The Economist

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MARCH 1ST–7TH 2025

THE DON'S NEW WORLD ORDER

Business

Photograph: Getty Images

BP's chief executive, Murray Auchincloss, unveiled a new strategy that he said would "fundamentally reset" the company's direction away from green energy and back towards oil and gas. Investments in renewables will be cut by 70%. Mr Auchincloss said that BP had underestimated the resilience of demand for fossil fuels and overestimated the speed of the green-energy transition. He had been under pressure to switch direction from investors unhappy with BP's inert share price. Elliott Management, an activist fund manager, has taken a 5% stake. BP says it is still committed to its sustainability goals.

Nvidia produced another solid set of quarterly earnings. Revenue rose by 78%, year on year, to $39bn, and quarterly net profit surged to $22bn. Demand for its latest-generation Blackwell chips is "amazing", said Jensen Huang, Nvidia's chief executive.

A few weeks ago it was the hottest stock on Wall Street, but Palantir's share price has fallen sharply of late, in part because of a new plan by Alex Karp, the boss of the software-analytics company, that

will allow him to sell 10m shares over six months. Market speculation that cuts to defence spending in America will affect Palantir's bottom line also hurt the stock. The Pentagon is one of Palantir's biggest customers.

Apple announced that it would invest $500bn in America over the next four years, create 20,000 jobs and open a new factory in Houston making AI servers. The announcement seemed to be aimed at seeking favour with the Trump administration. Apple has made similar declarations before, including in 2021, when it committed to spend $430bn in America over five years. Meanwhile, Apple's shareholders voted against a proposal from a conservative investor to abolish the company's diversity, equity and inclusion programme.

Upping the ante in competition between America and China, Alibaba made its own big declaration and said it would invest 380 billion yuan ($52bn) on AI and the cloud over three years, more than it has spent over the past decade.

iSpy

In Britain Apple took the controversial decision to disable its Advanced Data Protection tool for iCloud services. ADP offers end-to-end encryption, which prevents anyone except the user, Apple included, from unscrambling the data. Britain's government had demanded Apple weaken the system to allow it access. Apple refused, and has instead withdrawn ADP from the British market.

In a surprise decision Unilever removed Hein Schumacher as chief executive after less than two years in the job, and replaced him with Fernando Fernandez, the chief financial officer. The consumer-goods conglomerate is under pressure from investors who want a faster pace of restructuring.

Thames Water, a utility in Britain that is drowning in debt, reportedly asked KKR, a private-equity firm, and Castle Water, which provides water and sewage services to businesses and public bodies, to provide more details on their bids for the company. CK Infrastructure, which is based in Hong Kong, has offered to buy a majority stake in Thames Water, according to reports.

Prosus, a global tech-investment company, boosted its food-delivery portfolio by agreeing to buy Just Eat Takeaway, which operates mostly in Europe, for €4.1bn ($4.3bn). Both companies have their headquarters in Amsterdam.

Chart: The Economist

American consumer confidence fell sharply in February, in part because of expectations that inflation will rise over the coming months and increasing pessimism about the economy. The data suggest that Donald Trump's trade war and his imposition of tariffs on even friendly trading partners is starting to worry consumers.

Coinbase, a crypto exchange, said that the Securities and Exchange Commission had dropped its lawsuit against the firm for allegedly allowing trading in tokens that should have been classified as securities. The SEC also reportedly ended its investigation into the crypto business of Robinhood, a trading platform. The news comes amid a slump in crypto markets, despite Mr Trump's crypto-friendliness.

A recipe for disaster

Five years ago Elon Musk warned that Tesla's stock could be "crushed like a soufflé under a sledgehammer". The carmaker's share price has indeed tumbled this year, wiping out most of the gains it made after Donald Trump's victory in November. Its long-awaited update this week of its autopilot software in China left investors unimpressed. And Europeans are turning away from its vehicles in droves. Tesla's sales fell by half in Britain and the EU in January, year on year, according to the European Automobile Manufacturers' Association.

Finance & economics
Inheriting is becoming nearly as important as working

More wealth means more money for baby-boomers to pass on. That is dangerous for capitalism and society

Image: Javier Jaen

Work hard, children are told, and you will succeed. In recent decades this advice served the talented and the diligent well. Many have made their own fortunes and live comfortably, regardless of how much money they inherited. Now, however, the importance of hereditary wealth is rising around the rich world, and that is a problem.

People in advanced economies stand to inherit around $6trn this year—about 10% of GDP, up from around 5% on average in a selection of rich countries during the middle of the 20th century. As a share of output, annual inheritance flows have doubled in France since the 1960s, and nearly trebled in Germany since the 1970s. Whether a young person can afford to buy a house and live in relative comfort is determined by inherited wealth nearly as much as it is by their own success at work. This shift has alarming economic and social consequences, because it imperils not just the meritocratic ideal, but capitalism itself.

In part, the inheritance boom is a reflection of a wealthier and ageing society. As economies have become richer, they have accumulated capital per worker—capital that someone has to own. But because the pace of economic growth has slackened and housing markets have boomed, the scale of this wealth relative to incomes has ballooned. Nowhere is this combination of towering wealth and enduring sclerosis more evident than in Europe, where productivity growth has been dismal.

