

The Economist

The new economics of immigration

Will the shooting stop in Ukraine?

The real lesson of China's latest AI

Jesus Christ: screen saviour

MARCH 15TH-21ST 2025

**AMERICA'S
NEW
FOREIGN
POLICY**



Business



Photograph: Getty Images

American share prices were heading towards their fourth consecutive week of losses, with markets spooked by Donald Trump's erratic protectionism and the prospect of slowing economic growth. The S&P 500 index has fallen by 9% since a peak in February. Investors are seeking shelter elsewhere: over the same period, Europe's Stoxx 600 has risen by 2% in dollar terms, as has Hong Kong's Hang Seng.

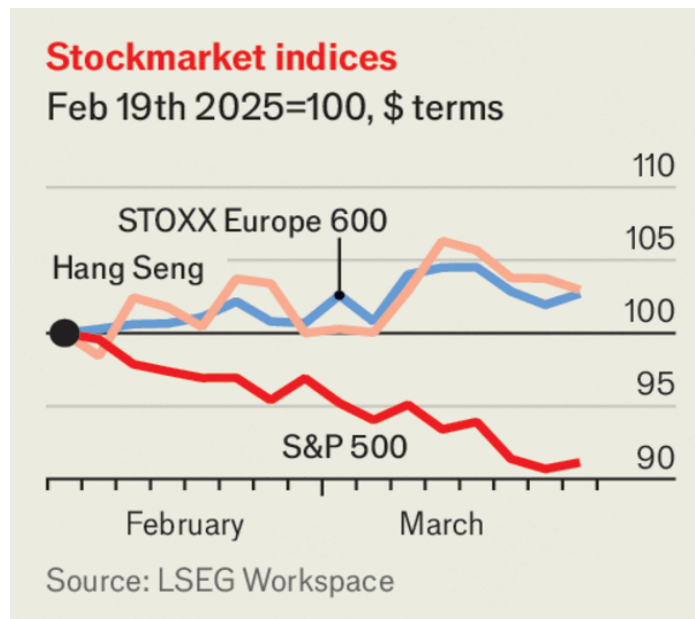


Chart: The Economist

It was another turbulent week for trade policy. Mr Trump imposed new 25% levies on all steel and aluminium products imported into America. Similar tariffs implemented during Mr Trump’s first term had a lower rate for aluminium and exemptions for several trading partners; the new ones do not. Canada’s Ontario province retaliated with a 25% surcharge on power exports to America; Mr Trump hit back with an additional 25% charge on Canadian metals. Both were cancelled in short order. Canada then announced tariffs on \$21bn-worth of American goods that remain uncanceled.

The European Union responded with its own tariffs on American exports worth €26bn (\$28bn) per year. They include levies of up to 50% on bourbon whisky, jeans and Harley-Davidson motorcycles. The new charges are due to come into force in April.

Time to cool down

America’s jobs report showed its economy had added 151,000 jobs in February—more than in January, but fewer than forecasters had expected. Its inflation release, meanwhile, showed consumer-price rises had slowed to 2.8% in the year to February, suggesting the Federal Reserve may be able to cut interest rates sooner than expected. Jerome Powell, the Fed’s chairman, said it is not “in a hurry” and that America’s economy is “in good shape”.

China’s consumer-price index fell by 0.7% in the year to February, the first time it had registered such deflation in 13 months. The figures may have been distorted by the lunar new year holiday, during which prices tend to increase, and which fell earlier than usual.

Goodbye, widower

Traders are increasingly confident that Japan has broken out of its long deflationary slump. The yield on ten-year government bonds rose to nearly 1.6%, a level it last reached in 2008.

The Bank of Canada lowered its policy rate by 0.25 percentage points, to 2.75%. It was the central bank's seventh rate cut in a row, and came after annual inflation had reached 1.9%. Officials, however, worried about the impact of American tariffs and warned that "monetary policy cannot offset the impacts of a trade war".

Northvolt, a Swedish battery-maker, filed for bankruptcy after failing to agree on a new financing package with investors. The firm was founded in 2016 and was once Europe's best-funded startup, touted as the continent's champion in an industry dominated by Chinese firms.

OpenAI, the designer of ChatGPT, struck a deal worth \$12bn with CoreWeave, a cloud-computing firm originally set up in 2017 to "mine" cryptocurrencies. CoreWeave will supply OpenAI with computing power to train and run its artificial-intelligence models for the next five years. The deal is part of OpenAI's efforts to reduce its dependence on Microsoft, its biggest partner. Google DeepMind unveiled its new "Gemini Robotics" AI model, which aims to help robots navigate complex, real-world environments.

