are also more likely to provoke opposition abroad from private rivals and from politicians who can argue that China's government is meddling in their economy. As for the country's entrepreneurs, cheap loans from state banks and a reluctance to issue equity leads them to assume too much debt and to speculate. They need to be politically connected to get bank loans and get around currency controls, but such connections can be fickle. In 2015 Fosun's boss was arrested and then released. This month Anbang has had to deny that its chairman is banned from leaving the country. China's outbound foreign investment dropped by 49% year on year in the first quarter of 2017, with an official clampdown on such speculative deals partly to blame.

More sensible ways of going global may be emerging, however. State-backed firms are using new mechanisms to persuade foreign countries that they will operate on a largely commercial basis. ChemChina has just bought Syngenta, a Swiss chemicals firm, for \$46bn. It has promised to keep Syngenta's headquarters and research in Switzerland. China Investment Corporation (CIC), a sovereign-wealth fund, is to spend \$14bn buying Logicor, a European warehousing business. CIC will presumably argue that it is a financial buyer and won't meddle. China's one-belt-one-road initiative is partly aimed at reassuring foreign countries that do business with state-backed firms, by putting contracts and activity under a bilateral, diplomatic umbrella.

M&A with Chinese characteristics

For China's private firms the focus must be on deals that contain industrial logic, rather than those with a strongly speculative or trophy-hunting flavour. Last year Haier, which makes white goods, bought General Electric's appliances business. Even these deals are hit and miss. Geely, a carmaker, has made a success of Volvo, which it bought in 2010, but Lenovo, a computer firm, has struggled since buying Motorola's handset business in 2014. Yet, over the long term they have a better chance of succeeding than almost anything else. As China's internet firms accumulate cash they will go abroad; they have much to offer in terms of expertise. Last year Tencent paid \$9bn for Supercell, a Finnish gaming firm.

In the past, each economic superpower has created its own corporate form abroad, reflecting its national character and the state of the world it sought to stride. British firms used managing agents in the 19th century to run remote businesses. From the 1970s American firms perfected the multinational, taking advantage of technology and open borders to run things on an integrated basis. China's firms are emerging out of a state-led economy into a more protectionist world. They must find their own ways to adapt to this environment if they are to fulfil their destiny. ■



Emerging markets

Awaking with BRICs

HONG KONG

The big four developing economies emerge from a bad dream

EMERGING markets have been through a lot over the past four years. The “taper tantrum” in 2013 (prompted by fears of a change in American monetary policy); the oil-price drop in 2014; China’s botched devaluation of its currency in 2015; and India’s botched “demonetisation” of much of its own currency in late 2016 (removing high-value banknotes from circulation). But 2017 has started more brightly. Indeed, for the first time in two and a half years, the world’s four biggest emerging economies (Brazil, Russia, India and China, known as the BRICs) are all growing at the same time.

Russia’s GDP bottomed out at the end of 2015 (using seasonally adjusted figures) after the longest recession since the 1990s. It has expanded at a gathering pace for the past three quarters. Higher oil prices have helped, though Russia cannot profit fully from the improved market by ramping up sales without violating the production limits that caused the market’s recovery.

During the collapse of the rouble in late 2014 and early 2015, it was easy to forget some of Russia’s economic strengths, such as its consistent trade surpluses and its substantial foreign-exchange reserves (which never fell below \$300bn). As Russia has regained its footing, the rouble has rebounded, gaining 15% against the dollar over the past 12 months, making it one of the world’s best-performing currencies.

Brazil’s torment has been even more prolonged. Its economy contracted for

eight consecutive quarters as commodity prices tumbled, a president was impeached and a corrupt political class was impugned. Brazil’s political scandals remain far from resolved, but at least the weather has improved. Generous summer rains in states like Bahia contributed to a bumper harvest of soyabean and corn in the early months of the year. That helped Brazil’s GDP expand by 1% in the first quarter (an annualised pace of over 4%). Since bumper harvests cannot be repeated every three months, some economists fear GDP may shrink again in the second quarter, but many forecasters believe growth will be positive for 2017 as a whole.

Faster growth has not jeopardised price stability. Rather, inflation has eased in Brazil, just as in Russia and India. Whether lower inflation will allow Brazil’s central bank to make further big interest-rate cuts partly depends on a new political furore engulfing Michel Temer, the president. If that prevents the government from reforming social security and curbing fiscal excess, the central bank may be loth to soften its stance dramatically, lest fiscal indiscipline and monetary easing combine to weaken the currency and push up prices.

If inflation has been too high in recent years in Brazil, it has been too low in China. Thanks to downward pressure on prices and the currency, China’s economy actually shrank in dollar terms in 2016 for the first time in 22 years. But the deflationary threat

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has since receded and the yuan has strengthened this year against the greenback, as capital outflows have been tamed. Indeed, China’s central bank may have resumed adding to its foreign-exchange reserves, which increased by \$24bn in May, having declined by about \$1trn since their peak in 2014 as capital fled.

Will the resumption of growth in Brazil and Russia (and the return of “dollar growth” in China) breathe new life into the BRICs brand? The term was coined by Jim O’Neill, when he was chief economist of Goldman Sachs, and took on a life of its own. The countries’ leaders began holding an annual summit, inviting South Africa to join as an additional member. They also set up a development bank, with its head- ►

No two BRICs the same



Sources: Goldman Sachs; IMF; The Economist

quarters in Shanghai but headed by an Indian, which now has operations in all five countries, having approved its first loan to Brazil in April. (Lord O'Neill has always felt that South Africa, a country of only 56m people with a GDP of less than \$300bn, was too small to stand alongside his original quartet. And so far this year, the fifth member's fortunes have diverged from the others', as South Africa's economy slipped into a recession in the first quarter.)

Having christened the BRICS in 2001, Goldman Sachs later sketched out their futures over the next five decades in a paper entitled "Dreaming with BRICS", pub-

lished in 2003. The investment bank then upgraded those growth projections in 2011 in light of the BRICS' strong performance over the previous decade. That proved to be a mistake. Of the four economies, only China's dollar GDP has kept pace with those optimistic 2011 projections (see chart on previous page). The others have fallen short of them by a combined \$3trn.

A similar disappointment befell stock-market investors. The BRIC equity index compiled by MSCI has lost 40% since its 2007 peak. In October 2015 Goldman Sachs folded one of its BRIC equity funds, meant for American investors, into a

broader emerging-market product ("a more holistic solution in emerging-markets equity", in its words). These setbacks seemed to vindicate the curmudgeonly sneer cited by Peter Tasker, of Arcus Investment, dismissing the BRICS as a "Bloody Ridiculous Investment Concept".

But if the BRICS have not sustained the euphoria of 2011, they have amply fulfilled the original "dream", as articulated by Lord O'Neill in 2001 and quantified by his team two years later. Even after their recent tribulations, their combined GDP (\$16.6trn) remains far greater than the Goldman team envisaged back in 2003 (\$11.6trn). ►

Buttonwood | Wrong numbers

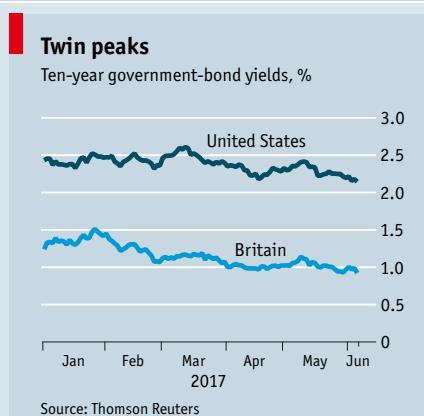
Once again, investors have been surprised by the bond market

EVERY year it seems that analysts and investors play a ritual game. They begin by asserting that government bonds are terrible value and that, accordingly, this must be the year when yields will rise (and prices fall). And then they get mugged by reality.

The same pattern seems to be playing out in 2017. Back in December, a poll of fund managers by Bank of America Merrill Lynch (BAML) found that pessimists on global bonds outnumbered optimists by 58 percentage points. Investors believed in a "reflation trade", with tax cuts from Donald Trump's administration leading to faster American growth, to which the Federal Reserve would respond with higher interest rates.

For a while, such forecasts seemed to be on the money. The yield on the ten-year Treasury bond picked up to 2.63% by March 13th (see chart). But since then the trend has changed. The Treasury-bond yield recorded a low for the year of 2.13% on June 6th. In Britain the yield on the ten-year gilt dipped below 1% on June 6th and 7th; in real terms (ie, after inflation), the yield is negative. Swiss ten-year bonds still offer a negative yield: investors will lose money if they hold them until maturity. According to BAML, by the end of May more money had flowed into global bond funds (\$168bn) this year than into equity funds (\$141bn).

All this is slightly at odds with the optimism that has helped push stockmarkets to repeated highs. Closing prices for the S&P 500 and NASDAQ Composite reached new peaks on June 2nd, even as the bond yield was dropping. The MSCI World Index, an equity benchmark, has risen by 10% so far this year. Global stockmarkets have been recovering since February 2016 on hopes of faster economic growth. That would usually be a signal



for bond yields to rise, not fall.

Although analysts are revising their global growth forecasts upwards, there is little sign yet of any rebound in inflation. In America the core inflation rate for personal consumption expenditure, a figure watched closely by the Fed, declined to 1.5% in April. Inflation rates in China, Japan and the euro zone are all under 2%. It is inflation that saps the appeal of fixed-interest investments like bonds.

In the absence of inflation, the Fed has less reason to keep increasing interest rates. Kit Juckes of Société Générale (SG), a French bank, says the market is pricing in short-term interest rates of only 1.7% in two years' time. "Investors are losing faith in the idea that the Fed will push rates up to 2.5% or above," he says.

Another reason why bond yields have retreated is that the fiscal stimulus promised by Mr Trump seems likely to be delayed. The proposed infrastructure programme (actually tax credits for investors) is a long way from fruition. And the administration's budget proposal includes cuts to popular programmes such as Medicaid that will struggle to get through Congress.

Since the stimulus was expected to push up the budget deficit (and require the issuing of more bonds), any delay is good news for bond yields.

More broadly, investors have also started to worry again about a potential slowdown in the Chinese economy, amid signs that the authorities are tightening monetary policy. Commodity prices, seen as an indicator of Chinese demand, are at a 12-month low.

If these worries are real, why is the stockmarket doing so well? One reason is the strength of corporate profits. According to Factset, annual profits growth in the first quarter for companies in the S&P 500 index was around 14%. Part of this is the result of a rebound in energy companies' earnings, after a slump in the oil price dropped out of the annual comparisons. But global profits forecasts for 2017 are still being revised higher.

Companies are benefiting because there is little sign of wage pressure. Even though the American unemployment rate dropped to 4.3% in May, year-on-year growth in average earnings in America was just 2.5%. "Labour is in demand because it is cheap," say analysts at Rabobank. In turn, subdued wage growth means there is little upward pressure on inflation—good news for bonds.

This helps to explain why investors keep getting caught out in their expectations for the bond market. In a normal economic cycle, bond yields would be heading a lot higher by now. But it has been pretty clear since 2008 that these are not normal economic times. Perhaps investors should have reflected on the example of Japan, where bond yields have stayed low for two decades despite the ups and downs of the cycle.

► Only Russia has failed to live up to those early expectations. China has easily surpassed them. In Brazil, growth was slower than Goldman Sachs projected but the country's real exchange rate appreciated further than they imagined, boosting its GDP in dollar terms.

Moreover, at some point after 2015, the BRICS became unmodish enough to count once again as good investments. Since Goldman Sachs closed its fund, the BRIC stockmarket index has gained almost 20%.