More wealth means more inheritance for baby-boomers to pass on. And because wealth is far more unequally distributed than income, a new inheritocracy is being born.

You can see this in the shifting fortunes of the super-rich. For much of the 20th century vast estates were often broken up by bad investing, or by war and inflation. By one calculation, if America's rich families in 1900 had invested passively in the stockmarket, spent 2% of their wealth each year and had the usual number of children, there would be about 16,000 old-money billionaires in America today. In fact, there are fewer than 1,000 billionaires and the vast majority of them are self-made.

These trends are being overturned, however, perhaps because billionaires are both amassing wealth and are better at preserving their riches. In 2023, 53 people became billionaires thanks to inheritance, not far short of the 84 who made their own fortunes, according to UBS, a bank. That may be because it is now easy to park wealth in an index fund, and the principles of wealth management are better understood. Moreover, many governments have obligingly cut inheritance taxes.

The most striking thing about the inheritocracy, though, is that it is not just about the uber-rich. The typical heir is someone inheriting a normal house, or the proceeds from its sale, not a superyacht or a country pile. And housing wealth has rocketed in recent decades, especially in apex cities like London,

New York and Paris. Those who were fortunate enough to buy property before the long boom have made lots of money, passing on a windfall to their heirs. As a consequence, bankers and corporate lawyers now fight bidding wars over houses from the estates of deceased taxi drivers. As housing has become ever more unaffordable in places like New York and London, so a 90th-percentile income has become too small to pay for a 90th-percentile life. You must have significant capital, too—if not from your parents' estate, then from the Bank of Mum and Dad.

If you consider this as a whole, the growing importance of inheritance starts to become clear. In Britain one in six of those born in the 1960s is projected to receive an inheritance that exceeds ten years of average annual earnings for that generation. For those born in the 1980s, the ratio rises to one in three. The inequality of what people inherit, meanwhile, is startling. A fifth of 35- to 45-year-olds are expected to inherit less than £10,000 ($13,000), whereas a quarter are expected to inherit more than £280,000.

For supporters of free markets, the rise of the new inheritocracy should be deeply disturbing. For a start, it creates a rentier class that faces a series of bad incentives. A loophole-ridden tax system means that the wealthy spend a lot of time gaming the rules; it would be better used to direct their capital to more productive uses instead. To protect their assets, homeowners become nimbys, blocking building and making housing unaffordable for those without inherited wealth. Knowing they can rely on their inheritance, moreover, the new rentiers may face little incentive to work or innovate.

More worrying still is how an underclass of non-beneficiaries is becoming increasingly left behind—and increasingly disaffected. If property becomes ever harder to buy, and a comfortable life harder to achieve, the incentive of young, aspirational workers to strive will be blunted. And when they believe that the system is stacked against them, their support for mainstream political parties withers.

Family fortunes

That is why fixing the problem is urgent. It would be mad to wish that inflation and war destroy fortunes, as they did in the 20th century. This newspaper has long argued that inheritance taxes are the fairest tool to deal with inheritocracy. Yet the taxes are so unpopular that, instead of enforcing them, governments have introduced loophole after loophole, raised the threshold at which they apply, or dismantled them altogether.

Fortunately, there are other remedies. Building enough houses in the right place is the single biggest action governments can take to restore the link between work and wealth. Levying sufficient annual property taxes, especially those that target underlying land values, would also help, because the tax would be capitalised as a fall in house prices, bringing down house-price-to-income ratios. And

anything that boosts economic growth, so desperately needed in Europe, would bring down wealth-to-GDP ratios. The heyday of meritocracy brought with it social mobility, growth and prosperity. With a little hard work, those days can return.

Prabowo Subianto takes a chainsaw to Indonesia's Budget

The result? More money for the president's boondoggles

Photograph: Getty Images

On the campaign trail last year Prabowo Subianto, a former general with a sketchy human-rights record, pledged to give every Indonesian child a free lunch. Experts predicted this would cost $28bn a year by 2029, or the equivalent of 2% of the country's GDP. Mr Prabowo refused to say how it would be paid for. Four months after he was sworn in as president, the answer, and much of his broader agenda, are becoming clear.

In January Mr Prabowo launched a cost-cutting drive unlike any the country has seen. He is seeking approximately $19bn in savings from this year's budget, which comes to about 8.5% of Indonesia's public-sector spending. A proposed second series of cuts, about which he has offered no other details, could lift the savings to $37bn.

Roughly $6bn of the savings will fund the school-lunch programme, which is being implemented in phases. The remaining two-thirds, the president announced on February 24th, will finance a new sovereign-wealth fund. This will back 20 "strategic projects", such as mineral-processing plants to help Indonesia secure a more prominent place in the world's electric-vehicle (EV) supply chain.

Mr Prabowo's aims have something going for them. Cutting red tape is a good idea for Indonesia, just as it is for Elon Musk's Department of Government Efficiency, or DOGE, to make America more efficient. Free school meals are supposed to reduce childhood stunting. And although Indonesia's bid to muscle its way up the EV value chain via industrial policy is a long shot, he does at least have a mandate for it from voters.