Elon Musk had a trying week. X, his social-media website, suffered a cyber-attack that disrupted its service. Mr Musk claimed, without much evidence, that it came from "the Ukraine area". Tesla's share price fell by 15% on March 10th and is nearly 50% below its peak in December. A launch attempt by SpaceX, Mr Musk's rocket company, ended with the Starship rocket exploding—the second such failure in a row. But there was a silver lining: SpaceX forged deals with Airtel and Jio, two telecoms firms, to run its satellite-internet service in India.

Rheinmetall, a German armsmaker whose share price has doubled since November, reported its financial results for 2024. Its operating profit was €1.5bn, a new record and 61% higher than that for the previous year. The company made €10bn-worth of sales, around 30% of which were to the German Bundeswehr. Business will probably continue to boom as Europe rearms and Germany plans to relax its restrictions on borrowing for defence. Rheinmetall expects sales to grow by as much as 30% this year.

Intel appointed Lip-Bu Tan as its new chief executive, replacing Pat Gelsinger, who left abruptly in December. Mr Tan himself had quit Intel's board in August. He faces a battle to rejuvenate the struggling chipmaker, which has laid off thousands of employees and seen its share price plummet.

Finance & economics

Trump's erratic policy is harming the reputation of American assets

Like the stockmarket, the dollar is also suffering from falling confidence and rising confusion



Photograph: AP

PRESIDENT DONALD Trump's bullying of America's allies and neighbours may appeal to the maga base. Unfortunately, investors feel otherwise. Confidence in the prospects for the American economy has been sapped and financial markets are sinking. The S&P 500 index of American stocks has dropped by 9% since its peak in February. Because Mr Trump's on-again, off-again protectionism defies logic, their faith in his administration's ability to steer the economy is evaporating.



Chart: The Economist

It is the same with the dollar. As Mr Trump has threatened tariff after tariff, it has fallen, dropping by nearly 6% against a basket of other currencies since mid-January. Most notable is its decline against the euro, spurred by expectations of a surge in European defence spending.

One source of confusion is that Mr Trump's team say they want different things. Scott Bessent, the treasury secretary, maintains that the administration wants a strong dollar, in line with recent American policy. Both Mr Trump and J.D. Vance, the vice-president, believe that the strength of the greenback is holding back American industry. Currency traders whisper about a "Mar-a-Lago Accord", a repeat of the Plaza Accord that in the 1980s prodded America's main trading partners to co-operate to weaken the strong dollar, and which was first proposed by Stephen Miran, now an adviser to Mr Trump.

Another source of confusion is that, just as with Mr Trump's tariff policy, the administration misunderstands the benefits and costs of having a weak currency. Proponents of a weak dollar say that it would help make exports more competitive. But the growth of global value chains in manufacturing over recent decades has blunted the impact of exchange rates on sales of goods abroad, because exporters today incorporate more imported material than they once did. In addition, the costs of currency weakness are widely felt. If the 13m Americans in manufacturing jobs benefit, that must be set against nearly 300m consumers who will pay for the rising cost of imports. Already households'

inflation expectations are rising, even though consumer-price inflation data, published on March 12th, came in a little below market forecasts.

The final—and most corrosive—source of confusion is the baffling logic behind the administration’s policies. By themselves, tariffs should boost the value of the greenback, as Americans buy fewer imports and therefore less foreign currency. Although the dollar may have fallen particularly sharply against the euro because of European spending, its weakness against other major currencies points to an act of grave self-harm: that the hit to the American economy from tariffs is more than outweighing their direct impact.

Consider the wildest suggestion of the weak-dollar enthusiasts, floated by Mr Miran. This is to tax foreign governments that hold Treasury bonds, in order to deter them from owning dollars. That makes no sense. It may not even achieve its purpose of weakening the greenback, because academic research is unclear whether reserve-currency status has consistently boosted the dollar’s value. Even if it did work, it should worry anyone who cares about America’s ability to project its power across the world. Financial sanctions against Russia, and those about to be deployed against Iran, would be less effective if the dollar made up a smaller portion of overseas trade and finance.

For decades investors were drawn by America’s exceptionalism: its strong growth and a government that was a wise steward of the economy. Now they are waking up to impulsiveness and incoherence. American assets will suffer.

How Trump provoked a stockmarket sell-off

Will the president win back investors? Does he even want to?



Rushing for a reason Photograph: Reuters

As they saw the line go down, American investors may have felt an unfamiliar sensation: anxiety. The S&P 500 fell by another 4% in the week to March 12th, leaving the world's most watched stockmarket down by 9% since its recent peak. The NASDAQ, dominated by tech firms, has fallen by 12%. It is not quite the bold new era of American growth promised by Donald Trump in his election campaign.