The trickiest problem for the BRIC concept may be its final consonant. China contributed about half of the club's GDP in 2001 and now accounts for fully two-thirds of it. China is also home to most of the group's biggest companies. Eight out of the ten largest stocks in the MSCI BRIC index are from China, including Alibaba, Baidu and Tencent (a tech trio that have their own acronym, BAT). As its markets grow and open up to capital inflows, China seems destined to become an asset class in its own right, one that is hard to contain in a "holistic" emerging-market fund, let alone a narrower four-country vehicle. The biggest threat to the BRIC idea may not be the quartet's economic shortcomings but the singular success of its largest member. ■

American third-party debt collectors

Bum rap

NEW YORK

Tighter loan-recovery rules make credit harder for borrowers to find

FEW cheer the rising levels of America's household debt, which reached a record \$12.7trn at the end of the first quarter. Nearly 5% of the total, or \$615bn, was in some stage of delinquency. One group, however, can barely hide its glee: third-party debt-collection firms, which try to recover mostly consumer loans on behalf of creditors without the resources to chase down bad borrowers themselves.

Business is expanding "at a robust rate", says Keith Kettellkamp, the boss of Remex, a debt collector based in New Jersey whose clients include banks, utilities and musical-instrument sellers. Across the country more than 6,000 collection firms contact debtors more than 1bn times a year. One in eight Americans has an account with a third-party collector. The average amount outstanding is just over \$1,300.

Third-party collectors have, it is fair to say, a dubious reputation: they are the target of more complaints from consumers than any other type of financial-services provider, according to the Consumer Financial Protection Bureau, a watchdog.

Their reputedly heavy-handed tactics



Not in the rule book

can largely be explained by their business models. Some operate on a contingency-fee basis: their sole remuneration comes from pocketing a percentage of any arrears they recover. Others buy the debts outright. They keep whatever they collect, but lose their whole investment if they fail to recoup what is owed. Both models encourage over-persistence.

Yet Mr Kettellkamp thinks the debt-collection industry is overburdened by regulations. These govern everything from when debtors may legally be contacted to the manner and content of those communications. They set out licensing requirements and impose hefty financial penalties for bad behaviour.

Consumer-rights advocates would doubtless scoff, but he may have a point. A provocative new paper by Julia Fonseca, of Princeton University, and Katherine Strair and Basit Zafar, of the Federal Reserve Bank of New York, reveals that restrictions on debt-collection practices may, perversely, hurt some consumers more than they help. The authors look at the "restrictiveness" of debt-collection legislation at the state level. They find that, after controlling for external factors, such as unemployment and income levels, borrowers in states where debt-collection practices are more strictly regulated find it moderately harder to access credit, because lenders cut back. Borrowers in states where debt-collection practices are less intense (owing to stricter rules) received on average \$213 less in car loans and \$136 less in retail and other personal loans than borrowers in states where debt collectors had a freer hand.

That is because a robust third-party debt-collection industry partially insures lenders against excessive losses, in much the same way that personal bankruptcy protects consumers. Without the deterrent effect of third-party collectors, consumers are likely to assume more risk and to over-

borrow. Default is perceived to come with lower costs. This is likely to lead to higher default rates, forcing lenders to reduce the supply of credit to mitigate losses. Those with low credit scores will bear the brunt, as they become even less likely to qualify for loans. So the debt collectors provide a service to borrowers as well as lenders. It will take more than a well-argued academic paper, however, to burnish the image of an industry neither lender nor borrower deals with by choice. ■

Remittances into Bangladesh

Give and taka

DHAKA

Inflows from migrant workers decline

IT IS a mystery. Last year Bangladesh's army of migrant workers abroad increased by a record 750,000, to reach 8m-odd. They travel to earn money for their families. Yet the statistics suggest they are sending less money home. In the fiscal year that ends this month, recorded remittances will have fallen for the second consecutive year, this time by more than 10%, to \$12bn (see chart on next page). To explain the puzzle, look to the places they work, to technology and to the growing popularity of a fiddle used by Bangladeshi importers.

The abrupt cancellation last November by the Indian government of most banknotes by value was one factor: monthly inflows crashed, as the millions of Bangladeshis working in India were strapped for cash. In the Gulf, the source of 60% of Bangladesh's remittances, the economy has been relatively sluggish.

But even without these shocks, remit- ►

tances were falling—and fewer were being counted. Bangladesh is not unique in suffering such a downturn: for the first time in three decades, remittances to developing countries fell in both 2015 and 2016, according to the World Bank. But it has punched a hole in the balance of payments. The current account swung from a surplus of \$3.7bn (1.7% of GDP) in the last fiscal year to a deficit of \$1.8bn in the first ten months of this one. This does not pose an immediate threat, but alarms a government used to double-digit growth in remittances.

It is especially worried about mobile apps that facilitate transactions through *hundi*, an informal money-transfer system in which an expat transfers an amount of money to an agent wherever they are based, and an equivalent payment is made in taka back in Bangladesh. *Hundi* is cheaper, faster and thought to handle at least as much in remittances as banks, without foreign currency ever crossing the border.

The authorities have identified 15 illegal mobile apps. As *hundi* goes digital, more and more are using authorised mobile-money operators, such as bKash, which alone has 28m accounts and 170,000 agents. In February the central bank limited daily deposits of mobile money to 15,000 taka (\$190) and withdrawals to 10,000 taka (down from 25,000 taka for both). In the budget, on June 1st, the finance minister promised to abolish banks' fees on remittance transfers and to come up with other ways to keep cash flowing through official channels. The exchange rate, controlled by the government, makes remitting money through banks unattractive. The spread between banks' and *hundi* rates is five taka (six cents) per dollar.

Ahsan Mansur of the Dhaka-based Policy Research Institute also links falling remittances to the rising demand among Bangladeshis to hold foreign currency abroad. Government cronies, businesses and the growing middle class are already nervous ahead of an election in late 2018 and want to keep money offshore.

Between 2005 and 2014, uncounted flows from Bangladesh amounted to \$61.6bn, according to Global Financial In-

tegrity, an American research and advocacy group. It blames an estimated 90% of these on trade misinvoicing. After an eight-fold increase since 2002, about 40% of Bangladesh's \$40bn in annual imports come from China and Hong Kong, where under-invoicing is rife. Typically, a Chinese exporter invoices a Bangladeshi buyer for, say, \$1 instead of \$10, evading Chinese foreign-exchange controls on most of the income; the importer pays \$1 through official channels, saving duties on \$9, which is transferred via *hundi*.

So the *hundi* network has a demand for dollars to buy with taka. Expatriate savings are an obvious source, and are now, in effect, helping pay for Bangladesh's imports from outside the country, shrinking official remittances. For all Bangladesh's booming economy, growing at 7% a year, it is still a place where those with money are looking for clever ways to dodge the rules. ■

Green shoots

Green bonds issued, worldwide, \$bn



Sources: Skandinaviska Enskilda Banken; Bloomberg

*To May 5th

and industry; and over 10% transport. But definitions of what counts as "green" vary widely. Initially, this judgment was made by the World Bank's environment department, or, for some of the first private issues, by the issuer itself.

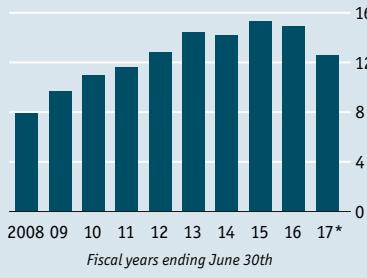
Over 130 of the world's largest banks and asset managers have since signed up to the Green Bond Principles, guidelines that specify what is green, stipulate reporting requirements and recommend the use of external reviewers. One option is certification offered by the Climate Bonds Initiative (CBI), an NGO. Others opt to get a second opinion from a specialised environmental consultancy such as Vigeo Eiris, or from a large auditor like EY or KPMG. The CBI reckons 85% of bonds issued in 2017 have undergone an external review.

Standards still vary widely, however. China's central bank, for instance, has its own standards for the Chinese market. Unlike the Principles or the CBI, for example, it regards investments in "clean coal" as green. India and ASEAN, a club of South-East Asian countries, are also working on their own rules. The WWF, a conservation NGO, has warned that the lack of a single standard opens up the risk of "greenwashing". Doubts about standards were highlighted recently when Lombard Odier, an asset manager, launched a climate-bond fund. It has set up its own assessment process and excluded a quarter of "green" bonds, citing insufficient reporting.

Progress is being made, however. Sean Kidney, head of the CBI, points out that China wants to harmonise its standards more closely with global ones. The Green Bond Principles are constantly refined, with the latest version due out this month. Credit-rating agencies are venturing into the business. Both Moody's, last year, and S&P Global, this April, have launched green-evaluation services. These resemble the conventional credit ratings the firms offer in that they will grade bonds on a scale of greenness rather than give a yes-no ruling. If they win market share, a binary judgment on what counts as "green" could evolve into a more nuanced debate on degrees of environmental impact. ■

Not coming home

Bangladesh, remittance inflows, \$bn



Source: Bangladesh Bank

*Jul 2016-May 2017, annualised

Green bonds

Bounding along

Questions about standards bedevil a fast-growing young market

WHEN Donald Trump announced America's withdrawal from the Paris climate agreement on June 1st, he spelled out that it would no longer contribute to the Green Climate Fund. This is a UN initiative to use rich countries' money to bring climate finance to developing ones. But even if the fund were going swimmingly, public-sector finance would only be able to provide a small part of the cash needed by poor countries, and indeed the world.

Private markets, however, are mobilising—notably that for "green bonds", which tie the proceeds of bond issues to environmentally friendly investments. The market started a decade ago with issues from municipalities and multilateral development banks, worth just a few hundred million dollars annually.

By 2016 issuance had grown to \$97bn, of which \$32bn came from China alone; SEB, a Swedish bank, reckons volumes may hit \$125bn this year. Public-sector issuers together accounted for only around 30% of the total last year. The largest portion, over 35%, was issued by financial institutions; around 20% came from other companies. Investor demand, too, is booming. Zurich Insurance, a Swiss insurer, has already invested over \$1.2bn in green bonds, with plans to reach \$2bn; BlackRock and other asset managers have set up dedicated green-bond funds.

As for the proceeds, over 40% is used to finance clean energy; nearly 25% buildings

Banco Popular

The popular mandate

MADRID

A relatively tidy clean-up of Spain's latest banking mess

EVEN a bank failure can be presented as a triumph. This week Banco Popular, a big Spanish lender, endured a run. Depositors were said to be withdrawing €2bn (\$2.2bn) a day. The bank lost half its stock-market value in four days, as a self-imposed deadline to find a saviour loomed. On June 6th, it was declared by the Single Resolution Board (SRB), an independent agency of the European Central Bank formed in 2015 and charged with winding down banks, to be "failing or likely to fail". The next morning, Santander, Spain's biggest bank, announced its purchase for the symbolic sum of €1 (\$1.10). It is to raise €7bn in capital to help absorb Popular's property-related losses.

Spain's government, the European Commission and Santander all cheered the outcome as a model European response to a bank crisis. Shareholders and junior bondholders in Popular have been wiped out. Spanish ministers pointed out that taxpayers would not have to pay for a rescue of the sort arranged for Bankia, a giant savings bank nearing collapse, when Spain needed a banking bail-out in 2012. Ana Botín, Santander's boss, declared the deal good for Spain, for Europe, for Popular's 4.4m customers and for her shareholders. Santander's market leadership in Spain and Portugal will be strengthened.

The cheerleaders do have a point. Compared with previous banking disasters, this one has been handled, in Ms Botín's words, with "agility and speed". But Popular's demise is also a reminder of Europe's residual banking woes (see box).

In Spain these go back to uncontrolled lending that financed a construction bubble which burst in 2008. Popular, a bank whose executives historically had close

ties to the Opus Dei movement in the Catholic church, tried to weather the crisis by turning to shareholders, not the government. In 2016 it completed its third capital increase since 2012. The strategy didn't work. Popular's 300,000 or so shareholders have now had the value of their investment reduced to zero. So have investors in some €2bn of bonds, including "contingent convertible" instruments, introduced after the crisis, that are turned into equity when things go wrong.

