International Monetary Review

October 2026, Vol. 13, No. 4

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Established on December 20, 2009, IMI is a non-profit academic institution affiliated to China Financial Policy Research Center and the School of Finance of Renmin University.

Following the "general theory of macro-finance", IMI aims to become a world-class think tank, focusing on the studies of international finance, in particular the international monetary system and RMB internationalization. Despite its relatively short history so far, IMI has established itself as a leading research institution and important forum, where industry leaders, policy makers and academic experts from home and abroad share their insights and expertise.

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Name of Journal: International Monetary Review
Frequency of Publication: Quarterly
Sponsor: International Monetary Institute of Renmin University of China
Publisher: Editorial Office of *International Monetary Review*
Editor-in-Chief: Ben Shenglin
Associate Editors: Song Ke, Qu Qiang, Xia Le
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Special Column on Global Treasury Markets

US Treasury Market Is Living on Borrowed Time *

By KARL SCHAMOTTA *

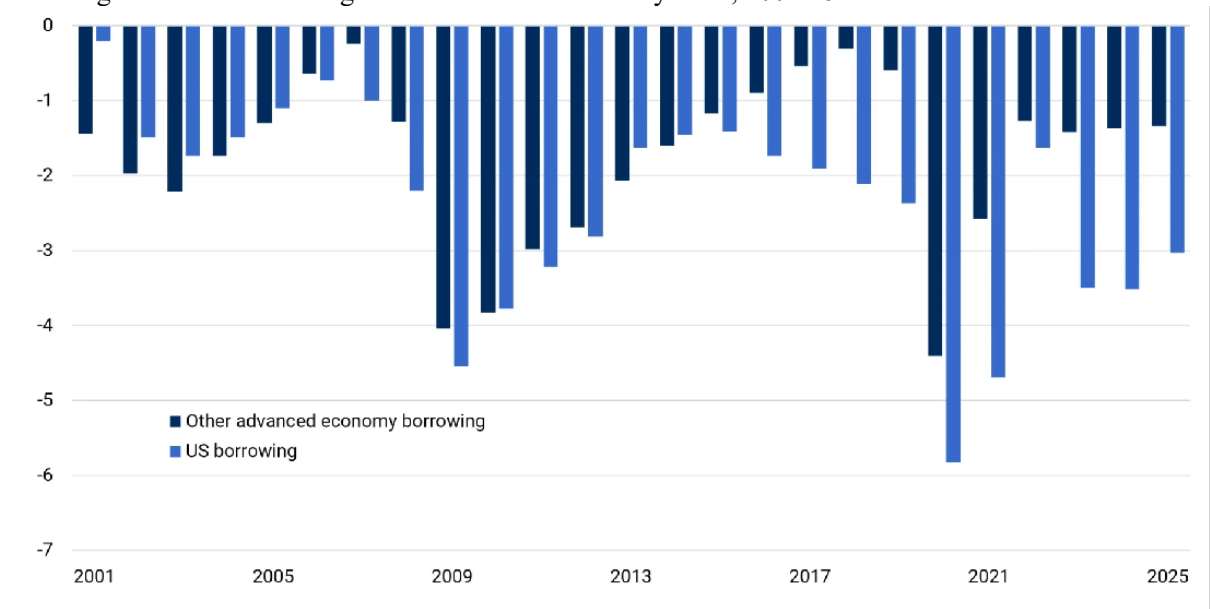
Traditional investors are turning away from US debt

The US Treasury market has long served as the world's financial anchor – deep, liquid and reliably stable. That reputation for placidity is becoming harder to sustain. America is borrowing at a pace that would have seemed extraordinary a generation ago, and the buyers who once absorbed that paper without blinking are quietly stepping away.

The scale of the fiscal expansion is astonishing. Publicly held US debt has risen more than fourfold since the 2008 financial crisis and now tops 100% of gross domestic product – a threshold last breached in the aftermath of the second world war. America borrows more than every other advanced economy combined (Figure 1).

Figure 1. US is the world's biggest borrower, and it's not even close

General government borrowing as % of advanced economy GDP, 2001-25



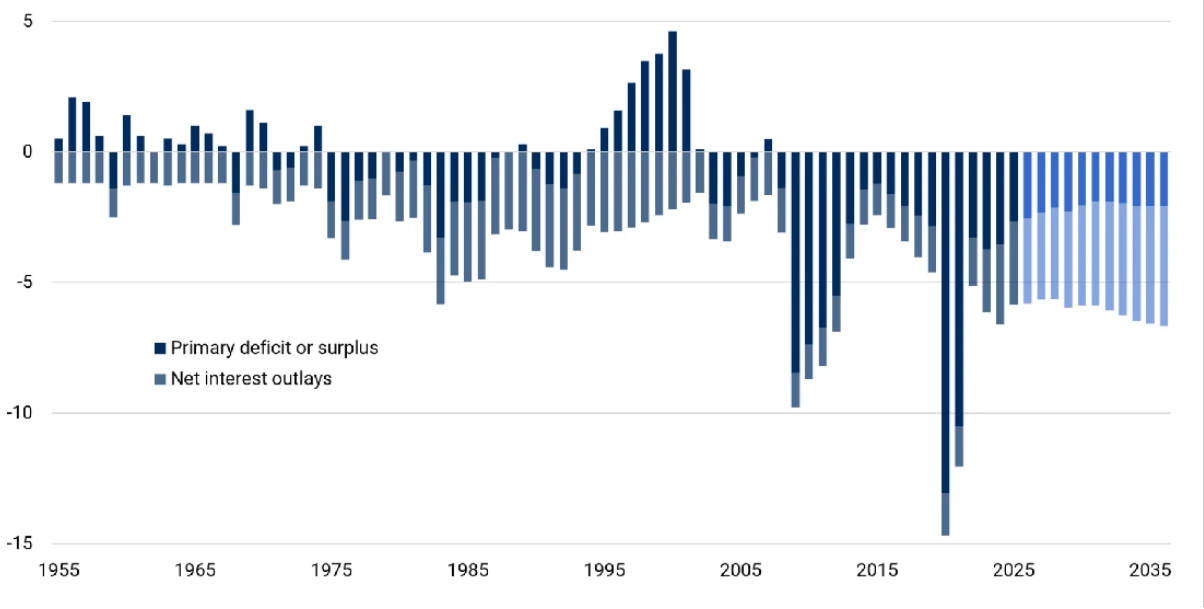
Source: International Monetary Fund

There is no let-up ahead (Figure 2). Where markets once imagined a Republican counterweight to Democratic spending, that illusion has been shattered. The latest update from the Congressional Budget Office shows President Donald Trump's policies widening the federal deficit by $1.4tn over the coming decade, a 6% increase on the previous forecast from January last year – and that estimate predates the courts' dismantling of his tariff agenda.

Figure 2. America's fiscal trajectory is worsening

US total and primary deficit or surplus as a share of GDP, 1955-2036

* The article was first published on OMFIF on June 17th, 2026.
* Karl Schamotta is Chief Market Strategist at Corpay Cross-Border.



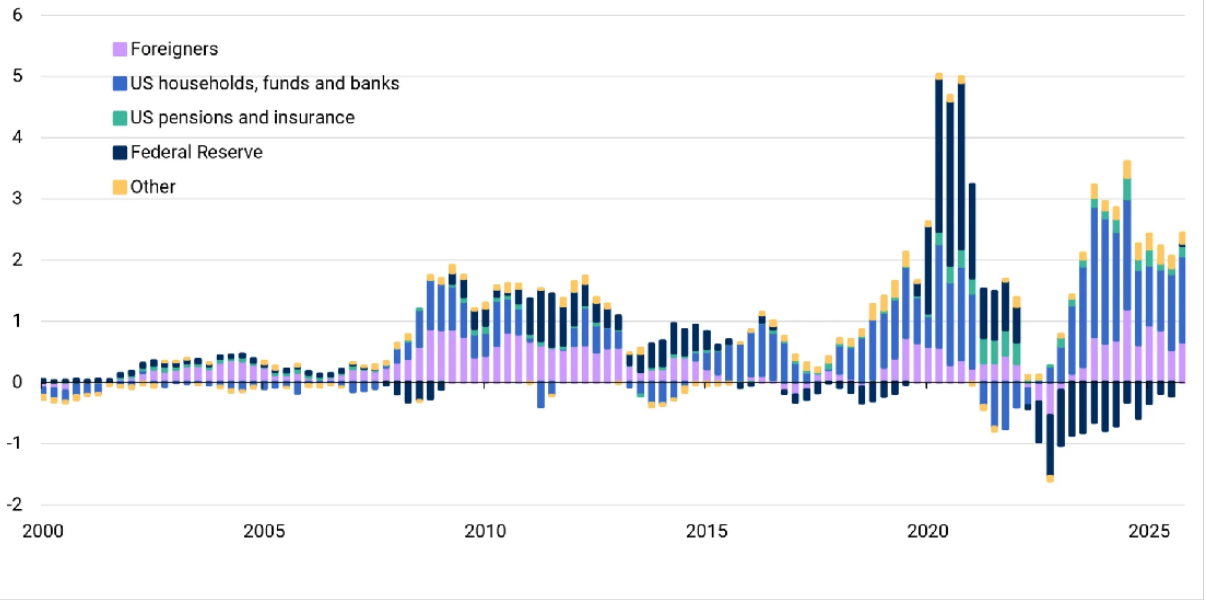
Source: Congressional Budget Office, Office of Management and Budget

What makes the situation newly dangerous lies on the demand side. Foreign central banks, once voracious accumulators of dollar reserves, have slowed their purchases as the trauma of the late 1990s fades from memory. Increasingly strapped petrostates are drawing down their holdings. The Federal Reserve, having spent years as the buyer of last resort, is still shrinking its balance sheet. Pension funds and insurers, long-duration buyers with little interest in market timing, are playing a diminishing role – one that demographic shifts, as populations age and draw down savings, are only accelerating.

The gap is being filled by investors of a very different temperament. Foreign commercial buyers, hedge funds, private asset managers and intermediary banks have stepped up – but they are, by nature, price-sensitive (Figure 3). They buy when yields (or basis spreads) are attractive and sell when conditions turn: a coalition united by the fact that none of them regard Treasuries as a permanent, unconditional holding. That is a fragile foundation beneath the world's supposedly safest asset.

Figure 3. 'Price-sensitive' investors now take bulk of Treasury issuance

Net Treasury purchases, four-quarter rolling sums, $tn, 2000 Q1-2025 Q4



Source: Federal Reserve, US Treasury, Bloomberg

The picture is complicated by structural shifts in the global economy. Governments elsewhere are loosening their purse strings, particularly on defence. Firms at the centre of the artificial-intelligence buildout, the energy transition and the commodities boom are driving a wave of capital expenditure not seen since the industrial era, and corporate borrowing is undergoing a step change. The result is a global scramble for long-term capital in which America's Treasury and Silicon Valley's hyperscalers are competing not only with each other, but with governments in Berlin, Tokyo and beyond.

None of this implies the greenback is doomed to decline – in fact, the opposite could prove true. The US is unlikely to default on its debt: the bulk of it is denominated in a currency Washington can always create more of, meaning any real default would be a political choice – a failure to raise the debt ceiling, say – rather than an inability to pay.

But if interest rates at the core of the global financial system settle at a structurally higher floor, punctuated by spasmodic bouts of volatility, countries without the privilege of issuing the world's dominant reserve currency could find themselves severely crowded out. To update John Connally's infamous warning about the dollar: it may be our Treasury market, but it's your problem.

What does this mean for currency markets? Once the dust settles in the Middle East, many participants expect trading to revert to fundamentals: relative shifts in growth, employment and inflation. They may find themselves wrong-footed instead by continued bond-market lurches that have little to do with any of these. Foreign exchange traders and corporate hedgers have spent a decade waiting for interest rates to return to normal. The unsettling possibility is that they already have.

IMI International Monetary Review

Bessent's Buyback Experiment Goes Off-Script ✶

By JAMIE FRANCO *

The US Treasury tears up its own playbook

When the US Treasury revived buybacks in 2024, the mandate was intentionally narrow: cash management buybacks to smooth seasonal cash swings, and liquidity support buybacks to retire ageing, illiquid issues and shore up market resilience.

Treasury debt managers, in line with the Treasury Borrowing Advisory Committee, said on the record that buybacks weren't a yield-management tool. Sizes were pre-announced quarterly and deliberately mechanical, so no operation could be interpreted as an effort to time markets.

However, in late August, the US Treasury has doubled the size of its 10- to 30-year buyback operations to at least $4bn from $2bn, effective 9 September through 4 November, after the 30-year yield touched its highest level since 2007. US Treasury Secretary Scott Bessent called it keeping the market 'in equilibrium' during 'a quiet period in a thin market' – language that, in fairness, never mentions yields, borrowing costs or the soaring deficit.

'Open-ended and opposite'

The case that the Treasury is using this facility for something other than its original stated purpose comes from actions rather than words – particularly in the light of Bessent's recent Japanese yen intervention and call for expanded usage of the Federal Reserve's Foreign and International Monetary Authorities facility. The US Treasury didn't wait for the next refunding, it instead upsized mid-cycle, days after the rise in the 30-year yield. Bessent didn't stop there, later telling reporters it could be 'more than $4bn per issue' – open-ended and the opposite of the mechanical sizing the programme was built on.

The clearest sign came from the reaction to the announcement itself, which quickly moved the 30-year yield down 15 basis points. The 10-year yield also fell some 10 bp. The buyback announcement became the week's biggest headline trade – exactly what the Treasury has historically wanted to avoid. Days later, yields had considerably retraced, stabilising after a brief surge following the announcement that the stock of US debt had reached $40tn.

Ultimately, buybacks will not have a meaningful, lasting effect on long yields. Longer term yields are rising because real rates are correcting upwards from a suppressed post-2008 financial crisis baseline towards a structurally higher neutral rate – massive fiscal deficits, deglobalisation, demographics and artificial intelligence capital demand, plus tariff shocks are adding a stickier inflation premium.

'Regular and predictable' issuance

Buybacks remain a debt-management tool, neither a monetary one, nor a tool to help the US Treasury manage the yield curve. Funding buybacks out of bill issuance shifts exposure towards front-end rollover risk rather than reducing it. At most, buybacks retire off-the-run paper and ease dealer balance sheets at the margin.

That's what makes the break with the past precedent costly. Since the 1970s, the US Treasury has been committed to 'regular and predictable' issuance. Since then, it has avoided trying to time the market. Rather, it issues and buys back according to a calendar rather than a desired price level.

Going forward, Bessent finds himself on a slippery slope. Once markets expect the Treasury to lean on buybacks when yields spike, a muted response next time will become its own negative signal, reducing confidence in the Treasury's debt management. It will be akin to a debt-management version of a 'Treasury put', however, unlike the Fed, the Treasury can't print money to make good on that. It can only borrow more at the front end, which is its own constraint and increases rollover risk.

None of this changes the core conclusion that the fundamentals driving yields higher remain untouched. Reducing our massive fiscal deficits and taming inflation are the keys to lower yield. Further, issuance strategy – not a repurposed liquidity facility – is the right tool for managing the weighted average maturity of Treasury debt.

✶ The article was first published on OMFIF on August 25th, 2026.

* Jamie Franco was formerly Head of Cross Asset Research and Sustainable Investment for TCW. She served at the US Treasury for a decade in international and domestic affairs, including on Treasury debt management policy.

The US Treasury spent some of its hard-won credibility in a buyback misadventure, particularly as a facility that worked precisely because it was boring, for a signal that is likely to buy very little.

IMI International Monetary Review

Where Will the Global Bond Rout Hit Growth and Equities? *

By NOURIEL ROUBINI *

In the US, the recent rise in bond yields is largely driven by structural factors like the end of the post-2008 Great Stagnation, higher potential growth from tech-industry investments, and greater private-sector demand for credit. Higher yields are more worrisome for advanced economies that are stagnating and innovating less.

A sharp rise in bond yields across key economies like the United States, Japan, Germany, the United Kingdom, and France has raised new concerns about the fiscal and financial risks that lay ahead. A common view is that this bond "rout" could augur severe disruptions to economic growth and pain for US and global stock markets.

But while it is true that yields have risen to levels unseen in almost two decades, the relationship between bond yields, economic growth, and stock markets is more complex than this naive view implies. After all, the recent rise in yields could reflect any number of different and contradictory factors.

Consider some of the obvious ones. First, higher inflation stemming from supply shocks—renewed protectionism and war-driven disruptions to the flow of oil—could push nominal yields higher and be stagflationary: reducing growth, increasing inflation, and pushing down equity prices.

Second, unsustainable fiscal deficits could lead to higher yields if markets expect that central banks will step in to monetize them, thus causing higher inflation. Alternatively, if the deficits aren't likely to be monetized, the higher yields could be driven by a rise of sovereign-risk premia, which could cause a public-debt crisis or crowd out private-sector spending and growth. In these cases, unsustainable fiscal policy does lead to lower growth, possibly higher inflation, and higher yields that hurt stock markets.

But then there is the third factor: a private-sector investment boom driven by capital expenditures (capex) on AI, which is pushing up nominal yields because it fuels higher demand for credit, rather than foreshadowing higher inflation expectations. In this case, higher bond yields are a signal of stronger future growth, which bodes well for stock prices.

This last factor has been a major driver of bond yields and stock markets for the last few years. Since the launch of ChatGPT in 2022, bond yields have gone higher—from a bottom of 1% in the US during the COVID-19 crisis to current levels around or above 5%—as US equities (and some global ones) chalked up double-digit returns. Even until mid-August, the rise in US bond yields coincided with new all-time highs for the main US stock index, the S&P 500.

This is what one would expect. When growth is strong and risk is on, equities do well and bond yields tend to rise; equally, when the appetite for risk is low and the economy is in recession, equities do poorly and bond yields fall. That is why lower bond yields are usually a sign of economic weakness, which in turn implies weakness for stock markets.

Of course, this positive correlation between bond yields and stock returns can turn negative—with bond yields rising as equity prices fall—when inflationary shocks lead to tighter monetary policy, or when there are serious concerns about fiscal sustainability. That is what happened in 2022, when surging deficits and the post-COVID inflation led to a sharp rise in bond yields and a bear market for US and global equities. And something similar occurred following US President Donald Trump's April 2, 2025, "Liberation Day" tariff announcement, and again during the oil shock triggered by this year's war with Iran, as well as with the most recent global bond rout, partly led by another spike in oil prices and fiscal concerns.

Whenever a correction in equities is led by bond yields, long-duration assets like tech stocks (whose dividend streams are further in the future) tend to react more to a rise in long-term bond yields than is the case with shorter-duration assets (like the equities of more mature firms). Hence, during the bond rout of 2022, the S&P 500 fell by about 15%, while the tech-heavy Nasdaq fell more than 20%, with many individual tech and growth stocks falling by more than 30%. And during this month's bond rout, the sharp rise in global yields hurt tech stocks more than the other broader market indices.

But given the positive outlook for growth in tech-led sectors, the returns to tech firms have been higher than traditional equities for the last five years, despite higher bond yields. One therefore should assume that in high-innovation countries like the US, the recent rise in bond yields is mostly driven by the rise in real yields rather than by an increase in inflation expectations, which remain well anchored slightly above 2%.

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* The article was first published on *Project Syndicate* on August 24th, 2026.

* Nouriel Roubini is a senior adviser at Hudson Bay Capital Management LP and Professor Emeritus of Economics at New York University's Stern School of Business.

Again, a rise in real yields is what one would expect, given tech firms' and hyperscalers' massive borrowing to finance data-center construction and other investments. While the US fiscal deficit is high, it has plateaued near 6% of GDP and is likely to fall in the next few years, owing to higher potential growth and some additional tariff revenues.

I am not trying to be Panglossian about the US fiscal outlook, which certainly requires serious austerity and entitlement reforms over the next few years. But I would point out that a US economy with higher potential growth—if new technologies increase potential output growth from 2% to 3% or more—has a better medium-term fiscal outlook than the likes of Japan or the eurozone, which are stuck with a potential growth rate of 1.2% for the eurozone and even lower for Japan.

So, both the secular and recent rise in global bond yields largely reflect structural factors like the end of the post-2008 Great Stagnation, higher potential growth and investment, and higher real yields. These are all positives for US and (some) global equities. Of course, in advanced economies that are stagnating and not innovating as much as the US, concerns about large fiscal deficits, public-debt accumulation, and future central-bank monetization are justified, as are fears of large negative aggregate supply shocks. Here, too, higher bond yields are exactly what one should expect.

IMI International Monetary Review

Is Another Eurozone Debt Crisis Looming? *

By DESMOND LACHMAN *

At a time when the cost of servicing sovereign debt is rising globally, France stands out as an especially fragile case. Its public debt-to-GDP ratio is edging up toward that of Greece on the eve of its sovereign-debt crisis, and the French political system seems unable to do anything about it.

In 2010, a Greek sovereign-debt crisis roiled world financial markets. Now, France threatens to do the same, but on a larger scale. Not only is its public debt-to-GDP ratio edging up toward that of Greece on the eve of its crisis, but the French political system seems unwilling or unable to address the country's gaping fiscal deficit.

There is every reason to fear that a French sovereign-debt crisis would have global spillover effects. France is the European Union's second-largest economy, with a debt many times the size of Greece's circa 2010. Moreover, France's debt problems are mounting at a time when bond yields in the United States, Japan, and the United Kingdom have all surged to multi-decade highs.

Not only has France's public debt ballooned from a little over 80% of GDP in 2010 to 119% today, but budget deficits reaching 5% of GDP continue to add to the problem. Worse, remaining on this unsustainable trajectory has become even costlier now that the French ten-year government bond yield has shot up to 4.81%. With a sclerotic economy that is being buffeted by an energy-price shock and higher interest rates—and which is officially projected to grow by less than 1% next year—France cannot hope to grow its way out of its debt problem.

To date, France has shown little political will to consolidate its budget and cut public spending, which now amounts to a staggering 58% of GDP. Over the past five years, French President Emmanuel Macron's administration has churned through six prime ministers, not one of whom has managed to reduce the budget deficit in any meaningful way. Deficit-reduction targets have repeatedly been softened, planned spending cuts and pension reforms have been diluted, and promised savings have fallen short of what was initially announced. So polarized is the National Assembly that reaching a consensus on how to achieve debt sustainability remains out of reach.

With a presidential election coming next April, little can be expected in terms of budget consolidation. All the candidates have an incentive to make lofty campaign promises, not to confront the electorate with painful economic-policy choices. Moreover, it is far from clear that any successor to Macron would be able to push through the economic reforms that the situation demands. For that to happen, the next president would need to win a working majority in the National Assembly, elections for which could take place several weeks after the presidential vote.

Even if France had the political will to address its public debt problem, doing so within the euro straitjacket would not be easy. France can neither pursue a currency depreciation nor cut interest rates to offset the contractionary effect of belt-tightening. Putting its fiscal house in order therefore comes with a high chance of recession (especially given the economy's current weakness); and a recession, in turn, would limit the potential gains from belt-tightening, by requiring increased social spending alongside reduced government revenue.

Markets seem to have taken note of France's unsustainable public finances and political dysfunction. The spread between French and German long-term interest rates has increased to 119 basis points, its highest level since the 2010 sovereign-debt crisis. The risk now is of a doom loop, where the French government's rising debt and higher borrowing costs exacerbate each other.

The good news is that the European Central Bank is better equipped than it was in 2010 to support a eurozone member state that is coming under market pressure. Its Transmission Protection Instrument, for example, allows it to buy unlimited quantities of a member's government bonds in the secondary market, provided that the country has a credible economic-adjustment program in place.

But France would be making a big mistake if it came to rely too much on an ECB safety net. Given the rise of Germany's right-wing, nationalist Alternative für Deutschland party, there would probably be little to no German public support for another ECB-orchestrated bailout of a fiscally irresponsible neighbor.

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* The article was first published on Project Syndicate on September 30th, 2026.

* Desmond Lachman, a senior fellow at the American Enterprise Institute, is a former deputy director of the International Monetary Fund's Policy Development and Review Department and a former chief emerging-market economic strategist at Salomon Smith Barney.

Even if France's mounting debt does not lead to the breakup of the euro, a new crisis for the common currency and tensions between the EU's two largest economies is the last thing that the world economy and financial markets need right now.

Global Economy

Xi's Upcoming US Visit to Chart Course for Bilateral Ties *

By XINHUA

At the invitation of U.S. President Donald Trump, Chinese President Xi Jinping will pay a state visit to the United States from Sept. 23 to 25, marking an exchange of visits between the two leaders within six months.

As changes unseen in a century are accelerating and uncertainties continue to grow around the world, the visit is expected to bring greater stability and predictability to China-U.S. relations and beyond.

CONSTRUCTIVE STRATEGIC STABILITY

China-U.S. ties have been widely regarded as the world's most important bilateral relationship. More than 50 years ago, leaders from both countries, with remarkable courage and political vision, took the historic step of breaking the ice.

Since then, the relationship has repeatedly found a way forward despite tensions and setbacks, with head-of-state diplomacy consistently providing strategic guidance.

In recent years, China-U.S. relations have weathered ups and downs. How the world's two major countries manage their relationship matters far beyond their own borders.

Hosting Trump in Beijing in May, Xi underscored the responsibilities shouldered by both countries in these changing times.

"Can China and the United States overcome the Thucydides Trap and create a new paradigm of major-country relations? Can we meet global challenges together and provide greater stability for the world? Can we build a bright future together for our bilateral relations in the interest of the well-being of the two peoples and the future of humanity? These are the questions vital to history, to the world and to the people," said Xi.

Xi has repeatedly said that the broad Pacific Ocean is vast enough to embrace both China and the United States. He has also urged the two sides to be partners and friends, and work together to accomplish more great and concrete things for the good of the two countries and the whole world.

Since Trump's return to the White House in 2025, the two leaders have stayed in close contact, speaking by phone many times, exchanging letters on several occasions and meeting face to face twice since late last year.

"I look forward to working together with you to set the course and steer the giant ship of China-U.S. relations, so as to make 2026 a historic, landmark year that opens up a new chapter in China-U.S. relations," Xi said in his meeting with Trump in May.

It was during their Beijing meeting that the two leaders agreed on a new vision of building a constructive China-U.S. relationship of strategic stability, providing strategic guidance for bilateral ties over the next three years and beyond.

"The building of a constructive China-U.S. relationship of strategic stability should not be a mere slogan, but concrete action taken by both sides toward the same goal," Xi said.

He outlined the "constructive strategic stability" as a positive stability with cooperation as the mainstay, a sound stability with moderate competition, a constant stability with manageable differences, and an enduring stability with promises of peace.

"The most important thing that comes out of leader-level meetings is that when the two leaders meet, they're able to build trust, and when they build trust, then everything else becomes easier," said Sean Stein, president of the U.S.-China Business Council.

"So for us, that's the most important thing we're looking for when President Xi travels to Washington to meet President Trump," he added.

WIN-WIN COOPERATION

* The article was first published on *Xinhua* on September 23rd, 2026.

As China and the United States share broad common interests and vast potential for cooperation, Xi has emphasized the need to expand mutually beneficial cooperation, strengthen dialogue and consultation, and turn shared interests into concrete outcomes.

China-U.S. economic ties are mutually beneficial and win-win in nature, Xi said in his meeting with Trump in May.

During his state visit to China, Trump was accompanied by top U.S. executives, including Apple's Tim Cook, Nvidia's Jensen Huang and Tesla's Elon Musk, whom he called outstanding representatives from the U.S. business community.

"China will only open its door wider," Xi said during the meeting with Trump. American companies are deeply involved in China's reform and opening up, and the U.S. side is welcome to enhance mutually beneficial cooperation, he added.

"As the world's two largest, most dynamic and most technologically advanced economies, it's just impossible for the U.S. and Chinese economies to function as well without a strong and viable relationship with the other, so it's absolutely essential," said Stein.

Despite frictions and challenges, China-U.S. trade has demonstrated strong resilience. In the second quarter of this year, bilateral trade in goods grew 13.7 percent year on year. As of July this year, U.S. companies had established more than 84,000 enterprises in China.

"What has happened demonstrates yet again that the description of China-U.S. cooperation benefiting both sides and confrontation hurting both sides reflects a common sense that has been repeatedly proven by experience, and the vision of China and the United States helping each other succeed and prosper together is a tangible prospect within reach," Xi said in a phone conversation with Trump in 2025.

This year marks the launch of China's 15th Five-Year Plan (2026-2030) for economic and social development, and the 250th founding anniversary of the United States. As both countries enter pivotal stages of their respective development, new opportunities for cooperation are emerging.

In July, a delegation of Chinese business leaders traveled to Salt Lake City, Chicago and Washington, D.C., where they met with representatives of more than 120 U.S. companies and organizations. Their discussions underscored that the appetite for cooperation remains strong.

Across the U.S. business community, there is growing recognition of the vast potential for Chinese and U.S. companies to work together in cutting-edge fields, from green energy and the digital economy to artificial intelligence and biomedicine.

Kate Sullivan, executive director of the Greater Columbus Chinese Chamber of Commerce, pointed to Illuminate USA, a joint-venture solar panel manufacturer in Columbus, Ohio, as a success story of China-U.S. cooperation.

"It is the epitome of advanced manufacturing in the state of Ohio, drawing on multiple strengths of Chinese manufacturing and supply chains," she said. "It makes sense for the United States and China to be in business together. It's not an emotional decision there. It's business. Supply and demand."

Looking ahead, business representatives also voiced expectations for a more stable environment for bilateral cooperation.

"We hope the two heads of state will maintain strategic communication, bringing greater stability, stronger confidence and a longer-term outlook to markets and businesses in both countries," said Wang Qi, chairman of the U.S.-China Green Energy Council.

PEOPLE-TO-PEOPLE EXCHANGES

Xi has consistently emphasized that the foundation and future of China-U.S. relations ultimately lie in the connections between the two peoples.

"Though geographically far apart, our peoples boast a long history of friendly exchanges," Xi said in a speech at a welcoming dinner hosted by local governments and friendly organizations in Seattle in 2015.

Over the years, Xi has maintained close personal ties with people from all walks of life in the United States. In 2015, Xi visited Lincoln High School in the U.S. port city of Tacoma. Without a tie, he presented gifts to the students, including books on China, a ping-pong table, and his personal invitation for the students to visit China.

In 2023, before the Welcome Dinner by Friendly Organizations in San Francisco, Xi met with veterans of the Flying Tigers and descendants of late General Joseph Stilwell, whose stories have become an important part of the history of China-U.S. friendship.

In 2024, in his reply to a letter from Lamont Repollet, president of Kean University in the United States, Xi encouraged universities in China and the United States to strengthen exchanges and cooperation and contribute to China-U.S. friendship.

During this year's Spring Festival, Xi replied to friends in the U.S. state of Iowa and sent them a Chinese New Year card with festive greetings, continuing their warm exchange of New Year wishes for the third consecutive year.

In 2023, during his visit to San Francisco, Xi announced that China was ready to invite 50,000 young Americans to China on exchange and study programs in the next five years. "We hope that our two peoples will make more visits, contacts and exchanges and write new stories of friendship in the new era," he said.

The invitation was warmly received by young people in the United States. In just over two and a half years, more than 50,000 young Americans from all 50 states have traveled to China.

Their trips have taken them to different parts of the country. They have toured smart factories, visited rural communities and experienced everyday life in places far from home. For many, the journeys have also led to new friendships with Chinese peers.

"I am particularly grateful to President Xi for his initiative of 50,000 in five years. I think that is possibly one of the most consequential initiatives in the last 20 years," said Luca Berrone, a four-decade-long friend of Xi in Iowa.

"I believe that people-to-people exchanges, particularly between China and the United States, are fundamental in continuing to strengthen the relationship, to improve understanding and acceptance," he said.

The US-Iran Agreement Is a First Step *

By MOHAMED A. EL-ERIAN *

While the recently announced US-Iranian memorandum of understanding is certainly good news, it is not definitive. The path from a statement of diplomatic intent to a fully restored, non-inflationary energy supply chain is fraught with political, technical, and physical risks.

Sunday's announcement of a memorandum of understanding between the United States and Iran is an important step forward. After months of open hostilities that have exacted a heavy toll—in both lives and livelihoods—and inflicted significant economic damage worldwide, the memorandum provides a much-needed foundation for diplomacy that could reverse the stagflationary spillovers of the war.

Since the war has complicated an already tricky outlook for most countries and companies, the announcement is understandably being celebrated. But as critical as it is, it's only a first step. A true return to global economic stability still depends on whether all the parties involved can move from a framework deal to a lasting agreement.

Of course, this uncertainty has not stopped global financial markets from reacting as though normal economic activity had already been restored. Expectations for a reopening of the Strait of Hormuz and a resumption of full-scale energy exports to international markets have triggered a sharp drop in global oil prices; and that, in turn, has boosted equity markets globally, as well as lowering borrowing costs.

Moreover, in the initial hours after the agreement's announcement, portions of the bond market revised down their assumptions about how aggressively central banks would need to hike interest rates, having inferred that the memorandum could lead to an easing of supply-side constraints fueling inflation.

But lasting relief for the global economy will depend on how the US and Iran navigate the profound operational complexities that their agreement entails. For economists and a substantial segment of financial markets, it is too early to declare "all clear." The next few weeks will be dominated by a step-by-step evaluation of whether renewed diplomacy can survive contact with structural realities.