The president's unpredictable trade policies got things going. On March 12th, in the latest twist in Mr Trump's trade saga, America levied tariffs of 25% on imports of aluminium and steel. After years of growth, the health of the American economy is a source of concern, too, with worries provoked by a drip of discouraging data. Statistics released the same day showed that consumer prices rose more

slowly in February than analysts had expected. But the relief for shoppers also hints that America's economy is shifting into a lower gear. Such news is beginning to undermine the idea of American exceptionalism: after all, investors have seen much better returns in China and Europe this year.



Chart: The Economist

During Mr Trump's first term, investors came to believe that his administration's focus on tax cuts and deregulation would ultimately overwhelm his unpredictable, protectionist tendencies. They also saw that he was sensitive to market moves, and keen to avoid falls. This combination was referred to as the "Trump put": temporary sell-offs, often driven by the trade conflict with China, were quickly reversed as the president did whatever it took to change the market mood. Investors who sold tended to regret their decision.

The current dynamic appears to be different. Mr Trump's new administration is more hard-nosed. On March 6th the president said that he was not looking at the stockmarket, but was concentrating on the long term. The same day, Scott Bessent, his treasury secretary, offered a similar view: "Wall Street's done great. Wall Street can continue doing well. But this administration is about Main Street." Then, on March 9th, the president avoided questions about whether America faced a recession, and warned of a "period of transition". Many market participants had believed that Mr Trump would use the threat of tariffs merely as a negotiating tactic. They are gradually being convinced that he really means it this time round.

And just look at the lovely alternatives. So far this year, as American stocks have swooned, Europe's Stoxx 600 index has risen by 12% in dollar terms, and Germany's DAX by 19%. A combination of factors, including a falling dollar and a boom in European defence stocks—driven by expectations of higher defence spending, to cope with America's newfound disregard for the continent—have put Europe in the limelight. Even China's moribund market has gone on a tear, inspired by hype about the progress of the country's artificial-intelligence firms. The Hang Seng, which includes many Chinese firms listed in Hong Kong, is up by 17%. For investors worried about their portfolios being dominated by a handful of American tech giants, overseas markets are increasingly enticing.

The sell-off has hit highly valued tech stocks hardest of all. Broadcom and Nvidia, two world-leading semiconductor manufacturers, are down by around 15% in the year to date. But the stand-out loser is Tesla, an electric-car firm owned by Elon Musk, a close ally of Mr Trump, which has fallen by 39% this year. On March 10th alone its value dropped by 15%. European sales of the firm's vehicles have dropped as the continent's consumers express their political opinions by buying other cars.

America's wobble is not confined to the stockmarket. The dollar has dropped by more than 5% against a basket of other currencies since its peak in January. Credit spreads on risky bonds, a measure of the protection that investors demand for holding them, have risen, too. On February 18th junk bonds issued by less creditworthy firms offered yields just 2.6 percentage points above Treasury bonds. By March 11th that margin had risen to 3.2 percentage points, near its highest in six months.

If Mr Trump wants to turn things around, which does not yet appear to be the case, it may take something big given the building economic gloom. On March 10th Goldman Sachs cut its forecast for American growth in 2025 by 0.7 percentage points, to 1.7%. Most analysts still predict some growth, but a few expect a recession. Peter Berezin of BCA Research is one of them. He notes that, on top of Mr Trump's turbulence, household savings built up during the covid-19 pandemic have been depleted, and past rises in interest rates continue to feed through to mortgages.