The terms of the Santander deal are likely to be challenged in court. Some shareholders called it an expropriation. Investors will also ask why supervisors with supposedly beefed-up powers failed to step in earlier. Popular underwent various

European banking stress tests and its successive capital increases were deemed sufficient by regulators. As recently as April, Spain's economy minister, Luis de Guindos, said it had "no problems of liquidity".

By then Popular had posted a record loss of €3.5bn for 2016. It was smaller than Bankia and never posed a systemic risk. That helped the government shun a bailout. But Spain's opposition parties called on Mr de Guindos to explain Popular's demise in parliament. "What riles people", said Miguel Ángel Revilla, head of the regional government in Cantabria, is that successive capital increases were authorised and various bank heads went home "weighed down by millions of euros" in pension and compensation packages. ■

Italian banks

Pastures new?

A state bail-out of ailing Monte dei Paschi draws near

HELP is at hand for the world's oldest bank. On June 1st the European Commission said it had agreed in principle to a bail-out by the Italian government of Monte dei Paschi di Siena, founded in 1472. For years Monte dei Paschi, Italy's fourth-biggest bank by assets, has lurched from crisis to crisis. Last July it flunked a test by European supervisors of its capital strength. In December a private-sector restructuring scheme came to naught and the state decided to step in.

The details, including the size of the bail-out, have yet to be hammered out. In December the European Central Bank (ECB) estimated that Monte dei Paschi would need €8.8bn (\$9.2bn) in capital to withstand the "adverse scenario" in last summer's test. The Bank of Italy reckoned that the state's share would be €6.6bn.

That included €2bn to compensate retail investors in the bank's junior bonds, many of them ordinary customers. European state-aid rules say that they should lose their money along with shareholders. Technically, they will. In fact, to preserve their savings and avoid a political outcry, they will be deemed to have been "mis-sold" the bonds: they will receive shares which will in turn be swapped for new, safer bonds.

Italy has to come up with a restructuring plan, likely to involve job losses and branch closures, for the commission's approval. (The ECB must also certify the bank's solvency.) Bosses' pay will be capped at ten times the staff average. And Monte dei Paschi must sell its *sofferenze*, the worst category of non-performing exposures, which in March amounted to 24% of all its loans. A state guarantee will cover senior tranches of these securitised



Not the world's oldest customer

debts. Atlante 2, a fund backed by Italian financial institutions, and others are negotiating with the bank over more junior slices.

Italian officials have high hopes for a cleaned-up Monte dei Paschi. The country's biggest bank, UniCredit, refreshed by a new boss and capital increase, is creaking no more. And the system's pile of bad loans is at last declining. But troubles remain, notably at two smaller lenders, Banco Popolare di Vicenza and Veneto Banca, which also want state help. The commission is said to want private investors to provide €1bn-plus before approving a bail-out; such benefactors are understandably hard to find. Italy's banking ills may be easing, but they are far from cured.

How to be popular

Banco Popular Español, share price, €



Free exchange | How to be wrong

To err is human. Society is suffering from an inability to acknowledge as much



A NEWSPAPER cannot publish for 174 years without some mistakes. This one has made its share. We thought Britain was safe in the European exchange-rate mechanism just weeks before it crashed out; we opined, in 1997, that Indonesia was well placed to avoid financial crisis; we noted in 1999 that oil, at \$10 per barrel, might well reach \$5, almost perfectly timing the bottom of the market; and in 2003 we supported the invasion of Iraq. For individuals, like publications, errors are painful—particularly now, when the digital evidence of failure is both accessible and indelible. But they are also inevitable. The trick, then, is to err well: to recognise mistakes and learn from them. Worryingly, humanity may be getting worse at owning up to its goofs.

Few enjoy the feeling of being caught out in an error. But real trouble starts when the desire to avoid a reckoning leads to a refusal to grapple with contrary evidence. Economists often assume that people are rational. Faced with a new fact, rational actors should update their view of the world in order to take better decisions in future. Yet years of economic research illuminate the ways in which human cognition veers from rationality. Studies confirm what is obvious from experience: people frequently disregard information that conflicts with their view of the world.

Why should that be? Last year Roland Bénabou, of Princeton, and Jean Tirole, of the Toulouse School of Economics, presented a framework for thinking about the problem. In many ways, beliefs are like other economic goods. People spend time and resources building them, and derive value from them. Some beliefs are like consumption goods: a passion for conservation can make its owner feel good, and is a public part of his identity, like fashion. Other beliefs provide value by shaping behaviour. The conviction that one is a good salesman may help generate the confidence needed to close sales; religious asceticism can help one avoid unhealthy habits.

Because beliefs, however, are not simply tools for making good decisions, but are treasured in their own right, new information that challenges them is unwelcome. People often engage in “motivated reasoning” to manage such challenges. Mr Bénabou classifies this into three categories. “Strategic ignorance” is when a believer avoids information offering conflicting evidence. In “reality denial” troubling evidence is rationalised away: house-

price bulls might conjure up fanciful theories for why prices should behave unusually, and supporters of a disgraced politician might invent conspiracies or blame fake news. And lastly, in “self-signalling”, the believer creates his own tools to interpret the facts in the way he wants: an unhealthy person, for example, might decide that going for a daily run proves he is well.

Motivated reasoning is a cognitive bias to which better-educated people are especially prone. Not all the errors it leads to are costly: preaching the superiority of Arsenal despite contradictory evidence does little harm. But when biases are broadly shared—within troubled firms, say, or financial markets or political parties—danger lurks. Motivated reasoning helps explain why viewpoints polarise even as more information is more easily available than ever before. That it is easy to find convincing demolitions of climate-change myths, for example, has not curbed misinformation on the topic. But the demand for good (or bad) information is uneven. Polling shows, for example, that Democrats with high levels of scientific knowledge are more concerned about climate change than fellow partisans with less scientific background; among Republicans, the level of scientific awareness has no effect on climate beliefs. Even, or especially, sophisticated news consumers look for what they want to find.

Work by Mr Bénabou suggests that groupthink is highest when people within groups face a shared fate: when choosing to break from a group is unlikely to spare an individual the costs of the group’s errors. If an individual politician’s fortunes rise and fall with his party’s, breaking from groupthink brings little individual benefit (and may impose individual costs). The incentive to engage in motivated reasoning is high as a result. Even as the facts on a particular issue converge in one direction, parties can still become increasingly polarised around starkly different belief-sets. That, in turn, can make it harder still for a member of one party to derive any benefit from breaking ranks. Indeed, the group has an incentive to delegitimise independent voices, such as statistical agencies or budget watchdogs. So the unanimity of views can be hard to escape until it contributes to a crisis.

Lowering the cost of admitting error could help defuse these crises. A new issue of *Econ Journal Watch*, an online journal, includes a symposium in which prominent economic thinkers are asked to provide their “most regretted statements”. Held regularly, such exercises might take the shame out of changing your mind. Yet the symposium also shows how hard it is for scholars to grapple with intellectual regret. Some contributions are candid; Tyler Cowen’s analysis of how and why he underestimated the risk of financial crisis in 2007 is enlightening. But some disappoint, picking out regrets that cast the writer in a flattering light or using the opportunity to shift blame.

I don’t want to be right

Public statements of regret are risky in a rigidly polarised world. Admissions of error both provide propaganda for ideological opponents and annoy fellow-travellers. Some economists used to seethe when members of the guild acknowledged that trade liberalisation could yield costs as well as benefits—though economic models had always allowed for this. In the long run, such self-censorship probably eroded trust in economists’ arguments more than it built support for trade. It is rarely in the interest of those in the right to pretend that they are never wrong. ■

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Meteorology

Eyes on the storm

An array of sensors that stretches from space to the deep ocean is keeping tabs on hurricanes in the Atlantic

IN SEPTEMBER 1961 a small hurricane called Esther swirled into being above the warm waters of the mid-Atlantic. It bore down on America's east coast, executed a graceful clockwise loop-the-loop off the shores of New York, then gusted up through Maine and into Quebec as little more than a squall.

Esther's place in history was not assured through its destructive power, although it did kill seven people when it brought down an American navy plane that was en route to Monrovia, in Liberia. It was, rather, the surveillance of Esther that made the storm famous, for this was the first hurricane to be discovered from space. Tracking began after the third Television Infrared Observation Satellite (*TIROS-3*), an early meteorological satellite launched by the United States, spotted precursor thunderstorms in the eastern Atlantic, southwest of the Cape Verde Islands.

America's suite of hurricane sensors has grown since 1961. The current Atlantic hurricane season, which began on June 1st, sees the country running a stack of instruments that reach from orbit to a kilometre beneath the ocean. *TIROS-3*'s successors keep a constant watch on storms' tracks and sizes. Gulfstream jets fly over and around storms, dropping sensors into them to measure wind speeds. Propeller-

driven planes fly right into storms, measuring their properties with radar and its modern, laser-based cousin, lidar. Unmanned drones fly in even deeper. And floats, buoys and aquatic drones survey storms from below.

All of the data these machines gather are transmitted directly to computer models which are used to forecast two things. The first is what track a hurricane will follow, and thus whether, where and when it will make landfall. The second is how much energy it will dump on North America if it does indeed cross the coast—a value known as its intensity.

An object of intense scrutiny

Of these two variables, intensity is by far the harder to predict, according to Paul Reasor of the National Oceanic and Atmospheric Administration (*NOAA*), an American government agency. Dr Reasor is the field director of this season's research programme. He says that how and why storms intensify rapidly is the big unanswered question in hurricane forecasting. Finding an answer is important because rapidly intensifying storms have the greatest potential to cause damage and offer the least amount of time for preparation and evacuation on shore.

Conversely, a better understanding of

intensification would also help ensure that evacuation orders are not issued needlessly. In 2011, for example, Hurricane Irene (pictured above) made landfall with far less intensity than predicted, after it ran into a pool of cold water that sapped its energy. Warnings that turn out to have been overblown may undermine public confidence in the forecasters. That could be risky when people really need to evacuate.

The reason a hurricane's intensity is hard to predict, whereas forecasting its track is reasonably easy, is that the things which influence a storm's course occur on a larger scale, and are thus simpler to measure, than those which affect its strength. The direction of the wind in the jet stream, a high-altitude circumpolar air current, plays a role in steering a storm, as do regions of high and low pressure around it. Satellites and high-altitude planes can measure both of these phenomena easily.

In contrast, many of the factors that contribute to intensity are tucked away in a storm's heart, where lack of light (both visible and infra-red) means it is difficult to make measurements. Winds there can have wildly different speeds and directions at different altitudes, a phenomenon known as vertical wind shear. This pulls energy out of a storm, acting as a brake. Pools of dry air tucked deep inside a storm have a similar effect, and are tricky to spot even with radar. Measuring all of these properties means getting sensors deep inside a hurricane. And sensors are needed, too, in the ocean ahead of a storm, for another thing that affects intensification is the temperature of the sea in the storm's path.

Advances in automated sensors, both those that fly and those that swim, are making it possible to gather more data ➤

▶ from both of these places. This season, for example, will be the first in which a constellation of microsatellites called CYGNSS (Cyclone Global Navigation Satellite System) watches storms as they roll in towards the east coast. The eight-satellite swarm, which was launched in December, listens for radio signals that come from GPS satellites directly above it in space, and for the same signals when they have been reflected from the ocean's surface beneath the hurricane being studied. Differences between the reflected signal and the original are a consequence of the state of that surface, and CYGNSS can use them to infer wind conditions there.