Unfortunately, as with DOGE, the closer you look, the worse his plans seem. Although civil servants cannot be fired to meet the new targets, contract employees can. The budget at the ministry of public works has been cut by 70%, forcing it to put on hold dozens of toll roads, ports and other investment projects. It has sacked over 18,000 contractors.

Other ministries are taking cuts of 30-50%. Departments are turning off the lights and air-conditioning at 4pm and sending staff home early, which may not help productivity. The meteorological and geophysical agency, handy in a country with at least 127 active volcanoes, had its budget slashed by half. It warns that delayed updates to tsunami sensors could extend the time needed to issue a warning from three minutes to five. That may not sound a lot, but every minute counts. A tsunami in 2004 killed more than 100,000 Indonesians.

The way to reduce stunting is to target children below the age of two, long before they arrive at school. Mr Prabowo's school programme seeks to increase eating. Yet Indonesian children are twice as likely to be overweight as underweight and stunting is often caused by a lack of micronutrients, not calories. More lives would be improved with better health care and education, including teaching parents about nutrition.

The new sovereign-wealth fund risks being badly run. Its board, unlike that of Indonesia's first such fund, will report directly to the president. Its CEO is Rosan Roeslani, who chaired Mr Prabowo's election campaign. Worse, a law passed in February setting up the fund removed it from the jurisdiction

of the government’s auditors and anti-corruption cops, and immunised managers against legal liability for any losses. Mr Prabowo is cancelling a lot of growth-enhancing infrastructure projects to create a piggy bank he can use as he pleases.

What could possibly go wrong?

Instead he should use the legislative process to enact smaller, more considered cuts to the state budget. That would be a more democratic way to fund his priorities, and more accountable than his sovereign-wealth fund. But for a president who loves flashy boondoggles, where would the fun be in that?

How to get rich in 2025

Forget about your career. Today an inheritance is what matters

Illustration: Javier Jean

“Asingle man of large fortune; four or five thousand a year. What a fine thing for our girls!” In “Pride and Prejudice” Jane Austen did not have to explain to the 19th-century reader what Mr Bingley’s “four

or five thousand a year" meant, or why it excited Mrs Bennet. It was obvious. Mr Bingley was an heir. And the surest way to get rich was not by working hard but by marrying the right person.

Fast-forward to today, and rich countries are starting to look like Austen's world. In ways that will upend the economy and society, inheritance is back.

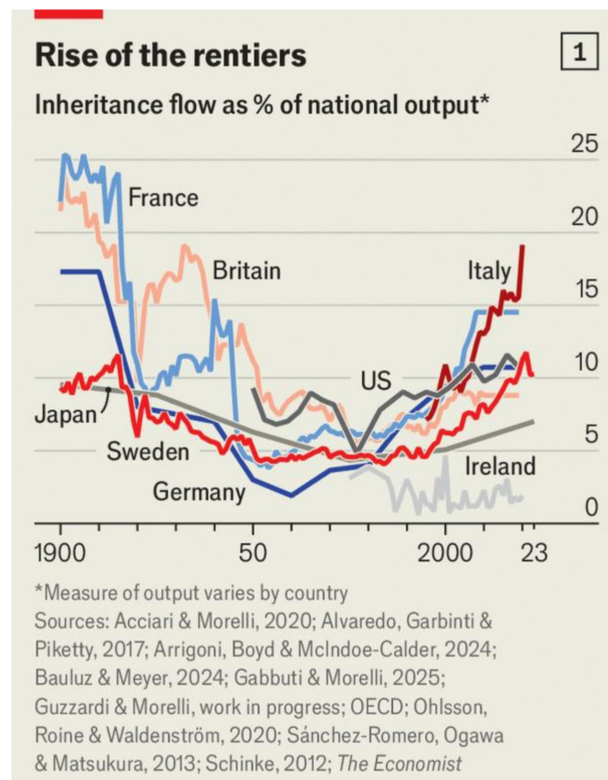

Chart: The Economist

Government statistical offices publish almost no data on inheritances, since their surveys are ill-equipped to track huge, one-off payments. So The Economist has gathered academic estimates on the annual "inheritance flow"—the value of what people pass on to heirs in art, cash, properties and the like—for a range of countries (see chart 1). In 1900 inheritances were worth over 20% of gdp in some countries, as people passed on vast stock portfolios and estates. The value of inheritances then fell in the 20th century, before more recently roaring back. By the end of the 2010s inheritances were worth, on average, 10% of gdp. This year people across the rich world will inherit on the order of $6trn.

In many countries the share of wealth that comes from inheritance is also rising. ubs, a bank, suggests that in 2023 53 people became billionaires by inheriting money, not far short of the 84 who did so by working. As a share of national output, annual French inheritances have doubled since the 1960s.

Germany's have almost tripled since the 1970s. In Britain they are twice as important, relative to earnings, for those born in the 1980s as for the generation before. Inheritances in Italy are now worth more than 15% of gdp—enough, perhaps, to get the modern Mrs Bennet to ship her daughters to parties in the palazzi of Rome. Only Ireland seems to buck the trend of becoming an inheritocracy: there, at least, bequests are modest and have not grown much in recent years.