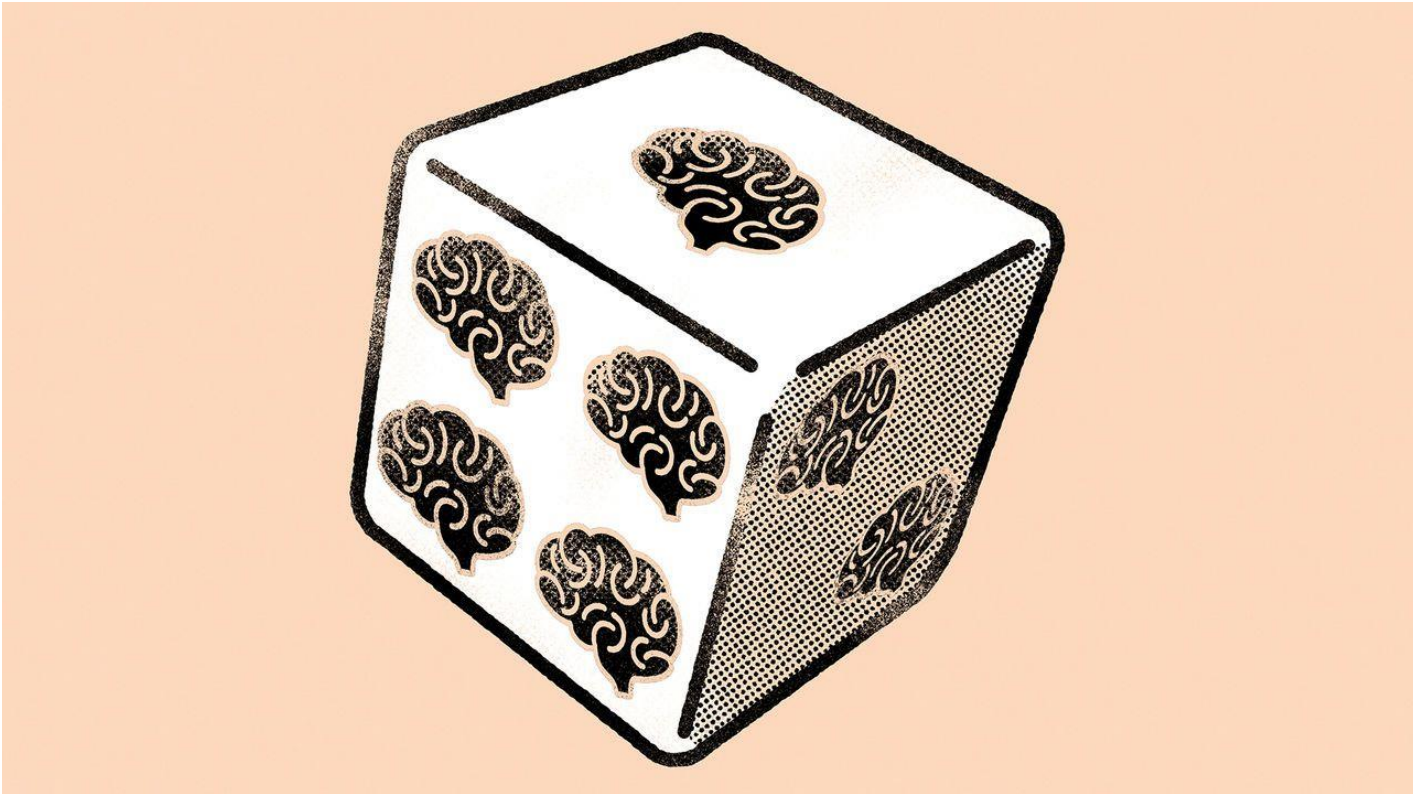
A month ago the federal-funds futures market suggested that investors believed there was a 70% chance the Federal Reserve's policy rate would remain at or above 4% by the year's end. Now it implies a chance of 12%, with a growing number of investors expecting more aggressive monetary easing. Although inflation remains above the central bank's target, Jerome Powell, the Fed's chairman and a long-time target of Mr Trump's ire, may have to cut rates faster than he had planned.

The S&P's remarkable rise in recent years—it has more than doubled in value since March 2020—means it remains vulnerable. The index's price-to-earnings ratio, based on expectations of the constituent firms' earnings over the next year, has dropped from 25 times to 21 times in less than a

month. Even so, by historical standards, stocks are expensive. Expectations for the American market, established over many years of strong performance, have become far easier to disappoint. So far, at least, the S&P's fall represents a wobble rather than a nightmare. How will things look after another round of tariffs?

What sparks an investing revolution?

Ideas that emerged from the University of Chicago in the 1960s changed the world. But as a new film shows, they almost didn't



What prompts a revolution? When it comes to investing, no change has been as great as that which began with researchers at the University of Chicago in the 1960s. Their financial-theory revolution changed the way that almost everyone invests, and made speculators many trillions of dollars.

The transformation is the subject of “Tune Out the Noise”, a documentary by Errol Morris, an Academy Award winner, which held its premiere in New York on March 6th. His film includes

interviews with academics and investors, such as Eugene Fama, Myron Scholes and David Booth, who took ideas about market efficiency and diversification from the textbook and put them into practice in the markets. This led to a surge in the use of data and a disciplined focus on costs, in turn providing the foundation for modern passive investing.

Mr Morris's film may, in theory, be about brilliant individuals, but its most powerful message is about the role played by chance. History, like markets, is affected by randomness, and luck brought together the right people at the right time. Each had to be present for the financial revolution to emerge.

The University of Chicago's role is just about the only part of the story that happened by design. It had become the nexus for financial research owing to its reputation for excellence in economics. The Centre for Research in Security Prices was established there in 1960, and its wealth of data on the price of bonds and stocks over decades enabled the academics to do their work.

Randomness is apparent just about everywhere else. Although Mr Fama, who would later win a Nobel prize for his work on asset pricing, completed a doctorate at Chicago in 1964, he almost never made it to the university. After completing an undergraduate education at Tufts University, he had to chase up his application to Chicago, discovering that it had never been received. On phoning the university, he reached the dean of students by chance, who told him about a scholarship for Tufts graduates, before offering it to him on the spot.