Satellite measurements like this are useful, but it also helps to get as close as possible to the hidden bottom kilometre of a storm. NOAA is doing this with drones called Coyotes, built by Raytheon, an aerospace company. Coyotes are released from tubes in the bellies of NOAA's research planes, then piloted remotely in order to gather data from the region in a storm that is just above the ocean's surface. The data the drones collect complement those from dropsondes, which are sensors that are pushed out of the same tubes and plunge down through a storm like bombs, transmitting as they go.

The research planes have also started using a device called a Doppler wind lidar to measure a hurricane's moisture content more accurately. Radar, a standard instrument on these planes, works at radio frequencies, which means it is reflected only from large drops of water. Lidar's use of light, which is also reflected by small—even microscopic—drops, paints a more accurate picture of the way moisture is distributed within a storm.

Engine room

What happens in the water beneath the storm is crucial, too. Hurricanes gain energy from warm water as they pass over it. But placing probes in front of a hurricane is a risky and expensive business. "You have to call up ships and get captains to say, 'Sure, I'll head out towards the hurricane,'" says Glen Gawarkiewicz, a research scientist at Woods Hole Oceanographic Institution, in Massachusetts. Unsurprisingly, many mariners are reluctant to do so.

A new instrument called ALAMO (Air-Launched Autonomous Micro Observer) solves the problem. It was designed at Woods Hole by Steve Jayne and his colleagues, and is intended to be launched out of the belly of an aircraft, in the way that dropsondes and Coyotes are. ALAMO parachutes into the ocean in front of a hurricane. Once there, it starts a cycle of descent and ascent, gathering a profile of the sea's top kilometre as the storm passes over it. Dr Jayne is currently stationed at Keesler Air Force Base in Biloxi, Mississippi, preparing his instruments for this sea-

Early man

Even earlier man

The time of humanity's emergence is pushed back farther into the past

HOW old is *Homo sapiens*? Comparing the genomes of modern humans with those from fossils of Neanderthals (*Homo neanderthalensis*) suggests that the lines leading to these two species split from one another more than 500,000 years ago. But that does not answer the question of when they achieved their distinctive forms.

Fossils recognisable as Neanderthals go back 250,000 years, about halfway between the present day and the time of their common ancestor with *Homo sapiens*, a member of a species called *Homo heidelbergensis*. Several sites older than 250,000 years and containing fossils intermediate in form between *heidelbergensis* and *neanderthalensis* are known, making 250,000 years a reasonably definitive date.

Until now, however, the most ancient bones universally agreed to have belonged to *Homo sapiens* have dated back only 195,000 years. And fossils intermediate in form between *sapiens* and *heidelbergensis* are scarce. How quickly the relevant branch of *Homo heidelbergensis*

turned into something that could be called *Homo sapiens* was therefore obscure. But work led by researchers at the Max Planck Institute for Evolutionary Anthropology, in Leipzig, Germany, which has just been published in *Nature*, has shed some light. The remains of at least five individuals, collected from a site called Jebel Irhoud, in Morocco, look like modern humans and seem to date back 300,000 years. That not only makes them the oldest *Homo sapiens* found so far (and shows that *sapiens* is actually an older species than *neanderthalensis*). It also demonstrates that *sapiens* was far more widespread than researchers had suspected, for previous early fossils of the species have come exclusively from eastern and southern Africa.

The fossils themselves are described by a group led by Jean-Jacques Hublin. They include a cranium, a lower jaw bone, an upper jaw, and various other skull fragments and teeth. Adding these together and filling in the blanks yields a model of the creature's skull (pictured), and comparing this with other fossils, some definitely identified as *Homo sapiens* and some equally definitely identified as not, shows that the parts from which it is composed come from a *sapiens* population.

The likely age of this population was worked out by Dr Hublin's colleague Daniel Richter and his team (of which Dr Hublin was also a member). They used a technique called thermoluminescence to date stone tools found in the same stratum as the fossils. They also re-dated a tooth that had been found in a badly recorded excavation carried out on the same site in the 1960s. This tooth had been thought to be 160,000 years old, and thus not of such great interest. However, both tools and tooth proved, within the margins of error of the techniques involved, to be about 300,000 years old.



A three-dimensional jigsaw puzzle

son's battle. He says that they might drop two or three of the probes on a good flight. Each would then gather about 150 up-and-down profiles as the storm passes over, sending data on temperature and salinity back to Woods Hole and NOAA's National Hurricane Centre via satellite. That ALAMO can be deployed this way is crucial to its success. Other sensors, such as Argo, are too big to fit in the launch tube, and must be pushed out of an open tailgate—an impossibility during hurricanes.

Every storm that rolls in from the Atlan-

tic this summer will thus be trailed by planes, punctured and scanned by dropsondes and drones, scrutinised from space by satellites, and monitored from the depths by floats like ALAMO. All the data these probes collect will be pushed immediately into models that help the National Hurricane Centre predict where storms will go and how strong they will be. In the longer term, those data will also shed light on the atmospheric and oceanic physics that underpin intensification, making better forecasts possible in the future. ■

Helping blind people navigate

White cane 2.0

Modern technology can help guide those with poor eyesight

FOR centuries, canes have served blind and partially sighted people well by giving them a means to negotiate the world around them. The only serious upgrade they have undergone dates back to 1921, when a Briton called James Biggs, who had recently lost his sight, painted his own cane white in order to make it easily visible and to alert others to the presence of someone unable to see nearby obstacles. In the opinion of Daniela Rus of the Massachusetts Institute of Technology (MIT), however, the white cane has had its day. Dr Rus would like to replace it with a system that scans its user's environment and communicates back to him what it sees.

Dr Rus's device, of which she demonstrated a prototype on June 1st at the International Conference on Robotics and Automation in Singapore, consists of a camera worn on a lanyard around the neck, and a belt. A computer inside the camera creates a three-dimensional image of the area ahead of the wearer, processes it to extract relevant information, and uses the results to pass on appropriate signals via the belt.

Dr Rus knew from previous attempts to build devices of this sort that what might seem the obvious way of manifesting those signals, namely as sounds with specific meanings, was not, in fact, a good approach. Blind people depend a lot on their hearing and do not like it when newfangled devices hamper this sense with beeps and clicks. Hence the belt, which has five vibrating motors installed in it. One sits over the centre of the wearer's abdomen. The others flank this central motor, with two spaced out on either side of it.

That configuration permits the computer to warn a wearer when he is on a collision course with an obstacle. It does so by telling the motor pointing most closely in the direction of the obstacle to vibrate. If the wearer is walking towards a wall, for example, the central motor vibrates softly when he comes within a couple of metres of it. If he ignores this, perhaps because he actually wants to reach the wall, the computer increases the amplitude as he closes in, giving him a good idea of exactly how far away he is. Similarly, if he is in danger of bumping, say, his right shoulder on a door frame while walking from one room to another, the right-most motor on the belt will warn him of the impending collision. And it works. When compared with navigation by white cane in one of MIT's famously



Belted up

crowded hallways, it reduced blind students' collisions with others by 86%.

The new system can, however, do more than just help someone walk around without collisions, for the belt incorporates a touchpad that is inscribed with instructions in Braille. This permits the user to program it to perform specific tasks.

For example, Dr Rus knew that blind students often struggle to find an empty seat in a crowded lecture theatre. Adding an appropriate algorithm to the computer's software helps get around this by enabling it to recognise chairs, and also whether or not a chair is occupied. In this case, the motors are used to indicate a direction to be travelled in, rather than one to be avoided. Activating the algorithm using the touchpad causes the motor pointing most closely towards an empty chair to vibrate when the system spots one.

Good vibrations

In trials involving a room that contained an empty chair, an occupied chair and also a recycling bin, the algorithm directed the belt-wearer straight to the empty chair 80% of the time. Cane users presented with the same arrangement always found the empty chair eventually, but in doing so came into contact with objects other than their target more than five times as often as those using the camera and belt.

Whether a camera (ideally, smaller than the one in the prototype) and a belt could replace a cane completely remains to be seen. In particular, Dr Rus's system does lack one important feature of Biggs's innovation. A white cane not only helps a blind person to navigate, it also signals his condition to the rest of the world, allowing others to adjust their behaviour accordingly. As a supplementary aid, however, her approach seems most promising. ■

Microelectronics

It's a wrap

A new transistor design offers another way to extend Moore's law—for now

ALL good things come to an end. Moore's law—the observation that the number of transistors that can be crammed onto a chip of a given size doubles every two years—has built the modern, computerised world. But as transistors get smaller, making them smaller still gets harder. In recent years Moore's law has begun to slow.

For all the fearsome complexity of computer chips, their basic components are simple. Transistors are nothing more than switches. To turn one on, a voltage is applied to part of it called a gate. This allows electrical current to flow through a channel between the transistor's input and output. As transistors shrink, though, insulation breaks down and the current applying the voltage tends to leak away, reducing the gate's ability to control the channel. One reason for this is a phenomenon called quantum tunnelling, in which the uncertainty of an electron's position means it is sometimes found in another part of the transistor without having physically crossed there.

To try to keep things ticking along, chipmakers have been tinkering with the basic design of the transistor itself. In 2012, for example, Intel, the biggest chipmaker of the lot, introduced transistors in which the gate surrounds the channel on three sides, making it better able to impose its will.

Now IBM, a computing firm, has gone one better. In collaboration with Samsung, a Korean electronics giant, and Global-Foundries, another big chipmaker, it has developed a new kind of transistor composed of three sheets of silicon, laid horizontally, which are surrounded completely by gate material. Such devices remain laboratory prototypes. But IBM's engineers reckon they should permit Moore's law to carry on until the mid 2020s.

After that, things get murkier. It is hard to improve on a design that wraps the gate entirely around the channel. If firms want to keep shrinking their products, more radical ideas will be needed. One is to use new materials, such as tubes composed of rolled-up sheets of carbon atoms, the physical properties of which permit components to be smaller. Another is to make a virtue of necessity and build devices that take advantage of quantum oddities such as tunnelling, rather than trying to resist them. A third option is to stack transistors on top of one another, keeping a chip's area the same but increasing its volume. IBM has fingers in all of these pies, too. ■

Quantum mechanics and relativity theory

Does one thing lead to another?

If time is fuzzy, that has implications for the idea of causality

THE thing about *Gedankenexperimente*—or thought experiments, for those who find Albert Einstein's native tongue too twisting—is that you never know where they might lead. For Einstein, they led to the theory of relativity. For James Clerk Maxwell, they conjured an imaginary demon who could violate the second law of thermodynamics. For Erwin Schrödinger, they created an existentially confused cat that was simultaneously dead and alive.

Physicists like to devise *Gedankenexperimente* because they are a way to consider ideas that cannot be tested for real, usually because the technology needed is not yet available or even envisaged. Though not a substitute for true experimentation, a good *Gedankenexperiment* may point to conclusions that proper experiments can indeed test. And, though the famous *Gedankenexperimente* mentioned above are all quite old now, the idea of conducting them has neither gone out of fashion nor lost its ambition. Indeed, some of the most recent such thought experiments, carried out by a group of quantum physicists led by Caslav Brukner of the University of Vienna, are questioning the nature of one of the fundamental aspects of the universe, time itself.

That one thing happens after another, and that there is no doubt about which came first, is intrinsic to the commonsense notion of time. It was also intrinsic to the development of the theory of relativity, the *Gedankenexperimente* for which often depend on clocks moving relative to one another. Add quantum theory to the mix, though, and then think through the consequences, and doubts start to emerge about what order events are really happening in.

Let's do the time warp again

The first thought experiment that Dr Brukner's group came up with, published earlier this year in the *Proceedings of the National Academy of Sciences* by him and two of his students, Esteban Castro Ruiz and Flaminia Giacomini, involved an imaginary clock of great precision. The accuracy with which such a clock could be read is constrained by Werner Heisenberg's uncertainty principle. This limits how well pairs of properties of any physical system (such as location and velocity) can be measured. The more precisely one member of a pair is known, the more uncertain is the value of the other.