In America today, for every $100 employers pay a year in wages, the dead leave behind $20. And such figures, striking though they are, understate the shift to an inheritocracy. The average family size has fallen sharply in recent years. A given inheritance is therefore spread over fewer people. Using British data, we estimate that in recent decades falling birth rates have raised the amount going to the average heir by some £60,000 ($75,000), or 24%. Having a brother or sister might be nice, but they come at a price.

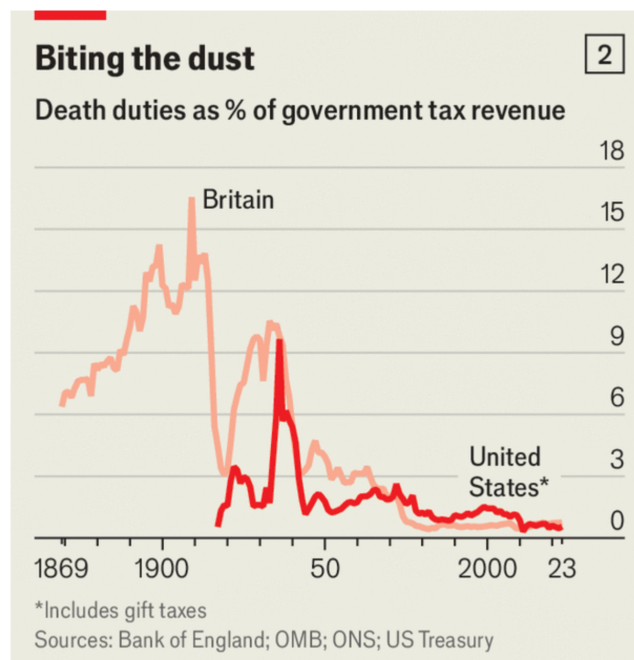

Chart: The Economist

Falling inheritance taxes also increase the share of a bequest that an heir can keep. In the early 20th century, revenues from death duties accounted for a sizeable chunk of the total tax take in America and Britain (see chart 2). But in the latter part of the century, politicians turned against the taxes. Some were swayed by lobbying. Others feared that, in a globalised world, taxes on wealth would prompt rich folk to up sticks. Today death duties account for well under 1% of government revenues across rich countries. Several places, including Australia, Canada, India, Norway and Russia, have abolished them

entirely. Many in America would sorely like their government to do the same. More than 20 American states binned their wealth-transfer taxes between 1976 and 2000.

Popular culture hints at the growing importance of inheritance. "Succession", a tv series, focuses on the wranglings of a set of siblings who hope to gain control of their father's media empire. "Crazy Rich Asians" follows the trials and tribulations of a woman marrying into a Singaporean dynasty. Popular fiction, from "The Nest" by Cynthia d'Aprix Sweeney to John Lanchester's "Capital", deals with the questions raised when people inherit vast sums. In the latter, a character receives a house in London: "The equation was too plain and too depressing. In the debit column, she had lost her mother; in the credit column, she now had a gigantic pile of cash."

The rise of the inheritocracy reflects three factors: increasing wealth, changing demography and slower economic growth. After the first and second world wars, the value of wealth, relative to national income, collapsed. Many of Europe's buildings were destroyed. High inflation eroded the value of cash and government bonds. Politicians developed a taste for heavy wealth taxes and nationalisation. Many wealthy families, including the Vanderbilts, squandered their fortunes.

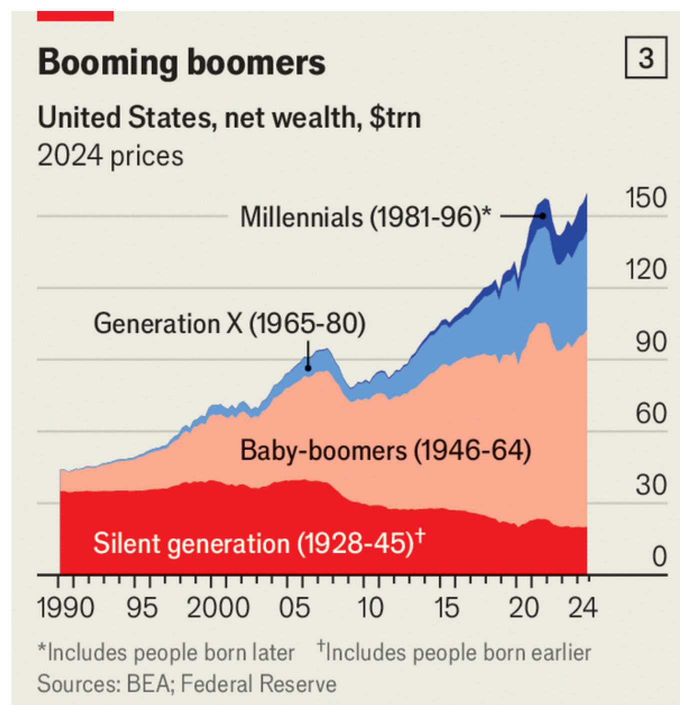

Chart: The Economist

Since then housing, in particular, has become more valuable, partly owing to restrictive planning policies, which constrain supply. The value of buildings owned by Britons has risen from just over £1trn (130% of gdp) in the mid-1990s to just under £7trn (270% of gdp) in recent years. Wealth taxes

are out of favour, stockmarkets have performed fantastically, while inflation, at least until recently, has been low. Because of the rise of wealth managers and index funds, the rich have become better at avoiding the fate of the Vanderbilts.