Specifically, further clarity is needed on four issues. First, can technical teams from both the US and Iran sort through what US Vice President JD Vance has described as "a lot" of yet-to-be-negotiated details? They must not only resolve current outstanding issues but also navigate the inevitable transition from the memorandum of understanding to constructive talks on the fundamental issues that caused the war—not least Iran's nuclear program and the broader issue of regional security.

Second, international and regional actors' reaction could either solidify or sabotage the fragile peace. On one side are America's European and Middle East allies, who are eager to end the energy supply shock. They are hoping for a broader multilateral effort to ensure an enduring peace—a push that will likely be on full display at this week's G7 summit in France. But then there is Israel, which has continued to strike targets in Lebanon and has already signaled its refusal to withdraw from the territory it has held since the start of the war.

Third, the speed of normalization will be critical for restoring global economic health. Reopening a chokepoint like the Strait of Hormuz is not as simple as flipping a switch. Adjusting shipping insurance rates, carrying out de-mining operations, and ramping up energy production all takes time.

Lastly, policymakers must carefully gauge the extent to which the war has left "economic scarring," on one hand, and built additional resilience, on the other. The ceasefire does not automatically reverse adverse effects such as the hit to global costs, some of which have yet to materialize (particularly in the food sector). But these shocks must be weighed against the resilience-building measures that countries and companies were forced to pursue—from establishing alternative energy supply chains that bypass current chokepoints to placing a heavier logistical emphasis on precautionary inventories.

Most economists will refrain from declaring "all clear" as each of these issues could derail or prolong the process. A sense of caution will initially dominate policymakers' approach, as will become clear in the commentary surrounding major central banks' policy meetings this week.

That includes the US Federal Reserve. It will welcome the ceasefire, but it is unlikely simply to assume that a preliminary framework agreement constitutes a complete, immediate reversion of the war's adverse impact on inflation. The Fed and other central banks will wait for tangible proof that the details are sorted out, that the Strait of Hormuz will remain open, and that production and shipping will in fact be restored.

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* The article was first published on *Project Syndicate* on June 17th, 2026.

* Mohamed A. El-Erian, a former president of Queens' College at the University of Cambridge, is Practice Professor at the Wharton School at the University of Pennsylvania.

While the recent announcement is certainly good news, it is not definitive. The path from a statement of diplomatic intent to a fully restored, non-inflationary energy supply chain is subject to political, technical, and physical risks. Indeed, the coming weeks will be about how quickly the US and Iran can overcome challenges to implementation. Until then, the global economy remains in a state of suspended hope, and not yet on a path toward definitive recovery.

Rethinking Global Imbalances *

By JEAN-PIERRE LANDAU, SÉBASTIEN JEAN *

Today's global imbalances, starting with China's massive trade surplus, are not simply the result of poor macroeconomic coordination. Rather, they reflect long-term strategic thinking and a departure from the bias toward openness on which the postwar trade order was built.

Global imbalances are moving back to the top of the policy agenda, reflecting angst about the "second China shock." As China's industrial exports have surged while imports have stagnated, its growing trade surpluses have become a problem for everyone.

The familiar recommendation to address this state of affairs is for China to consume more, Europe to invest more, and the United States to consolidate its fiscal position. But these prescriptions are incomplete, because each fails to capture the industrial and technological dynamics that are now at work.

At the root of the problem is the increasing asymmetry and concentration of industrial production and capacity in a few countries. Today's imbalances are not simply the result of poor macroeconomic coordination. Rather, they reflect strategic behavior and a departure from the bias toward openness on which the postwar trade order was built.

Gone is the idea that countries would try to maximize consumer welfare within a shared rules-based system. Instead, trade and industrial strategies in China and some other economies have exploited two old lessons of economic theory.

First, in modern economies, scale and learning decide all. A sector's performance improves as it gains size, and productivity increases and unit costs decline as experience accumulates. Together, scale and learning interact to generate increasing returns and create cumulative dynamics, where performance strengthens performance and ensures economic and technological dominance.

In other words, comparative advantage, as the Nobel laureate Paul Krugman emphasized as early as 1987, is created, rather than arising from underlying national endowments. China owes its spectacular success in electric vehicles, batteries, and solar panels not to some pre-existing comparative advantage, but to a cumulative interaction of scale, learning, industrial policy, and global market penetration.

Second, to generate this dynamic, firms must export, because domestic demand is rarely sufficient to reach the scale needed for technological leadership. Gaining global market share is not a by-product of success but rather a condition of it.

Meanwhile, to channel domestic resources toward research, production capacity, infrastructure, and industrial ecosystems requires policies that force savings and shift investment from non-tradable to tradable sectors, including through exchange-rate management. The risk of periodic oversupply and imbalances is seen as an acceptable cost of building scale in strategic sectors.

The analytical foundations for such policies have existed for decades. What is less often noticed is their price. By pushing exports and constraining consumption, such a strategy implies running sustained current-account surpluses. A current-account surplus is necessarily associated with a net export of capital—the economy necessarily produces more than it consumes and invests at home, which is both a financial and a real transfer to the rest of the world. Its workers and households forgo part of the goods and services they could otherwise enjoy. The difference is saved and exported.

These financial and real transfers are inseparable—two expressions of the same strategy. And herein lies the paradox: Countries receiving the transfers increasingly object to them.

In terms of welfare, European consumers should welcome cheap electric vehicles, batteries, and solar panels that are subsidized directly or indirectly by Chinese workers and taxpayers. But Europeans instead see them as a threat, which is rational from a dynamic perspective. Cheap imports may raise purchasing power today, but they can destroy the industrial base on which tomorrow's income depends. The transfer is generous in the present, but costly in the future.

The calculus is inverted for the surplus country, which sees present transfers as a small price to pay for unleashing the cumulative process of learning-by-doing, through which comparative advantage becomes larger and increasingly irreversible. The current-account surplus is not the final objective. It is a means to achieve market and technological dominance.

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* The article was first published on Project Syndicate on July 23rd, 2026.
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A useful complement to this strategy is capital controls. Controls on outflows keep domestic savings at home, while restricting inflows prevents the economy from rebalancing from tradable to non-tradable sectors—the opposite of what the strategy aims to achieve. Capital inflows strengthen the currency, weaken exports, and support consumption. They accelerate domestic absorption before scale and learning are secured, thus impeding the pursuit of comparative advantage.

These drawbacks explain why several Asian economies, China above all, have combined high savings, capital controls, exchange-rate management, and industrial policy. Each of these instruments is usually analyzed separately, with capital controls treated as financial repression, exchange-rate management as mercantilism, subsidies as trade distortions, and high savings as a macroeconomic imbalance. But, together, they form a coherent strategy for blocking normal domestic adjustment, keeping resources in tradable sectors, preserving competitiveness, and building dynamic comparative advantage.

The liberal assumption that all countries seek to maximize consumer welfare within a common trade-policy framework was too simple. We must accept the reality that different countries have different objectives with different time horizons. Global imbalances reflect deliberate strategies that use trade surpluses as instruments of industrial policy. The question is not just how to cope with insufficient coordination, but how to respond to conflicting strategies.

Acknowledging reality is a prerequisite for devising effective policy responses. But that doesn't mean advocating aggressive tariffs and retaliation, which at best may provide short-term relief (at consumers' expense), while failing to address the underlying dynamics that caused the problem in the first place.

Instead, different trade and exchange-rate disciplines will be required. In a world of powerful externalities and pronounced asymmetries, large actors may continue to have natural incentives to pursue export promotion and strategic dominance. If so, only effective red lines on market access and domestic subsidies can keep them in check. Otherwise, scale will compound itself, and the largest players will become harder to challenge.

Benign neglect of exchange rates is no longer tenable. Trade rules cannot be separated from exchange-rate policies and capital controls. Active surveillance of exchange-rate policies should therefore become a core part of the trade regime. As long as this goes unrecognized, the rules designed to govern international economic relations will remain little honored and often breached.

Don't Blame Global Imbalances on the Undervalued Yuan*

By GITA GOPINATH, PIERRE-OLIVIER GOURINCHAS, HÉLÈNE REY *

There is a comfortable ritual in international economic diplomacy. Whenever global imbalances emerge as a source of anxiety—as they have again today—the conversation gravitates towards the exchange rate. China runs large and growing external surpluses. America runs large and growing external deficits. Both are assessed as excessive by the IMF. If only policymakers could meet in some fancy hotel, agree to strengthen the yuan and weaken the dollar, the argument runs, then China would import more and export less, America would do the opposite and the world's lopsided pattern of surpluses and deficits would gently correct itself. Of late, this view has gathered supporters in the West.

To be clear, the Chinese yuan is no doubt undervalued. But the emphasis on the exchange rate as the lever of adjustment is misplaced. In a G7 expert report and an IMF policy paper on global imbalances, both published this year (with input from the authors of this article), the exchange rate is treated not as a culprit, but as an outcome—an undesirable but predictable consequence of a particular configuration of domestic policies.

A country that suppresses household consumption while simultaneously facing a collapse of property investment will run persistent current-account surpluses and will, other things equal, have a weak currency. A country with insufficient private savings and unsustainably large fiscal deficits will run persistent current-account deficits and will, other things equal, have a strong real exchange rate against other other currencies. The currency is misaligned because the underlying policy mix produces too much or too little saving. The exchange rate is a symptom, not the disease.

Some argue that China's exchange rate reflects currency-intervention policies to keep the yuan weak. Indeed, the yuan does not float freely, and it is possible to engineer both a persistent current account surplus and a weak real exchange rate through a combination of capital controls, consumption suppression and foreign-exchange interventions. But China's currency interventions in recent years have often been to prevent the currency from weakening, and the yuan, if anything, has been stable. The recent depreciation of China's real exchange rate has followed mainly from weaker inflation in China relative to its trading partners.

The knee-jerk emphasis on the currency has two serious drawbacks, and they compound each other. The first is economic. Suppose China did revalue tomorrow, sharply and by fiat, with no accompanying change in its underlying macroeconomic policies. Would the required global adjustment follow? In all likelihood, it would not. In the short run, the nominal appreciation would have limited effect on China's exports as the majority of its export prices are set in dollars and adjust slowly.

On the other side of the ledger, meanwhile, it would lower the yuan price of its imports immediately. All else equal, this can increase China's imports and reduce its trade surplus. But all else is not equal: the stronger yuan would further exacerbate China's deflation problem and reduce its overall demand. This is precisely the opposite of what rebalancing requires—which is that China absorb more of what the world produces.

Equally important, a nominal appreciation unsupported by macroeconomic-policy changes to rebalance the economy is likely to morph quickly into a real depreciation owing to deflationary pressures. Some argue that this would push China to reflate its economy. But if the goal is for China to ultimately pursue better policies, why not simply discuss those directly? Why route the request through the exchange rate?

The second drawback is political. Demanding a nominal revaluation as a headline concession is, in practice, extremely unlikely to be accepted. History is not encouraging. Contrary to what is often believed, the success of the Plaza Accord in 1985 relied on the co-operation of Japan and significant macroeconomic adjustments, including to America's fiscal stance, to support the dollar's depreciation. Today China may be more receptive to a conversation about strengthening its social safety net, its pension system or its non-traded service sector. When you push for growth-supporting reforms, you have a chance. When you push for an exchange-rate adjustment, you ask for conflict.

Big beautiful balance

None of this lets China off the hook. Its surpluses are real, large and a legitimate concern for the rest of the world, including for a European economy that cannot serve as the absorber of last resort. What China needs to do—and what is in its own long-term interest, given its ageing population and an investment model overly reliant on the tradable sector—is to raise the share of household income in GDP, expand social

* The article was first published on *Economist* on July 28th, 2026.

* Gita Gopinath was chief economist of the IMF from 2019 to 2022 and Pierre-Olivier Gourinchas from 2022 to 2026. Hélène Rey is a professor at London Business School.

insurance so that families feel able to spend, and stop financing tradable-sector expansion at the expense of consumption. Do those things, and a real appreciation of the yuan will follow.

But let's also be clear that the required adjustment is not only on China's side. America will also need to tackle its unsustainable fiscal policy, as well as its persistently low private savings. That, too, cannot be addressed by exchange-rate gimmicks.

The G7 and the IMF locate the problem correctly: it lies in the constellation of domestic macroeconomic choices on both sides of the imbalance. A policy package, whereby China pivots to consumption and services-led growth, and America reins in fiscal deficits, is less spectacular than a grand currency bargain. But it has the advantage of being both effective and achievable.

Global Growth Resilience

The Global Economy Has Been Resilient — So Far *

By M. AYHAN KOSE, GITANJALI KUMAR, PETER SELCUK *

Why has the global economy so far withstood the shock caused by disruption of oil shipments through the Strait of Hormuz?

The Middle East conflict delivered one of the biggest disruptions to global oil supplies in decades. The disruption of oil shipments through the Strait of Hormuz earlier this year briefly drove Brent crude prices to nearly $120 a barrel—roughly two-thirds higher than the price on the eve of the conflict. Yet the global economy has so far escaped the steep downturn that used to accompany similar oil shocks.

Consensus forecasts now put global growth at about 2.6 percent in 2026, close to what was expected in January and above the more pessimistic projections made in the spring. Yet the danger has not passed. The conflict has already added to inflationary pressures and pushed up borrowing costs, and a renewed rise in energy prices could further increase them.

The result is a striking paradox: The global economy has withstood a historic oil shock, but inflation and borrowing costs are rising. Five questions examine what has sustained this resilience—and why policymakers must remain vigilant.

1. How has the conflict affected energy and financial markets?

The effects have so far been severe but uneven.

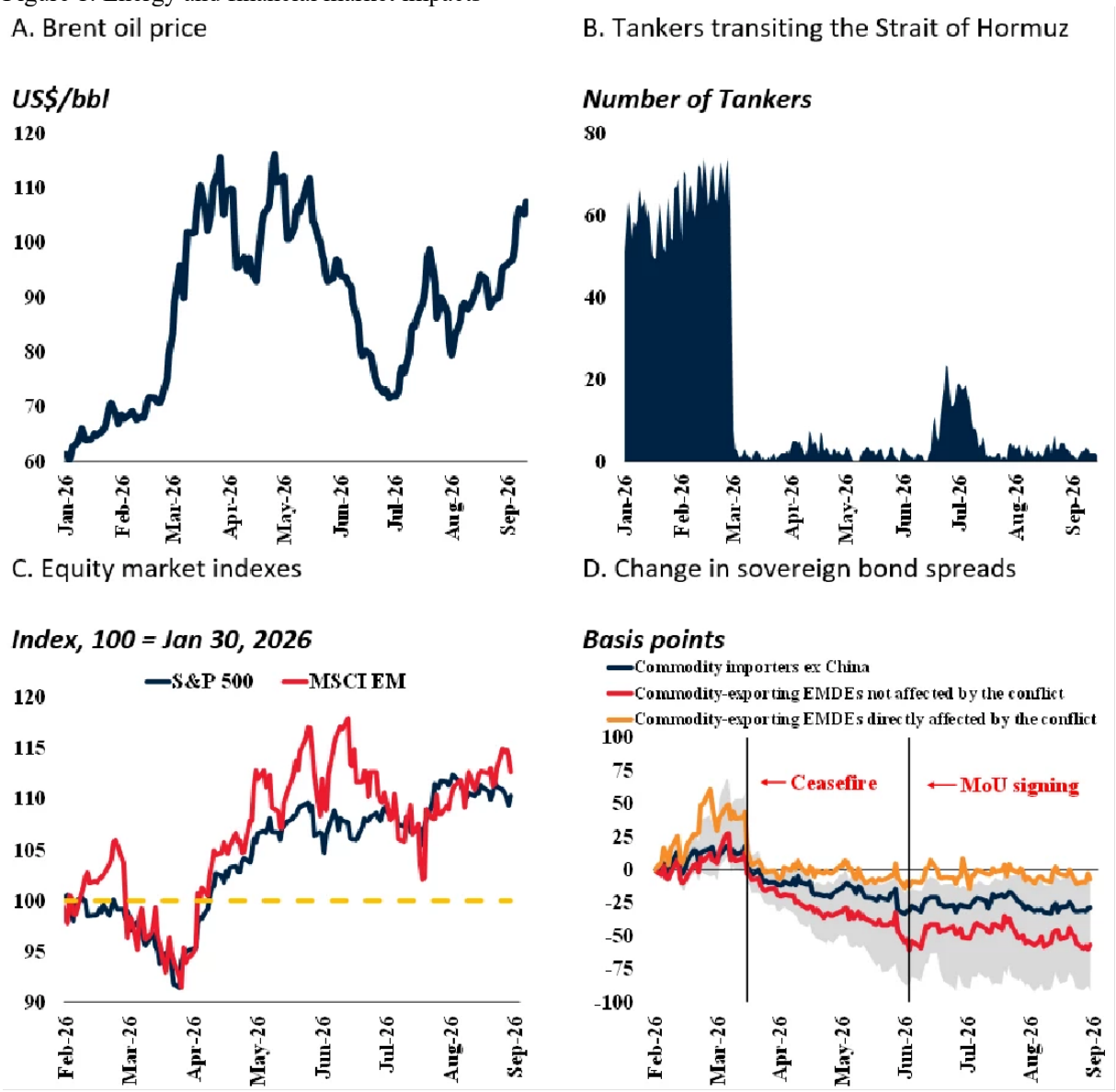
Oil prices surged after the conflict began, then retreated to near pre-conflict levels at the end of June as markets adjusted and fears of further disruption eased. More recently, prices have again approached the highs reached at the start of the conflict (Figure 1.A). The ongoing closures of the Strait of Hormuz have sharply reduced oil shipments and renewed pressure on energy and other commodity prices (Figure 1.B).

Financial markets have followed a different course. Investors initially retreated from risky assets, but equities rebounded strongly after the April ceasefire. Optimism about AI helped lift equity markets in advanced economies (Figure 1.C), and the gains spread to many emerging markets and developing economies (EMDEs). The recovery was not universal, however. Financial market indicators in energy importers dependent on Middle Eastern supplies—and economies with pre-existing vulnerabilities—recovered more slowly. On the other hand, commodity exporters outside the conflict zone and countries with stronger policy frameworks and larger buffers saw their sovereign bond spreads rebound more rapidly (Figure 1.D). Nevertheless, following the renewed escalation of the conflict, long-term bond yields in advanced economies have risen substantially, pushing up borrowing costs in EMDEs.

* The article was first published on The World Bank on September 28th, 2026.

* M. Ayhan Kose is the Deputy Chief Economist of the World Bank Group and Director of the Prospects Group. Gitanjali Kumar is a Senior Economist in the Prospects Group of the World Bank. Peter Selcuk is an economist in the Prospects Group of the World Bank.

Figure 1: Energy and financial market impacts



Sources: Bloomberg; Haver Analytics; J.P. Morgan; MSCI; World Bank.
Note: bbl = barrel; EMDEs = emerging market and developing economies.
A. Two-day moving average of Brent prices. Last observation is September 15, 2026.
B. Two-day moving average of vessels transiting the Strait of Hormuz, estimated from AIS ship-tracking data. GPS jamming, AIS spoofing, and vessels turning off transponders may distort recent data. Last observation is September 15, 2026.
C. Equity market indexes for the United States (S&P 500) and an aggregate of select emerging market economies (MSCI EM). Indexes are rebased to 100 on January 30, 2026. Last observation is September 11, 2026.
D. Lines show change in median EMBI spreads since February 27, 2026, using daily data, by economy group. The gray shaded area shows the 20th–80th percentile range. Sample includes up to 63 EMDEs. Vertical lines mark the dates of April 8 (ceasefire announced) and June 17 (Memorandum of Understanding signed). Commodity-exporting EMDEs directly affected by the conflict include Bahrain, Iraq, Saudi Arabia, and United Arab Emirates (included only through June 30th). Last observation is September 3, 2026.

2. How has the outlook for growth and inflation changed?

Since January, consensus forecasts for global growth in 2026 have fallen by only 0.1 percentage point (Figure 2.A), while inflation forecasts have risen by about 0.8 percentage point, to 3.4 percent (Figure 2.B). In EMDEs, projected inflation has increased from 3.3 percent to nearly 4.2 percent.

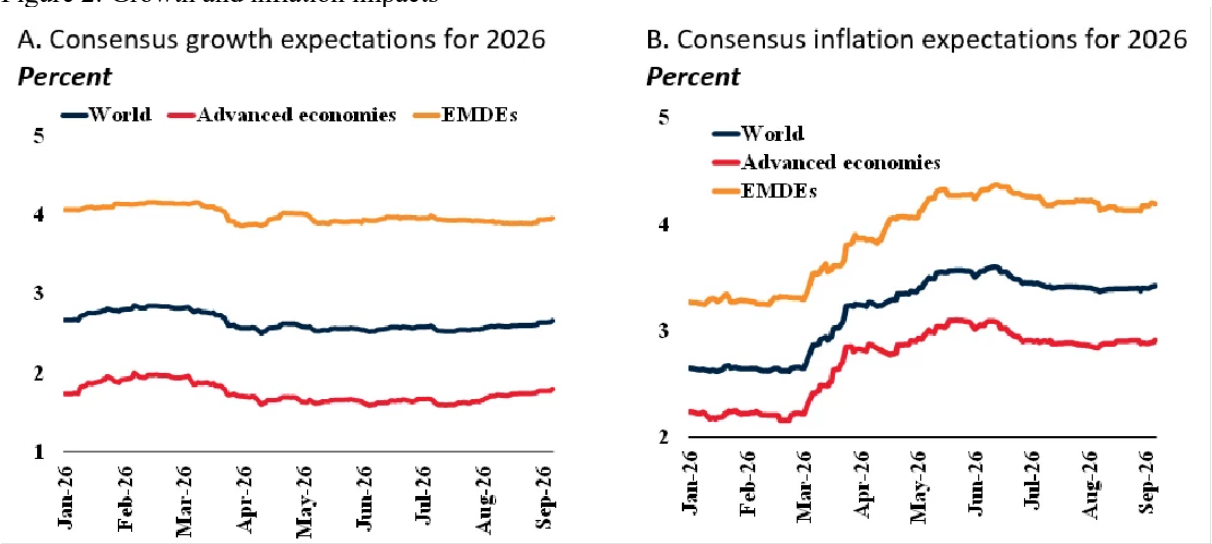
The growth picture is much less reassuring outside the largest EMDEs. Growth in EMDEs excluding China and India is forecast to slow from 3.0 percent in 2025 to 2.5 percent in 2026, about 0.4 percentage

point below January expectations. The impact is especially severe in economies directly affected by the Middle East conflict. By contrast, growth forecasts in East Asia and Pacific and South Asia are in line with, or stronger than January expectations. Strength in these regions has helped somewhat offset severe losses in conflict-affected economies.

Higher energy prices feed quickly into fuel and electricity bills and raise costs for transportation, shelter, food production, and manufacturing. Their effect on economic activity can take longer to emerge as households adjust spending and firms reconsider investment. The small revision to global growth forecasts since January may therefore understate the risk to growth if high energy prices persist.

Renewed price pressures have complicated the task facing central banks. Some, including in major advanced economies, have raised policy rates, while others have become more cautious about easing. If inflation remains elevated, higher borrowing costs could restrain spending and investment.

Figure 2: Growth and inflation impacts



Sources: Consensus Economics; World Bank.
Note: EMDEs = emerging market and developing economies. GDP aggregates calculated using real U.S. dollar GDP weights at average 2010-19 prices and market exchange rates. Sample includes up to 86 economies, including 34 advanced economies and 52 EMDEs, for which Consensus Economics provides continuous survey data. Last observation is September 11, 2026.
A. GDP-weighted averages of annual GDP growth forecasts by economy group.
B. GDP-weighted averages of inflation forecasts by economy group.

3. What has kept the global economy from sliding into a deeper downturn?

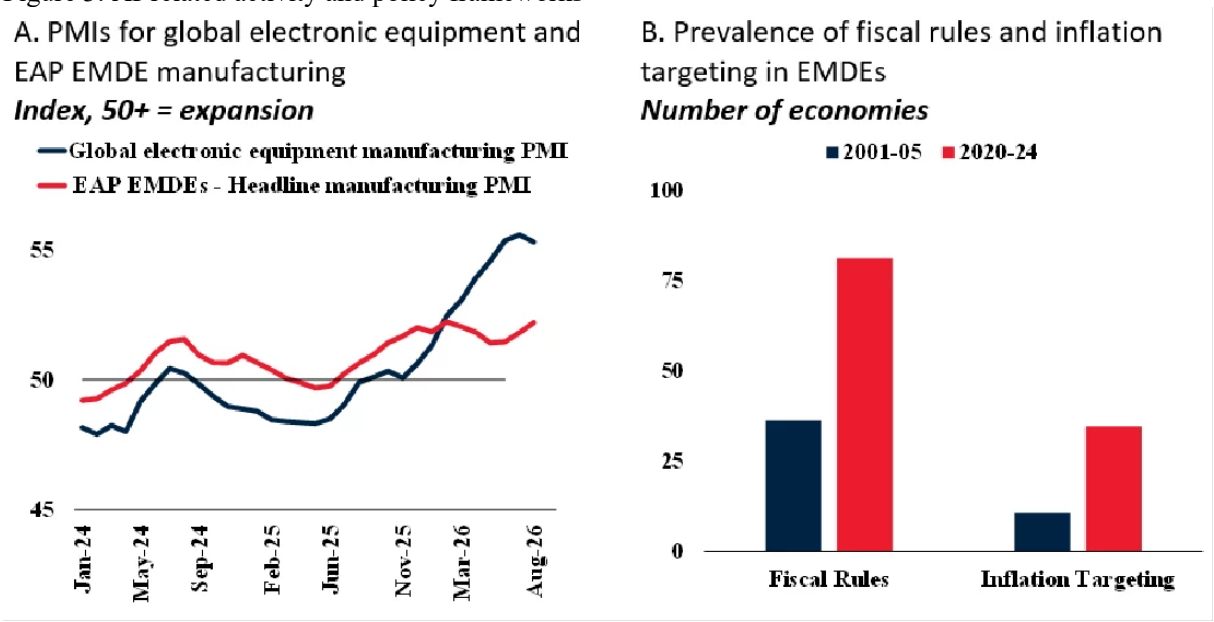
Four factors have made the difference. First, energy markets adjusted rapidly. Inventories were drawn down, producers outside the conflict region increased exports, and weaker demand in several major economies helped limit the rise in oil prices.

Second, governments acted quickly. Governments and businesses conserved energy, used strategic reserves, and switched to alternatives, including renewables and coal. Many developing economies introduced fuel subsidies, price caps, and other measures to shield households and businesses. These interventions provided immediate relief, though they also increased pressure on public finances. As the scale of the shock became evident, international financial institutions complemented these efforts. The World Bank Group made $50 billion to $60 billion available to help countries protect vulnerable households, strengthen public finances, and provide capital and liquidity to businesses. If conditions deteriorate further, it has room to scale up that support to $80 billion to $100 billion over 15 months.

Third, AI investment became a powerful engine of global demand. Large-scale capital spending in the United States has supported activity and trade. The benefits have extended to EMDEs, particularly in East Asian economies, through stronger demand for electronics and other inputs used in AI infrastructure, as reflected in the strength of global electronics manufacturing activity (Figure 3.A). New trade agreements and efforts to diversify supply chains have provided additional support.

Fourth, many EMDEs entered the crisis with stronger policy frameworks than they had during earlier shocks. More of these economies now use inflation targets and fiscal rules (Figure 3.B). Many have larger foreign currency reserves, deeper local capital markets, and more credible central banks. These strengths have helped some economies retain investor confidence.

Figure 3: AI-related activity and policy frameworks



Sources: Alonso et al. (2025); AREAER (database); Haver Analytics; IMF Fiscal Rules Dataset (database); World Bank.
Note: EAP = East Asia and Pacific; EMDEs = emerging market and developing economies; PMI = purchasing managers' index.
A. Blue line shows a three-month moving average of global PMI for the manufacture of electronic equipment. Red line shows a three-month moving average of headline manufacturing PMI for five EAP EMDEs (China, Malaysia, Philippines, Thailand, and Viet Nam). PMI readings above (below) 50 indicate expansion (contraction). Last observation is August 2026.
B. Bars show period averages.

4. What dangers lie beneath the global economy's resilience?

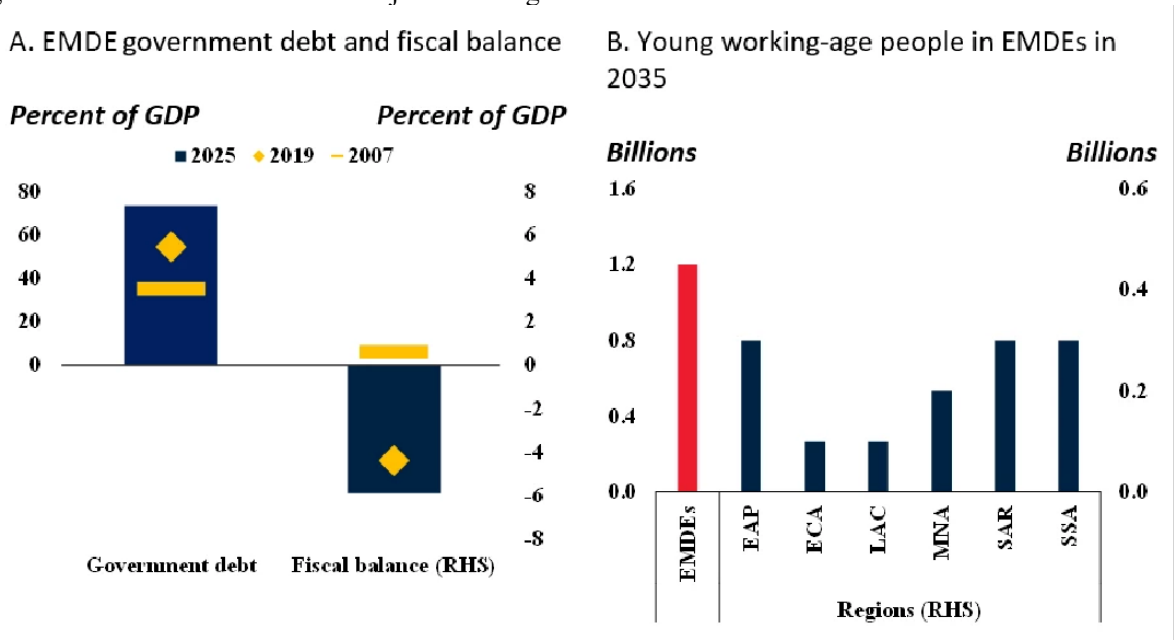
The latest shock hit economies already weakened by the pandemic, supply disruptions and the inflation surge, and geopolitical tensions. These successive blows have depleted fiscal buffers (Figure 4.A) and pushed debt higher in many EMDEs. Measures intended to protect households from the energy shock have added to the pressure. Rising global interest rates are now making that debt more expensive to refinance and service.

The result can be a vicious cycle. High debt and tighter financing conditions restrict public and private investment. Weak investment limits productivity and growth. Slow growth makes debt harder to manage. Governments are left with less room to respond when the next crisis arrives.

The long-term consequences of these successive shocks are already visible. By 2028, EMDEs excluding China and India are on track to have lost nearly a decade of income convergence with advanced economies. Many fragile and conflict-affected countries are falling farther behind. Further increases in food prices, potentially compounded by a historically strong El Niño, could deepen food insecurity in countries that are home to many of the world's poorest people.

These vulnerabilities are mounting just as EMDEs confront a jobs challenge of historic proportions. Over the next decade, an estimated 1.2 billion young people will reach working age (Figure 4.B). More than one-fifth of them live in economies affected by fragility and conflict. Creating jobs for this generation is both a formidable challenge and a major opportunity for growth.

Figure 4: Debt vulnerabilities and the jobs challenge



Sources: Kose et al. (2021, 2022); UN World Population Prospects (2024); World Bank. Note: EAP = East Asia and Pacific; ECA = Europe and Central Asia; EMDEs = emerging market and developing economies; GDP = gross domestic product; LAC = Latin America and the Caribbean; MNA = Middle East, North Africa, Afghanistan, and Pakistan; RHS = right-hand scale; SAR = South Asia; SSA = Sub-Saharan Africa.
A. Aggregates computed as weighted averages using GDP in U.S. dollars as weights, based on data for up to 151 EMDEs for government debt and up to 153 EMDEs for fiscal balances.
B. Bars show the number of young people aged 15–24 living in each region in 2035.

5. What should policymakers do now?

Three priorities are critical. First, protect the most vulnerable. Higher food and energy prices erode purchasing power, especially for poorer households, which spend more of their income on these essentials. Governments should provide targeted, temporary support to vulnerable households and businesses without placing significant further strain on public finances.

Second, make careful fiscal and monetary policy choices. Policymakers must prevent the energy price shock from turning into persistent inflation. Governments must manage debt vulnerabilities while rebuilding fiscal buffers. Higher borrowing costs make this harder, particularly for heavily indebted governments that must devote more resources to debt service. Credible medium-term fiscal policies and strong institutions will help economies withstand future shocks.

Third, strengthen growth and create jobs. That requires more investment, higher productivity growth, and greater opportunities in sectors capable of employing large numbers of workers. The priorities are to deliver foundational infrastructure, foster an environment in which businesses can grow, and mobilize private capital. Together, these efforts can turn demographic pressure into a source of job creation and growth.