In the case of a clock, the time it tells

and the energy required to run it form a Heisenberg pair: the more accurately the clock is read, the less accurately the quantity of energy involved can be determined. The result is that the clock's energy is in a state called a quantum superposition. The energy in question may be large or small, both at the same time—just as Schrödinger's cat is both alive and dead.

At this point, quantum mechanics and relativity collide. One consequence of Einstein's theories is that energy and mass are equivalent. This means energy, like mass, has a gravitational pull. A second consequence is that gravity changes the flow of time. Such gravitational time dilation is a well-established phenomenon. Atomic clocks kept at different altitudes on Earth, for example, get out of sync with one another because they are subjected to different gravitational forces.

Dr Brukner and his colleagues observed that in the case of their own hypothetical clock, the quantum superposition of its energy states means that the gravitational effects of those energy states also exist in a quantum superposition. The time dilation created by these gravitational effects thus becomes superposed, too. Worse, a second quantum effect, entanglement, means other clocks within the gravitational influence of the first will be affect-

ed by the superposition as well, and, reciprocally, will affect the original clock in a similar manner. Since clocks, whatever the specific details of their mechanisms, are the only way time can be measured, the whole concept of time itself therefore becomes fuzzy.

Nor is that the end of it. In the wake of the clock paper Dr Brukner and his colleagues are working on another *Gedankenexperiment*. This investigates the consequences that superposing gravitational fields has for causality—the idea that one event can truly be said to cause another.

The metric system

Besides mass-energy equivalence and gravitational time dilation, a third concept which emerges from the mathematics of relativity is something known as the metric field. Just as general relativity is an extension of Isaac Newton's theory of gravity, so the metric field is the relativistic extension of the Newtonian idea of gravitational potential—namely that the strength of the gravitational interaction between two objects depends on the distance separating those objects. The strength of gravitational interaction in a metric field similarly depends on the distance between objects. But because general relativity treats time as a fourth dimension, equivalent to the three dimensions of space, in a way that Newtonian gravity does not, metric-field distance is measured in both space and time.

According to Dr Brukner, the clock thought experiment shows that the metric field is yet another phenomenon which is subject to Heisenberg's principle, and therefore to superpositional effects. As a consequence, it is no longer only location in space that becomes uncertain, but also location in time. Often, therefore, it would no longer be possible to say which of two events came first.

The new *Gedankenexperiment* the team have devised to test this involves a giant atom in a superposition of two divergent energy states. They are attempting to calculate the consequences of such an object for the concept of causality, namely the idea of event A causing event B. They believe that if the atom's two energy states are sufficiently different it will become impossible to say whether A or B came first, and causality will thus disappear.

Although, like all *Gedankenexperimente*, this latest one cannot be conducted with current experimental technologies, all of the assumptions behind it have been so tested in the past. It therefore obeys both quantum mechanics and the theory of general relativity. But one big question nags. If the *Gedankenexperimente* that led to relativity relied on a linearity of time that the theory itself is now helping call into question, can those original thought experiments themselves be relied on? ■

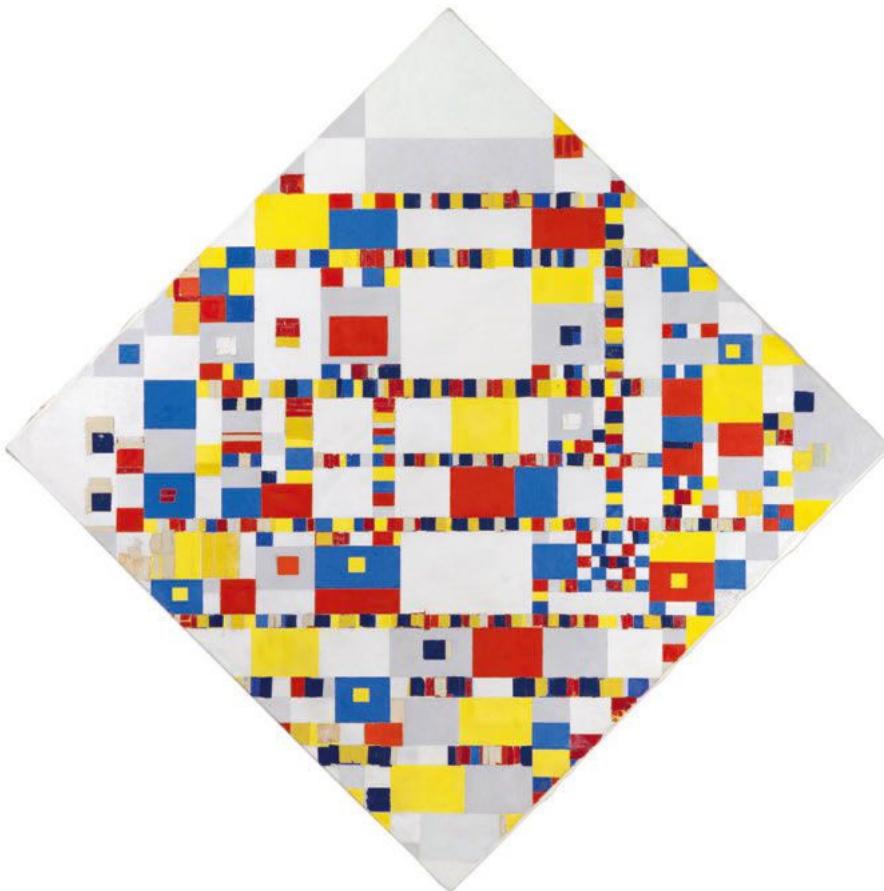


Piet Mondrian and the Stijl movement

Square man

THE HAGUE

The co-founder of the Stijl movement grew up drawing cows, but became the world's greatest abstract geometrist. A new exhibition explains how



WHEN he was 68, Piet Mondrian arrived in New York, having fled Nazi-occupied Europe. He was celebrated by such 20th-century American greats as Ad Reinhardt, Jasper Johns and Mark Rothko, who called him the most sensual of artists. Mondrian had an even more obvious impact on design, paving the way for Gerrit Rietveld's "Red Blue Chair", Yves Saint Laurent's 1965 shift dress, packaging for L'Oréal, a cosmetics company, and even Nike trainers. Along with Kazimir Malevich and Wassily Kandinsky, the Dutch painter is one of the fathers of abstract art.

What is less well known about Mondrian is that he only developed his signature style when he was in his 50s. The shift came after a long and focused process of searching and experimenting with paint, form and composition, which had begun when he was still in his teens and living in his native Netherlands, where the reigning genre was sombre landscape paintings

dotted with cows and windmills.

An important new show, "The Discovery of Mondrian", at the Gemeentemuseum in The Hague, plots every step of that development through the 300 works it owns—the largest trove of Mondrian's work anywhere. The most extensive exhibition ever devoted to his painting (no other artists feature), it is the centrepiece of a nationwide celebration of the Dutch master and De Stijl ("The Style"), the art movement that Mondrian helped found exactly a century ago.

In 2009 the Gemeentemuseum launched a project to re-examine every Mondrian painting in its collection. At the same time its chief Mondrian expert, Hans Janssen, was busy writing a new life of the artist, "Piet Mondrian: A New Art for a Life Unknown". Far from being an eccentric recluse, as has long been thought, Mondrian, it turns out, was something of a ladies' man. He loved jazz, learned all the latest

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dance steps and was fully engaged in the avant-garde culture that surrounded him.

"The Discovery of Mondrian" presents about a quarter of his output, from his earliest student drawings to his final masterpiece, "Victory Boogie Woogie" (pictured), which he left unfinished on his easel when he died of pneumonia in New York in 1944. Walking through the show, you can see a clear progression. It starts with traditional landscape paintings such as "Trees along the Gein" (1905)—by a precocious and skilled painter with a strong, intuitive sense of line, form and composition. These turn into more experimental landscapes, for example "Evening: The Red Tree" (1908–10) or the highly colourful and luminous "Mill in Sunlight" (1908), a response to Vincent van Gogh, and the more formally Luminist works, including "The Red Windmill" (1911). The visitor encounters such paintings as "Composition No. IV" (1914), inspired by Braque and Picasso, and sees how Mondrian moved into the familiar colour-grid works, notably "Composition with Large Red Plane, Yellow, Black, Grey and Blue" (1921).

The show is a visual pilgrimage. The artist moves from lush, realistic illusionism, paring down the act of painting until he reduces it to its essential elements: pure, clean colour, line and form. (The "Discovery" of the exhibition title happens both to Mondrian and to the viewer.)

The breakthrough to abstraction came after the first world war ended. Just before Mondrian returned to Paris in 1919, he painted two pictures with lots of colourful squares arranged in a Cubist structure, and made "Composition with Grey Lines", a diamond-shaped canvas with a grid of horizontal, vertical and diagonal grey lines that divide up the canvas into triangles and squares. The painting looks unassuming today, but it represented a revolution in art: "That was the moment we realised how far he dared to go," says Benno Tempel, director of the Gemeentemuseum and one of the curators of the show. "It became more and more about rhythm and harmony."

And then, after emigrating to America in 1940, Mondrian went even further. His late canvases—represented in this exhibition by just one work, "Victory Boogie Woogie", displayed in a room of its own—made art into a form of visual music, separating it from the world of the tangible to reach for the transcendent. ■

Football

Secrets and success

The Mixer: The Story of Premier League Tactics, from Route One to False Nines. By Michael Cox. HarperCollins, 486 pages; £16.99

The European Game: The Secrets of European Football Success. By Daniel Fieldsend. Arena Sport; 255 pages; £14.99

ON THE opening weekend of the Premier League in 1992, all but 13 players were from Britain or Ireland. In the 25 years since, the top tier of English football has been transformed into the sport's most globalised—and lucrative—domestic competition. As Michael Cox, a football journalist whose writing often focuses on tactics, shows in "The Mixer", the Premier League's sporting evolution has been mostly driven by foreigners.

In the league's early years Eric Cantona, Dennis Bergkamp and Gianfranco Zola were all revolutionaries. The three brought a dazzling skill to the game, and excelled at playing "in between the lines", defying the rigid tactical orthodoxy with which English football had traditionally been associated. When Arsène Wenger was appointed Arsenal's manager in 1996, he was derided by Sir Alex Ferguson, manager of Manchester United, as "a novice" who "should keep his opinions to Japanese football".

Yet Mr Wenger was also revolutionary. He transformed the diet and conditioning of players, who liked to eat full English breakfasts before training, and would engage in notoriously heavy drinking sessions on Tuesdays (the "Tuesday club") as they had a day off on Wednesdays. Mr Wenger steered Arsenal to the championship in 1998, his first full season: the first time the top-flight tournament had been won by a manager from outside Britain.

The trajectory has continued. José Mourinho and Rafael Benítez, who joined Chelsea and Liverpool respectively in 2004, introduced more technical nuance. Last season Antonio Conte, Chelsea's Italian manager, reintroduced the 3-4-3 formation, previously considered unpopular, and promptly won the title. Thanks to his meticulous research and his focus on strategy, Mr Cox finds a fresh perspective on a story that football fans will think they already knew.

"The European Game" is an interesting counterpoint to "The Mixer". It is an idiosyncratic book involving vignettes from 17 European teams, interspersed with the travel observations of the author, Daniel Fieldsend, a UEFA-qualified coach. Mr Fieldsend's book shows how globalisa-



Cantona en marche

tion, and the professionalisation of all facets of football, have transformed the sport on the continent, too.