The second factor is demography. Baby-boomers have soaked up wealth, having come of age just at the point when house prices and stockmarkets started soaring. Germans aged over 65, who make up a fifth of the population, own a third of the country's wealth. American baby-boomers, also a fifth of their country's population, own half of its net wealth, or $82trn (see chart 3). Now the boomers are starting to die, leaving large estates to their heirs.

Lucky Irish

Economic growth is the third factor. In 2014 Thomas Piketty of the Paris School of Economics and Gabriel Zucman, then of the London School of Economics, presented evidence that slow-growing countries accumulate more wealth, measured in relation to national income. People add to savings at a fairly consistent rate, but gdp rises less quickly. In recent years, owing to weak growth in both populations and productivity, rich-world gdp growth has slowed markedly. According to our data, the fastest-growing countries, such as America and Ireland, appear to be less afflicted by inheritocracy compared with the slowest, such as Germany and Italy.

The inheritance boom may, in turn, reinforce the trend towards slower economic growth. Just as in Honoré de Balzac's time, the best way to get rich is increasingly not to work hard, but to marry well. "You will need to suffer ten years of misery…and lick the courthouse floor with your tongue," says a character in "Père Goriot", as he lectures another about how only an idiot would choose a salary over an inheritance. In the 21st century, the incomes of the top 1% of French inheritors are once again higher than those of the top 1% of workers. The economic implications may be big. If people focus on matchmaking, rather than starting a company, innovation will suffer. Already, across the rich world, entrepreneurship is in long-term decline.

Surging inheritances are likely to have even larger social effects. They widen the gap between people at the top and bottom. Data from the Federal Reserve suggest the average American in the top 5% of earners has received well over $50,000 in inheritance, compared with about $5,000 for someone in the middle. Hero Ashman of the University of California, Berkeley, and Seth Neumuller of Wellesley College estimate that intergenerational wealth transfers explain a quarter of the wealth gap between black and white Americans.

The inheritance boom will create particular inequalities in the housing market, whether wealth transfers are made at death or during life. Research on America by Legal & General, a financial-services firm, suggests that if the "Bank of Mum and Dad" were a business, it would be among the ten biggest

mortgage lenders. Generous support from relatives, in turn, raises the homeownership rate among the young—by perhaps a third or more, according to a paper by Eirik Eylands Brandsaas of the Fed. At the same time, people without benefactors lose out.

These findings have important implications for the marriage market. Our advice is clear: you should find a modern-day Mr Bingley with "four or five thousand a year", rather than someone who is clever or hardworking. Consider two millennials, "Inheriting Isabel" and "Nonbeneficiary Nancy", who both live in London and earn more than 90% of people in the city (£100,000, or $126,000, a year). Given their pay, they both might expect to buy a 90th-percentile home in the capital. But that house costs on the order of £1.2m. Fortunately for Isabel, her parents have given her such a home. Nancy has no such luck. Although she works hard and puts away half her post-tax salary, she may never be able to pay off the mortgage on a house that pricey. Whom would you rather marry?

Indeed, the inheritance boom is already upending the marriage market. In wealthier parts of America, people in their 20s and 30s openly talk about the need to marry rich. Economists discuss the phenomenon of "assortative mating", where people exchange vows with those who are similar to themselves. Most research focuses on education or income, yet newer work suggests heirs are also likely to marry each other. Etienne Pasteau, formerly of the Paris School of Economics, and Junyi Zhu of the Bundesbank estimate that inheritance is two-and-a-half times more influential than income from work in explaining German marriage choices. Another paper, focusing on Denmark, finds that over time inheritance is becoming ever more important in explaining people's choice of spouse.

The inheritance boom is set to continue for a while yet. According to our calculations, baby-boomer deaths will rise until 2036, when in America 1.5m of them will pop their clogs. The value of housing and stocks will probably also rise, increasing the size of the pile to be passed on. In a world of higher interest rates, someone who inherits and puts the money in the bank or buys government bonds can do pretty well as a pure rentier. Meanwhile, governments keep cutting, rather than raising, inheritance taxes. Over the coming years, the world could see the emergence of an inheritor class that is even more enduring than the gentry of Austen's day. What a fine thing—for some.

Stablecoins: the real crypto craze

Policymakers are racing to catch up with their rapid rise

Illustration: Álvaro Bernis

BEHIND THE vaulted arches of Istanbul's Grand Bazaar, above the haggling and the crush, a quieter trade unfolds. In dimly lit corridors, men slip in and out of back rooms, clutching bundles of dollars. Amid the shadows, a trader says that he deals in millions daily, mostly swapped for stablecoins—cryptocurrencies pegged to other assets, usually the greenback.

Stablecoins are typically backed by cash or government bonds and run on public blockchains. Unlike bitcoin, the ur-cryptocurrency, their price barely fluctuates: tether, the biggest (whose issuer bears the same name), fetches a flat $1, within a few hundredths of a cent. They are mostly used to trade other cryptocurrencies, providing a stable bridge between wobblier digital assets. According to Chainalysis, a data firm, trading, payments and transfers in stablecoins hit $27.6trn last year, or two-fifths of all value settled on public blockchains, up from a fifth in 2020.