The global economy has taken repeated blows since 2020, and yet it has shown a notable capacity to withstand shocks. But, as the familiar warning to investors goes, past performance does not guarantee future results. Policy makers must use this period of resilience to rebuild economic strength—before the next shock arrives.

IMI International Monetary Review

The Global Growth Slowdown: AI to the Rescue? *

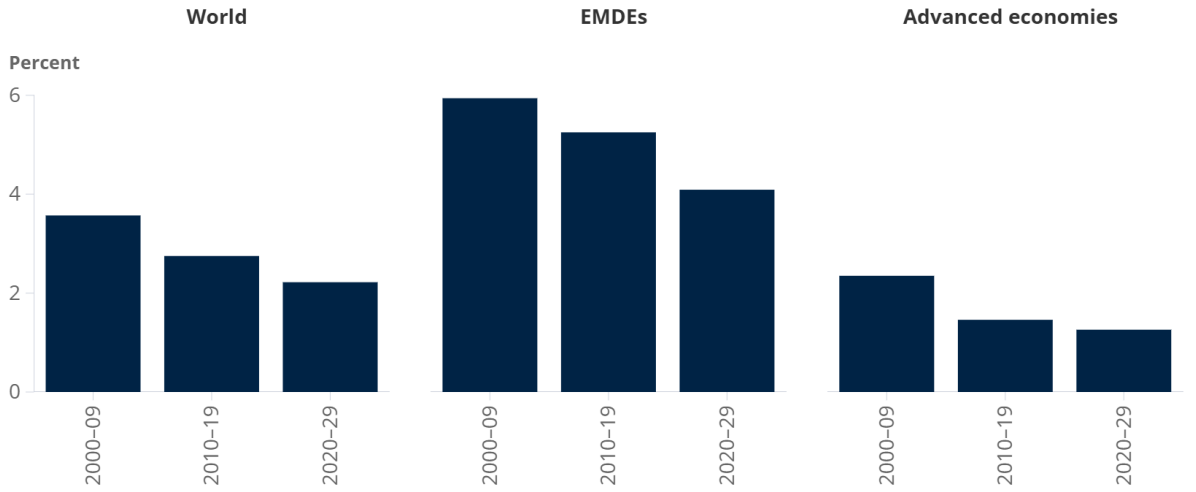
By M. AYHAN KOSE, KERSTEN STAMM *

Artificial intelligence (AI) is advancing rapidly at a moment when the global economy badly needs a new source of growth. The stakes are especially high in emerging market and developing economies (EMDEs), where growth has slowed to a two-decade low just as about 1.2 billion young people are set to reach working age between 2025 and 2035, likely their largest youth cohort ever. These economies need faster growth and more productive jobs. With the right complementary policies and investments, AI could help EMDEs achieve both, extending its benefits beyond the advanced economies already best equipped to use it.

A protracted growth slowdown

Global potential growth—the pace an economy can sustain without generating inflationary pressures—has fallen from 3.6 percent a year in the 2000s to 2.8 percent in the 2010s. It is projected to average about 2.2 percent in the 2020s. The decline has been steeper in EMDEs, where potential growth is projected to fall from 5.9 percent in the 2000s to 4.1 percent this decade (Figure 1). Weaker investment, slower labor force growth, and declining productivity growth have all contributed to this broad-based slowdown around the world.

Figure 1. Potential output growth



Sources: Kose and Ohnsorge (2024); World Bank.
Note: EMDEs = emerging market and developing economies. Averages, weighted by gross domestic product (GDP), of production function-based estimates of potential growth. Sample includes 31 advanced economies and 52 EMDEs. Data for 2022 and later years are projections.

Enter the era of AI

AI is already spurring investment, particularly in advanced economies, while rapidly growing trade in AI-related goods is spreading some of that demand across borders. Over time, however, its greatest promise lies in raising productivity. Early evidence is encouraging in some settings: for example, customer-support agents in the Philippines who had access to AI assistance increased their productivity by 15 percent, on average. Other studies find even larger gains in certain tasks, often for less-experienced workers.

The leap from task-level gains to economy-wide growth is much harder. Firms must adopt AI, reorganize work, train employees, and identify tasks where AI can improve productivity. Much of the evidence still comes from advanced economies. Some expert users have seen little benefit, and many tasks may prove difficult to automate or improve. As a result, estimates of AI's contribution to annual productivity growth range from about 0.07 percentage point in cautious assessments to as much as 1 percentage point in optimistic ones (Figure 2).

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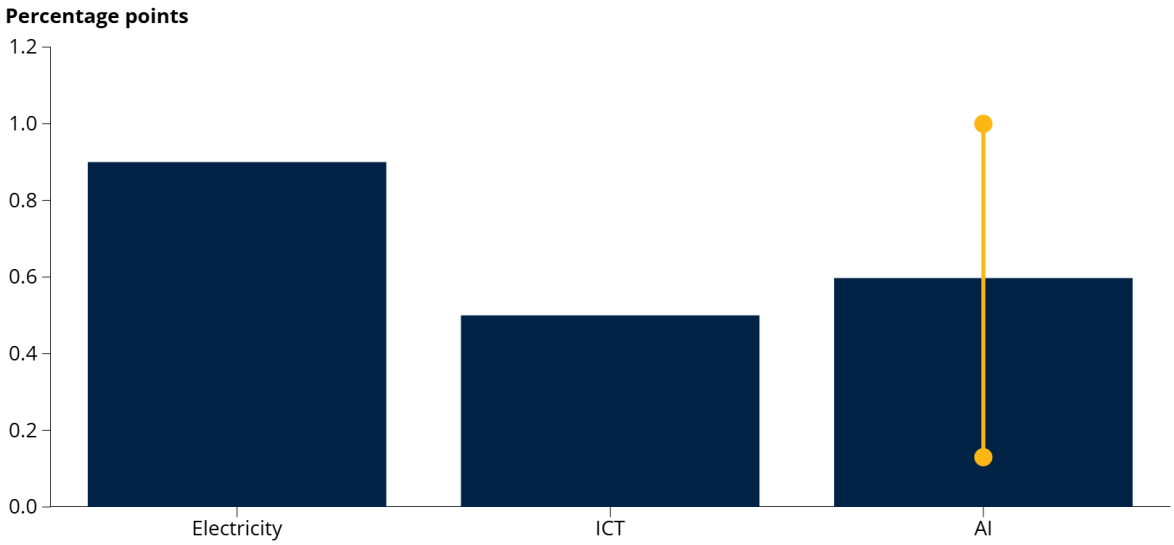
* The article was first published on The World Bank on Ocotber 5th, 2026.
* Ayhan Kose is the Deputy Chief Economist of the World Bank Group and Director of the Prospects Group. Kersten Stamm is a Senior Economist in the Prospects Group at the World Bank Group.

This wide range of estimates reflects uncertainty about the share of tasks that can benefit from AI, the productivity gains within those tasks, and the pace of adoption across firms, among other assumptions. A larger share of AI-compatible tasks or faster adoption implies greater economy-wide gains. The evidence so far comes largely from early adopters, whose experience may not generalize broadly.

Earlier technologies offer perspective and a reminder that benefits take time to spread. Electrification may eventually have added about 0.9 percentage point to annual productivity growth in Europe, but factories had to be redesigned and supporting infrastructure installed first. The information and communications technology revolution contributed about 0.5 percentage point to annual productivity growth in the United States. AI's eventual impact remains uncertain, and its broader gains are likely to emerge gradually.

Figure 2. Estimated productivity impact of general-purpose technologies



Sources: Aghion and Bunel (2024); World Bank.
Note: AI = artificial intelligence; ICT = information and communications technologies. Productivity refers to total factor productivity (TFP). Bars show the impact of the electricity and ICT revolutions on productivity growth in Europe and the U.S., respectively, taken from Aghion and Bunel (2024). Labor productivity estimates were converted to TFP estimates assuming a capital share of one-third. For the impact of AI, the bar shows the median impact estimated in the literature for the United States, and the whisker shows the range of estimates. The impacts for the electricity and ICT revolutions apply to a period of 12 years each. The estimated impact of AI generally spans a period of 10 years in the literature.

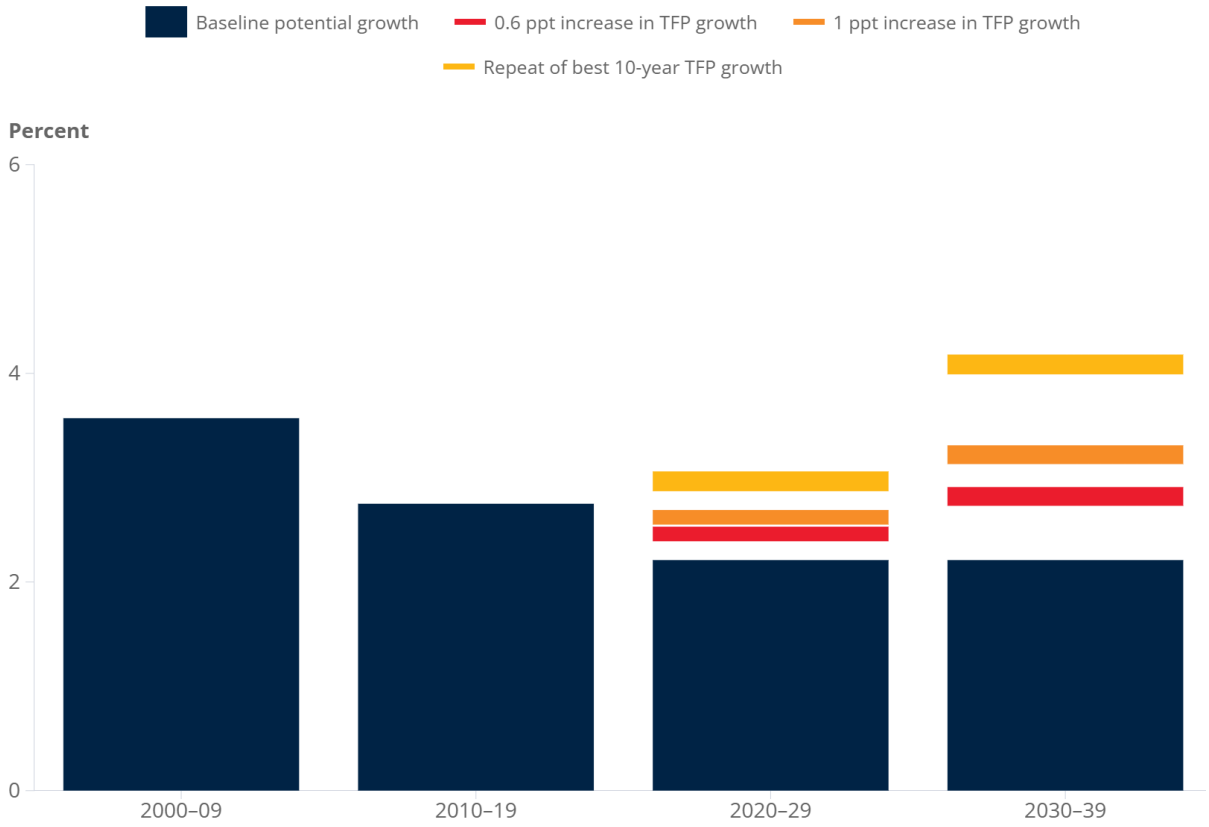
Could AI reverse the slowdown?

What could AI-driven productivity gains mean for growth? We explored three illustrative scenarios in which AI raises productivity growth from 2026 through 2039. Two scenarios assume annual increases of 0.6 and 1 percentage point, respectively. These are the median and high-end estimates of the impact of AI across studies. The third scenario considers a transformative outcome comparable to the strongest ten-year productivity growth performance recorded across economies. In this scenario, global productivity growth in the 2030s would more than triple relative to the baseline, rising from 0.8 percent to 2.7 percent per year.

All three scenarios lift global potential growth, but by very different amounts. In the transformative scenario, potential growth in the 2030s would exceed its average in the 2000s by 0.5 percentage point per year, making the 2030s possibly the strongest decade for global growth since the 1970s. The other two scenarios deliver additional growth without restoring global growth to its 2000s average (Figure 3).

These scenarios are illustrations, not forecasts. They abstract from the time and investment needed to adopt AI, changes in labor markets, and other forces that could strengthen or weaken its effects. They also assume similar productivity gains in advanced economies and EMDEs, an especially optimistic assumption for the latter.

Figure 3. Global potential growth scenarios



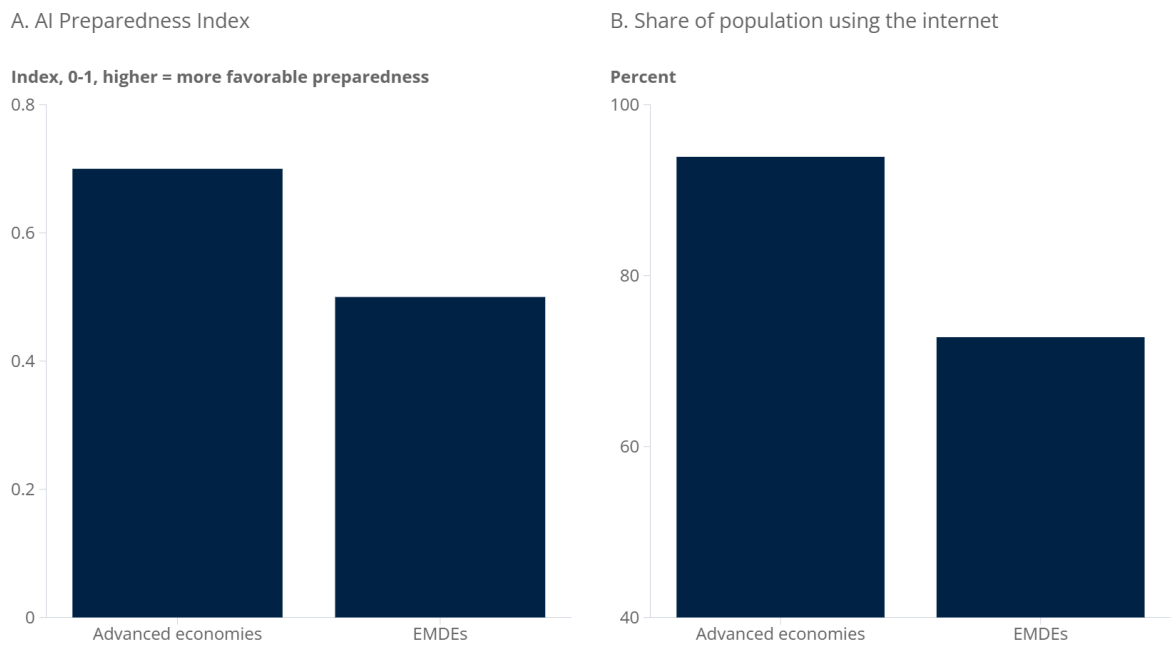
Sources: Kose and Ohnsorge (2024); World Bank.
Note: TFP = total factor productivity. Averages, weighted by gross domestic product (GDP), of production function-based estimates of potential growth. Sample includes 31 advanced economies and 52 EMDEs. Markers show the predicted impact of each scenario on global potential growth. Data for 2022 and later years are projections.

Preparing EMDEs for AI

EMDEs are less prepared, on average, to adopt AI. They have lower levels of internet use, digital skills, and overall AI preparedness than advanced economies (Figure 4). As of mid-2025, they hosted less than a quarter of global data-center capacity; low-income countries hosted less than 0.1 percent. In 2022, only one in four people in low-income countries used the internet. These gaps could limit the productivity gains EMDEs achieve relative to those illustrated in our scenarios.

Even as they address these gaps, EMDEs can pursue practical applications adapted to local needs and circumstances. Applications that run on mobile phones with limited connectivity, use local languages and data, and are inexpensive to deploy could extend AI's benefits well beyond large firms and major cities. Such "small AI" applications could help farmers identify crop diseases, provide customized tutoring, or support health workers in remote areas.

Figure 4.



Sources: Cazzaniga et al. (2024); International Telecommunication Union; World Bank.
Note: AI = artificial intelligence; EMDEs = emerging market and developing economies; ICT = information and communications technologies.
A. Panel shows scores on the AI Preparedness Index (AIPI) as of 2023 by Cazzaniga et al. (2024), covering 174 economies. Higher values represent more favorable AI preparedness. Country groups are as defined by the International Monetary Fund and aggregated using averages.
B. Bars show the median share of individuals using the internet in advanced economies and EMDEs. Sample includes 37 advanced economies and 154 EMDEs using the latest available data for each economy.

Looking forward

AI could offer a path to reversing the prolonged slowdown in global growth, but only if productivity gains are large, persistent, and widely diffused. For EMDEs, realizing this promise of AI requires investing in reliable electricity, data, digital connectivity, and skills, while supporting workers as tasks and occupations change. It also requires an enabling environment for businesses to grow and for an AI ecosystem to develop and adapt tools to local needs. Mobilizing private capital at scale will be essential to finance firms and ease constraints on growth, helping translate AI's gains into the productive jobs their growing workforces need. These policy and investment choices will determine whether AI becomes a broad-based driver of global growth or delivers gains concentrated mainly in advanced economies.

IMI International Monetary Review

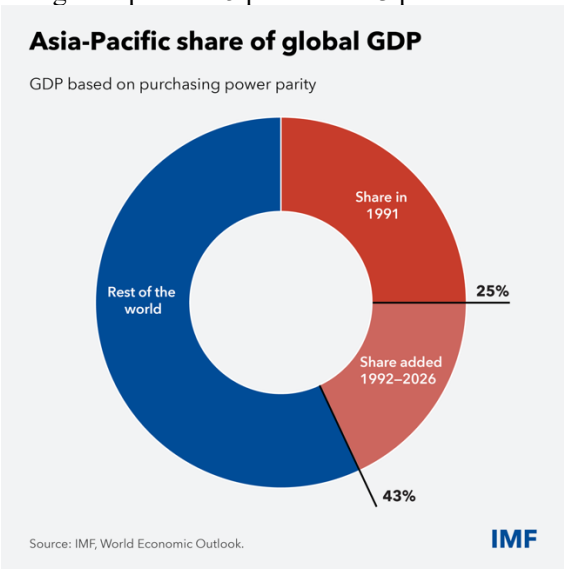
Navigating the Crosscurrents of a Changing World Economy *

By KRISTALINA GEORGIEVA *

Dear President Tharman, ladies and gentlemen, dear friends: it is a delight to be back in Singapore, on my way to Thailand, this year's host of the IMF–World Bank Annual Meetings. Singapore is a showcase of integration in regional and global value chains—and of the benefits it brings.

Next week, finance ministers and central bank governors of the IMF's 191 member countries will come together to assess the direction of the world economy at a time of high uncertainty and rapid change.

It is vital that they do, and Thailand is just the right host to have—another open and dynamic country at the heart of a vibrant region. Since Thailand last hosted our Annual Meetings 35 years ago, in 1991, Asia-Pacific's share of global GDP has gone up from 25 percent to 43 percent.



Asia and the world have steered through shock after shock with remarkable agility.

But whether this fortitude will be sustained and whether the world's underwhelming growth rates this decade can be bettered will depend on our success in navigating three major crosscurrents: the rapid arrival of AI, persistently high energy prices, and record levels of public debt.

This will be the central focus of our discussions in Thailand next week.

Let me start from the context in which our Meetings will take place. To put it simply, the global economy is being pulled in two opposite directions: a negative energy supply shock and a positive demand shock from AI. The combined impact of these two forces is highly uneven across the world.

Our World Economic Outlook will show that steady global growth has continued since the Spring, but behind the averages there are significant variations. The largest hits to growth this year are in economies ravaged by war: a war on Ukraine in its fifth year, a war in the Gulf in its eighth month, and too many other raging conflicts, destroying lives and causing global economic damage.

Smaller and more scattered hits to growth are also seen in other vulnerable countries, those reliant on energy imports and lacking sufficient policy space to cushion shocks.

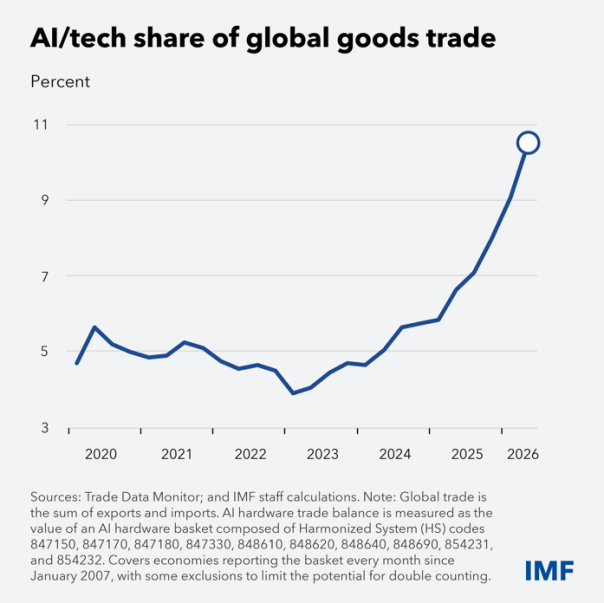
But we will also see higher growth in a few places—which takes me to the role of AI.

Love it, hate it, or fear it, AI is here, rapidly becoming a key driver of countries' relative fortunes in the world economy.

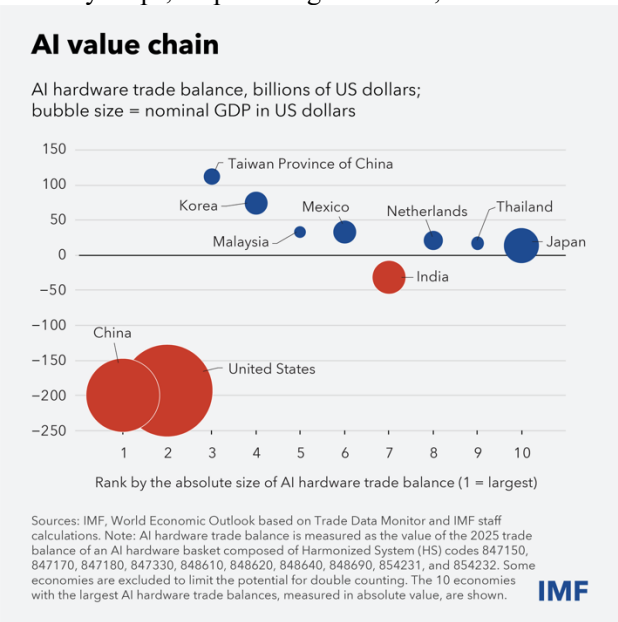
Global investment-to-GDP in AI will reach and likely exceed the amounts that went into building the railroads, the electricity grid, or the telecommunication network. We estimate AI hardware and related tech products now account for more than one-tenth of world goods trade and rising.

* The article was first published on IMF on October 7, 2026.

* Kristalina Georgieva, Managing Director, IMF.



Growth in AI-related trade reflects the investment boom in economies embedded in its value chain. These include the U.S., China, and India as net importers of AI hardware, building the infrastructure to be key AI providers. And then five of the seven other economies in the top-10 are Asian, supplying everything from top-end microprocessors to memory chips, chip-making machines, and robotics.

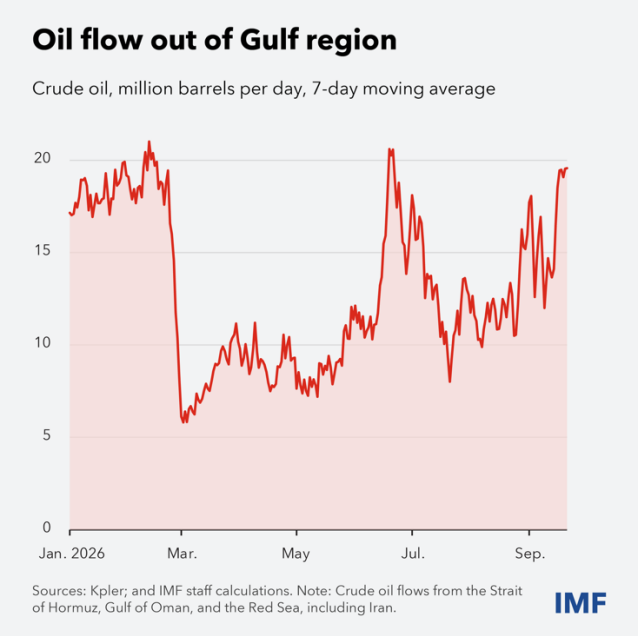


Yet as this drives forward today's AI economies, it largely bypasses most others, increasing the risk of widening economic inequality across the globe.

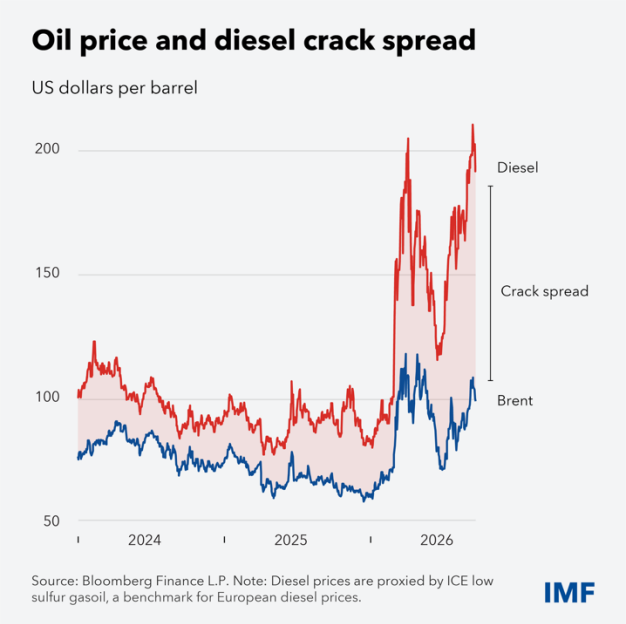
AI also adds to energy demand, which takes me to the second top-of-mind topic at our Annual Meetings: the rising cost of energy and, with it, fertilizers, food, and key industrial inputs—with food security put at even greater risk by this year's super El Niño. This pushes inflation up and growth down.

So far, the energy price shock has been large but contained thanks to energy efficiency, fuel-source diversification, reserve releases, supply chain agility, and the usual organic demand and supply response.

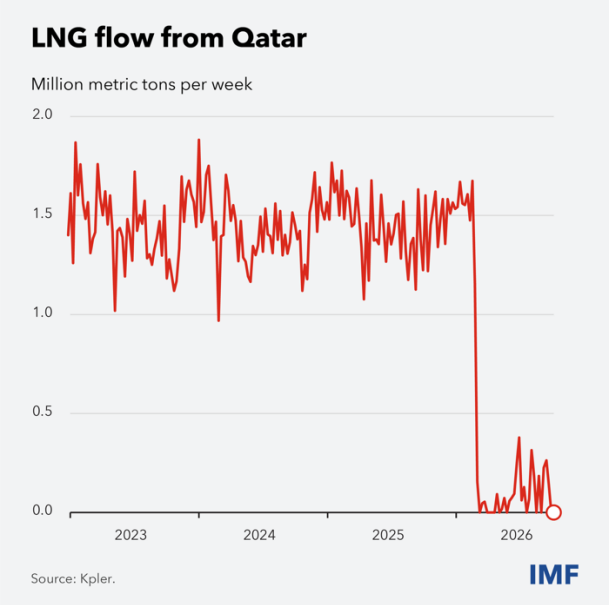
Nonetheless, despite a shaky recovery of flows out of the Gulf, oil prices remain around $100 per barrel reflecting risks, high transport costs, and other factors.



Add to this a crack spread of about another $100 per barrel due to a global shortfall in refining capacity, and we get retail prices of diesel and other refined products at record highs.



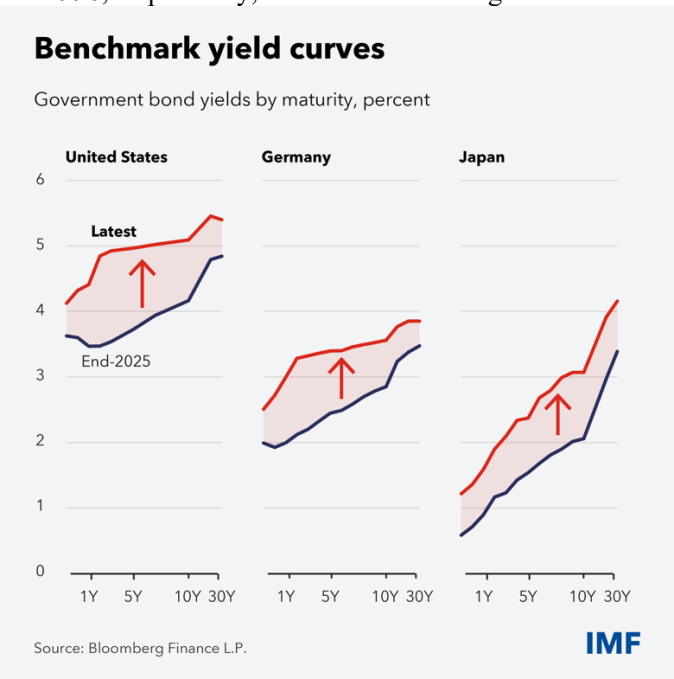
In addition, natural gas supply from the Gulf remains severely impaired, reflecting more-limited LNG transport options for as long as shipping through the Strait of Hormuz remains threatened. This has uneven impacts across the world, with Asia and Europe particularly hard-hit.



And, to quote from Game of Thrones, winter is coming. Price pressures may build further as countries replenish reserves and demand rises with the approach of the Northern hemisphere cold season.

Even if the war in the Gulf were to end soon, the problem of high energy prices would likely persist for some time. Brent futures, for example, now predict high oil prices through 2027.

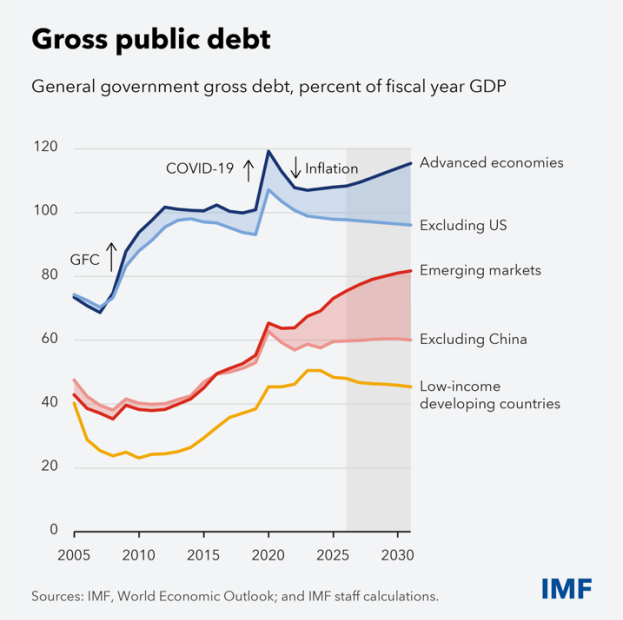
Higher energy prices are pushing up inflation, policy rates, and benchmark yield curves. After going up very significantly this year, U.S., German, and Japanese 10-year sovereign yields are now at their highest levels since 2007, 2009, and 1996, respectively, and are still climbing.



This takes us to the third major factor affecting the global economy today: excessive fiscal deficits, record levels of public debt, and high debt-servicing costs.

Global public debt is near its highest levels since after World War II and is on track to soon exceed 100 percent of GDP.

Advanced economies are the worst offenders with some of the highest gross debt loads. Debt-to-GDP ratios are generally lower for emerging markets and lower still for low-income countries, although we have to recognize that, in comparison to advanced economies, these two sets of countries also have relatively lower revenues to service debt.

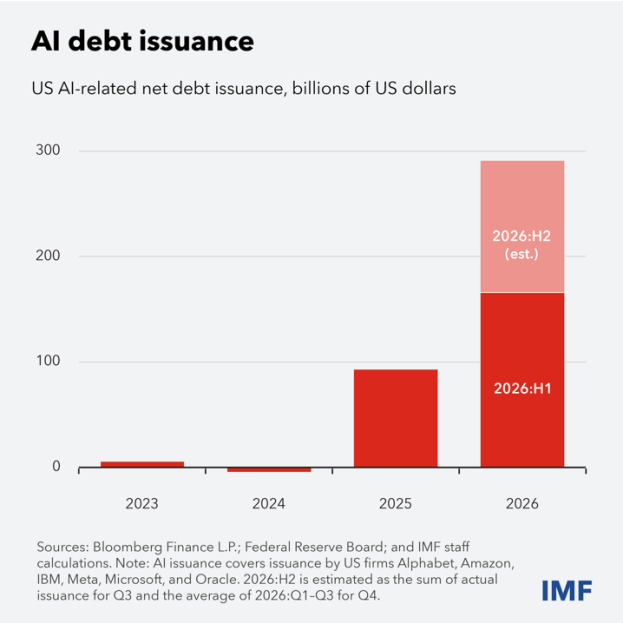


For many emerging market economies, the effects of rising core yields on funding costs are still being partially offset, for now, by tight risk spreads—the result of hard work over the decades to strengthen policies, frameworks, and institutions, but also of still-easy financial conditions.

For high-debt countries in the euro area, the situation is more challenging as bond spreads to German bunds keep rising—not only for France and Italy but also to a lesser extent for countries that successfully reduced their debt and deficits after the euro area crisis, including Ireland, Portugal, and others.