The book benefits from not just focusing on European superclubs. It tells the remarkable tale of Athletic Bilbao, one of three clubs never to have been relegated from La Liga, the Spanish top division, despite having a policy of selecting only Basque players. Bilbao's story emphasises a recurring theme of the book: the importance of development programmes for young players and the lengths that clubs go to in order to nurture footballers. Benfica, a Portuguese club, uses a 360-degree "football room", walled by LED lights, to train players in over 100 scenarios. Targets appear for the players to hit with the ball; sensors measure the players' effectiveness.

Important regional and national differences between teams still linger. Italian clubs, for instance, are better at nurturing veteran players, perhaps a reflection of how valued older generations are in Italian culture, Mr Fieldsend suggests. But clubs' unrelenting focus upon maximising revenue is now universal. Barcelona, which treasures its image as *més que un club* ("more than a club") has now become the embodiment of the modern giant. After years of not having paid advertising on players' shirts, it succumbed in 2010.

It seems inevitable that clubs will become ever more international. Less certain is whether the Premier League will maintain its position as the globe's most celebrated football league, or whether Brexit will undermine the league, cutting it off from footballing innovations in continental Europe. Richard Scudamore, the league's executive chairman, favoured Remain in the referendum last year, and clubs have called for European players to be exempt from immigration regulations should they be introduced after Brexit.

Whereas Britain's reputation abroad faces uncertainty, the globalised Premier League "is effectively Britain's best advertisement for itself," Mr Cox concludes. A recent poll of foreign citizens found that the league is the nation's most popular foreign brand. It has always relied on foreigners. Now, more than ever, Britain needs the example of the outward-looking attitude that has underpinned its football. ■

Botany

The gospel of bark

The Plant Messiah: Adventures in Search of the World's Rarest Species. By Carlos Magdalena. Viking; 217 pages; £16.99

WITH his long brown locks and his knack for rescuing rare flora from extinction, it is easy to see why Carlos Magdalena has come to be known as "the plant messiah". A botanical horticulturalist at Kew Gardens in London, he denies having a messiah complex. But his book, which tells of his efforts to track down and revive long-lost species, suggests otherwise.

Growing up in Spain as the son of a florist, Mr Magdalena's ability to nurture wildlife was his "miracle of the loaves and fishes". In his 30s he won an internship at Kew, where a "sixth sense" for breeding dying plants attracted interest and scepticism. Even after he saved several doomed species, "some people still did not believe the good news". In recent years he has been sent around the world to train other gardeners—or rather, "disciples".

Yet Mr Magdalena's claim to be a green-fingered Jesus has its merits. His record of ►

▶ propagating plants that others have consigned to botanical history is impressive. The most gripping passages are about his work with the last remnants of a species—a handful of seeds glued to an envelope or a plant discovered living in a single bubbling spring. He draws on his years as a waiter for similes: watering Kew's trees is like being a sommelier; the beetles that pollinate Amazonian waterlilies are like revellers flitting between nightclubs.

The botany can get thorny, with descriptions of stamens, stigmas and styles (and a rap on the knuckles for readers who were “daydreaming during biology”). The author comes across as passionate but prickly, with little time for bunglers. His gospel, however, is important. A fifth of plants face extinction. They feed people, clothe them, heal them and produce the oxygen they breathe. Some 30,000 plants have recorded uses for humans. Most people, the messiah preaches, are blind to these everyday miracles. This book will teach them to see. ■

Fiction

Sun, sea and spectres

Grief Cottage. By Gail Godwin. Bloomsbury; 324 pages; \$26. To be published in Britain in August, £18.99

OUT with the clichés of cold draughts and creaking doors. Contemporary novelists are refocusing the ghost story, revelling in its potential for psychological drama. “Grief Cottage” by Gail Godwin, a prolific American writer, is a quiet, hopeful ghost story—a wistful reflection on loss, loneliness, coming of age and coming to terms with the past.

Marcus, the narrator, is 11 years old when his mother is killed in a car accident. He is sent to live on a small island in South Carolina with his great aunt, a reclusive painter. A precocious, imaginative boy, he worries constantly about how his words and actions affect others.

Desperate not to burden his new guardian, he spends much of his time outdoors, finding himself drawn to a derelict house known as Grief Cottage because of a hurricane half a century earlier during which a teenage boy and his parents went missing. They are presumed to have been swept out to sea. One day Marcus sees a boy with a “flat unsmiling mouth” and “hungry dark pools” for eyes. He is both repelled and attracted by this apparition. Struggling to deal with his losses, Marcus believes the boy “had been waiting all this time...for someone to wonder where he was—to

Hans Sloane

Hoarder extraordinaire

Collecting the World: The Life and Curiosity of Hans Sloane. By James Delbourgo. Allen Lane; 503 pages; £25. To be published in America by Belknap in July; \$35

JOINED-UP words and sentences with verbs are not enough to describe Sir Hans Sloane. Only a list can do justice to this man, who was both quite remarkable and, to some, a little touched. Over the course of a lifetime, he managed to accumulate 3,516 volumes of manuscripts, as well as books of prints, which together amounted to 50,000 volumes; 32,000 medals and coins; 5,843 testacea and shells; 173 starfish; 12,506 vegetable substances and 55 mathematical instruments. This is just a selection from Sloane's collection,

miss him after he was gone”.

But “Grief Cottage” is no ordinary haunted-house tale. Marcus's relationship with the boy is at the heart of the novel, yet peripheral to its action. Marcus spends most of his time looking after his aunt, who is haunted by demons of her own. He also watches over a nest site of turtles' eggs, so that he can help them reach the sea once they hatch. When the weather is bad, he slowly works his way through the boxes of belongings packaged up after his mother's death and shipped to his aunt's house, sorting through all of their shared possessions and the memories they dredge up.

Ms Godwin's vivid prose ensures that these mundane activities are just as compelling as his encounters with the supernatural. The author, who turns 80 this month, never forgets that “there are enough horrors in the real world to worry about”, as Marcus's aunt puts it, when the boy finds himself grappling with “awful things I didn't want inside me”.

Like Joanna Briscoe's “Touched” and Sarah Waters's “The Little Stranger”, “Grief Cottage” is an ambiguous, beguiling tale in which the presence of the supernatural is entangled with—and perhaps precipitated by—characters who are undergoing an emotional crisis. Ms Godwin's interest lies not with the dead but with the living, and how they learn to lay their ghosts to rest.

much of which he eventually catalogued himself.

Or try this: “a set of surgeons' instruments made from fish-skin; inks and ink-horns; face-paint; medicinal powders and pills; women's shoes made of leather and silk; gold and silver pins and needles for the practice of acupuncture; tobacco pipes; several portable Buddhist ‘idols’; gilded rhinoceros horns; ‘metallic burning glasses’ and ‘a ball of several colours to be thrown into the fire to perfume a room.’” These are some of the objects Sloane acquired from Japan.

The Anglo-Irish physician, collector and naturalist was not a man of small ambitions. He aimed for universal knowledge, available to all humankind, with a serious play for personal immortality thrown in. He did not make such a bad fist of them: his acquisitions became the foundation of the British Museum, as well as the collections of the Natural History Museum and the British Library.

He would surely be irritated that his name endures more strongly in London's topography than in universal understanding. There are a dozen or so Sloanes and Hances listed in the city's “A to Z”, because Sloane had the presence of mind to buy up most of Chelsea in the course of his long and prosperous life.

He was born in Ulster in 1660 and died at 92 with a cunning plan to leave a permanent mark on human civilisation. He had set himself up in London as a physician and made himself the undisputed king of the capital's medicine men, attending the best bedsides for the best prices. He married money and enjoyed the revenues ►



Lots more where that one came from

Johnson | Don't go mad

Hyphens can be tricky, but they need not drive you crazy

“**I**F YOU take hyphens seriously, you will surely go mad,” warns the style manual of the Oxford University Press. This maxim is quoted in *The Economist’s* own style book, which goes on about the punctuation mark for eight pages.

People can get very excited over things like the presence or lack of a hyphen in “e-mail”. Most of the world is trending towards “email”; hyphens disappear over time, in favour of the closed-up form. (“Today” overtook “to-day” in frequency around 1926 in America, according to data from Google Books, and a bit later than that in Britain.) *The Economist*, being stylistically conservative, still prefers “e-mail”, but that may well change one day even if absolutely nobody is confused by either form.

English is a Germanic language that allows for many different kinds of compounds, including those made from two adjectives (“blue-green”), two nouns (“kitchen sink”), adjective-noun (“dark-room”), noun-adjective (“slate-blue”) and so on. But which ones should be written separately, which hyphenated and which closed up? As so often in language, those looking for perfectly clear strictures will be disappointed.

The rules are mostly unofficial ones. The shorter and more native (ie, Germanic) the roots are, the more likely they are to be closed up: you might call someone who is behaving like a fish “fishlike”. But long words behave differently: should someone behave like a cuttlefish, you are more likely to call them “cuttlefish-like”. That goes doubly for long words that came to English from French, Latin or Greek: almost no one closes up “rhinoceros-like” or “hippopotamus-like”.

These hyphens have nothing to do with grammar, and everything to do with feel, which is why people get into such



rows about the marginal cases. *De gustibus non est disputandum*, goes the saying: “there’s no arguing about taste.” Except that people argue endlessly about taste; a truer phrase is “there’s no way of proving your case in matters of taste.” *De gustibus non est probandum*.

Most of *The Economist’s* style book entry on hyphens consists of seemingly arbitrary rulings on disputable cases: “non-existent” but “nonaligned”, “arch-rival”, but “archangel”. Still, a few patterns emerge: “archrival” looks bad because of the ungainly “rchr” series of consonants in the middle. We write “co-operate” and “re-elect” for an analogous reason: this time breaking up vowels rather than consonants that would be awkward together. The overarching rule is that, at the very least, you should be consistent, so that readers don’t find “arch-rival” and “archrival” on the same page.

But in one case in particular, connois-

seurs should really insist that a hyphen is not a matter of taste. A bestselling guide to punctuation was subtitled “The Zero Tolerance Approach to Punctuation”. Punctuation pros sniggered. *The Economist*, like most other publications, would require a hyphen (“Zero-Tolerance”) here.

This hyphen is starkly different from the one in “arch-rival”. It has a critical grammatical function, not just a stylistic one. It tells the readers that several words are to be taken together as a single modifier. You can write “we have zero tolerance for bad punctuation,” but when “zero tolerance” is used to modify a noun, it acts a bit like an adjective. It does not become an adjective, as many people think. But taken together, as a modifier, “zero-tolerance” functions like a single word; hence the hyphen.

Reading means parsing grammar on the fly, a tricky task requiring concentration. Everything that helps with that does a favour to the reader. Strings of words with no punctuation can often be parsed in several ways. The hyphen eliminates one possibility. This not only speeds up comprehension, but in some (rare) cases, is crucial for avoiding ambiguity. The difference between a “third-world war” and a “third world war” is nothing to sniff at, and those selling a car might get rather more interest in the sale if they remember the hyphen in “a little-used car”.

This is not to be overdone. Most adjectives modified by an adverb, like “highly educated”, need no hyphen. And the company advertising a “Metal-Watering Can” on Amazon was presumably not trying to tempt rust aficionados. Fortunately, this is one rule that need not drive anyone mad: a group of words used as a single modifier should be hyphenated. Any other approach to hyphenation really should receive zero tolerance.

▶ from vast slave-plantations in Jamaica.

Sloane was president of the Royal College of Physicians and the Royal Society but he was not exactly a man of ideas. What he liked was stuff. He was a man of the Enlightenment, but not a man remarkable for enlightened thought. An enemy called him “master of only scraps”.

In his early days Sloane spent a year in Jamaica, working as a physician just as Britain was concentrating on acquiring an empire. Prudently he stuck to water while his patients drank themselves to death on Madeira wine. This was the time when he began to get serious about collecting.

After he had accumulated his Jamaican, he returned to London and set about collecting the rest of the world. In this he had the assistance of a large fortune, a vast network of contacts—he was reckoned to have 1,793 correspondents—and a limitless curiosity, or perhaps a limitless appetite for curious things.