It was a similar story for Mr Scholes, another future Nobel laureate. In the summer of 1963 he started a job as a computer programmer despite scant expertise. The six other programmers who were hired failed to show up for the job, leaving Mr Scholes alone to assist in the financial research of other academics. He took to the work, abandoning his plan to return to his family's book-publishing company, and was in time offered a place on the university's doctoral programme.

Mr Booth, whose name now adorns Chicago's business school, and Rex Sinquefeld, his business partner, put the academic ideas into practice by co-founding Dimensional Fund Advisors, a firm that today boasts \$777bn in assets under management. In 1969 Mr Booth narrowly avoided being made to fight in the Vietnam war, when a lenient officer postponed his conscription since he planned to study for a PhD. Mr Sinquefeld did serve in the armed forces during the war, but poor eyesight kept him from combat.

A few twists of fate—an unanswered phone call, a prickly recruiting officer, more diligent computer programmers or better eyesight—would have prevented some of the men from reaching Chicago.

Without the confluence of thought, investing might look very different today, making the world much poorer.

Such happenstance is found elsewhere, too: other parts of economics and nuclear physics, for instance, relied upon the concentration of talent in America after geniuses, often Jewish, fled from the Nazis. In the 1950s Silicon Valley looked to be an unlikely home for the American tech industry, with corporate research mostly taking place on the east coast. That changed in large part because William Shockley, an inventor of transistor technology, set up his own firm in the San Francisco Bay Area. The company's employees went on to establish giants including Fairchild Semiconductor and Intel. Shockley had picked the area simply because he wanted to be close to his elderly mother.

“Tune Out the Noise” leaves viewers wondering where the next investing revolution will come from. Quantitative trading has speeded up market activity, which is not quite as transformative as the changes that emerged from the 1960s. Some fret that cryptocurrencies are the most significant newish innovation, and that they are the preserve of speculators and criminals. But, in time, more useful ideas could emerge from the industry. There is always a chance.