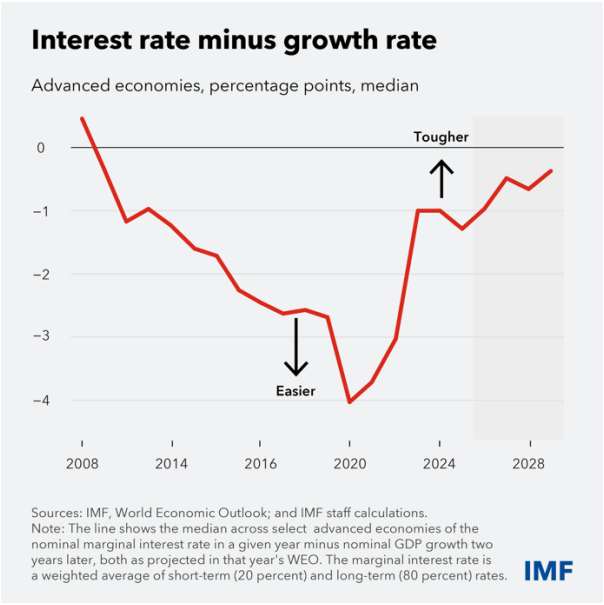


AI enters this mix in two ways. First, rising long-term private bond issuance competes for savings. Second, some portion of the increase in core yields may reflect anticipation of faster growth in the future.

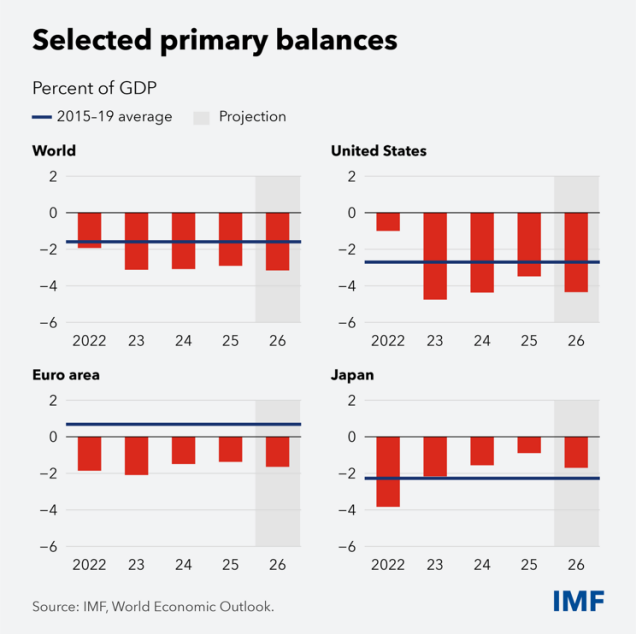


Yet expectations of higher growth solving fiscal problems can cause policy complacency. Policymakers had a relatively easy ride over the last 17 years as for all that time interest rates were stuck below GDP growth rates.

Economists are fond of expressing this as the interest-to-growth differential—"r – g"—which is much less favorable now than it was in the past many years and is set to climb higher. What this means is that the size of the growth pick-up needed to reduce public debt-to-GDP ratios without fiscal effort looks out of reach in the near term.



Higher core bond yields, of course, also reflect fiscal policy. With the succession of recent shocks having ballooned the public debt, and with most primary deficits having remained larger than their pre-pandemic averages over 2015–19, fiscal space is crying out for replenishment.

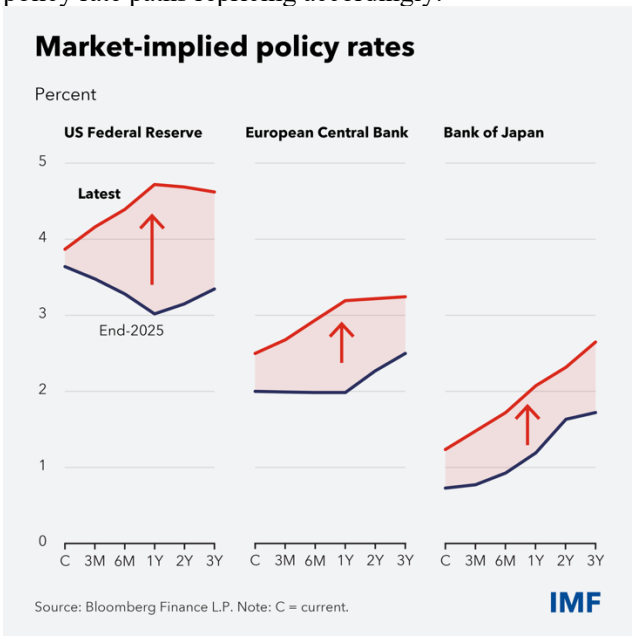


The situation demands an urgent and comprehensive set of policy responses.

Let me speak to monetary policy first. In many countries inflation exceeding target has been a headache for quite some time—in the U.S. case for over 5½ years. We draw comfort from long-term inflation expectations staying anchored, but let us not forget the simple fact that inflation is only anchored until it is not—as I learned the hard way from Bulgaria's hyperinflation.

The AI building boom is inflationary. The energy and food shocks are inflationary. Tariffs, defense spending, and high public debt can be inflationary. And memories of the recent high inflation are still fresh.

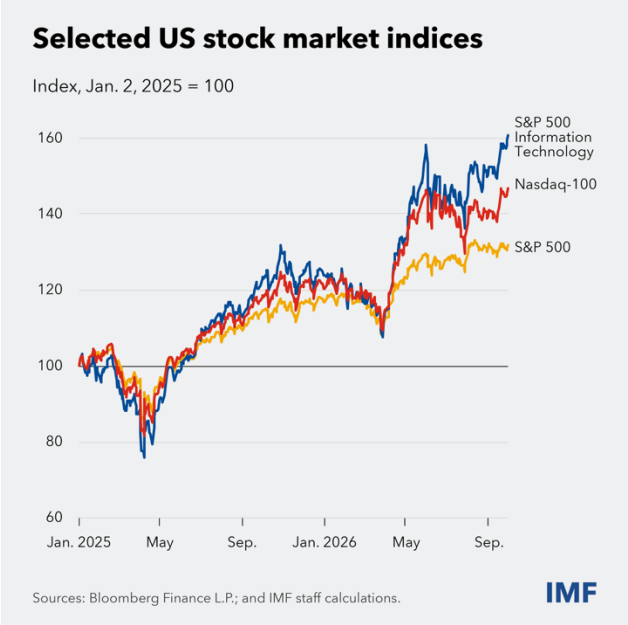
Now may be a good time for a prudently hawkish bias in many countries' monetary policy—and it is highly appropriate that the U.S. Federal Reserve, the ECB, and the Bank of Japan have all raised rates and spoken firmly, with future policy rate paths repricing accordingly.



Staying in the central banking lane, a few words on financial stability policy.

Given rising economic and financial concentration in AI, we would be wise to remember Amara's Law, which says we tend to overestimate a new technology in the short run and underestimate it in the long run. It is somewhere in the transition between today's AI building boom and tomorrow's arrival of AI's benefits that we will traverse the period of maximum risk.

Strong corporate earnings are driving share prices and wealth effects. Should earnings fall short, however, hyperscaler leverage and large and growing global holdings of U.S. equities could turn a disappointment into a far-reaching shock.



Here the first line of defense, of course, is regulation and supervision.

So now to fiscal policy: the place where all pressures meet. Elevated yields are inflating the interest bill at a time of tight budget constraints and competing spending priorities, including defense. Higher policy rates then lift the short end, feeding directly into the cost of short-term debt.

And yet we don't see decisive action in the high-debt advanced economies where the need of the hour is for credible medium-term fiscal consolidation plans, supported in some cases by upfront fiscal measures, including to take some of the pressure off monetary policy.

Emerging markets can find themselves confronting not only higher funding costs from rising benchmark yields and wider spreads, but also more volatile capital flows related in part to financial innovation. These economies, too, should strive to expand their fiscal space, while also growing their foreign exchange buffers.

Low-income countries, already hurting from financing constraints, high interest-to-revenue ratios, small tax bases, and shrinking aid flows, may be forced to cut much-needed development spending—a regrettable spillover that shows the collective nature of the fiscal challenge.

Putting all of it together, my message to the world's economic policymakers next week will be this: we cannot keep delaying necessary policy action—you have the tools, now have the wisdom to use them.

We at the IMF know fiscal consolidation will be a heavy lift. After a succession of shocks where, each time, fiscal policy has had to step in to cushion the impact, populations have grown accustomed to state support. Some very tough political choices stare us in the face.

To succeed, policymakers need to, first, explain why consolidation is needed; second, make plans that limit the costs to future growth to the extent possible and protect the most vulnerable; and third, pursue complementary structural reforms.

Yes, growth alone cannot solve the fiscal problem, but growth certainly helps.

Ambitious reform programs would support the fiscal effort, by delivering better workforce skills; more flexible labor markets; greater ease of corporate entry and exit; better access to patient risk capital; and energy security.

In an unforgiving global environment that leaves no room for self-inflicted injuries, I will urge authorities everywhere to slash red tape, clean out the cobwebs of obsolete rules accumulated over time, and free up the power of entrepreneurship.

Happily, these are the same attributes and policies needed to get the best out of AI—where the core benefits derive not from the short-run boost to demand from laying the tracks, but from the long-run boost to productivity from adoption.

IMF research suggests that AI, if done right, could over time deliver up to half a percentage point of extra world growth annually. Just think of it: going from 3 percent to 3½ percent—it will add an economy the size of ASEAN to the world economy over a decade.

We will learn as we go, but we know AI preparedness is key, including digital infrastructure, labor market readiness, and regulatory guardrails. This will help capture the benefits and manage AI's substantial perils: large-scale labor market fallout, serious cyber and stability risks, and frontier models threatening to escape human control and run amok.

Singapore can take pride in knowing that it ranks at the very top of the IMF's AI preparedness index—bravo and keep it up.

Success requires everybody be taken along to harvest the transformative power of AI, which is why it will be so important to deliver AI access around the globe. And that, of course, calls for cooperation.

In our interconnected world, countries cooperate not out of charity but out of self-interest. That is how trade finds its way around the obstacles thrown at it. That is why our members are keen to come together next week in Bangkok.

President Tharman, you have made many substantial contributions to international cooperation. Among them was leading the IMF's highest guiding body through a period of economic turmoil in Europe. Cooperation kept the crisis from festering and spilling over to the rest of the world.

Today, you host this kick-off of our 2026 Annual Meetings as the President of a country that has successfully transformed its economy and dramatically improved the lives of its people with prudent policies, sound institutions, and collaboration with its neighbors and the rest of the world.

These are the very same qualities the global economy needs in its quest for prosperity during this time of profound change. It is so fitting that I call on the world to embrace them from this stage, right here, at the Lee Kuan Yew School of Public Policy in Singapore.

Thank you.

Asia beyond Buffers: The Second-Generation Resilience Agenda *

By JULIA BINGLER, UDAIBIR DAS *

Absorbing shocks was the first generation of resilience-building, reducing exposure is the second

The closure of the Strait of Hormuz in March cut global oil supply by 10.1m barrels a day, the largest disruption on record, and exposed a limit to Asia's financial defences. The Association of Southeast Asian Nations+3 imports over a third of its oil and gas from the Middle East. Stronger balance sheets cushion the consequences of that dependence. They do not remove it. The International Monetary Fund expects regional growth to slow to 4.4% from 5% last year, with inflation rising, external balances weakening, financial conditions tightening and policy space narrowing.

The distinction between buffers and exposure frames Governing Finance for Sustainable Prosperity – an initiative of the Asean+3 Macroeconomic Research Office, the Council on Economic Policies and the South East Asian Central Banks Research and Training Centre. Earlier this year, the initiative hosted three roundtables in Tokyo, Seoul and Singapore to examine how financial governance should adapt to structural change.

A previous OMFIF commentary argued that resilience has become a governing ambition without operational meaning. The roundtables offered a practical route beyond that critique: defining what should be protected, identifying where exposure accumulates and examining whether policy instruments reduce it.

Asia is not starting from scratch. After the 1997 crisis, which began in Thailand, the region built reserves, deeper local-currency bond markets, AMRO surveillance and the $240bn Chiang Mai Initiative Multilateralisation – over $8.6tn in potential crisis-fighting resources in total. That architecture helps absorb financial shocks. It does less to reduce real-economy exposure to energy, climate, supply-chain and digital risks. Closing that gap is the second-generation agenda: extending existing protections, not displacing them.

What the roundtables bring into focus

Energy, climate and trade disruptions interact with structural shifts in digital finance and artificial intelligence. CEP and AMRO describe a world of novel risks: systemic, deeply uncertain, frequently cross-border and liable to materialise together. They put resilience at risk and need to be governed explicitly.

The roundtables pointed to three early conclusions. First, resilience must be operationalised to be governed. Authorities should answer five questions that guide instrument choice and policy formation: resilience of what, to what, for whom, measured how and governed by whom? The answers will differ by risk-driver.

Second, resilience means more than capital buffers. Buffers absorb losses, including unanticipated ones. Where risk-drivers are visible, resilience also requires reducing exposure and vulnerability beforehand. This means investing in diversification and the productive capacity that keeps essential systems functioning, while treating business continuity as standing practice rather than crisis response.

Third, the space to absorb shocks is shrinking. Repeated shocks erode fiscal room. As insurers facing correlated losses narrow cover, more residual risk settles on corporate balance sheets. If banks retrench simultaneously, asset sales turn correlated, credit contracts and firms lose the financing resilience investment needs. Prudence at the firm level becomes fragility at the system level. Breaking that loop requires coordinated incentives, not simply larger buffers.

From discussion to instruments

Exposure-reducing investment has long lead times. It must begin when risk-drivers become visible, not only when losses appear. Hormuz made the sequencing plain: dependence shaped the size of the impact; buffers and policy space only shaped the response.

Local-currency transaction frameworks can reduce reliance on third currencies in regional payments; Singapore and Indonesia operationalised theirs in August. The Asean Power Grid can diversify energy access, reduce vulnerability to imported-fuel disruption and support the low-carbon transition. These initiatives address exposures that emergency liquidity cannot remove.

Central-bank instruments are evolving too. The Bank of Japan's climate-response financing operations support private climate investment. Singapore's pandemic facility, priced at 0.1%, lowered banks' funding costs to sustain small and medium-sized enterprise lending. Malaysia's Climate Finance Innovation Lab supports energy-transition financing, alongside Bank Negara Malaysia's work on incorporating climate risk

* The article was first published on OMFIF on September 21st, 2026.
* Julia Bingler is a Senior Fellow at the Council on Economic Policies. Udaibir Das is Vice Chair of OMFIF.

into prudential standards. Bank Indonesia uses regulatory liquidity incentives to steer lending towards priority sectors, including green activities.

The next step is a standing resilience toolkit: regulation and central-bank instruments assessed and adjusted to reward investment before shocks occur, complementing the buffer regime rather than replacing it. Buffers protect solvency and lending capacity. Alone, they do not remove exposure or keep critical functions running under stress.

Monetary policy is part of the same question. Tightening after a shock raises financing costs for the long-lived, capital-intensive projects that would reduce exposure to the next one. Targeted refinancing can lower that cost in advance. If eligibility is tied to the areas hit hardest by tightening, the overall stance need not soften; only the burden shifts. CEP's work identifies the design choices: pre-defined eligibility, volume limits, sunset clauses and public reporting. Mandate boundaries still apply. Targeted refinancing must not become a second fiscal policy.

Supervision completes the toolkit. Authorities should identify critical functions, concentrations of exposure and connections to non-bank intermediaries and digital platforms. Capital and liquidity assessments should rest on scenario ranges, not only point estimates, because stress tests calibrated on history cannot capture unfamiliar risks. Above all, it takes a willingness to act under uncertainty. The Federal Reserve's review of Silicon Valley Bank found that supervisors kept accumulating evidence after material weaknesses became apparent. Once data show stress, it is usually too late.

No agreed measure of resilience or financial stability exists, nor does one for financial stability. Supervisors judge stability; they do not measure it. Judgement must therefore extend through balance sheets into the real economy, and it can start now, by mapping exposures, assessing vulnerabilities and establishing whether existing instruments add to or reduce these vulnerabilities. Adjusting them cannot wait for the metrics.

What Asia should settle

The instruments exist. What is missing is the decision to use them systematically. The IMF-World Bank annual meetings in Bangkok on 12-18 October, the first there since 1991, offer an opportunity to use them.

AMRO has set out the financing case for CMIM's evolution within the global financial safety net. The agenda advanced here is its real-economy counterpart: balance sheets and coordinated financial system policies that strengthen the economy's capacity to adapt, rather than relying on financing and borrowing once disruption arrives.

Asia should put this second-generation agenda on the table in Bangkok and at its upcoming regional meetings. National authorities should answer the five questions posed by the roundtables and start adjusting instruments; regional co-operation will spread the lessons. Private capital belongs in the process – residual risk now sits on corporate balance sheets.

Policy-makers cannot prevent every shock, but they can influence how prepared the economy is to deal with them, by reducing exposures, protecting essential functions and preserving policy room. Asia built its first generation of financial defences after a crisis. It should build the second before the next.

October 2026
Vol.13, No.4

Raising Revenue for Growth and Resilience in Asia *

By KENJI OKAMURA

Good morning, everyone. It is my great pleasure to welcome you to the fifteenth IMF-Japan High-Level Tax Conference for Asian Countries.

I would like to thank Japan's Ministry of Finance for co-hosting this event, and for its generous and longstanding support. I am also grateful to my colleagues in the IMF's Fiscal Affairs Department and the Regional Office for Asia and the Pacific here in Tokyo for organizing this annual event. I would also like to thank the participants, representing 20 countries in the region, for joining us.

We meet at a time of considerable uncertainty in the global economy. Two opposing forces are shaping the outlook. The conflict in the Middle East and resulting energy shock are weighing on activity and adding to inflation. At the same time, rapid advances in artificial intelligence and strong investment in technology are providing an important boost to growth. The net impact of these two forces differs across countries, depending on their macroeconomic vulnerabilities and their exposure to energy disruptions and AI.

For Asia, the picture is similarly nuanced. The region entered 2026 on a strong footing after showing considerable resilience to higher tariffs and trade policy uncertainty. At the same time, many Asian economies remain exposed to higher energy costs and continued uncertainty in the global trading system.

Globally, risks to the outlook are more balanced than they were at the Spring Meetings in April but remain tilted to the downside. Renewed geopolitical tensions, commodity price volatility, and further trade fragmentation could weaken growth and raise prices. Higher interest rates could also add to financing pressures, particularly in countries with elevated debt. And with fiscal buffers already stretched in many countries, governments have less room to respond to new shocks.

These developments make sound fiscal policy all the more important. Countries need to rebuild fiscal buffers while protecting essential development and social spending. For many countries, this will require not only spending better but also taxing better and raising revenue in ways that support growth.

This brings us directly to the central theme of this conference: domestic revenue mobilization. Strengthening domestic revenue is essential for creating fiscal space, supporting development priorities, and building resilience to future shocks. Our first session will take stock of revenue performance across Asia and discuss where countries have scope to raise more revenue and improve their tax systems through well-designed reforms.

How revenue is raised matters as much as how much is raised. Our forthcoming Fiscal Monitor will examine how the design of tax systems can support economic growth in a revenue-neutral way. The international tax landscape continues to evolve rapidly. We will discuss the future of the Global Minimum Tax following the Side-by-Side agreement, including its implications for tax policy, tax administration, investment incentives, and international cooperation.

We will also look at another increasingly important dimension of international cooperation: the exchange of tax information. Greater transparency and effective information exchange can help countries protect their tax bases and improve compliance as economic activity becomes increasingly global and digital.

Tomorrow, our attention will turn to important choices within domestic tax systems. We will discuss how governments can better measure and evaluate tax expenditures and consider the revenue and distributional implications of the changing tariff landscape.

Finally, we will look ahead. Our discussions on emerging issues in tax administration and tax policy, including compliance risk management and health taxes, will give delegates an opportunity to exchange views on the practical challenges they face—especially with aging populations and changing demographics—and the reforms they see as priorities.

The great value of this conference is precisely this exchange of experience. There is no single tax system or reform path that works everywhere. Learning what has worked in neighboring countries—and what has not—can help policymakers make better choices at home.

In Asia, the IMF supports these efforts through tailored policy advice and capacity development, including through our regional centers. The lessons and experiences shared at this conference also help us improve the support we provide.

I would like to conclude with one announcement. From next year, this High-Level Tax Conference will be integrated into the Tokyo Fiscal Forum. This will allow us to consider tax, spending, and broader fiscal

* Opening Remarks by Deputy Managing Director Kenji Okamura at the Fifteenth IMF-Japan High Level Tax Conference for Asian Countries, September 17, 2026.

policy issues in one forum. We look forward to continuing this important partnership with Japan and welcoming you back to Tokyo for this newly integrated forum next June.

I wish you a productive and engaging two days of discussion.

Thank you.

Central Banks

ECB Exorcises Ghosts of Inflation Past *

By DAVID MARSH *

Politics, psychology and economics play role in European interest rate decision

When the European Central Bank, as expected, raises interest rates on 11 June, it will be acting partly to exorcise the ghosts of inflation past.

With a probable 0.25 percentage point increase in its 2% key lending rate, the ECB is signalling a purchase of monetary insurance against an Iran war-induced inflation spike feeding through durably into greater price pressures. But it is also taking an incisive – and, we must hope, not too risky – step to atone for past mistakes: notably, failure to take seriously the inflation surge in late 2021 and the first half of 2022.

There are powerful economic, political and psychological reasons at play as to why the ECB might be correct to act now. But there is also a far from negligible chance that the anticipated rate rise could turn out to be a mistake. The European economy is flat-lining. Germany, the continent's strongest economy, has been stagnating since 2018 – by far, the longest phase of low growth since the country's post second world war rebirth, and unusual even against the volatile standards of the 1920s and 1930s. And there are few signs that the rise in euro area inflation to 3.2% in May 2026 is about to unleash a wage-price spiral.

'De-anchoring' inflation

Among the most prominent reasons for hiking now is the notion that consumers remember the inflation unleashed four years ago by over-easy monetary policy, the ending of the Covid-19 pandemic and the outbreak of the Russo-Ukrainian war. So, ECB experts say, inflation is far more likely to become 'de-anchored' this time around than in 2022, when previous experience of similarly elevated inflation had been 30 or 40 years earlier.

Policy-makers may wish to show – with a watchful eye on the (so far gloriously counterproductive) assaults on Federal Reserve independence by President Donald Trump – that they are not afraid of taking unpopular decisions.

Nipping in the bud

On the other side of the Atlantic, long in the tooth (and long retired) central bank economists such as William 'Bill' White and Charles Goodhart have claimed that central banks will be reluctant to hike rates for fear of causing higher borrowing costs for over-indebted governments. The ECB may want to prove these august veterans wrong – and underline that nipping inflation in the bud is the best way of preventing rises in long-term interest rates.

Furthermore, they may wish to demonstrate to a possible future far-right French president that the ECB will not be a push-over. Jordan Bardella, the youthful president of France's National Rally (RN), current frontrunner in the incipient election contest to decide in April 2027 the successor to President Emmanuel Macron, has flirted with asking the ECB to buy French bonds to lower borrowing costs. The suggestion was quickly withdrawn. It became clear that, if it transpired, the French state would have to submit to draconian ECB conditions. But that may not stop the idea from resurfacing next year.

ECB president contest

The biggest reason for a rate rise may however be the ECB's collective mood of mild embarrassment over the errors of 2021-22. Joachim Nagel, Deutsche Bundesbank president, is one of the candidates to take over from Christine Lagarde, residing president of the ECB, when she leaves at the latest at end-October 2027. He has been (predictably for a Bundesbank chief) foremost among those declaring the possible need for tighter money.

As a newcomer to the ECB governing council in January 2022, in his first speech as Bundesbank president, he presciently emphasised the risk of inflation (then running at 6% in Germany) remaining elevated for

* The article was first published on OMFIF on June 10th, 2026.
* David Marsh is Chairman of OMFIF.

longer than forecast. And he was a key figure engineering the belated (first of many) interest rate rise (from then negative rates) in July 2022.

The ECB's misjudgement on the 'transitory' nature of inflation (both pre- and post-Russian invasion) was shared by other central banks including both the Fed and Bank of England. But it was crystallised in Lagarde's December 2021 statement (when euro area inflation was close to 5%) that, 'under the present circumstances, it is very unlikely that we will raise interest rates in the year 2022.' She later admitted, 'I should have been bolder', that the ECB had been wrong in its earlier commitment not to start raising interest rates until it had stopped buying bonds through its pandemic crisis quantitative easing programme (phased out gradually in the first six months of 2022).

These episodes will be in policy-makers' minds when they make the interest rate decision on 11 June. So too, although less clear-cut, will be the shadow of two previous periods when the ECB erred in raising interest rates at the wrong time – in July 2008 (the more unfortunate and less forgivable occurrence) and in April and July 2011.

For the time being, the discomfiting collective memory of 2021-22 represents the dominant force governing the ECB's choice. Future developments will show whether it was justified.

Central Banks Are Riding the Wave of Persistent Volatility *

By YARA AZIZ *

Public investors no longer waiting for stability but investing through uncertainty

Every year, OMFIF's Global Public Investor captures a moment in the evolution of official investment, with some years defined by a single shock and others by a turning point in markets. This year's report is different because it points to something more durable: a world in which volatility is no longer a phase to get through, but a condition to be managed.

For central banks, sovereign funds and public pension funds, this demands a different kind of discipline. The challenge is not simply to respond to higher rates, geopolitical risk or changes in the monetary system, but to build portfolios and institutions that can continue to operate when all these forces are moving at once. The old assumption that public investors can wait for the environment to normalise looks increasingly unrealistic.

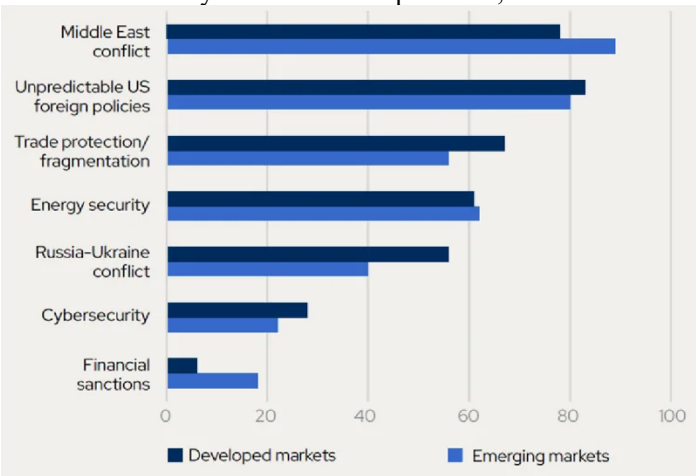
The title of this year's report, 'Riding the wave', reflects that shift. Public investors are not standing still, but neither are they making reckless moves. Instead, they are adjusting cautiously, testing new tools, diversifying where possible and holding on to the principles that have always defined official investment on safety, liquidity and long-term value.

In total, GPI draws on insights from a survey of 90 central banks, public pension funds and sovereign funds with over $10tn in assets under management. The report provides an important view of how public investors at the heart of the global financial system are navigating a more fragmented, volatile and technologically complex world.

The shocks that have shaped reserve management strategies in recent years have not disappeared, but they have changed form. Policy rates remain the dominant near-term driver of investment decisions. Geopolitical risk has become broader and more persistent, moving beyond last year's focus on trade protection. In 2026, reserve managers' concerns centre on the Middle East conflict, unpredictable US foreign policy and energy security (Figure 1).

Figure 1. Middle East conflict tops risk concerns

Which geopolitical risks most concern you? Share of respondents, %



Source: Global Public Investor 2026 survey

Capital preservation remains the leading investment objective, while sovereign risk repricing is viewed as the biggest threat to global financial stability over the same period.

The dollar continues to dominate portfolios and is still viewed as unmatched for safety and liquidity. But central banks increasingly expect to reduce dollar allocations over both the short and long term, especially in emerging markets. For the first time since the GPI series began recording reserve managers' long-term intentions in 2023, more central banks plan to decrease their dollar holdings than increase over the next 10 years (Figure 2). The euro and renminbi remain the main alternatives, while interest in smaller developed and emerging market currencies is rising. This year, 29% of respondents plan to increase euro holdings in the long term, up from 22% last year.

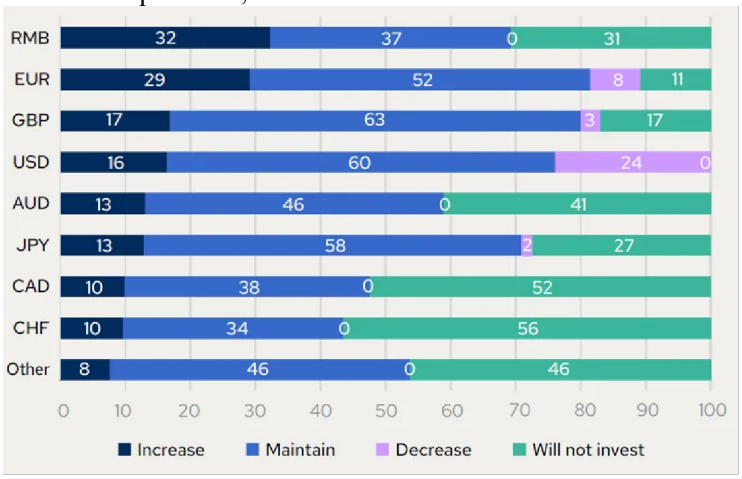
* The article was first published on OMFIF on June 30th, 2026.

* Yara Aziz is Senior Economist at OMFIF.

However, neither the euro nor the renminbi fully solves reserve managers' problem: the former lacks a single, deep safe asset market, while the latter remains constrained by market structure and geopolitical concerns.

Figure 2. Dollar decrease over the long term

Over the next 10 years, do you anticipate increasing, decreasing or maintaining your exposure to the following currencies? Share of respondents, %



Source: Global Public Investor 2026 survey

Gold has become the clearest beneficiary of this uncertainty. It leads short-term buying intentions and has moved to the centre of reserve strategies as a hedge against geopolitical risk and concerns about the international monetary system. In 2026, 82% of central banks hold physical gold, up from 71% last year.

A net 30% plan to increase their gold allocation over the next one to two years, while 61% expect the price to settle between $5,000 and $6,000 per ounce by June 2027. Only 28% say the current price is discouraging further purchases. The motivation behind gold purchases is increasingly strategic rather than purely financial. Protection against geopolitical risk is cited by 51% of respondents, up 11% from 2024.

This year's report also shows that adaptation is not only about asset allocation, as technology is becoming a more serious part of the reserve management conversation. Central banks are considering how best to integrate artificial intelligence and capitalise on the promise of greater efficiency, stronger analysis and better decision-making. Yet integration also introduces new questions around governance, model risk and cyber resilience.

Public pension and sovereign funds face a parallel challenge: they must meet long-term liabilities while navigating inflation, geopolitical uncertainty and shifting patterns of global growth. Their interest in real assets, emerging markets and AI-related opportunities reflects a willingness to look beyond immediate volatility while remaining selective about where and how they take risk.

Official institutions are not chasing every wave, but choosing carefully which ones to ride, and this is the central message of GPI this year. In a world of shifting tides, caution no longer means standing still but preserving optionality and being ready to move when the current changes.

Our thanks go to the central banks, sovereign funds and public pension funds that contributed to this year's research. Their participation allows GPI to continue documenting how official institutions are adapting their portfolios, operations and long-term strategies as the financial system around them becomes more fragmented and complex.

Warsh's Inflation Fight Transcends Monetary Policy*

By CHRISTOS PANOURGIAS *

Policy tensions and AI risks will test Warsh

Federal Reserve Chair Kevin Warsh may favour tighter policy, but the Fed and the Treasury are pursuing conflicting objectives. While Warsh focuses on inflation, Treasury Secretary Scott Bessent is increasingly concerned about rising borrowing costs.

The third discussion in OMFIF's Money Disrupted series, with Markus Brunnermeier, Edwards S. Sanford Professor of Economics at Princeton University and Harold James, Claude and Lore Kelly Professor in European Studies at Princeton University, explored how this tension clouds the direction of US policy and heightens existing concerns about the Fed's independence. Faced with political pressure, Warsh is likely to prioritise price stability to preserve the Fed's credibility. The resulting uncertainty has brought dollar dominance back into focus, although no obvious substitute is in sight.

Artificial intelligence offers a possible disinflationary counterweight. Its productivity gains could eventually expand supply and lower costs, but supply-side and fiscal concerns are likely to dominate in the near term. The benefits of AI may be widespread, but the profits may not be, leaving bond and equity valuations vulnerable to repricing.

The policy tug-of-war

Warsh sent a hawkish signal in his speech at the Jackson Hole Policy Symposium, calling the 2% inflation target firm and fixed. The latest payrolls release, confirming the labour market's resilience, lent support to that stance. Although Warsh avoided explicit forward guidance, his remarks shifted attention to the inflation side of the Fed's dual mandate and strengthened expectations of future rate increases. Rising oil prices are reinforcing the case for tighter policy.