Sloane sold the lot to the nation posthumously, for £20,000 (worth about £4m, or \$5.2m, now), which he reckoned was a quarter of its value, to be paid to his two daughters. Had the nation turned down this offer, his executors had instructions to offer the stuff to St Petersburg.

He was a curious man in every sense. His biographer has struggled with a shortage of anecdotal and humanising material. That gives “Collecting the World” a somewhat static feel, like a cabinet of curiosities. Little of Sloane’s stuff remains on display in London, though there is still a store of his Jamaican specimens in the Sir Hans Sloane herbarium at the Natural History Museum. It is a reminder of that great tradition of learning, based around museums and libraries and emblematic of what the British Museum would come to describe as being, “for the benefit of all studious and curious persons, native and foreign”. ■

Economic data

% change on year ago

	Gross domestic product			Industrial production latest	Consumer prices latest	Unemployment rate, %	Current-account balance			Budget balance % of GDP 2017†	Interest rates, % 10-year gov't bonds, latest	Currency units, per \$ Jun 7th	Currency units, per \$ year ago
	latest	qtr*	2017†				latest	months, \$bn	% of GDP 2017†				
United States	+2.0 Q1	+1.2	+2.2	+2.2 Apr	+2.2 Apr	+2.2	4.3 May	-481.2 Q4	-2.6	-3.5	2.14	-	-
China	+6.9 Q1	+5.3	+6.7	+6.5 Apr	+1.2 Apr	+2.1	4.0 Q1§	+170.1 Q1	+1.6	-4.0	3.62§§	6.79	6.57
Japan	+1.3 Q1	+1.0	+1.4	+5.7 Apr	+0.4 Apr	+0.6	2.8 Apr	+188.4 Apr	+3.6	-5.1	0.03	109	107
Britain	+2.0 Q1	+0.7	+1.6	+1.4 Mar	+2.7 Apr	+2.7	4.6 Feb††	-115.7 Q4	-3.4	-3.6	1.09	0.77	0.69
Canada	+2.3 Q1	+3.7	+2.2	+5.4 Mar	+1.6 Apr	+1.9	6.5 Apr	-48.4 Q1	-2.8	-2.7	1.41	1.35	1.28
Euro area	+1.7 Q1	+2.0	+1.8	+1.9 Mar	+1.4 May	+1.6	9.3 Apr	+403.9 Mar	+3.0	-1.4	0.26	0.89	0.88
Austria	+2.3 Q1	+5.7	+1.8	+3.3 Mar	+2.1 Apr	+1.9	5.5 Apr	+6.6 Q4	+2.3	-1.3	0.52	0.89	0.88
Belgium	+1.6 Q1	+2.6	+1.5	+2.6 Mar	+1.9 May	+2.2	6.8 Apr	-2.0 Dec	+1.0	-2.3	0.60	0.89	0.88
France	+1.0 Q1	+1.8	+1.4	+2.0 Mar	+0.8 May	+1.3	9.5 Apr	-27.4 Mar	-1.2	-3.1	0.67	0.89	0.88
Germany	+1.7 Q1	+2.4	+1.8	+1.8 Mar	+1.5 May	+1.7	3.9 Apr†	+287.5 Mar	+8.1	+0.5	0.26	0.89	0.88
Greece	+0.8 Q1	+1.8	+1.2	+8.7 Mar	+1.6 Apr	+1.0	23.2 Feb	-1.2 Mar	-0.9	-1.0	6.11	0.89	0.88
Italy	+1.2 Q1	+1.8	+1.0	+2.8 Mar	+1.4 May	+1.5	11.1 Apr	+46.9 Mar	+2.2	-2.3	2.29	0.89	0.88
Netherlands	+3.4 Q1	+1.8	+2.2	+4.0 Mar	+1.6 Apr	+1.3	6.0 Apr	+64.8 Q4	+8.8	+0.7	0.48	0.89	0.88
Spain	+3.0 Q1	+3.3	+2.8	-10.2 Apr	+1.9 May	+2.1	17.8 Apr	+26.2 Mar	+1.6	-3.3	1.52	0.89	0.88
Czech Republic	+3.9 Q1	+5.4	+3.0	-2.5 Apr	+2.0 Apr	+2.3	3.3 Apr†	+2.3 Q4	+0.9	-0.5	0.79	23.4	23.8
Denmark	+3.1 Q1	+2.4	+1.5	-5.6 Apr	+1.1 Apr	+1.1	4.3 Apr	+26.5 Mar	+7.8	-0.6	0.54	6.60	6.55
Norway	+2.6 Q1	+0.9	+1.7	+3.3 Mar	+2.2 Apr	+2.4	4.5 Mar††	+22.4 Q1	+5.0	+2.9	1.48	8.50	8.12
Poland	+4.4 Q1	+4.5	+3.2	-0.6 Apr	+1.9 May	+2.0	7.7 Apr§	-0.1 Mar	-1.0	-2.8	3.19	3.73	3.83
Russia	+0.5 Q1	na	+1.4	+2.4 Apr	+4.1 May	+4.2	5.3 Apr§	+34.9 Q1	+2.8	-2.2	8.13	56.9	65.0
Sweden	+2.2 Q1	+1.7	+2.6	+0.8 Apr	+1.9 Apr	+1.6	7.2 Apr§	+22.0 Q1	+4.8	+0.3	0.44	8.69	8.14
Switzerland	+1.1 Q1	+1.1	+1.4	-1.3 Q1	+0.4 Apr	+0.5	3.3 Apr	+70.6 Q4	+9.7	+0.2	-0.17	0.96	0.97
Turkey	+3.5 Q4	na	+2.9	+2.8 Mar	+11.7 May	+10.2	12.6 Feb§	-33.0 Mar	-4.5	-2.4	10.49	3.54	2.90
Australia	+1.7 Q1	+1.1	+2.6	-0.8 Q1	+2.1 Q1	+2.2	5.7 Apr	-25.0 Q1	-1.5	-1.8	2.39	1.32	1.34
Hong Kong	+4.3 Q1	+2.9	+3.0	-0.9 Q4	+2.1 Apr	+1.6	3.2 Apr†‡	+14.9 Q4	+6.6	+1.5	1.18	7.79	7.77
India	+6.1 Q1	+7.2	+7.2	+2.7 Mar	+3.0 Apr	+4.6	5.0 2015	-11.9 Q4	-1.2	-3.2	6.57	64.3	66.8
Indonesia	+5.0 Q1	na	+5.2	+5.5 Mar	+4.3 May	+4.2	5.3 Q1§	-14.6 Q1	-1.7	-2.2	6.93	13,305	13,270
Malaysia	+5.6 Q1	na	+5.2	+4.5 Mar	+4.4 Apr	+4.0	3.4 Mar§	+6.6 Q1	+1.4	-3.0	3.87	4.26	4.06
Pakistan	+5.7 2017**	na	+5.5	+10.5 Mar	+5.0 May	+4.6	5.9 2015	-7.2 Q1	-2.6	-4.8	8.96†††	105	105
Philippines	+6.4 Q1	+4.5	+6.5	+11.1 Mar	+3.1 May	+3.3	6.6 Q1§	+0.6 Dec	+0.4	-2.8	4.63	49.5	46.1
Singapore	+2.7 Q1	-1.3	+2.6	+6.7 Apr	+0.4 Apr	+1.3	2.3 Q1	+59.0 Q1	+19.0	-1.0	2.06	1.38	1.35
South Korea	+3.0 Q1	+4.3	+2.7	+1.7 Apr	+2.0 May	+1.9	4.2 Apr§	+93.0 Apr	+6.0	-0.5	2.16	1,124	1,163
Taiwan	+2.6 Q1	+3.8	+2.3	-0.6 Apr	+0.6 May	+0.5	3.8 Apr	+69.1 Q1	+12.3	-0.8	1.02	30.1	32.3
Thailand	+3.3 Q1	+5.2	+3.5	-1.7 Apr	nil May	+0.8	1.3 Apr§	+42.3 Q1	+11.8	-2.4	2.34	34.0	35.2
Argentina	-2.1 Q4	+1.9	+2.5	-2.5 Oct	+27.5 Apr†	+24.3	7.6 Q4§	-15.0 Q4	-2.7	-5.7	na	16.0	13.8
Brazil	-0.4 Q1	+4.3	+0.6	-4.5 Apr	+4.1 Apr	+4.1	13.6 Apr§	-19.8 Apr	-1.3	-7.7	10.36	3.27	3.47
Chile	+0.1 Q1	+0.7	+1.6	-4.2 Apr	+2.7 Apr	+2.8	6.7 Apr§††	-5.0 Q1	-1.4	-2.2	4.07	668	681
Colombia	+1.1 Q1	-0.9	+2.0	+4.8 Mar	+4.4 May	+4.2	8.9 Apr§	-12.5 Q4	-3.8	-3.2	6.17	2,902	2,949
Mexico	+2.8 Q1	+2.7	+1.9	+3.4 Mar	+5.8 Apr	+5.5	3.6 Apr	-22.0 Q1	-2.5	-2.4	7.13	18.2	18.6
Venezuela	-8.8 Q4~	-6.2	-7.0	na	na	+591	7.3 Apr§	-17.8 Q3~	-0.6	-19.6	10.43	10.0	9.99
Egypt	+3.8 Q4	na	+3.5	+13.7 Mar	+31.5 Apr	+22.5	12.0 Q1§	-20.1 Q4	-5.8	-9.3	na	18.1	8.88
Israel	+4.0 Q1	+1.4	+3.6	-1.5 Mar	+0.7 Apr	+1.0	4.4 Apr	+12.4 Q4	+4.2	-2.5	2.00	3.54	3.83
Saudi Arabia	+1.7 2016	na	-0.5	na	-0.6 Apr	+2.2	5.6 2015	-24.9 Q4	+4.0	-7.1	3.68	3.75	3.75
South Africa	+1.0 Q1	-0.7	+1.0	-2.4 Mar	+5.3 Apr	+5.7	27.7 Q1§	-9.5 Q4	-3.5	-3.1	8.48	12.8	14.9

Source: Haver Analytics. *% change on previous quarter, annual rate. †The Economist poll or Economist Intelligence Unit estimate/forecast. §Not seasonally adjusted. ‡New series. ~2014. **Year ending June. ††Latest 3 months. ††3-month moving average. §§5-year yield. †††Dollar-denominated bonds.