Tecnology

With Manus, AI experimentation has burst into the open

The old ways of ensuring safety are becoming increasingly irrelevant

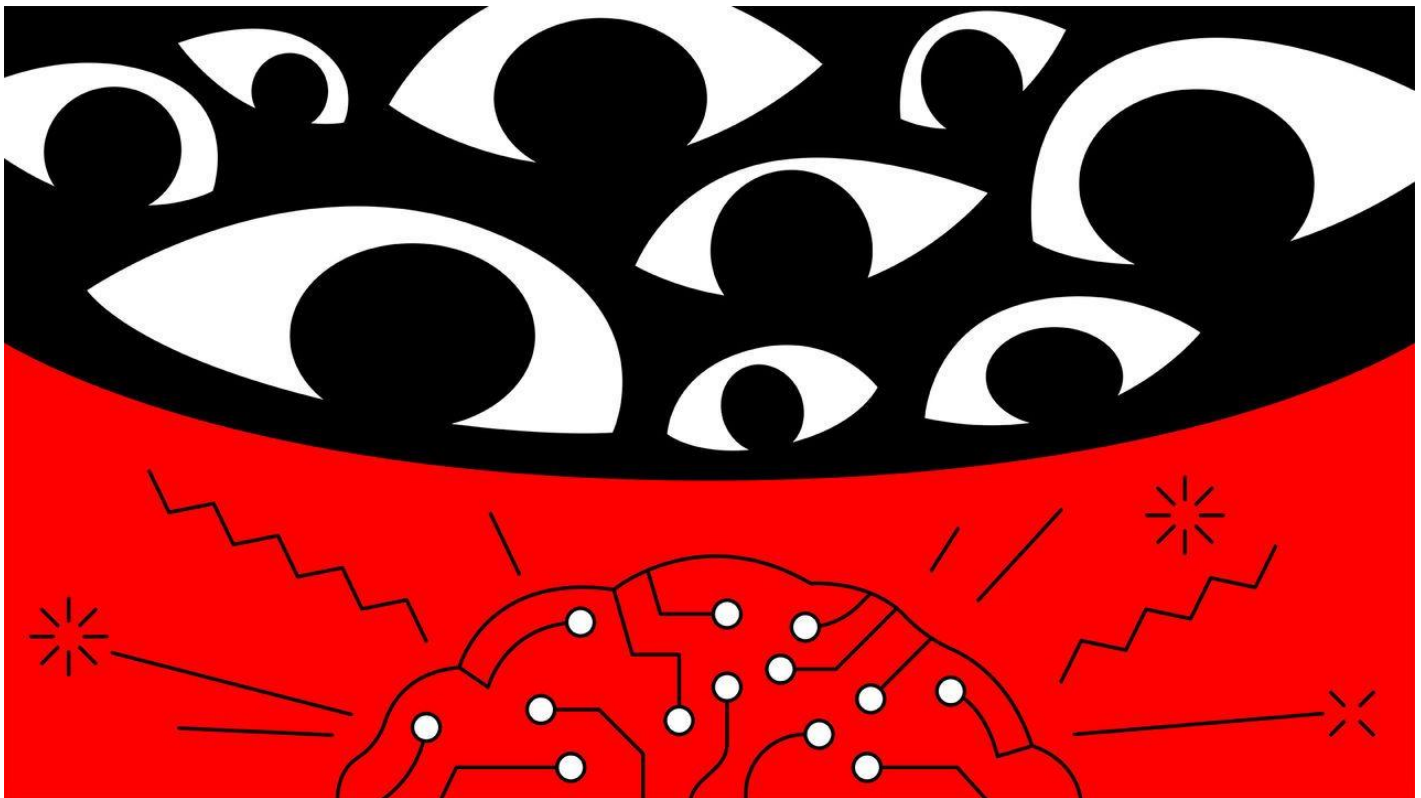


Illustration: Rose Wong

Watching the automatic hand of the Manus AI agent scroll through a dozen browser windows is unsettling. Give it a task that can be accomplished online, such as building up a promotional network of social-media accounts, researching and writing a strategy document, or booking tickets and hotels for a conference, and Manus will write a detailed plan, spin up a version of itself to browse the web, and give it its best shot.

Manus ai is a system built on top of existing models that can interact with the internet and perform a sequence of tasks without deferring to a human user for permission. Its makers, who are based in China, claim to have built the world's first general AI agent that "turns your thoughts into actions". Yet ai labs around the world have already been experimenting with this "agentic" approach in private. What makes Manus notable is not that it exists, but that it has been fully unleashed by its creators. A new age of experimentation is here, and it is happening not within labs, but out in the real world.

Spend more time using Manus and it becomes clear that it still has a lot further to go to become consistently useful. Confusing answers, frustrating delays and never-ending loops make the experience disappointing. In releasing it, its makers have obviously prized a job done first over a job done well.

This is in contrast to the approach of the big American labs. Partly because of concerns about the safety of their innovations, they have kept them under wraps, poking and prodding them until they hit a decent version 1.0. OpenAI waited nine months before fully releasing gpt-2 in 2019. Google's Lamda chatbot was functioning internally in 2020, but the company sat on it for more than two years before releasing it as Bard.

Big labs have been cautious about agentic ai, too, and for good reason. Granting an agent the freedom to come up with its own ways of solving a problem, rather than relying on prompts from a human at every step, may also increase its potential to do harm. Anthropic and Google have demonstrated "computer use" features, for instance, yet neither has released them widely. And in assorted tests and developer previews, these systems are as limited by policy as technology, handing control back to the user at regular intervals or whenever a complex task needs to be finalised.

The existence of Manus makes this cautious approach harder to sustain, however. As the previously wide gap between big AI labs and upstarts narrows, the giants no longer have the luxury of taking their time. And that also means their approach to safety is no longer workable.

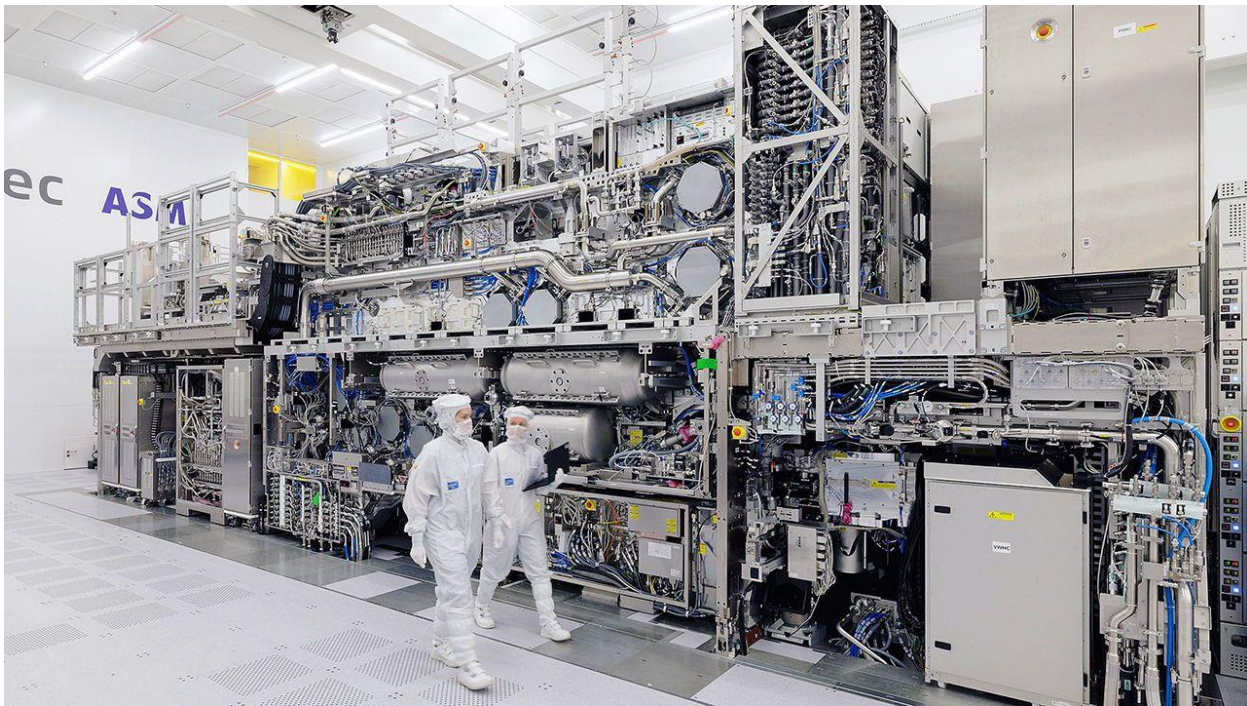
To some American observers, fixated on the idea that China might be stealing a march on the West, the fact that Manus is Chinese is especially threatening. But Manus's success is nowhere near the scale of that of DeepSeek, a Chinese firm that stunned the world with its cheap AI model. Any company, be it American, Chinese or otherwise, could produce a similar agent, provided it used the right off-the-shelf components and had a large enough appetite for risk.