The Treasury is pulling in another direction. Bessent has argued that yields do not reflect fundamentals, while his policies indicate growing concern about soaring borrowing costs. Expanded bond buybacks have blurred the line between liquidity support and market intervention. In July, the Treasury also sold euros rather than dollars to buy yen, supporting Japan's intervention and reducing the volume of US Treasuries Japan needed to sell. Together, these measures are unsettling markets by resisting higher yields without addressing their underlying causes.

Political pressure on the Fed and rising defence spending compound the inconsistency. Attacks on Jerome Powell and the attempted removal of Lisa Cook have intensified concerns about Fed independence, while President Donald Trump continues to demand lower rates. These pressures echo 1951, when the Truman administration asked the Fed to suppress borrowing costs as the Korean war increased financing needs. The central bank resisted in order to contain inflation, and the resulting Treasury–Fed Accord reasserted its control over monetary policy. Similarly, Warsh is likely to prioritise the Fed's credibility by putting price stability ahead of short-term political demands.

Dollar dominance by default

These policy tensions extend beyond the inflation outlook, adding uncertainty around the dollar and the continued appeal of Treasuries as safe assets. Intervention may steady disorderly markets, but ad hoc efforts to contain yields treat the symptoms rather than the underlying fiscal and inflationary pressures. By blurring the line between debt management and market support, the Treasury risks raising the term premium and weakening confidence in dollar assets.

This does not mean the dollar is about to lose its reserve status. Its share of global foreign exchange reserves rose to 57% in the first quarter of 2026 and has remained broadly stable. Yet gold demand and OMFIF's Global Public Investor 2026 point to gradual diversification: 79% of surveyed central banks expect the global monetary system to become more multipolar.

There is also no obvious substitute. The euro is the closest contender, but political fragmentation makes it harder to create a large, liquid and homogeneous safe asset. Jean-Luc Mélenchon has proposed cancelling part of France's debt held by the Banque de France and the European Central Bank, an idea ECB President Christine Lagarde called 'financially dangerous'. Meanwhile, Alternative for Germany advocates leaving

* The article was first published on OMFIF on September 15th, 2026.
* Christos Panourgias is an Economist at OMFIF.

the euro and replacing the European Union with a looser association of sovereign states. Europe has the necessary economic scale but still lacks the fiscal architecture and political cohesion to support a stronger reserve currency. The dollar therefore remains dominant, supported partly by the absence of a viable alternative.

AI's promise and credit risk

Beyond these policy tensions, AI adds another source of uncertainty for inflation, interest rates and financial markets.

AI may eventually make Warsh's job easier. By enabling firms to produce more with the same resources, it could lower costs, expand supply and ease inflation. Yet these gains may take years to materialise, while the current investment boom is already increasing demand for electronics and electricity. Even if AI ultimately proves disinflationary, the Fed's immediate focus will remain on bringing down sticky inflation. Conversely, a sharp repricing of AI-related assets could tighten financial conditions and complicate further rate rises.

It is also uncertain whether AI's economic benefits will translate into durable earnings for the companies funding its development. The 19th-century railway boom offers a useful parallel. Railways transformed commerce and raised productivity, but overbuilding, competition and heavy borrowing undermined returns and pushed many operators into bankruptcy. Similarly, AI applications in medicine, pharmaceuticals and education could deliver substantial social benefits without generating commensurate profits for today's hyperscalers.

The growing use of borrowing to fund AI capital expenditure adds to these concerns. The five largest hyperscalers issued $121bn of US corporate bonds in 2025, more than four times their 2020-24 annual average, while private credit is also financing AI infrastructure. If earnings disappoint, investors may reassess equity valuations and credit risk, potentially widening spreads and raising refinancing costs.

Warsh should defend the Fed's credibility, but quelling inflation will also depend on fiscal policy, supply shocks and AI's effects on productivity and financial conditions.

Further Yen Gains Could Constrain Bank of Japan Tightening *

By CHRISTOS PANOURGIAS *

BoJ should move faster while preserving flexibility

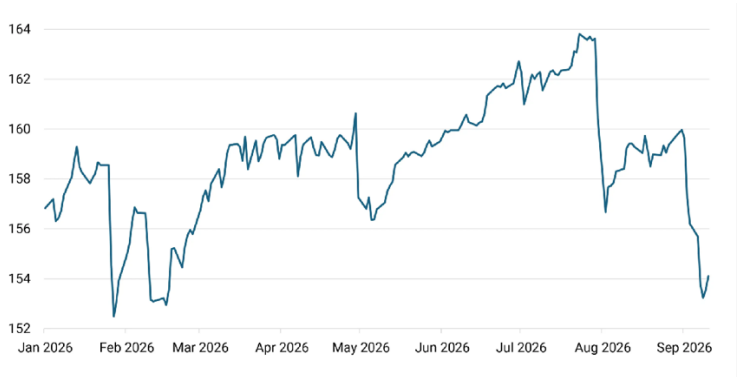
The Bank of Japan must normalise rates faster while guarding against the underappreciated risk of a yen overshoot. The yen's latest rally shows how quickly its gains can surprise markets and why policy-makers cannot assume that appreciation will be easy to contain.

Dollar-yen fell to around 154 from above 160 in less than a week, but what prompted the move remains unclear (Figure 1). Investors have cited expectations of a more hawkish BoJ and speculation about a shift in the Government Pension Investment Fund's portfolio, but neither fully explains its scale. Rate pricing has shifted only modestly relative to the scale of the appreciation, while the prospect of greater domestic investment by GPIF was first reported in July.

The episode brings an underappreciated policy tension into sharper focus: tighter policy is needed to ease inflation and put the yen on a firmer footing, but it could also reinforce a rally that proves difficult to contain.

Figure 1. The yen has strengthened

Dollar-yen exchange rate



Source: LSEG Workspace

Tighter policy would sustain yen gains

It is no secret that the yen's weakness is largely due to Japan's wide interest rate differential with the US. The latest rally has eased immediate depreciation pressure, but faster monetary tightening would help make the yen's appreciation more durable. With inflation close to, if not already at, target, the case for withdrawing monetary accommodation is increasingly clear.

Trend inflation and inflation expectation measures are broadly around 2%, the output gap is positive and labour shortages are contributing to wage raises. Upside risks have also intensified, as high energy prices and yen weakness lift import costs, which rose 29% year on year in August. Yet the BoJ's 1% policy rate remains accommodative and markets expect only a gradual tightening cycle.

The market-implied terminal rate sits at the upper end of the 1% to 2.5% range of neutral-rate estimates cited by the Bank. Even so, the slow path towards it appears overly cautious for an economy in which underlying inflation is approaching target and upside risks have intensified.

The danger of a yen overshoot

For the BoJ, policy normalisation is a double-edged sword. Tighten too slowly and lingering yen weakness will sustain inflationary pressure; move too quickly and the yen could overshoot, disrupting the Japanese economy and global markets.

A sharp appreciation would squeeze exporters' profit margins and weaken their capacity to raise wages and prices. This risk is not merely hypothetical. Following the 1985 Plaza Accord, under which major economies agreed to devalue the dollar, the yen roughly doubled in value by 1988. Kenneth Rogoff, former International Monetary Fund chief economist, identifies the appreciation as a catalyst for the slowdown that preceded Japan's 1990s financial crisis.

Decades later, the episode still helps explain policy-makers' aversion to excessive yen appreciation. During the 2024 carry unwind, for example, the BoJ tempered expectations of further tightening to steady

* The article was first published on OMFIF on September 11th, 2026.

* Christos Panourgias is an Economist at OMFIF.

the yen. Evidently, the possibility of excessive yen appreciation continues to constrain the pace of policy normalisation.

Irrespective of what triggered the current appreciation, it is a reminder that the currency's medium-term upside risks persist. Beyond the possibility of further intervention and shifts in speculative positioning, rising domestic rates could create two additional sources of yen demand. As the interest-rate differential narrows, hedging foreign assets becomes cheaper. Given Japan's vast overseas holdings, even a modest increase in hedge ratios could generate significant yen-buying flows. Higher domestic bond yields could simultaneously encourage investors to repatriate capital. These flows could add to appreciation pressures and increase the risk of an overshoot.

The BoJ's delicate balancing act

The BoJ is widely expected to raise rates by 25 basis points at its next monetary policy meeting on 17-18 September. Failure to deliver could reverse some of the yen's gains and revive doubts about the Bank's commitment to control inflation. Conversely, guidance pointing to consecutive increases could intensify appreciation pressures.

The Bank should navigate these risks by emphasising a faster but flexible approach. Hajime Takata, the board's most hawkish member, described 2026 as a 'regime change' requiring nimbler, data-dependent rate increases. This would mark a shift from the current pace of two hikes per year. Governor Kazuo Ueda should echo that message at his post-meeting press conference without committing the Bank to a fixed schedule.

Markets currently price around 40bps of tightening by year-end. A 25bp hike in September, accompanied by guidance that keeps the door open for another move before year-end, would signal the BoJ's willingness to accelerate normalisation. This measured approach would preserve flexibility while limiting the risk of a yen overshoot.

Tighter policy would help contain inflation and put the yen on a firmer footing. However, the BoJ must ensure that a necessary correction does not go too far. Moving faster while preserving flexibility over subsequent hikes would help strike that balance. The yen has spent years weakening under the weight of monetary divergence; as that divergence narrows, policy-makers should not assume the reversal will be gradual.

Monetary Multipolarity

The Golden Bridge to Monetary Multipolarity *

By HIPPOLYTE FOFACK *

Gold has overtaken US Treasuries as the world's top reserve asset because it offers a solution to the challenges of a rogue America. But its renewed relevance also reflects how rapid technological diffusion and increasing dispersion of economic power are creating a more diversified international monetary system.

One clear sign of de-dollarization and the shift toward a multipolar monetary order is gold's renewed prominence in global financial markets. Investors increasingly view the metal as a strategic asset; central banks are buying record amounts of it to bolster resilience against financial and geopolitical risks, with last year marking the fourth-largest expansion of gold reserves on record. The Dutch central bank's decision to move much of its gold reserves out of the United States, citing "geopolitical unrest," is but the latest example of this trend.

Market reactions to US Treasury Secretary Scott Bessent's intervention in bond markets after the sharp selloff in longer-dated US debt and the resulting higher yields in the usually quiet month of August further support the perception of gold as the ultimate safe-haven asset. Bessent's intervention sparked a sharp drop in the dollar and a massive rally in gold prices.

This follows the European Central Bank's confirmation in June that gold had overtaken US Treasuries as the world's top reserve asset. That status seems likely to harden and spread. According to a recent survey by the Official Monetary and Financial Institutions Forum, more central banks plan to decrease their dollar holdings than to increase them over the next decade. The World Gold Council's 2026 Central Bank Gold Reserves survey reports similar findings, with 74% of respondents anticipating moderate or significantly lower dollar reserves over the next five years.

It is, of course, unlikely that a new global monetary hegemon will replace the dollar any time soon, especially in a digital age marked by rapid technological diffusion and increasing dispersion of economic power. Instead, the slow retreat from the greenback signals the emergence of a more diversified international monetary system in which several currencies—the dollar, the euro, and the renminbi—play important roles, particularly in central-bank reserve holdings. In such a system, gold serves as the politically neutral reserve asset linking competing monetary blocs.

Central banks, sovereign wealth funds, and institutional investors have begun to prioritize capital preservation over high returns, mainly because high-yield investments lose their appeal if the underlying assets are at risk of becoming inaccessible during periods of conflict or instability. Gold, whose relationship with the dollar's trade-weighted exchange rate is typically negative, carries no sovereign counterparty risk, making it a superior hedge against the challenges of a rogue America and geopolitical turbulence.

Geopolitical risks have transformed the international monetary system from a neutral infrastructure that facilitates global commerce and cross-border investment into an arena of strategic competition, fundamentally altering the risk-return balance and elevating national security from a peripheral concern to a threshold condition for investment decisions. Strong demand for gold reflects a broader transformation in global finance, marked by a shift from financial claims to tangible ownership, from efficiency to resilience, and from dependence on a single reserve currency to a more diversified and strategically balanced monetary order.

This reassessment of sovereign risk has certainly influenced the People's Bank of China's reserve strategy. In July, the PBOC increased its gold reserves for the 21st consecutive month to 76.08 million troy ounces. Meanwhile, China is building up its physical gold inventories in Hong Kong, which recently launched a gold clearing and settlement system on a trial basis, and has limited retail investors' access to precious-metals trading.

China's shift toward holding physical gold underscores the evolution of the metal's function, from a financial asset to a strategic monetary asset. In addition to reducing dollar exposure, gold's larger role in the

* The article was first published on *Project Syndicate* on September 4th, 2026.

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management of the country's currency reserves also promises to strengthen trust in the renminbi and reinforce confidence in the PBOC's balance sheet. It also seems aimed at boosting efforts to facilitate the renminbi's broader use, including through bilateral currency-swap agreements, trade-settlement mechanisms, and debt issuances, with the market for renminbi-denominated debt instruments (offshore "dim sum" and onshore "panda" bonds) rapidly expanding.

But China's push to promote the renminbi does not mean that the currency is capable of unseating the dollar. The renminbi remains subject to capital controls and lacks the financial depth to compete with the greenback globally.

Similarly, recent initiatives to internationalize the euro, most notably the expansion of the enhanced Eurosystem repo facility for central banks and the growing issuance of euro-denominated debt, have been relatively successful, with it becoming the leading currency in the green and sustainable international bond market in 2025. But still, the euro cannot hope to fill the dollar's global shoes, owing to structural and institutional barriers, notably the lack of a unified fiscal policy and deep, seamless capital markets.

Even so, gold complements the rise of rival currencies and supports diversification by providing a common store of value that is accepted without regard to geopolitical alignment or other monetary arrangements. Thus, its ascent reflects efforts—including local-currency settlement between BRICS members and cross-border payment systems in Asia and elsewhere—to deepen regional integration and reduce dependence on the dollar for trade and investment.

Digital technologies that enable the circumvention of traditional correspondent banking networks add another dimension to gold's renewed relevance. Central bank digital currencies and real-time payment infrastructure enable the creation of a decentralized monetary system in which multiple currencies coexist, forming the backbone of a new global financial system for the digital age. Yet technology cannot replace the need for trust: gold continues to provide the universal credibility that underpins confidence during periods of structural change.

While conventional wisdom that "there is no alternative" to the dollar still holds, the process of de-dollarization was never expected to be abrupt. Global redistribution of monetary influence will almost surely be gradual and cumulative, mirroring the realignment of economic power.

The case for gold—the ultimate neutral reserve asset, trusted by all countries and controlled by none—as a shield against geopolitical and financial shocks remains undeniable. But it is hardly the only reason for embracing the metal. In the face of a huge technological revolution and a global economic reordering, authorities are also seeking to strengthen their monetary sovereignty and end reliance on any single reserve currency.

This structural transformation of the international monetary system is the deeper and more enduring driver of demand for gold, suggesting that strong demand for the metal, which serves as the natural bridge to monetary multipolarity, is here to stay. As Shakespeare's Cloten rightly observes about gold in Cymbeline: "what can it not do and undo?"

October 2026
Vol.13, No.4

Gold's Return as Monetary Collateral *

By STEVEN FELDMAN *

Market infrastructure can't keep pace with gold remonetisation

Gold is not returning to the monetary system in the form its advocates often imagine. It is unlikely to replace fiat currency, restore Bretton Woods or become the daily medium of exchange for modern economies. But it is returning in a more practical and consequential role: as reserve collateral.

Since the US severed the dollar's convertibility to gold in 1971, fiat currencies backed by sovereign credit and confidence have dominated. That confidence is now being tested. US federal debt has crossed $39tn. Every major credit rating agency has downgraded the US from triple-A. The dollar's share of allocated global reserves fell to 56.4% at the end of 2025 before rebounding modestly to 57.1% in early 2026. Even the world's benchmark risk-free asset no longer feels entirely free of risk.

Central banks responded by purchasing more than 1,000 tonnes of gold annually in 2022, 2023 and 2024 – nearly triple the 2010–21 average. In 2025 that pace moderated to 863t as prices surged to successive records. But the retreat is relative, not directional: 95% of central banks surveyed by the World Gold Council still expect global official-sector gold reserves to grow over the next year, the highest reading in the survey's eight-year history. On current trends, official world gold holdings are approaching their 1965 peak of 38,300t – a milestone that would mark gold's return to a central, if different, role in the world monetary system half a century after it was officially retired.

The scale of that shift showed up in an unexpected place last year. According to the International Monetary Fund's Currency Composition of Official Foreign Exchange Reserves data, gold surpassed US Treasuries as a share of official reserves in 2025 – though that development was driven almost entirely by gold's price appreciation rather than fresh buying, and it is not reflected in COFER's dollar-share figures, which track currencies rather than gold.

This a valuation effect, not a wave of new accumulation. But a valuation effect of that size is itself revealing. It means central banks now hold enough gold, at current prices, for its aggregate value to eclipse their Treasury holdings – a threshold that would have seemed remote a decade ago, and one that no central bank needed to vote on or announce.

I have spent much of the past year thinking about why this is happening now, and about what stands between gold's growing monetary relevance and its actual usability. The answer to the first question is well understood: debt, deficits and the weaponisation of the dollar reserve system, most visibly through the freezing of Russian central bank assets in 2022, have made gold's oldest virtue – that it is no one's liability – newly valuable.

The second question is less discussed, and it is the one I want to focus on here. Gold is being rebuilt into the monetary system through balance sheets, collateral practices and market infrastructure. Gold's problem is infrastructure, not demand.

A market voting with its actions

Central bankers rarely say the quiet part out loud, but 2024 gave us a memorable exception. Announcing a €21.6bn annual loss driven by unfavourable interest rate exposure on the Bundesbank's government bond holdings, President Joachim Nagel was asked whether the bank might sell part of its 3,350t of gold to shore up its balance sheet. He would not consider it, he said, 'for a nanosecond'.

The remark was more than colour: German gold, revalued at year-end prices, generated a revaluation account surplus of €193bn – nine times the surplus recorded when the euro was introduced in 1999, and more than enough to offset the bank's quantitative-easing losses. Poland's central bank has been even more direct about intent, lifting its gold target from 20% to 30% of reserves. Hungary, Czechia and a widening circle of central banks from the Middle East to Europe have followed similar logic, often citing the same underlying rationale: balance-sheet protection in a world where government bonds no longer behave the way reserve managers were trained to expect them to.

None of this required a change in law or a formal reset of the monetary order. It happened the way most consequential monetary shifts actually happen: quietly, asset by asset, inside institutions that have every incentive not to announce what they are doing until the pattern is undeniable.

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* The article was first published on OMFIF on August 18th, 2026.
* Steven Feldman is Co-founder and Chief Executive Officer of GBI, which owns the GBI Platform, the institutional infrastructure for physical precious metals that serves global wealth managers, banks and fintechs.

The infrastructure problem hiding behind the demand story

This remonetisation is occurring despite an infrastructure that has barely changed since the mid-20th century. Gold custody remains fragmented across vault networks that cannot see or reconcile with one another in real time. Pricing is negotiated inside closed dealer relationships rather than discovered transparently. Settlement of institutional-size positions remains substantially manual. And the market's own plumbing contains a structural feature that gets too little attention.

According to the London Bullion Market Association, more than 90% of interbank, wholesale and over-the-counter precious-metals trading clears through unallocated 'Loco London' accounts, where the holder generally has a contractual claim against the clearer rather than title to specific bars. That is not a footnote. It is a counterparty-risk layer sitting underneath an asset that institutions increasingly value because they believe it can reduce counterparty risk.

Put simply: the world is re-adopting gold as a monetary anchor faster than the market infrastructure is modernising to support that role. The practical question is how much further and faster this remonetisation could travel if the infrastructure caught up.

Redeemability, quietly reappearing

The classical gold standard rested on one mechanical promise: paper could be exchanged for gold on demand. That promise was what made the system credible. When US President Richard Nixon closed the gold window in 1971, he didn't just change an exchange rate – he removed the redemption mechanism that had made the entire arrangement trustworthy.

Something like that mechanism is now reappearing, not through treaty but through market structure. Stablecoins were built to solve a narrower problem: giving crypto markets a stable unit of account. But the largest issuers are beginning to diversify their own reserve composition beyond Treasuries. Tether has said it aims to hold 10% to15% of its investment portfolio in gold and reportedly holds roughly 130t of bullion. That gold sits alongside equity stakes Tether has taken in gold royalty and streaming companies, a supply-side hedge that would have been unthinkable for a crypto-native firm a few years ago.

None of this makes stablecoins a gold standard. But it points towards one plausible path to a market-driven version of redeemability: if a dollar-pegged token is itself partly collateralised by gold, and the infrastructure exists to make conversion between the two seamless, auditable and instant, then holders gain something the pure fiat system stopped offering in 1971 – an exit, at their discretion, into an asset no government can print or unilaterally freeze. That is a meaningfully different proposition from simply owning gold, or simply owning a stablecoin. It is optionality, restored voluntarily by market participants rather than mandated by treaty, which is precisely the kind of gold standard that might actually survive contact with modern politics.

Separately, gold-backed tokens that attempt to circulate as everyday transactional money – PAXG and Tether's own XAUT among them – have not achieved meaningful payment volume. The reasons are intuitive: issuers bear real storage costs, and gold's stability – the thing that makes it valuable as collateral – makes it a poor vehicle for the kind of price movement that drives trading activity. I do not think that is where gold's digital future lies. Gold's evolving role looks much more like superior collateral than like a circulating medium of exchange – which is precisely why the infrastructure argument matters more than the payments argument.

What this means

To be clear, this article is not a case for a return to a rigid, treaty-based gold standard. The mechanics that made the classical system workable – a world with far less monetary demand chasing a fixed and much smaller pool of official gold – do not map cleanly onto a $39tn-debt economy with global capital mobility. Nor is this a prediction that gold will displace the dollar as the world's primary reserve and transaction currency; the dollar's institutional depth, liquidity and network effects remain formidable, whatever the erosion at the margin.

What I am arguing is narrower and more durable: gold is being remonetised as collateral, not currency, and that remonetisation is happening through market infrastructure rather than political decree. Central banks are demonstrating this with their balance sheets. Stablecoin issuers are beginning to demonstrate it with their reserve composition. What is missing is the connective tissue – custody, ledger, liquidity and redemption infrastructure – that would let this remonetisation proceed at the scale and speed that demand warrants.

Gold finished 2024 near record highs, reached new highs in early 2026 and has since given back a meaningful portion of that gain as markets price in higher rates and a stronger dollar. That volatility is itself instructive. A genuinely remonetised collateral asset should be expected to behave like one – priced by

markets, not managed by decree, moving with the same macro forces that move every other reserve asset. The test of gold's monetary rehabilitation was never going to be a one-way chart. It is whether, through the inevitable drawdowns, the institutions that have spent the past three years adding gold to their balance sheets keep doing so. So far, they have.

Half a century after the gold window closed, the metal is finding its way back into the architecture of financial trust – not through the front door of a formal standard, but through the side door of reserve diversification, collateral practice and, increasingly, redeemability. The task now is not to recreate a nostalgic monetary order, but to build the custody, liquidity, ledger and redemption mechanisms that a modern monetary collateral asset requires.

IMI International Monetary Review

Dollar Has New Neighbors on Monetary Stage *

By MARIA LUIZA FALCÃO SILVA *

An increasingly multipolar financial world is taking shape as other currencies such as the euro, the renminbi and interconnected digital payments are used in preference to the US currency

The dominant position in global finance enjoyed by the US dollar for much of the 20th century and early 21st is evolving in an increasingly multipolar world.

At the end of World War II, the United States emerged as the world's top economic, financial and military power. While Europe lay in ruins and Japan began reconstruction, the US accounted for a dominant share of global industrial production and held the bulk of the world's gold reserves.

Against this backdrop, 44 countries gathered in Bretton Woods, New Hampshire, in 1944 to design a new monetary order. The system they created pegged major currencies to the US dollar, while the dollar itself was anchored to gold at a fixed rate. The world economy effectively became organized around the US currency.

Even after former US president Richard Nixon ended dollar convertibility into gold in 1971, the currency's privileged position remained intact. Subsequent arrangements with major oil-producing nations, particularly Saudi Arabia, reinforced the dollar's international role by making oil transactions overwhelmingly dollar-denominated.

This led to the emergence of the so-called petrodollar system. Oil-importing countries needed dollars to pay for the oil, while oil-exporting countries accumulated large dollar reserves and reinvested them in US Treasury securities. This created a self-reinforcing cycle of global demand for the US currency.

Other factors also helped. The world's largest stock exchanges were in the US. The deepest financial markets were in New York. International trade was largely invoiced in dollars. Central banks across the world held substantial dollar-denominated reserves. Whenever a global crisis erupted, investors sought safety in US Treasury bonds.

From a national currency, the dollar became the backbone of international finance.

This dominance gave extraordinary advantages to the US. It enabled Washington to finance external deficits on favorable terms, allowed US companies privileged access to global capital, and made US financial sanctions powerful instruments of economic statecraft and geopolitical influence.

For decades, this arrangement worked smoothly. But profound transformations in recent years have gradually altered the foundations of this monetary order. The first driver is the structural change in the global economy. While the US remains a powerhouse, its share of global output has declined because other economies have expanded more rapidly.

After the rise of the European Union as a unified euro market, China became the most visible example. In just a few decades, it has transformed from a marginal player into the world's top manufacturing power. China is the major trading partner of more than 100 countries, a central force in the green transition and a leader in several emerging technologies. It has also significantly expanded its financial and diplomatic influence.

A second factor is geopolitical. The increasing use of financial sanctions as a foreign policy tool has led many governments to reassess their dependence on existing financial systems. The objective is not necessarily to replace the dollar, but to reduce vulnerabilities and increase strategic flexibility.

Before discussions about the internationalization of the renminbi gained momentum, the euro was seen as the principal challenger to the dollar.

Launched in 1999, the euro was one of the most ambitious monetary projects in modern history. For the first time since World War II, an economic bloc comparable in size to the US introduced a shared currency. For several years, the prospect of a bipolar monetary system centered on the dollar and the euro appeared plausible.

But the global financial crisis of 2008 and the subsequent European sovereign debt crisis exposed structural weaknesses in the monetary union. Eurozone members shared a common currency, but maintained separate fiscal systems and sovereign debt markets. Europe lacked a unified sovereign asset comparable to the US Treasury market.

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* The article was first published on *China Daily* on July 28th, 2026.

* Maria Luiza Falcão Silva is a Brazilian political economist and former professor at the University of Brasília.

The euro became the second most important international currency while the dollar remained the dominant reserve and crisis-management currency.

The Ukraine crisis accelerated trends that were already underway while putting more pressure on the euro. The financial sanctions imposed on Russia triggered an urgent search for alternative payment arrangements and reserve assets. Russia expanded the use of the renminbi in international transactions, strengthened commercial relations with Asian partners and developed alternative financial mechanisms.

The broader significance was not the emergence of a replacement system but the profusion of options. What might have taken decades began to evolve more rapidly. China has intensified its efforts to internationalize the renminbi through currency swap agreements, expanded cross-border payment infrastructure and promoted the use of it in bilateral trade. At the same time, emerging economies have intensified discussions on alternative financial arrangements.

The most significant changes are happening away from diplomatic summits. Across Asia and other regions, instant payment systems are becoming interconnected. Central bank digital currency projects are advancing. New financial platforms are facilitating cross-border transactions. Regional financial cooperation mechanisms continue to expand.

Despite these changes, the US still has the world's deepest and most liquid financial markets. US Treasury securities are the preferred safe asset during periods of uncertainty and the country's capacity to attract global capital remains unmatched. While the renminbi is expanding its international presence, it is not aimed at replacing the dollar.

The central question, therefore, is not whether the dollar will be replaced. It is whether the global economy will continue to rely on a single overwhelmingly dominant currency.

The dollar is likely to remain the leading international currency. The euro will continue to play a significant role. The renminbi will expand its presence, particularly across Asia, Africa and parts of Latin America. Bilateral trade in local currencies could become more common. Digital technologies may further diversify payment options.

In such a system, multiple currencies can coexist, each serving different functions and regions. Therefore, this is not the end of the dollar-centered world, but the gradual emergence of a more plural monetary landscape.

The world is witnessing an important historical transition. For the first time since the end of World War II, the US faces monetary alternatives. None is strong enough to dethrone the dollar, but several are becoming sufficiently important to reduce its exclusivity.

That may ultimately become one of the defining characteristics of the emerging international order: a world that is increasingly multipolar not only in geopolitics, economics and technology, but gradually in international finance as well.

IMI International Monetary Review

Digital Finance

China Is Running the CBDC Experiment the West Designed Away*

By KUN TIAN *

Digital public money that acts like bank deposits

Reports in the Financial Times that China is preparing to commercialise Project mBridge, the multi-central bank platform that settles cross-border payments directly in digital currencies, have revived the familiar question of whether Beijing can loosen the dollar's grip.

The platform has now handled around $69bn in cross-border settlement, up from $55bn the Atlantic Council tracked in November 2025, with the digital renminbi making up roughly 95% of the total. But this figure is the wrong thing to watch. The more consequential decision took effect quietly on 1 January, when the People's Bank of China reclassified the digital renminbi from digital cash into interest-bearing deposit money.

That reclassification is the step other central banks examined but declined to take. The question it answers – whether a central bank digital currency can pay a return, and so be worth holding, without draining deposits from commercial banks – is the central design problem of retail CBDCs. Most monetary authorities have avoided it by refusing to take the risk.

The disintermediation problem

The European Central Bank committed to paying no interest on the digital euro and proposed holding limits, precisely to stop it becoming a savings vehicle that pulls funding from banks. The Federal Reserve's 2022 review warned that an interest-bearing CBDC could do the same and heighten run risk, and Washington has since stepped back from a retail CBDC altogether.

The fear is disintermediation: when the safest money in the system also earns a return, balances migrate from commercial banks to the central bank, eroding the deposit base that banks lend against and, under stress, accelerating digital runs. The orthodox response has been to keep retail digital money cash-like, unremunerated and capped.

China's design takes the opposite turn, but with a twist that is easy to miss. It has not made central bank money interest-bearing. It has reclassified the digital renminbi held in commercial-bank wallets as a bank deposit liability: remunerated at deposit rates, covered by deposit insurance, carried on banks' balance sheets and folded into their reserve requirements, with non-bank operators holding full reserves against the digital renminbi they distribute.

PBoC Deputy Governor Lu Lei described the instrument as carrying 'the attributes of commercial bank liabilities.' The digital renminbi is therefore centrally designed and standardised, yet within this framework it behaves like a bank deposit. Because savers are not moving funds to the central bank, the disintermediation the West feared is engineered around rather than ignored.

What changes instead is subtler and arguably more consequential. The central bank is not displacing the commercial banks; it is becoming the standardised layer beneath them, writing the rules and operating the infrastructure for a single, account-based, programmable form of money that participating banks can offer. That money now sits within the direct reach of monetary policy. The state's monetary footprint expands into the deposit base in exactly the place the West chose to keep it small. The move extends both policy reach and a degree of visibility over balances that were, until now, purely private.

Beijing as a live experiment

The domestic logic is straightforward. For years the digital renminbi has lost to Alipay and WeChat Pay; despite Rmb16.7tn ($2.5tn) in cumulative transactions, everyday use remains thin. With low deposit rates, a wallet that pays interest is the most direct lever Beijing has found to make people hold the currency rather than just spend it and to compete with private platforms and dollar stablecoins on return.

* The article was first published on OMFIF on July 2nd, 2026.
* Kun Tian is a Senior Lecturer at Kent Business School, University of Kent.

The cross-border ambition is the other motive and it carries a catch. The same framework builds an international digital renminbi centre in Shanghai and is meant to widen the currency's use abroad; interest is what might persuade foreign institutions to hold renminbi rather than merely route payments through it.

Yet an instrument that is, by Beijing's own account, a claim on Chinese commercial banks is not the sovereign-grade asset reserve managers prefer and it still sits behind a closed capital account. Even for Hong Kong, the largest offshore-renminbi centre and an mBridge member, the design that makes the digital renminbi stable at home is a harder sell to international users than the ambition assumes.

For central banks elsewhere, China becomes the live experiment they never ran. The ECB and the Fed are still settling their own positions on holding limits and remuneration; they now have a real economy in which to observe how deposits behave and how the system holds under strain. The results on adoption, deposit migration and transmission will be the first real-world evidence on questions the rest of the field has only modelled.

The contest worth watching is not the familiar one between renminbi and the dollar. It is whether a state can make digital public money behave like a private bank deposit without paying the price others were unwilling to risk. China has decided to find out at scale and in public. Everyone else will be taking notes.

IMI International Monetary Review

The Digital Euro — Promoting Innovation, Safeguarding Sovereignty, Strengthening Europe *

By JOACHIM NAGEL

1. Introduction

Ladies and gentlemen,

I'm delighted to be able to speak to you here today. I would have liked to have been there in person, but an important personal occasion means that unfortunately I can't. I'm therefore all the more pleased to be able to send you a few thoughts via video message.

In case some of you were watching England play until almost midnight last night or Croatia until just before 3:00 this morning, I am relying on your sense of fair play to nevertheless now get back into the zone and concentrate. I promise you: my speech won't go on for 90 minutes!

This International Bankers Forum conference is being held under the title "Payments & Banking made in Europe 2026". This title hits a nerve because although making a payment is one of the most common economic activities there is, it's one that is currently undergoing fundamental change.