In part, this reflects a broader rise in crypto prices over the period—but stablecoins are increasingly used for real-world purposes, too. Migrants send remittances with them, replacing a correspondent-banking system beset by high fees and delays. The Turkish trader says that shopkeepers in the Grand Bazaar pay suppliers with the coins as they are the fastest option. In countries where inflation erodes savings and dollars are scarce, they are catching on as a store of value. A survey of stablecoin-holders in Turkey and four other emerging markets by Castle Island Ventures, which invests in crypto startups, and Visa, a payments giant, finds that nearly half use them for this purpose.

Chart: The Economist

As stablecoins have gained real-world traction, notes Bernstein, a broker, their market capitalisation has decoupled from that of cryptocurrencies more broadly (see chart). America, where stablecoins are central to crypto trading, remains the world's biggest market, according to Chainalysis. Relative to economic size, though, Turkey is now the home of stablecoin transactions: in the year to March 2024 purchases alone were worth 4.3% of GDP. In the year to June, Ethiopia saw the fastest growth—almost a tripling—in transactions of less than $10,000, most of which were probably remittances and everyday payments.

Tether, the dominant stablecoin, accounts for 70% of activity. Tether, the company, makes money by investing its reserves. It says it has $113bn, or 72% of its assets, in mostly short-duration Treasuries, which rising yields have turned into a cash cow. But dominance brings risks. A loss of confidence in tether could shake the market, as the fall of Terra-Luna, an algorithmic stablecoin system, did in 2022.

If Tether was forced to fire-sell its Treasuries and other holdings, that could also have consequences for mainstream financial markets.

Tether insists its model is secure. It has proved resilient: during the Terra-Luna collapse, the firm made more than $10bn in redemptions in a fortnight while maintaining its peg to the dollar. Yet Tether's opacity means that future difficulties cannot be ruled out, says Rajeev Bamra of Moody's, a rating agency. Unlike Circle, its main rival, Tether does not undergo independent audits, making it hard to know whether its assets—which besides Treasuries include riskier things, such as bitcoin—match its liabilities. Nor does it disclose where its reserves are held. S&P, another rating agency, assigns tether a risk rating (in terms of its ability to keep its dollar peg) of four out of five. Circle's USDC gets a two.

Many governments are becoming stricter. In January European exchanges delisted tether for failing to comply with new EU laws. Paolo Ardoino, Tether's boss, is critical of the rules, especially a requirement that stablecoins must hold 60% of reserves in bank deposits. "If a bank fails, the stablecoin fails with it," he argues. Still, he says, emerging markets are his real focus.

Yet their governments are growing uneasy, too. Tether is registered in El Salvador, whose president, Nayib Bukele, is eager to make his country a hub for digital assets. Before that, it was based in the British Virgin Islands. Neither place is noted for over-intrusive regulation. In 2023 a study by TRM Labs, a blockchain-intelligence company, found that a relatively high share of tether transactions were part of criminal activity. Iran and Russia have used the coin to evade sanctions. A UN report called it the "preferred choice" for South-East Asian money-launderers. Tether says that it works closely with law enforcement, freezing wallets linked to illicit activity and complying with official requests.

On February 25th Turkey began to require crypto exchanges to be licensed, enforce anti-money-laundering controls and verify users' identities. Platforms such as Binance and KuCoin have scaled back their presence in the country in response. In Nigeria stablecoin volumes fell by 38% in the year to July after authorities revoked the licences of over 4,000 exchanges, blaming them for the naira's decline.

At the same time, America may move in a different direction. In January Donald Trump signed an order directing officials to draft a regulatory framework for digital assets within six months. He declared that America would be "the crypto capital of the planet". The order backed "lawful and legitimate dollar-backed stablecoins" to bolster the greenback's dominance among conventional currencies.

Oversight is not all bad for stablecoins, facilitating interest from mainstream finance. Stripe, a payments firm, has bought Bridge, a stablecoin-infrastructure startup. Visa has built a platform to help lenders issue coins; BBVA, Spain's second-largest bank, will be among the first to use it, perhaps for money transfers. Stablecoins have shown their value in the backrooms of the Grand Bazaar. Their next task is to do so in the regulators' offices and boardrooms of Washington and Wall Street.