Markets

	% change on			
	Index Jun 7th	Dec 30th 2016	one week	in local currency terms
United States (DJIA)	21,136.2	+0.6	+7.0	+7.0
China (SSEA)	3,288.8	+0.7	+1.2	+3.5
Japan (Nikkei 225)	19,984.6	+1.7	+4.6	+11.5
Britain (FTSE 100)	7,525.0	+0.1	+5.3	+9.9
Canada (S&P TSX)	15,464.6	+0.7	+1.2	+0.7
Euro area (FTSE Euro 100)	1,213.3	+0.1	+9.1	+16.5
Euro area (EURO STOXX 50)	3,554.2	nil	+8.0	+15.4
Austria (ATX)	3,171.6	+1.5	+21.1	+29.4
Belgium (Bel 20)	3,878.3	-0.3	+7.5	+14.9
France (CAC 40)	5,269.2	-0.3	+8.4	+15.7
Germany (DAX)*	12,690.1	+0.6	+10.5	+18.1
Greece (Athex Comp)	777.5	+0.3	+20.8	+29.0
Italy (FTSE/MIB)	20,760.0	+0.1	+7.9	+15.3
Netherlands (AEX)	521.7	-0.5	+8.0	+15.3
Spain (Madrid SE)	1,092.4	nil	+15.8	+23.7
Czech Republic (PX)	1,006.0	+0.4	+9.2	+19.6
Denmark (OMXCB)	909.4	+1.2	+13.9	+21.6
Hungary (BUX)	34,927.0	+1.1	+9.1	+16.8
Norway (OSEAX)	780.8	-0.1	+2.1	+3.7
Poland (WIG)	60,723.5	+1.1	+17.3	+31.6
Russia (RTS, \$ terms)	1,041.2	-1.1	-9.6	-9.6
Sweden (OMX30)	1,637.9	-0.1	+8.0	+13.0
Switzerland (SMI)	8,908.3	-1.2	+8.4	+14.3
Turkey (BIST)	98,331.5	+0.8	+25.8	+25.9
Australia (All Ord.)	5,707.8	-0.9	-0.2	+3.8
Hong Kong (Hang Seng)	25,974.2	+1.2	+18.1	+17.4
India (BSE)	31,190.6	+0.1	+17.1	+23.4
Indonesia (JSX)	5,707.8	-0.5	+7.8	+9.2
Malaysia (KLCSE)	1,785.9	+1.1	+8.8	+14.4
Pakistan (KSE)	50,144.6	-0.9	+4.9	+4.4
Singapore (STI)	3,230.5	+0.6	+12.1	+17.4
South Korea (KOSPI)	2,360.1	+0.5	+16.5	+25.8
Taiwan (TWI)	10,210.0	+1.7	+10.3	+18.2
Thailand (SET)	1,569.0	+0.5	+1.7	+7.0
Argentina (MERV)	22,355.6	nil	+32.1	+30.7
Brazil (BVSP)	62,954.7	+0.4	+4.5	+3.7
Chile (IGPA)	24,605.6	+1.0	+18.7	+18.9
Colombia (IGBC)	10,818.6	+1.3	+7.0	+11.1
Mexico (IPC)	49,218.6	+0.9	+7.8	+21.7
Venezuela (IBC)	82,593.6	+9.7	+161	na
Egypt (EGX 30)	13,626.8	+2.2	+10.4	+10.4
Israel (TA-100)	1,292.6	-0.2	+1.2	+10.0
Saudi Arabia (Tadawul)	6,933.3	+0.9	-4.2	-4.2
South Africa (JSE AS)	52,251.9	-2.4	+3.2	+10.3

The Economist poll of forecasters, June averages (previous month's, if changed)

	Real GDP, % change		Consumer prices		Current account	
	Low/high range	average	2017	2018	2017	2018
Australia	2.1/2.9	2.5/3.4	2.6 (2.7)	3.0	2.2	2.3
Brazil	nil/1.3	1.4/3.6	0.6 (0.7)	2.3 (2.5)	4.1 (4.3)	4.6 (4.5)
Britain	1.0/2.0	0.7/1.8	1.6	1.3 (1.2)	2.7	2.7 (2.8)
Canada	1.7/2.8	1.5/2.7	2.2 (2.1)	2.1 (2.0)	1.9	1.9
China	6.5/6.8	4.6/7.0	6.7 (6.6)	6.3 (6.2)	2.1 (2.3)	2.3 (2.4)
France	1.2/1.7	1.4/2.0	1.4 (1.3)	1.6 (1.5)	1.3	1.3
Germany	1.3/2.1	1.4/2.2	1.8 (1.6)	1.7 (1.6)	1.7 (1.8)	1.6 (1.7)
India	6.3/7.5	6.8/8.0	7.2 (7.1)	7.6 (7.5)	4.6	4.9 (4.8)
Italy	0.8/1.3	0.7/1.2	1.0 (0.8)	0.9 (0.8)	1.5 (1.4)	1.2
Japan	0.9/1.7	0.5/1.7	1.4 (1.3)	1.0 (1.1)	0.6 (0.7)	0.9 (1.0)
Russia	0.8/2.0	0.9/3.3	1.4	1.7 (1.8)	4.2 (4.3)	4.2
Spain	2.4/3.0	1.6/2.8	2.8 (2.6)	2.3 (2.1)	2.1	1.5
United States	2.0/2.9	1.8/3.4	2.2	2.4 (2.5)	2.2 (2.3)	2.1 (2.3)
Euro area	1.5/2.0	1.4/2.1	1.8 (1.7)	1.6 (1.5)	1.6	1.4 (1.5)

Sources: Bank of America, Barclays, BNP Paribas, Citigroup, Commerzbank, Credit Suisse, Decision Economics, Deutsche Bank, EU, Goldman Sachs, HSBC Securities, ING, Itaú BBA, JPMorgan, Morgan Stanley, Nomura, RBS, Royal Bank of Canada, Schroders, Scotiabank, Société Générale, Standard Chartered, UBS. For more countries, go to: Economist.com/markets

Other markets

	% change on			
	Index Jun 7th	one week	in local currency terms	Dec 30th 2016
United States (S&P 500)	2,429.3	+0.7	+8.5	+8.5
United States (NAScomp)	6,275.1	+1.2	+16.6	+16.6
China (SSEB, \$ terms)	323.8	+0.9	-5.3	-5.3
Japan (Topix)	1,597.1	+1.8	+5.2	+12.1
Europe (FTSEurofirst 300)	1,530.5	-0.1	+7.1	+14.4
World, dev'd (MSCI)	1,926.1	+0.7	+10.0	+10.0
Emerging markets (MSCI)	1,015.9	+1.1	+17.8	+17.8
World, all (MSCI)	467.4	+0.8	+10.8	+10.8
World bonds (Citigroup)	929.4	+0.5	+5.1	+5.1
EMBI+ (JPMorgan)	830.7	+0.9	+7.6	+7.6
Hedge funds (HFRX)	1,236.6 [§]	+0.4	+2.7	+2.7
Volatility, US (VIX)	10.5	+10.4	+14.0 (levels)	
CDSs, Eur (iTRAXX) [†]	62.3	-0.2	-13.7	-7.8
CDSs, N Am (CDX) [†]	60.7	-1.5	-10.4	-10.4
Carbon trading (EU ETS) €	5.0	-0.2	-24.5	-19.3

Sources: IHS Markit; Thomson Reuters. *Total return index.

[†]Credit-default-swap spreads, basis points. [§]June 5th.

Indicators for more countries and additional series, go to: Economist.com/indicators

The Economist commodity-price index

	2005=100		% change on	
	May 30th	Jun 6th*	one month	one year
Dollar Index				
All Items	142.2	140.7	-0.3	-0.2
Food	153.3	153.0	+0.1	-10.6
Industrials				
All	130.6	127.8	-0.9	+16.8
Nfa [†]	134.2	130.9	-2.4	+9.6
Metals	129.0	126.5	-0.3	+20.3
Sterling Index				
All items	201.0	198.4	+0.1	+12.7
Euro Index				
All items	158.1	155.3	-3.6	+0.6
Gold				
\$ per oz	1,262.5	1,295.3	+6.4	+4.3
West Texas Intermediate				
\$ per barrel	49.7	48.2	+5.0	-4.5

Sources: Bloomberg; CME Group; Cotlook; Darmenn & Curl; FT; ICCO; ICO; ISO; Live Rice Index; LME; NZ Wool Services; Thompson Lloyd & Ewart; Thomson Reuters; Urner Barry; WSJ. *Provisional

[†]Non-food agriculturals.



One in the eye for the Chairman

Yu Zhijian, defiler of Mao's portrait during the protests in Tiananmen Square, died on March 30th, aged 53

THE work was some of the trickiest Yu Zhijian and his friends had ever done. First they had to break each egg, 20 of them, neatly over a bowl. Then they had to fill each one with oil paint, dark blue, red or yellow, and glue it back together. Whose lousy scheme was this? he thought. Lousy except for the giant omelette, with spring onions, they were going to devour afterwards? Well, his. He had realised that eggs by themselves were too pale to leave much of a splash. So here he was sticky-fingered in Beijing, working like a snail, when inside he was jumping round like the Monkey King, able to fly 22,000km in one somersault, do magic with every hair of his body, and freeze demons. Ready to overturn China, in fact.

There were three of them, all from Liuyang in Hunan province: himself, his classmate Lu Decheng, a mechanic for the bus company, and Yu Dongyue, no relation, just a poetry-scribbling short-sighted friend, who wrote about art for the local paper. Yu Zhijian was not the eldest, but the tallest and fastest, so with his long legs he tended to take the lead. He taught at a primary school in town until, because he kept griping, he was demoted to one in the countryside. Troublemaker was his middle name. In the *Deed with the Eggs* he was the one who held people back while the oth-

ers launched their missiles. A shame; he would have got more on target.

They were all in their 20s in the spring of 1989, unbelievably pumped up with political fervour. Literature had been their passion, again at his instigation, because his head had been spinning since high school with Byron, Shelley, Hemingway, Kant and Nietzsche, as well as the more familiar poets of the Tang dynasty. Before the *Deed with the Eggs*, revelling in impending doom, he wrote a last letter to his family. It was full of Byron.

At home in Liuyang the friends would crash together at his place and talk literature or philosophy all night. After the death that spring of Hu Yaobang, a reformist former general secretary of the party, the all-nighters switched to politics. They seemed to be the only people in that stuck-in-the-mud town who cared whether China festered in authoritarian corruption or embraced democracy. A bunch of hotheads, waiting for the hour to strike.

It was his idea, using proper ink-stone and ink-brush, to write slogans in Hu's honour shouting "Democracy! Freedom!" and stick them round a few streets, which made people tut. But at Changsha, the provincial capital, he and his friends found much more sympathy. Bus-drivers refused to take their fares (just as well, since they

were broke), and when they hectored the crowds at the railway station more than 3,000 yuan was stuffed in their donations box. That gave them the train fare north to Beijing, where they had never been, and they crammed on, standing almost all the way, to bring the regime down.

The outlaw band

How to do it, though? In that May of 1989 the student-led protests were going strong, but his fire-breathing gang were disdained. They were older, had jobs, came from the provinces; they didn't fit in. Their extra-long counter-revolutionary banner was called irresponsible by the students, so careful, so stupidly polite, kneeling down to present their petition to the prime minister, like the subjects of a feudal monarch. Yu Zhijian refused to kneel to anyone. No, he would lead a band of outlaws like the bandit-heroes of "Water Margin", his favourite medieval tale. Too bad there were only three of them, and not 108.

His thoughts turned to the giant portrait of Mao Zedong that had hung since 1949 over Tiananmen Square. There was the source of evil, the bastard despot whose cult had to end before China could remake itself, the man he had blubbed so hard for when he died in 1976, competing with his classmates to see who could wail loudest. The portrait was much too high and heavy to take down. But what symbolism, even art, if they could defile it! Hence the eggs.

On the day they hung up two banners: "Time to end 5,000 years of tyranny! Time to lay the cult of Mao to rest!" Then they hurled the eggs, which mostly fell short, though a blue one cracked Mao's eyebrow and ran down his nose. At once they were seized by the students, who disowned them and handed them over to the security forces: an act which did not save the students from the massacre later. Yu Zhijian heard the gunfire in the square from his jail cell, like someone sautéeing peas in a pan.

They were all jailed, for almost 12 years in his case, as "rapists of the Great Leader". Afterwards they fled into exile; he ended up in Indianapolis. With a wife, a son, diabetes and not much money, it was hard to get by. His main job was looking after Yu Dongyue, who had lost his mind in prison. He felt that heartbreak was his fault.

Apart from that, no regrets about the eggs. Just worries that his fervent gesture would fade from minds, and that the spectre of Mao would remain. Sadly, he was right on both counts. He and his friends, "all average nobodies", were forgotten in exile, his death largely unnoticed and his memories, recounted to the poet Liao Yiwu for a book, untranslated until now. Meanwhile Mao's portrait, replaced mere hours after the eggs landed and many times since, continues to stare out over China from the Gate of Heavenly Peace. ■