What used to involve reaching for your wallet or purse now oftens entails a click, a swipe or your account being debited in the background. This changes not only the way we pay, but also the infrastructure that supports our monetary system on a day-to-day basis.

All this is happening at a time when Europe is reassessing its strategic dependencies. Developments in recent years have shown how vulnerable strategic dependencies are – for example, in the areas of energy and defence. The question of Europe's capacity to act is increasingly also being raised in the domain of payments. That's why "Payments & Banking made in Europe" is more than just a conference title. It's a strategic task.

In my speech, I would like to explain why the digital euro should become a central element of the payments system in Europe. My core message is that the digital euro isn't an end in itself – it's rather a response to three developments: First, the digitalisation of our day-to-day payments, second, the growing importance of European sovereignty and third, global competition in the digital financial world. I would now like to go into these three points in more detail.

2. Propelling central bank money into the digital age and promoting innovation

My first point is that the digital euro would propel central bank money into the digital age and promote innovation.

The starting point for reflections on the digital euro is the change that we are all experiencing in our everyday lives. Each of us can probably confirm this for ourselves: The way we pay has changed fundamentally in recent years. Cash remains important, but we have observed over many years that it's being used less and less frequently for payments.

In the euro area, only two-fifths of the total value of payments at the point of sale were made in cash in 2024. By comparison, this share was almost one-half in 2019. At the same time, the share of online purchases – which by their very nature are cashless – doubled in value terms from 18 % to 36 %. And the share of outlets in the euro area that do not accept cash tripled between 2021 and 2024 to 12 %.

This shows that the payments system is undergoing profound change. It's becoming more digital and more mobile. In addition, payment processes are becoming increasingly intertwined with digital business processes. This is why we, as a central bank, are faced with a fundamental question: How can we ensure that central bank money also remains accessible and relevant in this digital world?

This is precisely where the digital euro comes into play. It's not a rejection of cash. It's a digital complement. It's about further developing central bank money in an increasingly digital world. This is because central bank money is and remains the anchor of our monetary system.

Currently, in their day-to-day lives, people only hold and use central bank money in the form of cash. The digital euro would ensure that, in future, central bank money would remain available in everyday life not

* Speech by Dr Joachim Nagel, President of the Deutsche Bundesbank, at the International Bankers Forum, Frankfurt am Main, 24 June 2026.

only as cash, but also in digital form. Like cash, it could be used as legal tender throughout the euro area with the aim of being universally accepted.

Or to put it in a nutshell: The digital euro would propel central bank money into the digital age.

It's important to me to make it clear here that central bank money and private payment solutions have long existed side by side. They fulfil different functions to some extent. That is precisely why they complement each other in a meaningful way. The introduction of the digital euro would not change this.

The Eurosystem would provide the basic public infrastructure for the digital euro. The digital euro isn't intended to crowd out private solutions, but to complement and support them. It aims to create trust, facilitate access to consumers throughout the euro area and promote common technical standards in the payments system. On this basis, private sector providers can develop tailored and innovative services.

The digital euro isn't therefore intended to be developed in opposition to the financial sector, but in conjunction with it. Banks and payment service providers will continue to play a central role in the payments system. They will continue to be the interface with clients. The digital euro isn't intended to create a parallel world. It's intended to fit into the existing financial system.

When I look at the current technical developments, I am certain that the digital euro can serve as a basis for new business opportunities for the financial sector. Consider, for example, conditional payments, which are triggered automatically when certain conditions are met. For example, the automatic payment of an insurance settlement as soon as a claim has been digitally confirmed.

It's also clear that the digital euro must be designed in a way that preserves financial stability and does not impair bank lending. Holding limits for credit balances in digital euro and the absence of interest payments on digital euro holdings are important levers in this regard.

Despite holding limits, payments of higher amounts should of course be possible – namely through the so-called waterfall approach. For payment amounts above the holding limit, the difference would be automatically transferred from the bank account linked to the wallet.

The digital euro is intended to serve as a means of payment – not as a form of investment and not as a substitute for bank deposits. From a European perspective, the digital euro could also help domestic payment service providers to increase their reach. And that brings me to my second point: The digital euro can safeguard European sovereignty in payments.

3. Securing digital sovereignty

Recent geopolitical developments have made it very clear to us in Europe that dependencies in critical areas pose high risks. Many people will immediately think of energy and defence. However, the payments system isn't just a service running in the background either. It's critical infrastructure.

And this is where the crux of the matter lies: Europe's payment system is heavily dependent on non-European providers in important segments. At present, more than two-thirds of all card payments in the euro area are settled via non-European systems. 13 out of 21 euro area countries do not have a national payment solution. They depend entirely on international payment service providers.

Of course, this does not mean that the international providers currently present in Europe are providing a poor service. On the contrary, many of these solutions are convenient, reliable and have become well established. But convenience must not be at the expense of sovereignty.

Recent geopolitical developments have shown us very clearly that it's not enough for something to function well under normal circumstances. Crucially, Europe must also remain capable of taking action if the worst comes to the worst. This also applies to the payments system.

Anyone making a payment is using infrastructure. And those who provide the payment infrastructure shape standards, availability and scope for action. The digital euro would therefore be a central and concrete step towards greater European sovereignty in payments. Or, linking back to the title of this conference, it would be a key component for "Payments & Banking made in Europe".

Not in the sense of isolation or self-sufficiency. Not as a vote of no confidence in private sector providers. But as an autonomous European basic infrastructure. An infrastructure that can be used throughout the euro area, that is under European control and that fosters private innovation.

But it's not only a matter of technical sovereignty. It's also about strengthening important values in digital payments. Data protection, privacy, inclusion and a clear legal framework are not merely added extras. They are among the key specifications of the digital euro's design.

In concrete terms, this means, for example, that the Eurosystem can only see holdings and transaction patterns of pseudonymised users. It therefore cannot link payment data to a specific person and cannot create individual payment profiles. The offline mode of the digital euro actually provides a level of privacy that is almost as high as that of cash. This is because such payments are made, for example, directly from smartphone to smartphone, without having to use central systems.

The digital euro would therefore not result in people's transactions being laid bare. Rather, its design aims to ensure the best possible technical and organisational safeguards for data protection and privacy. The digital euro can thus play a decisive role in safeguarding Europe's sovereignty in payments – based on European values.

4. Strengthening Europe's role in the digital financial world

Let me now turn to my third point: Europe's role in a changing digital financial world. The digital euro isn't the only response to these changes. It's an important building block in a broader European payments strategy.

This is because money is never just a technical payment instrument. The value of a currency always reflects trust as well. Trust in institutions, in stability, in the rule of law and in the economic performance of a currency area.

Over the past few decades, the euro has established itself as a currency that is stable both internally and externally. The average inflation rate since the introduction of the euro has been around 2 %. The euro exchange rate is flexible but without major fluctuations. And the euro is the second most important currency in the international monetary system, for example in foreign reserve assets, international bond issuances and payment transactions.

This status isn't a given. Trade, financial markets and value chains are becoming increasingly digital. That is why the euro's infrastructure also needs to be further developed. After all, the attractiveness of a currency isn't based solely on its stability in the traditional sense. It also depends on whether payments can be settled securely, efficiently and innovatively – in retail payments, but also in financial markets.

This is precisely why the Eurosystem's comprehensive payments strategy is deliberately broad-based. The aim is to create a European payments system that is innovative, competitive and resilient. In this overall picture, the digital euro is – first and foremost – modern digital central bank money for day-to-day payments in the euro area.

At the same time, the digital euro can be used to create new offerings that strengthen Europe as a financial location in the broader sense. This includes better interfaces for enterprises and more efficient payment processes. In this way, the digital euro could indirectly increase the attractiveness of the euro.

At the same time, new digital solutions are emerging around the world. Tokenised market environments, in which assets are digitally represented, transferred and settled, are one important development here. They give rise to new requirements for how such transactions are settled.

In addition, privately issued digital forms of money such as stablecoins are becoming more widespread. They can enable new forms of payment and settlement, but at the same time raise questions about regulation, financial stability and monetary sovereignty.

Europe should play an active role in shaping these developments. This applies to technical standards, market structures and regulatory requirements. This way, the euro will remain competitive and practical to use in the digital financial world, too.

For example, the Eurosystem is currently working on making central bank money usable in new DLT-based market environments. Specifically, the Pontes project is providing a solution for the settlement of large-value payments and securities transactions in central bank money. In contrast to the digital euro, which is geared towards day-to-day payments, this is tokenised central bank money for the wholesale sector.

Taken together, it's about more than just a new way of paying. It's about Europe's place in a digital world economy. The digital euro isn't the whole answer here. But as part of a broader strategy, it will help to transfer the strength of our currency into the next technological era.

5. Closing remarks

And that brings me to the end of my speech. Before you jump straight into the discussion, I would like to briefly summarise my main messages once again.

Our monetary system is evolving. I believe that the digital euro is the logical answer to this – for three reasons: First, it would propel central bank money into the digital age and promote innovation. Second, it would secure Europe's sovereignty in payments. And third, it would help to consolidate Europe's role in the digital financial world.

The digital euro isn't a substitute for cash and not a counterproject to the financial sector. It's a European basic public infrastructure for the digital age – sovereign and open to private innovation.

I am very grateful for the opportunity to speak to you today. This event brings together representatives from all relevant areas of the financial sector. Your ideas and critical objections will help us to further refine the digital euro project.

With this in mind, I would like to close with an appeal: Let's make the digital euro a joint project and shape it together.

I wish you a productive discussion. Thank you very much for your attention.

IMI International Monetary Review

AI and the Future of Payments Policy *

By DAN KATZ *

Thank you, Graeme, and thank you SWIFT for the kind invitation.

The theme of this year's conference is digital finance for AI-driven economies. This is an important topic for the IMF because an efficient and secure payments system is critical to economic growth and stability.

Clearly, as the theme suggests, the financial system, and payments in particular, will need to evolve. If AI is used as widely as proponents expect, a great deal of economic activity will be undertaken by AI agents rather than by people. The current payments system was not built for autonomous agents operating continuously and at scale.

At the same time, AI has extraordinary potential to transform the payments system we already have, even before we get to the more difficult questions about how the financial system itself may need to evolve.

Today, I want to explore three points: first, how AI can improve the payments system; second, whether and how the financial system needs to be reengineered to support an AI-intensive world; and third, how policymakers should respond to certain risks that are unique to AI.

I. What AI can do for payments

Let me start with how AI can improve the payments landscape.

One way is by reducing information frictions and switching costs. AI agents can assess fees, services, exchange rates and execution quality continuously, routing each transaction to the most efficient provider. That lowers barriers to entry, increases competition and puts pressure on incumbents to improve their prices and services. This applies not just to financial services, but to all forms of commerce. One might even wonder whether a sustained reduction in information frictions and switching costs could have macroeconomically significant consequences for inflation.

Second, agents can automate complex transactions that today require extensive human involvement. They can manage the mechanics of paying, coordinating machine-to-machine payments and optimizing the timing based on liquidity, costs, and contractual obligations. Some of this is possible today through programmability. But programmability only takes you so far. It requires explicit instructions for each task and operates within predefined parameters. By contrast, agentic systems can interpret context and operate without requiring a new set of instructions for each transaction. That would open up more commerce to automation, increasing the volume and speed of transactions.

Third, agentic AI could substantially lower the costs of regulatory reporting and compliance by automating the collection, reconciliation and reporting of data across institutions and jurisdictions. Agents could continuously monitor transactions and positions against regulatory requirements, identify gaps in real time, and produce compliance documentation.

The benefits of AI become even more powerful in the context of cross-border payments, which bridge different legal systems, currencies and regulatory requirements. Agents could automate activities such as customer due diligence and sanctions screening, improving the speed and consistency of compliance. And the benefits from agent-enabled price comparison are likely to be even larger than in the domestic context, given the incremental frictions faced by retail consumers making cross-border payments.

I would not underestimate the scale of the benefits of applying AI to the existing payments architecture. Payments are about much more than just the public infrastructure that supports them. A full payments product requires regulatory compliance, dispute resolution, and customer support. Those functions are needed regardless of whether payments run on blockchain rails or other infrastructures.

Many of the benefits promised by a reimagined financial system can instead be delivered by upgrading the core payment systems that we already have. That is where AI can help. In the short run, this is where we are likely to see more tangible benefits.

The scale alone makes the case for investment. IMF staff estimate that cross-border payments move nearly $1 quadrillion a year. At that scale, even improvements measured in basis points can translate into very large gains.

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* The article was first published on IMF on September 28th, 2026. Remarks by Dan Katz, First Deputy Managing Director at Sibos 2026.

* Dan Katz, First Deputy Managing Director.

II. How the financial system might evolve

As AI agents become a significant part of economic activity, the financial system will need to evolve alongside them. It must become more digital, more interoperable and more programmable.

A range of payment technologies could supply the infrastructure needed for autonomous agents to transact across financial networks. Tokenization may be especially promising, since tokenized assets are natively programmable and can settle almost instantly, at any hour.

We are already seeing progress. CHIPS, for example, is leading a multi-bank initiative to create a shared tokenized deposit settlement platform.

The challenge for policymakers is to support innovation without compromising stability. That begins with legal and regulatory frameworks that permit different payment technologies to compete on their merits.

The law needs to clearly establish the legal nature of tokens, including the rights and claims of purported owners and parties with varying degrees of contractual privity. It must also define the relationship between tokenized assets and their real-world equivalents. Authorities should avoid erecting unnecessary obstacles to interoperability across networks. And liquidity frameworks will need to keep pace because while atomic settlement removes counterparty risk, it also raises intraday liquidity needs by requiring prefunding.

If banks continue to embrace tokenization, it naturally raises the question of how central banks should respond, as the existing bank-based payments architecture rests on a foundation of central bank money that is not currently tokenized.

Stablecoins, too, raise questions of the form of liabilities issued by the government. To maintain a stable value and function as a payment instrument, they need to be backed by safe and liquid assets like short-term government obligations, central bank deposits, or insured commercial bank deposits that are ultimately supported by central bank money.

At the Fed's Jackson Hole conference this year, we had very interesting discussions about whether central banks should offer new forms of central bank money, such as tokenized reserves, and whether they should extend access to central bank money to new parties. Finance ministries, too, might consider whether they should issue government obligations in tokenized form.

We are seeing a wave of experimentation across these domains. For example, the ECB's recently launched Project Pontes is designed to enable wholesale transactions on distributed ledger platforms to settle in central bank money. The Bank of England is requiring certain issuers of stablecoins to hold central bank deposits.

The diversity of these approaches reflects varying country circumstances and underscores why policymakers should keep their options open, observe how developments unfold, and consider tailored solutions as the market matures. This is an area where the IMF supports central banks in evaluating alternative pathways through technical assistance.

It is certainly appropriate for central banks to provide new public infrastructure that supports competition, such as tokenized reserves. But these services should be constructed in a way that does not lock out new technologies and business models that might emerge from market-based competition. The objective should be to create an enabling environment, while ensuring the integrity and stability of the payment system.

Preserving space for competition is not just about increasing efficiency and innovation. It is also a financial stability issue. Policymakers that encourage overly narrow solutions often discourage heterogeneity in business models that can be a source of resilience. When the inevitable shock comes, similar institutions tend to fail in the same way, creating systemic risk.

III. Approaching AI risk

The development and diffusion of AI technologies may pose broader risks that need to be considered. Cyber risks are of course at the top of the list. AI is reshaping cyber risk by accelerating the speed, frequency, and breadth of vulnerability discovery and potential exploitation. Tokenized markets depend heavily on shared, complex infrastructure and a small number of third-party providers. That means a cyber incident can propagate widely enough to become systemic.

Fortunately, we have not yet seen a macro-critical cyber event. Private risk management and the existing supervisory architecture have contained risks. That approach still applies: strong governance, technical controls that limit the blast radius of a breach, and robust incident response and recovery. We need more coordination among standard setters and supervisory networks, and between governments and industry.

As frontier AI tools are deployed by cyber actors, defenders will need those same tools to respond. And that gets to a broader debate about whether increasingly powerful AI systems could pose such severe risks to society as a whole that new regulation is needed to slow the pace of development.

These concerns deserve to be taken seriously. The IMF contributes to this vital debate by bringing a macro-financial lens to questions of regulation and risk. We focus on where market failures may arise; where risks can become systemic or macro-critical; and where private incentives may diverge from the public interest.

In AI, that may include major externalities from defective products, information gaps between developers, users, and regulators, or operational dependencies on a small number of providers. It could also include the loss of competitiveness and concentration of market power that may result from the imposition of a poorly designed regulatory framework that creates barriers to entry.

The starting point should be to identify demonstrable market failures and evaluate whether existing regulatory frameworks are sufficient to address them. To the extent that new interventions are needed, they should be proportionate, targeted, and internationally coordinated, while taking great care not to discourage competition and innovation.

AI could be transformative for the payments system. Handled well, AI can help build a payments system that is more efficient, more competitive, and better suited to the economy of the future.

For policymakers, the challenge is to enable this transformation, while safeguarding against risks. The IMF supports our membership by helping them assess spillovers and vulnerabilities from this transformation.

More broadly, the Fund also facilitates the international dialogue needed for the payments system to remain open and stable—consistent with our 80-year mandate to ensure the stability of the international monetary and financial system.

Thank you very much.

October 2026
Vol.13, No.4

What Comes after the G20 Cross-Border Payments Roadmap? *

By MARTIN MOLONEY *

Questions and lessons for stakeholders as 2027 approaches

In 2020, the G20 launched the roadmap for improving cross-border payments, developed by the Financial Stability Board in coordination with the Committee on Payments and Market Infrastructures and other standard-setting bodies. The goal has now become something of a mantra: to make cross-border payments faster, cheaper, and more transparent and inclusive. Making it a reality has proven challenging.

We understood from day one that this was going to be difficult. To calibrate the ambition and to create a degree of accountability, in 2021, we asked the G20 to endorse a set of global quantitative measures, most of which are set for end-2027. And those measures tell us we still have a way to go.

With the end of the roadmap approaching in 2027, we have the opportunity to reflect on what we have achieved so far and what further steps would be helpful. And it's not just for us in the FSB to ask those questions. It's for every other stakeholder as well.

Challenges along the road

The history of the roadmap is full of lessons for us. The simple fact that we have had to update and reset the roadmap a number of times is itself striking. This is not plain sailing.

The first challenge has to do with market structure and incentives: people will have different views, and payment specialists think their work is the most important. But cross-border payments are somewhat marginal to the business model of most of the companies that provide this service. Furthermore, the sense in which there is a traditional competitive market driving quality and innovation is limited, because those markets are complex. Each major corridor sometimes seems to behave like its own market, with distinct frictions. Regions behave differently from each other. We talk about global cross-border payments, but it's more complex than that phrase suggests.

Second, we face exogenous dependencies: for example, it has become clear that cross-border payments rely heavily on foreign exchange markets, which are the largest markets in the world and outside the remit of our roadmap.

Third, technology adoption dynamics are important in cross-border payments. We are constantly told that there is immense technological potential for efficiencies and new services, but it remains a fact that the market is dominated by participants who often appear to be seeking second- or even third-mover advantage.

Finally, the necessary political and regulatory authority is widely distributed: there is no global authority with a mandate to make this work well. Even at the domestic level, there is often limited effective coordination. Importantly, the issue cuts across the sensitive division of responsibilities between central banks and finance ministries. At the same time, there are many global standard-setters and organisations with an interest. We have tried to work with all of them.

Adding all that up amounts to a real challenge for policy-makers. On the one hand, we may not be able to rely as much as we hoped on competitive markets to resolve issues, even if we do everything we can to make space for competition to work well. On the other hand, we haven't got well-established global authorities to direct change. Neither the visible nor the invisible hand seems to have a strong grip on this issue.

Where next?

But it is far from hopeless. I suspect the FSB back in 2020 did something important in trying to find a way through these challenges. When we set up the roadmap, we bought into an important simplifying idea: use the FSB's convening power to smooth out as many as possible of the regulatory and policy impediments in market dynamics to improve cost, speed, transparency and access. We have done that. The thought was 'let's test what competition can achieve'.

As we move towards 2027, however, we now have to ask the difficult question of what the results are telling us about that approach. Has our focus on removing frictions been sufficient? Should we double down on it? Should we pivot to operational planning such as we are currently testing with the jurisdictional and regional action plans we are working on? Or should we step back and just let the technology innovators lead?

Technology solutions

* The article was first published on OMFIF on July 10th, 2026.

* Martin Moloney is Deputy Secretary General of the Financial Stability Board.

Turning to technology innovators first, a much-talked about option is whether stablecoins could be the silver bullet. There are varying measures for the volume of cross-border payments, but let's just say total payments in 2024 were at or around $200tn. In contrast, the volume of cross-border payments being made by stablecoins is estimated to be only a fraction of this – by some estimates less than 0.2% of total cross-border payments in 2025.

The order of magnitude tells a clear story: today, stablecoin volumes remain a very small share of total cross-border flows. There has been some exploration of large financial institutional use cases. Their most immediate value may be as components in hybrid models – integrated with bank money and interoperable foreign exchange/settlement – rather than as standalone global rails. But neither is more than a possibility at this point.

Reducing frictions

The work has not just been about creating better policy frameworks; it has also been about technical frictions. Poor data quality and limited standardisation of data exchange make cross-border payments more complex to process, in turn affecting their speed, price and transparency. Promoting the adoption of common message formats, including conversion and mapping from legacy formats and the use of legal entity identifiers and common protocols for data exchange, does mitigate the frictions.

When ISO 20022 was first introduced in 2004, it marked the beginning of an important journey towards a new era of simpler, more data-rich payments for banks and their customers. One of the original building blocks of our roadmap in 2020 (building block 14) was adopting ISO-harmonised message formats. Twenty-plus years after the original version of the ISO standard, we are at 77% of fast payments systems and 53% of real-time gross settlement systems reporting implementation of the messaging standard.

This is good. But it has taken a very long time and it's not complete. Without the extensive work of CPMI, I suspect we would not have achieved this much. We also know that implementation is necessary but not sufficient. The value of the ISO standard comes from consistent usage, ensuring rich data and embedding the standard into end-to-end operations; for example, screening, reconciliation, fraud analytics and supervision, not just message conversion.

Extensive efforts here have undoubtedly made a difference. But to fully realise the potential benefits of the ISO standard, continuous development is needed to align the messages to evolving market practices and embed them into operations. For example, while ISO 20022 includes enhanced data elements that can strengthen anti-money laundering and countering the financing of terrorism measures, a recent study found that many financial institutions continue to rely on traditional screening methods developed for payment messages.

ISO 20022 carries more data than legacy messaging formats, so banks could use it to create a fully integrated payments experience, giving them an end-to-end view of operations from initiation and delivery of the payment to exceptions, investigations and reporting. But this requires a pretty large investment.

Other challenges persist

Our work has also highlighted other challenges where we have sought to promote better practices, but we continue to hear about issues. These include: data sharing to fight fraud; smooth processes where capital controls exist; efficient ways to do sanctions screening; how foreign exchange access restrictions work; payment versus payment coverage; and opening hours.

How do we get from identifying frictions to global implementation of solutions to those frictions? One of our key reflections is about leadership and regional organisation. This is an area that the International Monetary Fund and the World Bank have done a lot of work on. Jurisdictions need to carefully assign responsibility, regions need effective regional co-operation structures.

What comes after the roadmap?

My view is this: we are coming to the end of the roadmap, but not yet the end of the journey. The roadmap's goals surely endure. Perhaps the lesson of recent years is that coordination is proving to be the scarce resource.

So, as we look beyond 2027, the question is not simply what we do next, but how we choose to organise ourselves to do it. Is continued friction-removal enough to unlock better outcomes, or do we need corridor-by-corridor or region-by-region operational plans with clear ownership?

If neither path is sufficient on its own, what blend would be credible and politically sustainable across jurisdictions? How far should we push standardisation or integration without eroding domestic policy

options or privacy protections? As technology evolves, should stablecoins and tokenised deposits complement integrated models, or catalysts for new rails? Who will be the champions of a second roadmap?

And finally, what should success look like after 2027 – not just in metrics, but in lived experience for people and companies in every region? Maybe speed, cost and transparency are not all equally important to end-users.

We need the help of every stakeholder in the system to reflect on where we are and what we should achieve, to convene discussions, to send us submissions, to engage with us and each other to make sure a further roadmap really leads to substantive change.

IMI International Monetary Review

Climate Changes

Nature Risk Threatens Financial Stability *

By MAUD ABDELLI *

Ecosystem degradation is under-reported, under-priced and underestimated

Three types of capital are central to understanding risk and return: financial, human and natural capital. While the financial system has long recognised the importance of financial and human capital, the role of natural capital is only now coming into focus.

As financial institutions increasingly view biodiversity loss and ecosystem degradation as systemic threats to economic stability, nature-related risk is moving higher up the financial agenda.

Depending on nature

Nature forms the foundation on which everything else is built. More than half of global gross domestic product – around $58tn – is moderately or highly dependent on nature. Economies rely on healthy ecosystems for everything – from agricultural production and water supply to the raw materials used in construction and manufacturing. Ecosystems also help protect against physical risks such as flooding, wildfires and landslides.

But ecosystems are approaching tipping points across oceans, freshwater and forests. As these ecosystems further degrade, the risks are increasingly being felt across the economy and financial markets. These include disrupted supply chains, inflationary pressures – particularly in food and commodities – and increasing pressure on insurance markets. Nature risk is therefore not only an environmental issue, but a financial stability issue.

Despite the growing economic importance of nature-related risks, it remains largely absent from market pricing and risk assessment. To examine how financial institutions can better measure, assess and address biodiversity and nature-related risks, OMFIF co-hosted a roundtable with WWF's Greening Financial Regulation Initiative. Participants discussed the constraints preventing more meaningful progress in this area, while also identifying the opportunities for investors.

From data challenges to action on nature risk

Roundtable participants stressed that significant progress has been made when it comes to developing nature-related datasets and analytical risk tools. The challenge now lies in improving their standardisation and ensuring that the existing data can be used more effectively to identify both risks and opportunities.

Unlike climate risk, which can be assessed using a widely recognised metric – greenhouse gas emissions – nature-related risks are often highly location-specific and encompass multiple dimensions of ecosystems, making them more complex to measure.

But this complexity should not be a reason for inaction. Central banks and financial regulators can already start integrating nature considerations into risk assessments using the information available today, while continuing to refine methodologies as data quality improves.

The development of common metrics for ecosystem impacts and dependencies, together with greater corporate transparency on interactions with nature, will further strengthen decision-making. As data, standards and disclosure practices continue to evolve, institutions will be better equipped to identify risks, seize emerging opportunities and scale investment in nature-positive solutions.

Another challenge for central banks and regulators is building capacity and improving coordination. Participants agreed there is a need for shared frameworks and methodologies across jurisdictions, as well as greater coordination between the public and private sectors. Financial institutions also need to invest in training and education to strengthen internal expertise and raise awareness of nature-related risks.

Moving forward

* The article was first published on OMFIF on June 25th, 2026.

* Maud Abdelli is Lead, WWF Greening Financial Regulation Initiative and Sarah Moloney is Editorial Director at OMFIF.

While advances in geospatial data and analytics are improving the ability to identify, measure and map nature-related risks, more work is needed to build credible indicators and standardised datasets that can support financial decision-making.

Standard setting is also evolving. The International Sustainability Standards Board requires companies to disclose material information about all sustainability-related risks and opportunities, including those that could reasonably be expected to affect a company's prospects (International Financial Reporting Standards S1). The ISSB Board has now proposed a non-mandatory IFRS Practice Statement to provide guidance on how these risks may be reported.

The Task Force on Nature-related Financial Disclosures is emerging as the main reference point for companies and financial institutions to assess, report and act on nature-related issues. It provides a structure for identifying dependencies, impacts, risks and opportunities linked to nature. There is a clear direction towards more harmonised and investor-relevant disclosures. However, fragmentation in frameworks and difficulties with collecting and processing data mean that implementation will take time.

Cross-sector and cross-border collaboration will be essential in developing nature scenarios, improving risk models and creating greater consistency in standards globally.

From risk to opportunity

While much of the discussion focused on risk, participants also highighted the growing investment opportunities linked to nature. Nature-based solutions and resilience investments were identified as areas with strong potential for attracting capital, although a gap remains between investor interest and the availability of investable opportunities.

OMFIF's Transition Finance Working Group found similar views in discussions with pension funds in 2025. All the institutions we spoke with said that, while they were not yet actively investing in nature-related products and assets, they were closely monitoring the market. Many see long-term potential in nature as an emerging asset class, but some believe that the necessary frameworks are not yet in place for them to fully enter the market.

To address this, participants stressed the need for clearer and stronger incentives to support risk mitigation, making use of blended finance vehicles to allow private investors to enter more deals. Aligning financial returns with nature-positive outcomes would help to enable a shift from treating nature as an externality to recognising it as a core asset within the economy.

A market in transition

Nature-related risk is gradually becoming an integral part of mainstream financial risk management, but the market is still in transition. As the degradation of nature and ecosystems worsens, threats to the stability of the financial system grow stronger every year.

The roundtable provided a valuable platform for bringing together key actors from across the financial and policy landscape, including financial regulators, central banks, finance ministries, data providers and civil society organisations like WWF's Greening Financial Regulation Initiative. By fostering dialogue across sectors, it helped build a shared understanding of the challenges and opportunities for integrating nature-related risks into financial decision-making.

Building on this momentum, OMFIF and WWF plan to host further roundtables in 2026 to review progress, deepen collaboration and identifiy concrete actions to accelerate the transition towards a net-zero, nature-positive economy and financial system.

IMI International Monetary Review

To Avoid Climate Peril, the World Must Electrify *

By MURAT KURUM *

The war in the Gulf has unleashed powerful market forces that the rest of the world can harness to accelerate electrification and keep the Paris climate agreement's primary objectives on track. Doing so will not only mitigate climate change, but also strengthen economic resilience worldwide.

The cascade of shocks to the global economy over the past few months has offered a glimpse of our new reality. The Gulf conflict has taken an extraordinary—and dangerous—amount of oil, gas, and fertilizer off the market, and now a possible "super" El Niño cycle could bring more extreme weather. That means this year's United Nations Climate Change Conference—COP31 in Antalya, Turkey—will come just as millions of people have been pushed deeper into energy and food poverty, forced to suffer truly terrible conditions as they endure more severe natural disasters.

These perils underscore the danger of continuing to depend on imported fossil fuels. Around 80% of the global population lives in countries that remain net importers of fossil fuels, and we have just witnessed how vulnerable this reliance leaves our economic security. Around the world, but especially in developing countries, the prices of essentials have spiked, financial conditions have deteriorated, and debt distress has spread.

This latest global crisis further reinforces the need for cleaner, more resilient sources of energy. Three years ago, at COP28 in Dubai, governments agreed that we need a just, orderly, equitable transition away from fossil fuels. This year, we must map that high-level vision into a day-to-day reality.

To that end, my goal as president-designate of COP31 is to spark a global conversation about electrification. We must move from abstract debates to address the real decisions that ordinary people face. Think of the family considering whether to buy an electric car; the landlord installing solar panels, batteries, or heat pumps; the city planner investing in electric buses; or the paper producer electrifying its heating process.

This topic is critical, because while 45% of global direct emissions come from buildings, transportation, and industry, only around 20% of energy demand is met by electricity rather than direct fossil fuels. Thus, one of our core objectives at COP31 will be to forge an agreement on how everyone can contribute to a new global electrification target of 35% by 2035 as part of our Action Agenda.

These targets are not pulled out of thin air. The data show that they can be reached if policymakers heed the assessments by the International Energy Agency and the International Renewable Energy Agency of the steps needed to limit global warming to 1.5° Celsius above pre-industrial levels, as set out in the Paris agreement. That overarching ambition is now over a decade old, and this new target is an important stepping stone.

But simply electrifying daily life is not enough. We also must rapidly scale up renewables, so that electrified economies are powered by clean energy. We need expanded and resilient grids to manage the new load. And we need more financial support for developing countries to bring them along.

Previous COPs have set targets for each of these needs. At COP28, everyone committed to tripling the world's renewable-power capacity by 2030. At COP29 in Baku, 74 countries recognized the need to boost energy-storage capacity sixfold, and to add or refurbish 80 million kilometers of grids by 2040. And donors committed to mobilizing at least $300 billion annually by 2035 for developing countries.

All these targets matter. Together, they form the architecture for the energy transition. They send strong market signals and provide a shared basis for rallying global collective action in a fractured world. They are meaningful precisely because they are "stretch goals"—ambitious but achievable.

In 2026, two additional developments give us hope. The first is the extraordinary collapse in the costs of essential ingredients like batteries and solar panels. Owing to this trend, Turkey has now provided permits for more battery storage than any EU member.

Second, historic events like the war in the Gulf can lead to historic movements, as the 1970s oil crises did by driving unprecedented energy-efficiency gains. The current crisis has unleashed powerful market forces that we can harness, at COP31 and beyond, to accelerate electrification.

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* The article was first published on *Project Syndicate* on June 22nd, 2026.

* Murat Kurum, Turkey's Minister of Environment, Urbanization, and Climate Change, is President-designate of the 2026 United Nations Climate Change Conference (COP31).

There is no one-size-fits-all model. Each country will make a different contribution, and each sector will map out its own pathway. Africa's challenges and opportunities are not the same as Europe's. Electrifying transportation is not the same as electrifying industrial processes and buildings. No one can or should try to impose solutions on anyone else. But everyone must recognize that electrifying daily life is how we move away from fossil fuels. It is how we can make these volatile commodities superfluous. And it is how we can shield families from the effects of spiraling energy prices.