Tecnology

CRISPR technologies hold enormous promise for farming and medicine

Don't waste it

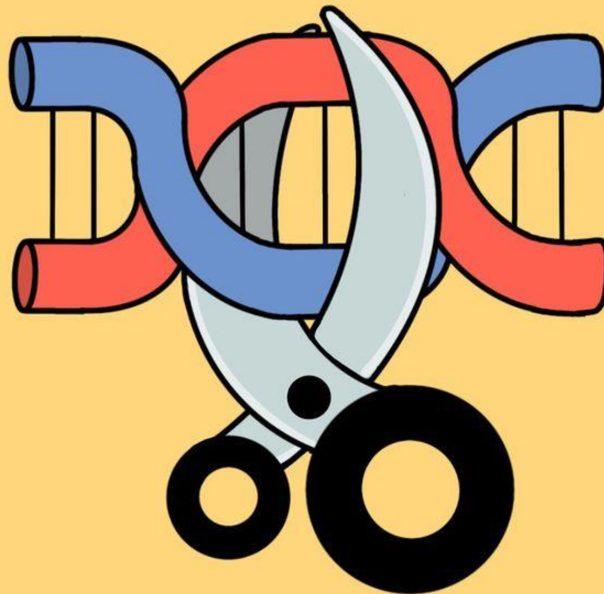

Illustration: Travis Constantine

OF THE MANY patients who need an organ from a donor, 90% go without. About 240m people live with rare genetic diseases, most of which cannot be treated. Each year poor diets cause more than 10m early deaths. Suffering on such an immense scale can appear hopeless. However, a technique called CRISPR gene editing promises to help deal with these issues and many more—and wise regulation can spur it on.

CRISPR is like an editor that can rewrite DNA letter by letter or gene by gene, to remove harmful mutations or add protective ones. Clinical trials will begin this summer on pig organs edited for transplanting into humans. Last year the first new therapy went on the market. It seemingly cures sickle-cell disease and beta-thalassemia, two blood disorders that afflict millions. If ongoing clinical trials succeed, a one-off therapy could provide lifelong protection against heart attacks. Farming will benefit, too: CRISPR could raise yields or protect crops from climate change. Consumers could soon get white bread with fibre-like starch or tastier varieties of healthy but unpopular foods, such as mustard greens.

But as we report in our Technology Quarterly, now is a critical moment. Since CRISPR's discovery in 2012, it has begun supplanting old ideas that never reached their potential. Gene therapy, a different technique that uses viruses to insert genes into patients, can treat many rare genetic diseases but is and will remain costly to prepare. Genetically modified (GM) crops, which borrow genes from other species, have faced misguided opposition in Europe and elsewhere. CRISPR offers an alternative to both. But if, unlike them, it is to live up to its promise, it will need to attract a continuing flow of investment—which, in turn, means chalking up some real-life successes.

For that to happen, scientists must show that they can get CRISPR into more types of cells in the body cheaply and easily. The technology would also be boosted if it could serve as a platform to create personalised therapies for people's individual mutations. That will require new science, but it would also be catalysed by a better system of regulation.

Regulations that govern drugs for rare diseases were not designed for an era of specialist medicines and will hinder patients from receiving new treatments. Developing drugs for a small group of people has always been difficult and many CRISPR companies are struggling, despite government help. But CRISPR is programmable, meaning that the same drug can be tweaked to target many different mutations. On-demand, small-batch drugs for rare diseases could be made more cheaply today if requirements on safety testing and manufacturing standards were loosened. For many desperately ill people who may die before a drug is approved, if it is developed at all, that is a worthwhile trade-off. In America the Food and Drug Administration has already taken some steps towards liberalisation.

Agriculture also badly needs reform. Gene-edited foods fall under GM regulation in many regions, including the European Union, despite being quite different: gene-edited plants have had their own genes tweaked rather than incorporating genes from other species. Mindful of the threat of climate change to food security, Britain is poised to implement new liberal laws governing gene-edited foods; the EU should follow. However, public trust in regulators and scientists could become a problem with the confirmation as health secretary of Robert F. Kennedy junior. He has invested in CRISPR therapies, but is also anti-GM. If America slows down or even goes into reverse, it will be a blow to progress—and humanity.