Fortunately, there is little sign yet that Manus has done anything dangerous. But safety can no longer be just a matter of big labs conducting large-scale testing before release. Instead, regulators and companies will need to monitor what is already used in the wild, rapidly respond to any harms they

spot and, if necessary, pull misbehaving systems out of action entirely. Whether you like it or not, Manus shows that the future of ai development will play out in the open.

The race is on to build the world's most complex machine

But toppling ASML will not be easy



Photograph: ASML

Few would expect the future of artificial intelligence (AI) to depend on Eindhoven, a quiet Dutch town. Yet just beyond its borders sits the headquarters of ASML, the only company that makes the machines, known as lithography tools, needed to produce cutting-edge AI chips. ASML's latest creation is a 150-tonne colossus, around the size of two shipping containers and priced at around \$350m. It is also the most advanced machine for sale.

The firm's expertise has placed it at the centre of a global technology battle. To prevent China from building whizzy AI chips, America has barred ASML from selling its most advanced gear to Chinese

chipmakers. In response, China is pouring billions of dollars into building homegrown alternatives. Meanwhile, Canon, a Japanese rival, is betting on a simpler, cheaper technology to loosen ASML's grip. Yet unlike software, where industry leadership can shift in a matter of months, success in lithography is a slow-moving race measured in decades. Overtaking ASML won't be easy. At stake is control of the machine that will shape the future of computing, AI and technology itself.

ASML's most advanced machine is mind-boggling. It works by firing 50,000 droplets of molten tin into a vacuum chamber. Each droplet takes a double hit—first from a weak laser pulse that flattens it into a tiny pancake, then from a powerful laser that vaporises it. The process turns each droplet into hot plasma, reaching nearly 220,000°C, roughly 40 times hotter than the surface of the Sun, and emits light of extremely short wavelength (extreme ultraviolet, or EUV). This light is then reflected by a series of mirrors so smooth that imperfections are measured in trillionths of a metre. The mirrors focus the light onto a mask or template that contains blueprints of the chip's circuits. Finally the rays bounce from the mask onto a silicon wafer coated with light-sensitive chemicals, imprinting the design onto the chip.

High stakes

ASML's tools are indispensable to modern chipmaking. Firms like TSMC, Samsung and Intel rely on them to produce cutting-edge processors, from AI accelerators to smartphone chips. No other company makes machines that can reliably print chips that are called "7 nanometres" (billionths of a metre) and below (though these terms once related to physical resolution, they are now primarily used for marketing). Even for more mature technologies ("14nm" and higher), the firm's tools account for over 90% of the market.

A microchip is an electronic lasagne: a base of transistors topped with layers of copper wiring shuttling data and power. A leading-edge processor can pack over 100bn transistors, contain more than 70 layers and have more than 100 kilometres of wiring, all on a piece of silicon around one-and-a-half times the size of a standard postage stamp. To build these tiny features, a lithography machine works in stages by etching patterns of transistors and metal wires on a wafer, layer by layer. A single wafer can contain hundreds of chips.

ASML's tool is complex, yet its basic principle is much like that of an old slide projector: light passes through a stencil to project an image onto a surface. The smallest feature an optical lithography tool can print depends mainly on two factors. The first is the wavelength of light. Just as a finer paintbrush allows for more detailed strokes, shorter wavelengths enable smaller patterns. ASML's older systems used deep ultraviolet (DUV) light, with wavelengths between 248nm and 193nm, producing features as small as 38nm.