We will use the convening power of the COP presidency to focus minds, forge stronger partnerships, and move into implementation mode. Our world is in peril, and electrification is our salvation.

IMI International Monetary Review

What It Means for Global Warming to Exceed 1.5°C *

By NICHOLAS STERN *

A sobering new report from the United Nations Environment Programme warns that even if governments deliver on all their existing climate pledges, warming could reach 1.8°C later this century. That means humanity must pivot from simply containing global warming to finding ways to reverse it.

The world must now face up to the fact that the increase in average global temperatures will surpass 1.5° Celsius, the more ambitious of the 2015 Paris climate agreement's targets. That means devising a plan for managing the consequences—by increasing our focus on adaptation, loss and damage, and geoengineering—while redoubling our efforts to cut greenhouse-gas (GHG) emissions.

A sobering new report from the United Nations Environment Programme (UNEP) warns that even if governments deliver on all their existing climate pledges, global warming could reach 1.8°C later this century. Meanwhile, a continuation of current policies could produce warming of 2.6°C by 2100. Either way, overshooting 1.5°C will expose the world to serious costs, including more frequent and intense heatwaves and bouts of heavy rain in many places. It will also bring us closer to breaching climate thresholds (or "tipping points") beyond which lie far greater risks—such as destabilization of the polar ice caps in Greenland and West Antarctica.

While the poorest countries will continue to be hit earliest and hardest, this summer has demonstrated that even rich countries like the United Kingdom are not prepared for the climate-driven risks that are already materializing, let alone the risks that await us. Temperatures will rise, and the negative effects of climate change will continue to mount until global GHG emissions are reduced to net zero and atmospheric concentrations stop growing. As long as they are still rising, so will the costs to us all. The net-zero target follows from physics, not ideology.

The effects of overshooting 1.5°C will require much larger investments in adaptation and resilience, ranging from higher sea defenses to the development of more drought-resistant crop varieties. Such investment will become a much higher priority, and overall investment needs will become much greater than would have been the case had we met the Paris target.

But there are limits to adaptation. Breaching major climate thresholds could lead to conditions so hostile that socioeconomic development itself would be reversed, forcing hundreds of millions of people to move despite whatever adaptation measures are in place.

The longer it takes us to reach net-zero emissions, the larger the costs will be. Minimizing those costs will require more investment in rapidly cutting emissions through the deployment of renewables and electric vehicles, while making more rapid progress in hard-to-abate sectors such as maritime shipping and air travel.Although investment in the necessary technologies has been growing strongly, we still need a marked and sustained acceleration to phase out the polluting, inefficient practices that are making emissions rise further. Despite the International Energy Agency's warning five years ago that limiting warming to 1.5°C would require that no new fossil fuel projects be launched, many producers have been expanding their exploitation of oil, gas, and coal reserves. As a result, managing climate change will require stranding even more fossil-fuel infrastructure, creating a real cost for investors who have backed dirty energy over renewables.

One must also acknowledge the high costs associated with depending on international hydrocarbon markets. The competition for fossil fuels drives violent conflict, and price volatility has repeatedly caused severe economic crises. And yet, in most of the world, clean energy is now cheaper than dirty alternatives. Investing in clean, efficient technologies and infrastructure offers developing countries the chance to generate strong, sustainable, and resilient economic growth while cutting emissions.

Nonetheless, the UNEP report points out that reversing the 1.5°C overshoot will require us to go beyond net zero to achieve negative emissions, meaning we will eventually need to remove much more carbon dioxide from the atmosphere than we add. Though we can and should expand natural carbon sinks, including forests, these are unlikely to offer the total capacity we will need. Closing the remaining gap therefore will require greater investment in artificial methods of extracting and storing billions of tons of atmospheric CO2.

We should also examine carefully the potential of other geoengineering solutions, including those designed to reduce the total amount of solar energy reaching the Earth's surface. Further research is needed,

* The article was first published on *Project Syndicate* on September 21st, 2026.

* Nicholas Stern, a former chief economist of the World Bank (2000-03) and co-chair of the international High-Level Commission on Carbon Prices, is Professor of Economics.

however, because these options come with significant risks and ethical implications. For example, cooling the planet while leaving high levels of CO2 in the atmosphere would acidify our oceans, with potentially dangerous consequences.

The next few decades will be challenging. There will be many opportunities for investment and growth, but also serious dangers, owing to our hitherto slow response to the risks of climate change. We must come to grips with our new reality before we blow past yet another dangerous threshold.

IMI International Monetary Review

Working Paper

Disciplining the Factor Zoo: Identifying Pricing Factors in the Chinese Stock Market *

By QINGBIN MENG, JI QI, SOLOMON WANG AND XUANKAI ZHAO *

1. Introduction

Delving into fresh factors related to cross-sectional variations in stock returns remains a central focus of asset pricing studies. With ac ademics and practitioners uncovering numerous market anomalies and their associated pricing factors (Harvey et al., 2016; Hou et al., 2019), the exponential growth in these factors poses a formidable challenge. Pooling all these pricing factors for a systematic examination of each factor's marginal effect becomes increasingly complex. This complexity arises partly from the limitations of traditional linear regression models in identifying the explanatory power of factors and the so-called curse of dimensionality. Addressing this challenge, Cochrane (2011) underscores the need to discern which factors genuinely harbor unique information capable of predicting expected returns. Are the factors genuinely rooted in unique risk premia required by investors, or are they merely results of data mining? These questions highlight the need for discerning the true signal amid the noise of an expanding array of pricing factors.

Certainly, identifying the risk factor(s) influencing the stock returns in the turbulent Chinese stock market poses an even greater challenge. The unique market participant structure and institutional differences introduce distinctive pricing dynamics in the emerging market, even when considering the same risk factor applied in the developed market. Despite its considerable size, the Chinese market exhibits a larger pro portion of irrational retail participants, heightened transaction costs, and more frequent government intervention compared to developed markets (Hanauer et al., 2024). The market regulator also imposes restrictions on the costs for short-selling and sorts of arbitrage, which potentially leading to significant abnormal returns.

Moreover, it is important to assess the marginal contribution of each factor while adequately controlling for other variables. Despite the recent surge in attention to anomalies in China's stock market (Hsu et al., 2018), a few studies, led by Li et al. (2023) and Hou et al. (2023), test the significance of over 450 long-short trading strategies, revealing that when a more stringent hurdle rate is applied, the significance rate diminishes—a trend consistent with findings in the U.S. stock market.

In this paper, we further investigate which factors really determine the movement of cross sectional expected returns within a factor zoo of 100risk proxies in Chinese stock market.Specifically, we test risk factors under the Stochastic Discount Factor (SDF) framework instead of the linear multivariate factor model. That is because the linear pricing model is a specific form of the SDF and assesses the effectiveness ac cording to the significance of a factor's risk premium. This could falsely identify a risk factor because of the correlation with some uneasily observed true pricing factor(s), thus failing to explain the variation of cross-sectional returns. By contrast, the SDF better reflects the correla tion between the factors and the expected stock returns (Cochrane, 2011) and thus more effectively identify the incremental information of risk factors. Our work complements extant studies mostly focusing on discovering new asset pricing anomalies or predicting cross-sectional return (Leippold et al., 2022; Hou et al., 2023), by finding indepen dent factors that are marginally contribute to cross sectional returns.

Armed with advanced machine learning techniques, we choose Double Selection LASSO(DSLASSO)method to identify key factors from a large pool of Chinese factor zoo. Notably, controlling for other factors is essential for selecting the factors that truly drive cross-sectional return variation. The traditional linear regression method is trapped by data snooping bias or P-hacking and can easily qualify spurious factors when controlling for high-dimensional factors (Harvey et al., 2016;

* Published in *Economic Modelling*, Volume 155, February 2026.
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Linnainmaa and Roberts,2018;Hou et al.,2019). Under the sparsity hypothesis, LASSO has emerged as a viable approach to handle high-dimensional factor problems through regularization, aiming to avoid overfitting and simplify the model. Post-LASSO (Belloni and Chernozhukov, 2013; Belloni et al., 2012) aimed to correct the estimation bias of LASSO but might omit relevant variables when LASSO is run only once. The DS LASSO method proposed by Belloni et al. (2014) and further supported by Feng et al. (2020) is claimed to address this issue. The DS LASSO method offers more advantages by modifying the omitted errors and making more accurate statistical inferences for the coefficients of the factors remain to be tested during the estimation (Belloni et al., 2014; Feng et al., 2020).

Technically, the DS LASSO method conducts a two-stage estimation. First, it selects control factors from benchmark factors b by performing LASSO variable selection twice. The selection of factors from b t occurs in two rounds, which is essential for obtaining accurate inferences about the testing factor x t t . In the initial round, factors are chosen from b based on their pricing ability for the cross section of returns, excluding those with little contribution to cross-sectional asset pricing. However, running LASSO only once may eliminate factors with small SDF loading but strong cross-sectional covariance with the testing factor x t 's exposures. Such omissions distort the estimator's asymptotic distribution, leading to wrong inferences about the significance and sign of x t t t 's SDF loading. Therefore, in the second round, if a deleted benchmark factor has a strong correlation with a testing factor, it is necessary to add it back to the model. Finally, the method conducts cross-sectional regressions in the second stage, using the twice-selected benchmark factors as control variables, to estimate the SDF loading of the testing factor x . The marginal explanatory power of x t is determined by the statistical significance of the relevant parameters.

Our data cover all Chinese public-listed firms between January 2001 and September 2019[1]. For each year of the sample, we assign individual stocks into different portfolios according to firm characteristics in order to obtain testing assets and risk factors proxies. To measure cross-section of stock returns, we divide individual stocks into 5 ×5 double sort portfolios according to the market size of floating shares and one of the 97 risk character variables[2]. In total, we obtain 2425 (97× 25) portfolios as test assets, and then calculate value-weighted returns for each portfolio.

Based on the anomaly factors found in Chinese studies, we construct a factor zoo of 100 factor proxies in Chinese stock market. Specifically, 16 commonly perceived factors are from popular asset pricing models such as CAPM (Sharpe, 1964; Lintner, 1965), Fama-French multifactor models (Fama and French, 1993), Q4 and Q5 multifactor models (Fama and French, 2015), mispricing factor model (Stambaugh and Yu, 2017) and Chinese multifactor models (Liu et al., 2019). Those risk factors are mostly supported theoretically and empirically in developed markets. If they also perform well in Chinese stock market as in its advanced counterparts, we expect most of them would be significant in the test. Thus, it would be very useful to include those mainstream factors in our empirical analysis for understanding the real roles they are playing in determining cross sectional return variation.

Following the classical method of Fama and French (1993), other 84 risk factors are calculated from the return spread of the long and short portfolios which are obtained 2 × 3 double sort with one dimension as market size and the other dimension based on one of the 84 firm character variables. Those risk factors are from the established literature corresponding to market anomalies founded in developed market and the cross-section of stock returns are measured in the same way. Moreover, all 100 factors can be categorized into two classes and 9 subgroups according to each firm's financial performance and market trading behavior. The first class is firm financial factors, which represent an individual firm's daily operating and financial performance, including 8 investment factors, 9 profitability factors, 11 growth factors, 11 value factors, 12 other financial factors. The second group is related to market trading friction and volatility factors, which illustrate the return and volatility dynamics, including 10 momentum factors, 12 liquidity factors, 5 return factors, and 22 volatility factors. In empirical analysis, classifying factors serves to succinctly summarize the pattern of risk factors that dominate cross-sectional asset pricing. This is achieved by comparing factor exposures across different groups.

To unleash the power of DS LASSO better and more robust, we carefully choose a handful of benchmark factors to serve as control variables. The selection of benchmark factors is crucial as they directly impact the statistical inference of the factors being tested. We adopt two approaches in choosing them. First, we consider the inclusion of 16 well accepted factors derived from popular asset pricing models, forming what we term as theoretical benchmark factors. This method allows us to investigate whether the marginal explanatory

[1] Our study focuses on a period of relative stability in China's market and excludes structural disruptions. This period is characterized by a consistent economic environment where factor performance primarily reflects market driven risk premia, rather than distortions caused by post-2019 pandemic shocks, policy shifts, or global crises. Including such events could distort factor significance and hinder the identification of genuine incremental pricing information.

[2] The market risk premium factor is not used for portfolio construction. We also have two value factors (HML) constructed at annual level and monthly level. One of them is not used in portfolio construction. Therefore, 98 factors of the 100 are used for portfolio construction for the cross-section returns.

power of other risk factors, outside the mainstream asset pricing theory, is statistically significant in the Chinese market. This approach is particularly significant as it provides insights into whether classic factors that are well-established in developed markets also hold sway in the Chinese market concerning cross-sectional expected returns.

Second, the other approach is to select benchmark factors based on the timing of their publication in academic journals. We term this approach simple recursive benchmark factors. Given that only a few benchmark factors are supported by asset pricing theories, numerous factors remain to be tested. A concern arises that these untested factors might show significance easily if the benchmark factors provide limited information about the sources of risk in the Chinese stock market. Since risk factors or anomalies are identified in a time sequence, it is prudent to discern redundant or spurious factors while controlling for all preceding factors. Building on the methodology outlined by Feng et al. (2020), we rank all risk factors based on their publication dates. Subsequently, we recursively expand the benchmark set to control for all existing factors when testing newly discovered factors. Our analysis reveals that a substantial proportion of tested factors remains statistically significant, even after applying a more stringent t-statistic cutoff of 3 for multiple testing (Harvey et al., 2016).

However, anomalies in Chinese stock market do not decline or disappear as in U.S. market due to various barriers to arbitrage trading. Simple recursive regression analysis according to publication dates probably omit or misjudge some influential risk factors specially underlying in China. Thus, it is necessary to cover full time periods before and after publication. Another reinforced way is to make restriction on the procedure of selecting benchmark factors to ensure important prior information be incorporated into control variables. At the start, Fama French 3 factors are selected as the initial benchmark, and the remaining factors are individually tested sequentially with publication dates, and the one with the highest t-statistics value is added to the benchmark recursively. Consequentially, 18 benchmark factors are filtered out automatically, and then used as controls for identifying other risk factors. The advantage of this approach is that the benchmark selection is data driven and each benchmark factor contains as much independent information as possible. We term this approach expand recursive bench mark factors.

Overall, our results show that most of the factors have significant marginal explanatory power. The factors related to firm financials and market trading frictions both serve as the most important sources for risk premia from the perspective of statistical significance. Specifically, more than 60 % of the testing factors contain incremental information in different model specifications. 50 of the 84 testing factors are significant in relative to the benchmark of 16 classic risk factors, while 55 of the 82 risk factors are shown to be effective based on the data-driven augmented benchmark factors. And we show that volatility factors are particularly more important determinants of assets pricing, which consistent with the notion that the limit to arbitrage is quite pronounced in China. Our findings answer the questions raised in Cochrane(2011) in explaining cross section of returns. There are such many marginally significant risk factors that it is hard to pin down a parsimonious linear factor model to explain the variation of expected return. Furthermore, some influential risk factors in developed markets do not significantly drive the cross-sectional returns in China.

Our paper contributes to the growing literature in three aspects. First, we quantify the marginal contribution of each factor to explain the cross-sectional variation of stock returns via constructing the zoo of 100 factors. Our study provides a comprehensive view on which factor(s) determine the movement of cross-sectional stock returns, rather than precisely predict future returns. Although some studies pay attention to anomalies and multifactor asset pricing models in the Chinese stock market (Hsu et al., 2018; Hou et al., 2023; Li et al., 2023), such works do not depict the informativeness of each risk factor. In contrast, our paper emphasizes a different fundamental question: which factors marginally contribute to explaining the cross-sectional returns in the Chinese stock market? Rather than finding new anomalies or selecting a model that predicts returns, our goal is to select factors whose coefficients are reliably significant under the SDF framework when controlling for all other factors. We aim to identify factors containing independent and incremental information among high-dimensional factors. This work not only disciplines the Chinese factor zoo, but also gives important insights into understanding anomalies and asset pricing models in an emerging and transitional stock market.

Additionally, Chen et al. (2021) also uses double selection LASSO to test Chinese factors. The key differences lie between our study and theirs. We focus on evaluating the marginal contribution of a new factor rather than estimating a full reduced-form asset pricing model, e.g. using the GRS test of Gibbons et al. (1989). In contrast, Chen et al. (2021) primarily investigates whether newly discovered factors through DS LASSO can improve the performance of a Chinese asset pricing model proposed by Liu et al. (2019). Instead of evaluating the incremental information of factors within a single pricing model, we assess them

against various benchmark factor sets, including theoretical and data- driven ones. Second, we confirm significant differences between the Chinese market and the developed markets in the determination of cross section of returns. Our findings reveal that factors related to a firm ' s financial status and market frictions are major sources of risk premia, and that volatility-related factors are consistent over time in explaining stock returns. While China ' s stock market trading is characterized by insufficient liquidity, transaction costs, information asymmetry, etc., These factors are important sources of risk premia and have marginal pricing power (Hu et al., 2021). Our paper contributes to the literature by presenting how differences in institutional environments could deter mine the market efficiency as well as dynamic characteristics of risk factors (Jansen et al., 2021). To some extent, our paper provides new evidence that links cross-sectional return variation to financial market structure.

Third, our study extends the application of the Double Selection LASSO method following the work of Feng etal. (2020) by adopting two different benchmark factor selection procedures. Although Feng et al. (2020) proved that DS LASSO is effective for parameter estimation, the benchmark factors may contaminate the statistical inference of other testing factors. We modify their methodology by introducing various specifications of benchmark factor sets, such as classic pricing factors implied in theories and data- driven pricing factors automatically selected by the LASSO process. The empirical results based on these methods are generally consistent. Moreover, the number of new factors in Feng et al. (2020) is limited, so their setting may underestimate the number of testing factors and neglect the issue of potential multi-collinearity among them. We overcome these shortcomings by assessing across different sizes of testing factors and by adopting stepwise regressions in the second stage of DS LASSO.

The rest of the paper is organized as the following. Section 2 provides a literature review. Section 3 explains empirical modeling and parameter estimation. Section 4 presents analysis results. Section 5 shows robustness tests and Section 6 concludes and offers implications.

2.Literature review

Since Capital Assets Pricing Model (CAPM) was developed by Sharpe (1964) and Lintner (1965), many researchers have used simple factor model to explain the variation of assets' expected returns. Fama and French (1993, 2015, 2018) first extend the CAPM by incorporating size, value, profitability, investment, and momentum factors to develop three-, five-, and six-factor models. These models have been tested to be effective in both U.S. and international markets (Fama and French, 2016; 2017). Meanwhile, Hou et al. (2015, 2021) and Stambaugh and Yu (2017) propose four-factor and mispricing factor models, respectively, with stronger explanatory power. In addition, numerous anomalies (e.g., in firm financials, market friction) have been identified so far. Although there are common methods for testing anomalies[3], inconsistencies in data periods, benchmark models, and performance metrics make it difficult to determine whether the anomalies are truly linked to excess returns. Statistical bias can lead to wrongful identification of fake anomalies (Harvey et al., 2016; Linnainmaa and Roberts, 2018; Hou et al., 2019). This issue is more prominent in developed stock markets (Jacobs and Muller, 2020), while in developing markets, arbitrage limitations from market segmentation and asset mispricing outweigh it.

Our paper relates to the asset pricing literature that incorporates machine learning or statistical methods. For example, Rapach et al. (2013) employ LASSO regression, Harvey and Liu (2021) use a stepwise sampling method, and Gu et al. (2021) apply a non-linear machine learning algorithm to enhance stock return prediction. Given the high-dimensionality issue of asset pricing, LASSO also becomes a mainstream technique for dimension reduction and variable regularization (Feng et al., 2020; Freyberger et al., 2020). Kozak et al. (2018) highlight common determinants in asset returns, while Lettau and Pelger (2020) use penalized pricing errors to identify latent factors. Kelly et al. (2019) view asset risk exposure as a function of firm characteristics and apply Principal Component Analysis (PCA) to extract common factors. Although these methods improve stock prediction ac curacy and capture nonlinear correlations among variables, they often lack interpretability and theoretical economic grounding.

From the perspective of China's stock market, the relevant asset pricing research remains insufficient compared to developed markets. Existing literature mainly focuses on two aspects: replicating anomalies or adapting factor models for Chinese A-share market. In anomaly replication, China's distinct market features (e.g., more retail investors and state-owned firms, short-sales restrictions, etc.) generates anomaly patterns diverging markedly from the U.S. markets. Jansen et al. (2021) only find value, risk, and trading anomalies work well in China. Both Hou et al. (2023) and Li et al. (2023) find that few of the over 450 replicated

[3] Generally, there are two primary methods to test anomalies. One approach is to form portfolios based on a characteristic and then calculate the long-short portfolio return (i.e., the risk premium). Another way is to run Fama-MacBeth regression at firm-year level, using the factor as the independent variable and stock returns as the dependent variable.

anomalies are significant in conventional single portfolio test. Interestingly, machine learning-based composite strategies outperform univariate ones in raw and risk-adjusted returns (Leippold et al., 2022; Hou et al., 2023).

Regarding factor models, scholars adapt classical frameworks to China's context. Liu et al. (2019) revise the value factor and add a sentiment factor. Huang (2019) enhances the five-factor model with a profitability factor. Li and Rao (2022) propose a revised factor model that excludes shell firms via expected shell probability (ESP). Lu and Li (2023) test Liu et al.'s (2019) three-factor model in China and use a wild bootstrap GRS test to address the time-varying volatility of returns. Ma et al. (2023) employ instrumented PCA to derive a latent factor model from hundreds of anomalies with strong explanatory power.

While prior research on Chinese stock market anomalies and multifactor models examines asset pricing dynamics, these studies neglect to assess individual risk factors' informational value. We address this gap by answering a fundamental question: Which factors in the Chinese factor zoo provide independent explanatory power for cross-sectional returns when controlling for all coexisting factors? Different from anomaly discovery or return prediction, we employ the SDF framework to systematically identify factors carrying non-redundant incremental information. To this end, we follow Belloni et al. (2014), Feng et al. (2020) and use double selection LASSO method to examine the marginal explanatory power of all the risk factors.

3. Empirical model and parameter estimation

3.1 Analysis framework

Our empirical analysis is based on stochastic discount factor (SDF) pricing model and DS LASSO method for parameter estimation and statistical inference. No previous studies have shown that any factors have the full explanatory power, so a randomly specified model could include redundant or even useless factors. The method we use not only modifies the statistical bias due to simply variable selection in a big data environment, but also identifies the marginal explanatory power of the risk factors and reduce data peeking bias.

In the studies of assets pricing, SDF model and linear pricing model are the two major methods. In the framework of mean-variance analysis, the factors in SDF model can be replaced with corresponding portfolios. Thus, linear assets pricing model provides the same function as linear SDF does. Still significant difference exists between the two models. For example, the risk premium in the linear pricing model is the return required by investors to compensate the relative risk, but it does not explain the variation of cross-section returns. A factor could falsely lead to a risk premium, just because it is correlated with the true factor. Thus, SDF provides better estimation since it reflects the relationship between the factor and cross-section of assets prices (Cochrane, 2011). To test the effect of risk factors in the Chinese stock market, we primarily rely on SDF models.

We also emphasize the methodology of parameter estimation in the big data environment. The pre-condition to find an effective risk factor is to properly identify common factors in all specifications. DS LASSO could do the favor. This method was first raised by Belloni et al. (2014) to analyze treatment effect with big data. Later, Feng et al. (2020) extend its usage to identify the risk factors that affect cross section of stock returns. They use benchmark factors as control variables to examine other factors. When risk factors are overly numerous, DS LASSO outperforms traditional LASSO in model specification and statistical inference in cross-sectional analysis.

3.2 Model specification

To test the marginal effectiveness of the factors, we follow Hansen and Richard (1987) and use SDF framework to construct a benchmark assets pricing model. The price of a financial asset equals to the summation of discounted expected cash flows in the future: $E\left(m_t R_{i,t}\right) = 1$, where $R_{i,t} = P_{i,t}/P_{i,t-1}$ is the total return of the assets at time t, and $P_{i,t}$ is the price of financial asset i at time t. mt is SDF that describes the cor relation between the cash flow received from holding the assets at time t and the asset price at $t-1$.

An asset pricing model can identify an mt as linear or non-linear. If mt is linear and determined by a variety of factors, then:

$$m_t = \alpha_0^{-1} - \alpha_0^{-1}\beta_v^{'} v_t = \alpha_0^{-1}\left(1 - \beta_x^{'} x_t - \beta_b^{'} b_t\right) \quad (1)$$

where α_0 is the return of the risk-free portfolio or zero-Beta portfolio; v_t represents the combination of all risk factors, and it is composed of two vectors: x_t and b_t, where x_t is the vector of testing factors in $p \times 1$ dimensions and b_t is the vector of benchmark factors in $q \times 1$ dimensions, or control variables in the model. To retain statistical generality, x_t and b_t are both decentralized with $E(x_t) = 0$ and $E(b_t) = 0$. β_x and β_b

are the vectors of parameters for x_t and b_t, or SDF loadings. We test the statistical significance of β_x to conclude whether x_t is marginally effective. If x_t belongs to the pool of significant determinants of SDF, then it can significantly affect cross section of stock expected returns.

Since SDF is unobservable, the estimation of factor parameters needs to clarify the quantitative relationship between the factors and the returns. Based on Equation (1), we derive the cross section of expected returns E(rt) as the covariance matrix of various asset returns and risk factors, as expressed below:

$$E(r_t) = \iota_n \alpha_0 + C_v \beta_v = \ell_n \alpha_0 + C_x \beta_x + C_b \beta_b \quad (2)$$

where, ι_n is a column vector in n × 1 dimension, while n denotes the number of assets to be examined. $C_v = Cov(r_t, f_t)$, $f \in \{x, b\}$, is the covariance between asset returns and risk factors, as a way to measure the risk exposure of the factors. To reach an accurate estimation of β_x, one must consider the cross-sectional correlation between parameter C_x and C_β. The relation between the two vectors can be expressed in the following equation:

$$C_x = \iota_n \xi' + C_b \chi' + \mu_e \quad (3)$$

where ξ is a p × 1 vector, χ is a p × q matrix of parameters, and μ_e is an n × p matrix of residuals from cross sectional regression.

It is worth mentioning that our estimation model has different economic meaning than multiple linear beta regression, the latter of which focuses more on the relation between factor risk premium and related risk exposure[4], as indicated in the formula below:

$$E(r_t) = \iota_n \alpha_0 + \tau_x \gamma_x + \tau_b \gamma_b \quad (4)$$

where γ_x and γ_β are risk premia of risk factors x_t and b_t. The parameter estimates are the corresponding risk exposures[5]. This model is used to test whether the asset pricing model itself is effective or whether the tested risk premia are significant. The model cannot accurately measure whether the risk factors are directly related to the cross section of expected returns. Even if a factor is tested to be related to a risk premium, the risk premium could be caused by another factor that is true but not tested in the model. Therefore, a better estimation methodology is needed.

3.3 Parameter estimation in DS LASSO

If there are not many risk factors in the regression, then a cross sectional analysis could yield statistical inference with confidence. As the number of risk factors increases, the curse of dimensionality emerges and the effectiveness of parameter estimation declines. If the number of risk factors exceeds the sample size, even the standard Fama- Macbeth regression cannot be implemented. Thus, it is important to control other factors when testing the marginal explanatory power of certain factors. Under the hypothesis of sparsity, LASSO is a feasible way to process the high dimensions of factors through regularization[6].

The LASSO method was developed by Tibshirani (1996) to obtain a suitable predicting model through proper variable selection and regularization process. Belloni and Chernozhukov (2013), and Belloni et al. (2012) developed Post-LASSO method to modify the estimation bias. They first run the basic LASSO for variable selection. With the selected variables, they run regression again for the finalized estimation results. The pitfall of this method is that relative variables could be omitted during the selection process, when LASSO was run only once. Belloni et al. (2014) argue that a DS LASSO method could solve the problem. Feng et al. (2020) also propose that the model selection method in DS LASSO could avoid the bias due to omitted variables.

Following Feng et al. (2020), in the first stage of our estimation, we run LASSO regression twice for variable selection and extract the common risk factors b_t. In the second stage, we run cross-sectional regression using b_t as control variables, to examine the testing factors x_t. The marginal explanatory power of x_t is derived from the statistical significance of β_x. The flow chart as shown in Fig. 1 explains the above estimation process.

3.3.1. Variable selection in double selection LASSO

In the first round of variable selection, we extract the most significant factors from the vector of benchmark factors bt and simultaneously delete the factors with SDF loading near 0. In particular, we run cross sectional LASSO regression of expected returns on Cb, which is the covariance between expected returns and the benchmark factors, as shown below:

$$\min_{\alpha,\beta} \{ n^{-1} |\bar{r} - \iota_n \alpha - \widehat{C_b} \beta| - \lambda_0 n^{-1} |\beta|_1 \} \quad (5)$$

where $\hat{C}_\beta = Cov(r_t, b_t) = T^{-1}\bar{R}B'$[7]. The index of benchmark factors selected are marked as $\hat{I}_1$.

[4] See Cochrane (2011).
[5] To be consistent, the risk exposure of factors expressed as τx and τb, or beta parameter.
[6] The sparsity hypothesis predicts that among many factors, only a few determine the variation of the observed variable. The purpose of regularization is to avoid overfitting and reduce complication. A common way is to impose a penalty parameter for pricing errors.
[7] For a matrix M = (m1: m2 : ⋯ mT), we use $\bar{m} = T^{-1} \sum_{t=1}^{T} m_t$ and, $\bar{M} = M - \iota_T' \bar{m}$, where $\|M\|$ and $\|M\|_1$ express the matrix operator and L1 norms, respectively.

In the second round of LASSO, we add more risk factors in addition to the benchmark factors, with the goal to extract more significant factors. When a factor appears insignificant in affecting asset returns, it would be deleted in the first round of LASSO analysis. If the deleted factor has strong correlation with a testing factor, then the deletion would lead to bias in the statistical inference of the testing factor. Thus, it is important to add the deleted factor back to the model as a control variable. Specifically, for the jth testing factor x_{jt} (j = 1, …, p), its covariance with returns ($\hat{C}_{xj}$) is regressed on the covariance between returns and all control factors ($\hat{C}_{\beta}$) with the formula below[8]:

$$\min_{\xi_j,\chi_j}\left\{n^{-1}\left|\widehat{C_{x_j}}-\iota_n\xi_j-\widehat{C_b}\chi_j\right|_2^2+\lambda_j n^{-1}|\chi_j|_1\right\} \quad (6)$$

Each benchmark factor extracted in this step is collected in the group $\{\hat{I}_{2,j}\}$.

At last, we gather the benchmark factors from the double selection LASSO regression into a union, $\hat{I} = \hat{I}_1 \cup \hat{I}_2$. The collection will be used as the control variable index in the next stage of analysis.

3.3.2. Cross sectional regression

We regress the expected return on control variable b_t and test variable x_t to obtain the estimates of SDF parameters. In the regression, control variable b_t is selected from the first-stage index set $\hat{I}$, with its formula expressed below:

$$\left(\widehat{\alpha_0},\widehat{\beta_x},\widehat{\beta_b}\right)=arg\,min_{\alpha_0,\beta_x,\beta_b}\left\|\bar{r}-\iota_n\alpha_0-\widehat{C_x}\beta_x-\widehat{C_b}\beta_b\right\|^2$$

$$:\beta_{b,j}=0,\ \forall j\notin\hat{I},\ \hat{I}=\widehat{I_1}\cup\widehat{I_2} \quad (7)$$

In the first-stage of LASSO regression, the regularization parameter λj(j = 0, 1, ⋯ p) is used to adjust the degree of penalty in the control model. A higher value of λj indicates less variables being selected. When it equals 0, the model is the same as a least-square regression model. In addition, to incorporate the factors from well-accepted previous studies such as size factor and value factor, we apply restricted LASSO regression that retains these factors as controls with no penalty.

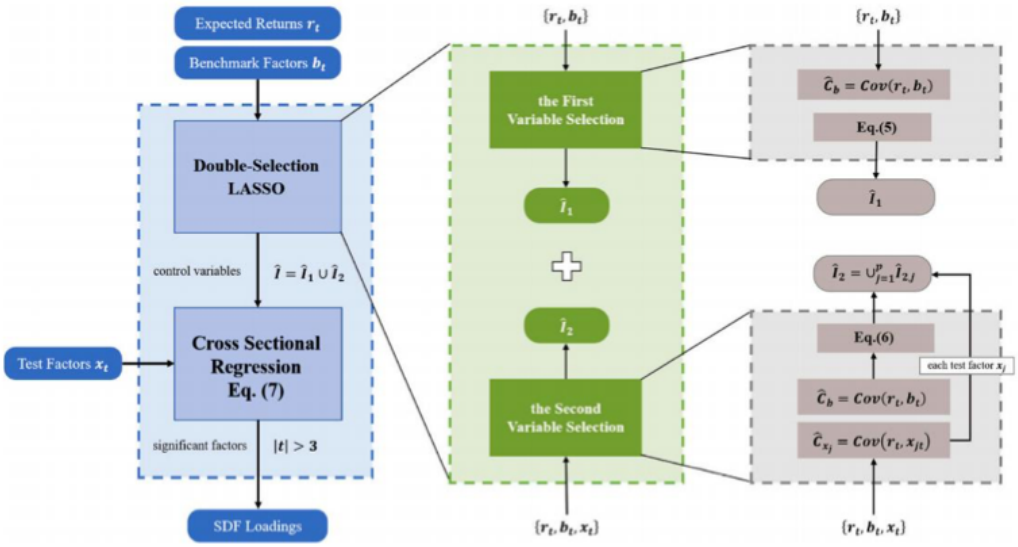

Fig. 1. Flow Chart of Model Estimation Process. Notes: The left section depicts the complete model estimation process, while the middle and right sections provide additional details on the first stage of the estimation. This includes running the LASSO regression twice to select variables and extract common risk factors, ensuring accurate control variable selection and reducing testing errors.