How artificial intelligence can make board games better

It can iron out glitches in the rules before they go on the market

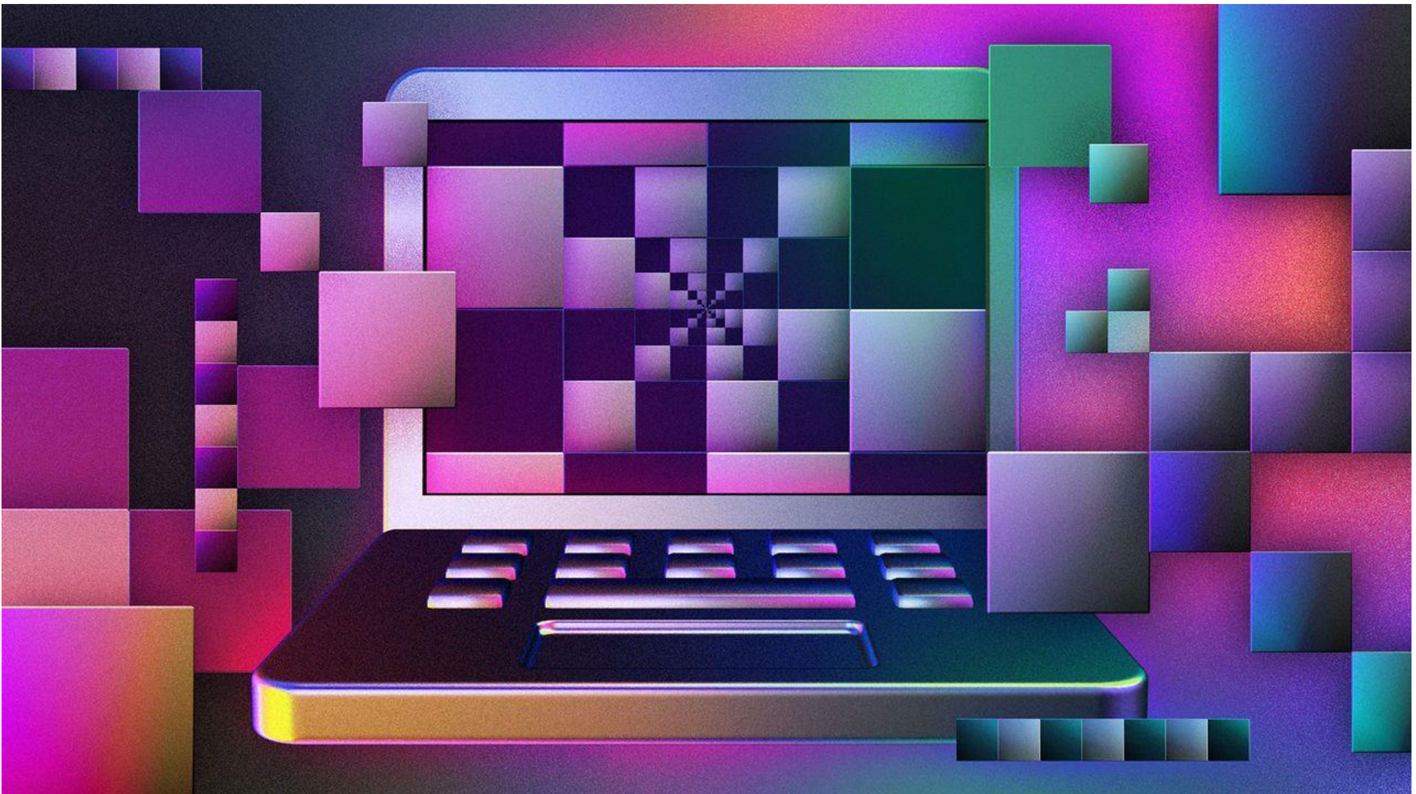

Illustration: Shira Inbar

BOARD GAMES have long fascinated artificial-intelligence (AI) researchers. They have clear rules, well-defined playing fields and objective winners and losers. This makes them perfect “sandpits” for training AI software. Sometimes, though, their rules contain glitches. Aficionados of Go will be familiar with ko fights—situations in which the basic rule set would permit a game to carry on for ever, and for which an exception had to be created. Avoiding similar problems in newly invented games is something AI can help with.

That, at least, is the experience of Alan Wallat, a board-game designer from London. His latest offering is Sirius Smugglers, in which interstellar merchants try to make an illicit profit. In the olden days, checking its rules would have involved lots of tests by human players, who would probably have wanted to be paid—in beer, perhaps, if not in cash.

Instead, he took his brainchild to Tabletop R&D, an AI startup, where a game-playing algorithm allowed him to play thousands of times in the blink of an eye. He was then able to scan the results for irregularities, statistical biases and any features that were under- or over-used.

It was here he discovered a problem. A quirk in the rules meant the decision to end the game could rest with the losing players. Whoever was ahead, and therefore had the greatest incentive to bring matters to a close, was sometimes unable, alone, to trigger the condition which would finish the game. Like Go without the ko-fight exception, Sirius Smugglers could thus go on indefinitely.

The minds behind Tabletop, Diego Perez-Liebana and Raluca Gaina, are computer scientists at Queen Mary, a college of the University of London, who wanted to build a general games-playing AI platform on the cheap. The approach which built the AI models that could play Go well enough to beat world champions involved a system playing itself, over and over again, and learning from its victories and defeats until it reached superhuman potential.

But that requires a lot of computing time. Instead, they chose to use a less resource-intensive approach called a Monte Carlo tree search, to look forward to possible future positions and choose appropriate play from among them. It was intended as an academic exercise, says Dr Perez-Liebana, but in doing it they realised they had accidentally developed a tool that had value in its own right as an aid for game designers seeking to perfect their creations.

Thinking caps on

For this to happen, the AI must be taught to play like a human. Unless told otherwise, AIs are liable to chase victory single-mindedly but without strategic vision, like a chess player who refuses to sacrifice pieces for a stronger long-term position. This training can be subtle. In games where players are

assigned information hidden from their opponents (for example, in card games like bridge or poker, where others cannot see a player's hand), designers must decide whether to give the AI the ability to memorise play so far and to count the pack perfectly, or else to act in a sloppier—and more humanlike—manner.

Giving the AI more time to think, and so plan for a wider range of outcomes, is equivalent to adjusting the skill with which it plays. To simulate beginners, it can be set to act as if on instinct, after less than a tenth of a second. To mimic competence it is allowed to think for as long as five seconds per move, and is therefore able to plan many moves ahead.

When they're good, they're good, says Dr Gaina of the resulting models. Testing the approach with a copy of Terraforming Mars, a famously weighty strategy title, she admits she found the system was more than capable of defeating her.

A game-run provides enough detailed data to let designers tweak the parameters they care about, from ensuring proceedings are fair to avoiding long periods of dull gameplay. At least, that is the plan. Mr Wallat is Tabletop's first customer. More may soon be tempted. Fun is hard to measure, says Dr Gaina, but things that make a game bad, never-endingness among them, are easier to spot.