To shrink chip features even more, ASML turned to EUV light, with a wavelength of 13.5nm. Whereas EUV is naturally emitted in space by the solar corona, producing it on Earth is far trickier. EUV light is also completely absorbed by air, glass and most materials, so the process must be enclosed in a vacuum, using special mirrors to reflect and guide the light. ASML spent two decades perfecting the method that fires lasers at molten-tin droplets to create and generate this elusive beam.

The other dial that sets the smallest feature size is the numerical aperture (NA) of the mirrors, a measure of how much light they can collect and focus. ASML's latest systems, called high-NA EUV, use mirrors with an aperture of 0.55, allowing it to print features on chips as small as 8nm. To go smaller still, the firm is studying what it calls hyper-NA by cranking the aperture up to more than 0.75 while still using existing EUV light. A higher NA means that the mirrors collect and focus light coming in from a broader range of angles, improving precision. This comes at a cost. Larger NAs require bigger mirrors to intercept and direct the expanded light paths. When ASML increased the NA of their machines from 0.33 to 0.55, the mirrors doubled in size and became ten times heavier, now weighing several hundred kilograms. Increasing the NA again will only add bulk, raising concerns about power consumption.

Another obstacle is pricing. ASML does not disclose precise figures, but its latest EUV machine was almost twice as expensive as its predecessor. A hyper-NA system would be dearer still. Though the company cautions that there are no guarantees of it ever being produced, Jos Benschop, ASML's head of technology, believes a hyper-NA machine could arrive within the next five to ten years, pending demand.

Some researchers are already planning to go beyond EUV light, aiming for wavelengths of around 6nm. This would require breakthroughs in light sources, optics and photoresist (the light-sensitive coating on wafers). Shorter wavelengths also bring new challenges, including "shot noise", or random particle movements that blur patterns. But Yasin Ekinci of the Paul Scherrer Institute, a Swiss research centre, sees this as a "plan B" if hyper-NA fails to deliver.

While ASML pushes the boundaries of optical lithography, China—cut off from the most advanced chipmaking tools—is trying to extract more from the older ASML machines (capable of 28nm and above) it can still import. One approach is multi-patterning, in which a pattern is broken into multiple etching stages, allowing a machine to print details twice or four times as small. Multi-patterning is effective, but adds complexity and slows production.

China is also trying to build its own lithography tools. SMEE, a state-owned firm, is reportedly making progress on a machine capable of producing 28nm chips using DUV light. But developing an EUV system is an entirely different challenge. Jeff Koch of SemiAnalysis, a research firm, points out that

beyond mastering EUV light itself, China would need to replicate ASML's vast supply chain, stretching to more than 5,000 specialised suppliers.

ASML's dominance in high-end lithography, therefore, seems unshakable. But Canon, once an industry leader, is betting on an alternative. Nanoimprint lithography (NIL) stamps circuit patterns directly onto wafers, much like a printing press. In theory, NIL could create features with nanometre accuracy, offering a low-cost, compact rival to ASML's EUV machines.

The NIL process begins with the creation of a master mask which has the template of the circuit etched onto it by an electron beam. Next, droplets of a liquid resin are applied to the wafer before a mask presses the circuit pattern onto the wafer. Ultraviolet light is then used to solidify the resin and form the circuit patterns, after which the mask is removed. This step is repeated for every layer of the chip. Canon estimates that its approach costs around 40% less than a comparable machine from ASML.

For NIL to become a mainstream chipmaking technology, it must overcome several challenges. Defects are a big concern—tiny particles or imperfections on the mould can create repeating flaws across entire wafers. Alignment is another hurdle. Since chips are built in layers, the circuit patterns of every layer must line up precisely. Any variation in wafer flatness or slight misalignment between the mould and wafer can cause nanoscale errors, disrupting electrical connections. Canon claims its system achieves nanometre precision, but maintaining this consistently during production is difficult. Then there is throughput, or how many wafers a machine can process per hour. ASML's high-NA EUV tools can handle over 180 wafers per hour, with some older models reaching nearly twice that. In contrast, Canon's latest NIL system manages only 110 wafers per hour, making it less suited for high-volume chip production—at least for now.

So far NIL has found more success outside semiconductor manufacturing, particularly in making smartphone displays and other high-precision components. The technology is now making inroads into memory-chip production, where higher defect rates are more tolerable than in logic chips. Iwamoto Kazunori, the head of Canon's optical division, believes that NIL can co-exist with EUV lithography, cheaply performing manufacturing steps where it can and steering clear of finer detail.

Such innovation could help firms design faster and more energy-efficient chips capable of powering a new generation of AI models. If ASML is not careful, the world's most important machine may not keep its title for ever.

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