4. Data and variables

4.1. Data selection and variable construction

Our data is extracted from the databases of Wind and China Stock Market Accounting Research (CSMAR). The samples cover the monthly performance of all public-listed firms in China with the basic information of firm financials and stock trading records. The data period covers from January 2001 to September 2019. Since the risk premia of the factors and the risk exposures vary overtime, we form portfolios with less volatile

[8] For any matrix M, the use of $M_{i,\cdot}$, $M_{\cdot,j}$ is to express the i th row and j th column, respectively.

returns in our SDF models. In particular, we divide stocks into 5 × 5 bivariate independently sorted portfolios as testing assets. We first sort individual stocks into quintiles based on the ascending market size of floating shares at the June in fiscal year t-1, then are further sorted into quintile portfolios ranked according to one of the 97 firm risk characteristics. This results in 25 portfolios with each having equal number of stocks. After the process, a total of 2,425 (97 × 5 × 5) portfolios are yielded as test assets. The value-weighted excess monthly return for each portfolio is calculated.

We collect 100 risk factors following the existing literature, among which 51 factors are related with firm financials and 49 factors with stock market frictions. The financial factors include 8 investment factors, 9 profitability factors, 11 growth factors, 11 value factors, 12 factors about other accounting information, while the market friction factors cover 10 momentum/contrarian factors, 12 liquidity factors, 5 factors of return performance, and 22 volatility factors. The details of our factors are listed in Table 1.

The DS LASSO methodology requires a group of benchmark factors to be selected in the first stage and then used as control variables in the second stage. These papers introduced classical models including CAPM, Fama-French multi-factor model (Fama3, Fama5, Fama6), Q4 and Q5 factor model based on Tobin's Q theory (HXZ4, HXZ5), mispricing factor model, and the factor model in the Chinese stock market (CH3, CH4)[9]. In addition, we add the modified high-minus-low value factor developed by Asness and Frazzini (2013), which provides more timely updated equity and book value information. The description of these benchmark factors is in Table 2.

4.2. Descriptive statistics

First, we show the return distribution for the portfolios formed based on different characteristics in Table A1 of Appendix A. In total, we have 2425 bivariate-sorted portfolio returns for 224 months, as shown in the first row for all portfolios. The average return reaches 1.05 %, which is considerably high, compared to the performance of stock market index during the same period, mostly because the portfolio returns are more tilted towards small stocks after the sorts. Each row in the rest of the table reports the returns of the portfolios formed on one characteristic plus size. For example, in the second row for accruals, the samples are 25 portfolios in 5 groups formed on sizes intersecting with 5 groups formed on accruals. The average return of the portfolios is 1.37 %, which is ranked the highest among that for other characteristics. The factors in Table A1 is sorted based on the average return in a descending order. Down the bottom of the table, the portfolios sorted by 120-day liquidity yield the average return at 0.77 %, the lowest of the rank.

Second, we construct risk factors. To construct a risk factor, Fama and French (1993) conduct a 2 × 3 portfolio sort based on market cap and a unique stock characteristic, namely, book-to-market ratio. The risk factor is the equal-weighted return difference between the portfolios with highest rank of the characteristics and the portfolios with lowest rank. We use this method to calculate our Fama-French factors (SMB.FF, HML.FF, CMA.FF and RMW.FF) and the 84 testing factors. For each of the factors, the portfolios can be formed monthly, quarterly, or annually, depending on the data structure. For example, the FF factors are calculated for every year, while the momentum/contrarian factors are calculated for every month. In addition, for the three

[9] Liu et al. (2019) find that in China, small public companies are potential targets of reverse mergers by private firms, who intent to bypass the lengthy and risk IPO process. Based on this unique feature, they developed the size factor to explain cross section of Chinese stock returns.

Table 1
The details of the 100 risk factors.

Type	Name	Code	ID	source	Type	Name	Code	ID	source
Panel A Corporate Financial Fundamentals (51)									
Investment (8)	PPE and inventory Investment to Assets	*dPPE_and_inventory*	55	Titman et al. (2004)	**Growth (11)**	Fama-French Size Factor	*SMB.FF*	21	Fama & French (1993)
	Net operating assets	*Net_operating_assets*	56	Hirshleifer et al. (2004)		HXZ Market Cap Factor	*SMB.HXZ*	87	Hou et al. (2015)
	Investment over assets ratio	*dIA*	99	Hou et al. (2020)		Change of Inventory	*INVGchg*	54	Thomas & Zhang (2002)
	Accruals	*ACC*	28	Sloan (1996)		Growth of Inventory	*INVG*	53	Thomas & Zhang (2002)
	Change of accruals	*ACCP*	74	Hafzalla et al. (2011)		Growth of Leverage	*LG*	59	Richardson et al. (2005)
	Expected investment growth factor	*Expected_dIA*	98	Hou et al. (2020)		Growth of Book Value of Equity	*BVEG*	58	Richardson et al. (2005)
	Fama-French Investment Factor	*CMA.FF*	83	Fama & French (2015)		Size Factor with Shell Contamination	*SMB_CN*	97	Liu et al. (2019)
	HXZ Investment Factor	*R_IA.HXZ*	86	Hou et al. (2015)		Tax Growth	*TAXchg*	79	Thomas & Zhang (2002)
Profitability (9)	HXZ Earnings Factor	*ROE.HXZ*	85	Hou et al. (2015)		Profit Margin Growth	*PMG*	34	Abarbanell & Bushee (1998)
	Change of ROE	*dROE*	100	Hou et al. (2020)		Sales Growth	*SG*	27	Lakonishok et al. (1994)
	Profit/Assets Ratio	*PA*	82	Novy-Marx (2013)		Difference in Sales Growth and Inventory Growth	*SgINVg*	35	Abarbanell & Bushee (1998)
	Gross Profit Margin	*gross_profit*	69	Soliman (2008)	**Value (11)**	Fama-French Value Factor	*HML.FF*	22	Fama & French (1993)
	Cash/ Productivity Ratio	*cashpr*	70	Chandrashekar & Ramesh (2009)		Dividend/Price Ratio	*DP*	7	Litzenberger & Ramaswamy (1982)
	Cash/Assets Ratio	*cash*	80	Palazzo (2012)		Monthly Price/ Earnings Ratio	*PE.M*	6	Basu (1977)
	Capital Turnover Ratio	*CT*	29	Haugen & Baker (1996)		Monthly Price/ Book Ratio	*PB.M*	8	Rosenberg et al. (1985)
	Return on Assets	*ROA*	73	Balakrishnan et al. (2010)		Value Factor with Shell Contamination	*PE_CN*	95	Liu et al. (2019)
	Fama-French Profitability Factor	*RMW.FF*	84	Fama & French (2015)		Earnings/Price	*EP*	32	Basu (1977)
Other Financials (12)	O-Score	*Oscore*	33	Dichev (1998)		Sales/Price	*SP*	30	Barbee et al. (1996)
	Management Factor	*MGMT*	94	Stambuagh & Yuan (2017)		Operating Cash Flows/Price	*OCFP*	57	Desai et al. (2004)
	Current Ratio	*CR*	12	Ou & Penman (1989)		Monthly Book-to-Market Ratio	*HML.M*	81	Asness & Frazzini (2013)
	Growth of Current Ratio	*CRG*	13	Ou & Penman (1989)		Leverage Ratio	*LEV*	10	Bhandari (1988)
	Quick Ratio	*QR*	14	Ou & Penman (1989)		Total Assets/ Market Value	*AM*	9	Bhandari (1988)
	Quick Ratio Growth	*QRG*	15	Ou & Penman (1989)	**Other (cont.)**	Performance Factor	*PERF*	93	Stambuagh & Yuan (2017)
	Cash Flow/Debt	*CFdebt*	11	Ou & Penman (1989)		Sales/Inventory	*saleinv*	16	Ou & Penman (1989)
	R&D Expenses	*RD*	64	Guo et al. (2006)		Sales/Cash	*salescash*	17	Ou & Penman (1989)
	R&D Expenses/ Sales	*Rdsales*	65	Guo et al. (2006)					
Panel B Market Friction (49)									
Momentum and Reversal (10)	120-day Momentum	*imom.120.D*	75	Blitz et al. (2011)	**Volatility (22)**	120-day Beta with excess return	*BETA.120.D*	3	Fama & MacBeth (1973)
	1-month Reversal	*revSimple.1M*	24	Jegadeesh & Titman (1993)		120-day beta with raw return	*beta.120.D*	2	Fama & MacBeth (1973)
	24-month Momentum	*momSimple.24M*	18	Jegadeesh (1990)		120-day Skewness of Residuals	*resid_Skewness.120.D*	71	Boyer et al. (2010)
	24-month Reversal	*revSimple.24M*	25	Jegadeesh & Titman (1993)		120-day Std of Share Amount	*std_amount.120.D*	44	Chordia et al. (2001)
	2-month Momentum	*momSimple.2M*	19	Jegadeesh (1990)		120-day Std of Turnover	*std_turn.120.D*	47	Chordia et al. (2001)
	36-month Reversal	*revSimple.36M*	26	Jegadeesh & Titman (1993)		120-day Skewness of Returns	*skew.120.D*	88	Amaya et al. (2015)

(continued on next page)

Table 1 (*continued*)

Type	Name	Code	ID	source	Type	Name	Code	ID	source
	36-month Momentum	*imom.36.M*	76	Blitz et al. (2011)		120-day Idiosyncratic Volatility	*idvol.120.D*	62	Ang et al. (2006)
	3-month Momentum	*momSimple.3M*	20	Jegadeesh (1990)		120-day Downward Beta	*betad.120.D*	60	Ang et al. (2006)
	6-month Momentum	*momSimple.6M*	23	Jegadeesh & Titman (1993)		120-day Total Volatility	*vol.120.D*	66	Ang et al. (2006)
	12-month Momentum Factor	*UMD.FF*	31	Carhart (1997)		36-month Beta with excess return	*BETA.36.M*	5	Fama & MacBeth (1973)
Liquidity (12)	120-day Illiquidity	*illq.120.D*	51	Amihud (2002)		36-month Skewness of Residuals	*resid_Skewness.36.M*	72	Boyer et al. (2010)
	120-day Turnover	*turn.120.D*	36	Datar et al. (1998)		36-month Std of Share Amount	*std_amount.36.M*	45	Chordia et al. (2001)
	120-day Daily Volume	*amt.120.D*	40	Chordia et al. (2001)		36-month Std of Turnover	*std_turn.36.M*	48	Chordia et al. (2001)
	36-month Illiquidity	*illq.36.M*	52	Amihud (2002)		36-month of Return Skewness	*skew.36.M*	89	Amaya et al. (2015)
	36-month Turnover	*turn.36.M*	37	Datar et al. (1998)		36-month Idiosyncratic Volatility	*idvol.36.M*	63	Ang et al. (2006)
	36-month Total Volume	*amt.36.M*	41	Chordia et al. (2001)		36-month Beta with raw return	*beta.36.M*	4	Fama & MacBeth (1973)
	3-month Turnover	*turn.3M*	38	Datar et al. (1998)		36-month Downward Beta	*betad.36.M*	61	Ang et al. (2006)
	3-month Total Volume	*amt.3M*	42	Chordia et al. (2001)		36-month Total Volatility	*vol.36.M*	67	Ang et al. (2006)
	Turnover with Shell Contamination	*Turn_CN*	96	Liu et al. (2019)		3-month Std of Share Amount	*std_amount.3M*	46	Chordia et al. (2001)
	Monthly Turnover	*turnover.M*	39	Datar et al. (1998)		3-month Std of Turnover	*std_turn.3M*	49	Chordia et al. (2001)
	Monthly Volume	*volume.M*	50	Chordia et al. (2001)		3-month Skewness of Returns	*skew.3M*	90	Amaya et al. (2015)
	Monthly Share Amount	*amt.M*	43	Chordia et al. (2001)		3-month total Volatility	*vol.3M*	68	Ang et al. (2006)
Return Based (5)	Market Factor	*Rm_Rf*	1	Sharpe (1964); Lintner (1965)					
	120- day Maximum Return	*retnmax.120.D*	77	Bali et al. (2011)					
	36-month Maximum Return	*retnmax.36.M*	78	Bali et al. (2011)					
	120-day Alpha for Pricing Error	*alpha.120.D*	91	Stambaugh & Yu (2017)					
	36-month Alpha for Pricing Error	*alpha.36.M*	92	Stambaugh & Yu (2017)					

Notes: Table 1 reports the details of 100 risk factors considered in our analysis, including the factor types (51 corporate financial factors in panel A and 49 market friction factors in panel B), the name, and the shortcode of each factor. We also give the serial number (ID) of each factor based on the year of publication; the corresponding reference shown in the last column.

Table 2
Academic sources of the 16 benchmark factors.

Code	Factor Name	Literature Source	1	2	3	4	5	6	7	8
Rm_Rf	Market Factor	Sharpe (1964), Lintner (1965)	●	●	●	●	●	●	●	●
SMB.FF	Size Factor	Fama & French (1993)			●	●	●			●
HML.FF	Value Factor	Fama & French (1993)			●	●	●			
CMA.FF	Investment Factor	Fama & French (2015)				●	●			
RMW.FF	Profitability Factor	Fama & French (2015)				●	●			
UMD.FF	Momentum Factor	Carhart (1997)					●			
SMB.HXZ	Size Factor (HXZ)	Hou et al. (2015)						●	●	
ROE.HXZ	Earning Factor (HXZ)	Hou et al. (2015)						●	●	
R_IA.HXZ	Investment Factor (HXZ)	Hou et al. (2015)						●	●	
Expected_dIA	Expected Growth Factor	Hou et al. (2020)							●	
PERF	Performance Factor	Stambaugh & Yu (2017)								●
MGMT	Management Factor	Stambaugh & Yu (2017)								●
PE_CN	P/E Factor (China)	Liu et al. (2019)	●	●						
Turn_CN	Turnover Factor(China)	Liu et al. (2019)		●						
SMB_CN	Size Factor (China)	Liu et al. (2019)	●	●						
HML.m	Monthly Value Factor	Asness & Frazzini (2013)								

Notes: This table shows shortcode, name and literature source of each factor. The numbers from 1 to 8 in the title row represent eight factor models: CH3, CH4, Fama3, Fama5, Fama6, HXZ4, HXZ5, and MS.

factors in Q4 and Q5 models (SMB.HXZ, ROE.HXZ, R_IA.HXZ), we conduct 2 × 3 × 3 sort using monthly data. For the factors based on the study of Chinese market (PE_CN, Turn_CN and SMB_CN in Liu et al., 2019), we delete the stocks with market cap below 30 % percentile.

We then present the summary statistics of the 100 risk factors in our study in Table A2 of Appendix A. In Panel A, 5 of the 16 benchmark factors are statistically significantly different from 0 at the 5 % level. The economic significance of Turnover factor and the P/E factor are particularly high, and they appear negative at − 1.08 % and − 0.6 %, respectively. It shows that the heavily traded stocks and stocks with high investor expectations often experience lower returns subsequently. In Panel B, 47 out of the 84 testing risk factors

appear significantly different from 0. Among them, 33 are related with market frictions. Some are positively related to cross section of returns, namely monthly turnover rates (turnover.M, turn.3M, etc.), short-term price reversal(revSimple.1M), and return volatilities at overall level and idiosyncratic level. On the other hand, factors related to trading volume, share amount, and volatilities of trading activities (std_amount.120.D,std_turn.3M, std_amount.3M) are negatively correlated with the cross section of stock returns.

5. Empirical results

The selection of proper benchmark factors is the key to the success of testing newly added factors. Although DS LASSO has been proved effective for parameter estimation, still two potential problems can be found in this method. First, it cannot determine the sufficiency of the economic interpretation of the risk factors. Second, the initial combination of benchmark factors could contaminate the statistical inference of other testing factors. To address these issues, we use two methods to select and construct the pool of benchmark factors, based on well accepted classical factor pricing models, and publication dates of those factors, respectively, as shown in Fig. 2.

5.1. Estimation based on theoretical benchmark factors

5.1.1. Full sample analysis

Our empirical testing is carried out in two stages. In the first stage, two rounds of LASSO regression are conducted. In the first round of LASSO regression, we regress stock returns on the 16 benchmark factors and find the significant factors from this set. Since the 16 benchmark factors are cross-sectionally correlated with the other 84 testing risk factors, it is necessary to modify the selection of control variables to avoid omitting important variables. Thus, in the second round of LASSO regression, we further assess the correlation between the 84 testing variables and the 16 benchmark variables. If a benchmark variable is highly correlated with the testing variables but was omitted in the first round of LASSO, we will add this benchmark variable back as a control.

The estimation of penalty parameter λ is important, since it defines the sparsity of the valuation model. A different λ would come from a different pool of risk factors. When $\lambda = 0$, the model will select all of the risk factors; when $\lambda = \infty$, no factor would be picked. Therefore, a proper balance should be in place for a regression model with high fitness and application extensiveness.

To this end, we run 10-fold cross-validation 50 times to train and determine the two tuning parameters of the two LASSO regressions and so to reach the optimized specification. Specifically, we run 50 times of 10-fold cross-validation exercises using 50 different randomization seeds. For each seed, the cross-validation process selects a different value of the tuning parameter λ. Each time, we randomly separate our samples into 10 groups and use one group as the testing set and the other 9 groups as the training set. The process is repeated for each of the 10 groups and λ is estimated as the average of all times. As a result, we obtain 50 values of λ and use their average to specify the empirical LASSO regression model[10].

Comparing the results of the two LASSO regressions, one can detect the omitted benchmark factors. They can still affect the effectiveness of other factors. In the 50 cross examinations, we calculate the probability of selecting a benchmark factor. In Fig. 3, we provide the probabilities for selecting each of the 16 benchmark factors in the first round of LASSO regression. We can see that 13 of them are selected with 100 % probability. Among the other 3 factors left, Expected_dIA is chosen with 42 % probability, while ROE.HXZ and SMB.HXZ are not selected for low probabilities. It shows that it is difficult to explain the cross section of Chinese stock returns with certain mainstream multi-factor models.

Fig. 4 shows the selection probabilities of the 16 benchmark factors being selected in the second round of LASSO regression based on 84 tested risk factors. Here, we only present six testing factors as examples. Please refer to Appendix C for the results of other testing factors. For different testing factors, the selected factors are significantly different from the basic combination in the first-round LASSO regression. After taking the union of the tests, all of the 16 benchmark factors are selected as the control variables for the second step cross sectional regression. Meanwhile, the result shows strong correlations between benchmark factors and other risk factors**.**

In the second stage, a cross-sectional regression is conducted to test the predictability and orthogonality of the other 84 risk factors. Based on our Equation (7), we regress portfolio returns on 84 testing factors and

[10] The selection of variables by the LASSO estimator can vary depending on the choice of the penalty parameter λ. Different choices of λ result in different models selected by the estimator; the estimator is robust if the conclusions (in this case, the factors that get selected) remain substantially unchanged as λ varies. To evaluate the robustness of the selected model, we use 50 different values for λ though 50 times of 10-fold cross-validation. We utilize a heat map in Appendix B to visualize the t-values of each testing factor across the 50 cross validations. The figure demonstrates that the t-values stays quite stable, indicating that the randomness of the LASSO process does not significantly affect the production of robust estimations.

16 benchmark factors cross section. Following Feng et al. (2020), we conduct our DS LASSO regressions by pooling all test variables in one regression.

Table 3 reports the estimation results based on the DS LASSO regressions. Out of the 84 testing factors, 50 factors appear significant for the pooled cross-sectional regression. This result shows that the Chinese stock returns are determined by numerous risk factors in addition to the benchmark factors in the existing assets pricing model. Compared to the benchmark factors, these risk factors originate from different market anomalies and contain novel information that can explain cross section returns. Besides, the number of significant factors in each group is shown in the column 4. 27 risk factors belong to the category of market frictions and 23 to the category of corporate financial fundamentals. Among the subgroups, 16 factors related to volatility are significant. Overall, about 60 % of the testing factors appear to contain significant incremental information for expected stock returns.

5.1.2. Rolling window analysis

The marginal effectiveness of the factors may change with the time window selected. To examine the dynamics of the parameter estimates, we further use fixed rolling window regression for our DS LASSO analysis. Since more dimensions of risk factors can cause limited rank of the covariance matrix, we set the window to be as long as 240 months to ensure sufficient sample size for estimation. After deleting the missing values, our rolling window covers the period from June 2011 to September 2019, including 100 rolling months. Each window is accompanied with a DS LASSO to select and finalize the combination of benchmark factors, and the 2nd stage cross-sectional regression is set to test all risk factors.

We estimate the 84 testing factors, aside from the 16 benchmark factors, for each rolling window and count the number of times that each factor is statistically significant. As shown in Fig. 5, 17 factors appear significant over 80 % of the rolling windows and 25 factors are below 20 %. The performance of these factors is consistency across the rolling windows. When we compare with the results of full sample analysis in Table 3, among the 50 significant risk factors, only 16 factors appear consistently significant with over 80 % of the rolling windows. These factors include volatility factors, for example, beta.120.D, BETA.120.D, betad.120.D, idvol.120.D, resid_Skewness.36.M, skew.36.M, skew.3M, std_amount.36.M, std_turn.120.D, and vol.120.D. The insignificant factors with over 80 % of the times (or significant for less than 20 % of the times) are mostly momentum factors such as momSimple.2M, revSim ple.24M, revSimple.36M.

The rolling regression allows us to directly observe the changing of t statistics of all factors for the structural change of the parameter estimates. To summarize the results, we categorize the risk factors into 9 groups in Fig. 6 (Please refer to the heat map in Appendix D for detailed t-statistics of each factor at each rolling time). The stacked area chart shows the significant ratio of each type of risk factors. A drastic change occurs as time goes by, especially between August 2015 and September 2016 when the Chinese stock market experienced a large shock of price decline, so the number of effective factors suddenly declines.

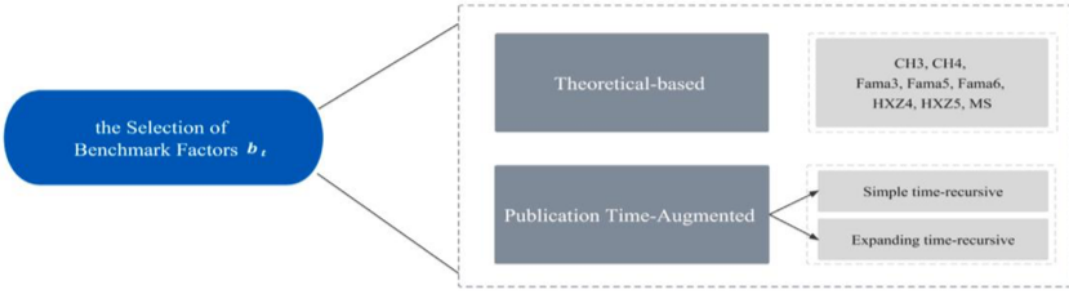

Fig. 2. Two methods to select and construct the pool of benchmark factors.

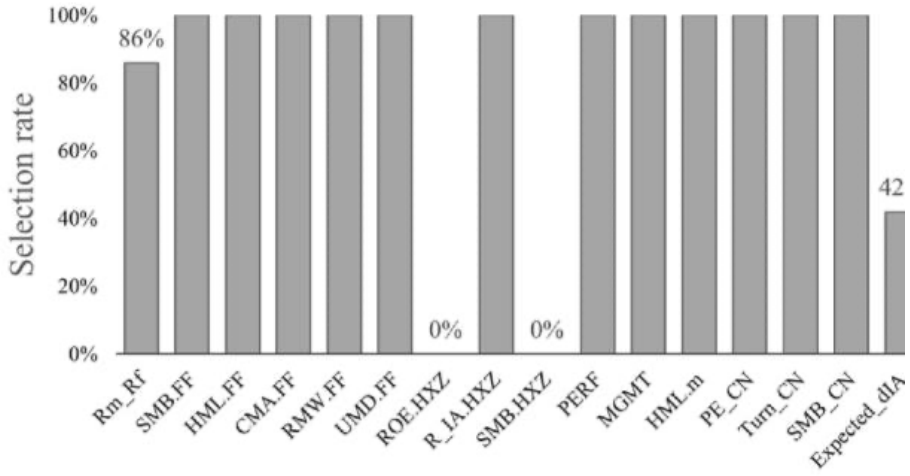

Fig. 3. The Selection Probability for the 16 Benchmark Factors in the 1st Step of LASSO Regression. Notes: The bar plot shows the selected percentage of each benchmark factor in the first LASSO step of the double-selection procedure across 50 cross-validations. Each benchmark factor identified by the factor shortcode is represented on the X axis, and the Y axis indicates the fraction of times of each benchmark factor selected by cross-validation in the 50 crossexaminations.

We then divide the rolling time into three intervals and use a bar chart at the top, i.e., the subplot (a) of Fig. 6, to illustrate the changes in the average significant ratio among the three segments. It was found that the mean significant ratio is stable across segments for abnormal return factors and profitability factors; value factors, other financial factors, and liquidity factors became more significant after 2016; volatility factors and growth factors were more significant between 2015 and 2016. Investment factors and momentum factors appear to be quite insignificant over time.

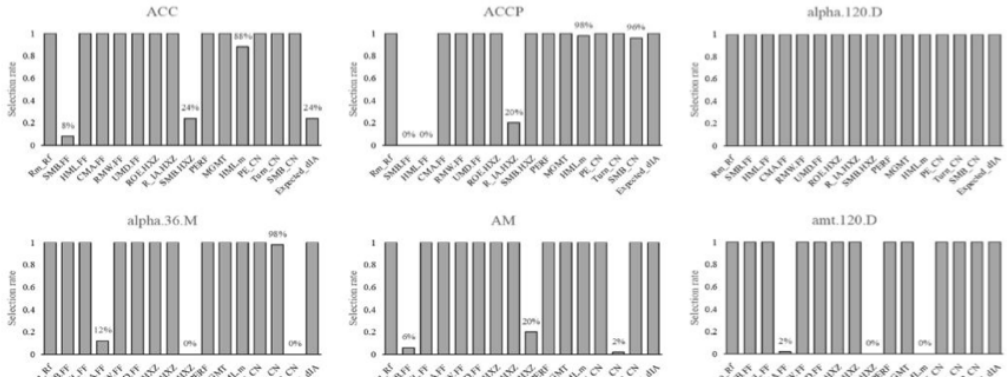

Fig. 4. The Selection Ratio of benchmark factors for testing Factors in the 2nd Step of LASSO Regression. Notes: We are presenting only six testing factors as examples. Please refer to Appendix C for the results of other testing factors. Similar to Fig. 3, each subplot in Fig. 4 illustrates the probability of a test factor selecting each benchmark factor in the second LASSO step across 50 cross-examinations.

5.1.3. Different sets of testing factors

It has been argued that most pricing factors in the stock market are highly correlated. How many testing factors and how they are included in the regression model would substantially affect on the results. Feng et al. (2020) merely use the DS LASSO regression method on a few of the risk factors introduced from 2012 to 2016. They assume that the number of testing factors is small compared to the benchmark factors, thereby neglecting the potential for multicollinearity between these testing factors. This is particularly problematic when the number of testing factors is substantial in less efficient stock markets. Thus, this part analyzes the variation of significant testing risk factors across different boundaries of benchmark/testing factors.

Firstly, we change the proportion of benchmark factors (bt) to testing factors (xt).[11]. Table 4 reports results for analyzing the post-2002 and post-2015 testing factors. The proportions of benchmark to testing factors are 50:50 (in columns 2, 7, and 12) and 82:18 (in columns 3, 8, and 13), respectively. This is done to account for the high dimensional setting of the benchmark factors. After 2015, 13 of the 18 testing factors are still

[11] Here, x_t is the vector of testing factors in p × 1 dimensions and b_t is the vector of benchmark factors in q × 1 dimensions.

significant, which are predominantly associated with profit ability and growth. Clearly, the number of significant testing factors increases with the size of testing factors. In all three cases, the ratio of significant factors is more than 60%.

Secondly, we modify the second stage of DS LASSO by adopting stepwise regression to mitigate potential multicollinearity. For comparison, we also implement two alternative cross-sectional regression designs, with all three approaches reported in Table 4. The single-added variable regression (column 5) conducts independent tests by individually adding each of the 84 test factors to the regression. However, this method neglects correlations among the test factors, potentially under estimating the interaction effects between variables. The pooled regression (column 4), following Feng et al. (2020), includes all test factors simultaneously in one regression. While this design captures factor interactions, it is vulnerable to potential multicollinearity, especially given the high correlation between pricing factors in China's stock market. To mitigate the limitations of the above two designs, the stepwise regression (column 6) adopts an iterative variable selection strategy, which uses the Akaike Information Criterion (AIC) as the selection rule and sequentially adds significant factors while removing redundant ones in each iteration. Meanwhile, we randomize the order of factor addition to avoid selection bias.

From a statistical standpoint, not much difference exists in the three types of regressions, ensuring the robustness of our findings. However, the stepwise regression, by handling multicollinearity among the factors, leads to a slight rise in the number of significant factors. Out of the 84 test factors, 56 appear significant in the stepwise regression, and 50 and 51 appear significant for the pooled regression and single-added variable regression, respectively. These results underscore that Chinese stock returns are indeed influenced by a variety of risk factors beyond the benchmark factors in classical asset pricing models. Furthermore, columns 9–11 of Table 4 show the proportion of significant factors in each of the factor types. The significant factors from the three ways of adding test variables in the regression model, i.e., "Pool," "Single," and "Step," are distributed similarly.

Table 3

The results of double LASSO regression with 16 benchmark factors (Pooled regression).

Panel A: Corporate Financial Fundamentals (38 factors)			
Type	Code	T-statistics	Number of Sig. Factors
Investment (5)	*dPPE_and_inventory*		1
	Net_operating_assets		
	dIA		
	ACC	4.336	
	ACCP		
Profitability (7)	*dROE*	4.078	3
	PA		
	gross_profit		
	cashpr	−7.160	
	cash	6.290	
	CT		
	ROA		
Growth (8)	*INVGchg*	−4.352	6
	INVG	5.650	
	LG	3.230	
	BVEG		
	TAXchg	−4.008	
	PMG	9.158	
	SG		
	SgINVg	6.600	
Value (8)	*DP*	4.674	6
	PE.M		
	PB.M	−4.643	
	EP		
	SP	3.382	
	OCFP	4.162	
	LEV	4.262	
	AM	3.425	
Other Financials (10)	*Oscore*	5.609	7
	CR	−5.913	
	CRG	−4.621	
	QR		
	QRG	3.085	
	CFdebt		
	saleinv	−7.885	
	salescash		
	RD	−8.088	
	Rdsales	8.844	

Panel B: Market Friction (46 factors)

Type	Code	T-statistics	Number of Sig. Factors
Momentum and Reversal (9)	*imom.120.D*		3
	revSimple.1M		
	momSimple.24M	−6.033	
	revSimple.24M		
	momSimple.2M		
	revSimple.36M		
	imom.36.M		
	momSimple.3M	−3.250	
	momSimple.6M	4.591	
Liquidity (11)	*illq.120.D*	−7.300	6
	turn.120.D	−4.658	
	amt.120.D	3.074	
	illq.36.M	5.976	
	turn.36.M		
	amt.36.M	−3.019	
	turn.3M		
	amt.3.M		
	turnover.M		
	volume.M	6.540	
	amt.M		
Volatility (22)	*BETA.120.D*	6.558	16
	resid_Skewness.120.D	−3.299	
	std_amount.120.D		
	std_turn.120.D	−5.956	
	skew.120.D	−5.761	
	idvol.120.D	8.327	
	beta.120.D	−6.541	

Panel B: Market Friction (46 factors)

Type	Code	T-statistics	Number of Sig. Factors
	betad.120.D	5.793	
	vol.120.D	−5.754	
	BETA.36.M	7.657	
	resid_Skewness.36.M	7.327	
	std_amount.36.M	−5.960	
	std_turn.36.M		
	skew.36.M	−10.287	
	idvol.36.M	3.054	
	beta.36.M	−7.443	
	betad.36.M		
	vol.36.M		
	std_amount.3M		
	std_turn.3M		
	skew.3M	−6.081.	
	vol.3M	−6.618	
Abnormal Return (4)	*alpha.120.D*		2
	retnmax.120.D		
	alpha.36.M	4.205	
	retnmax.36.M	6.229	

Notes: When utilizing DS LASSO regression, we test variables by pooling all test factors into one regression. The finalized result remains consistent regardless of the order of variable testing. Columns 1–2 display the type and shortcode of testing factors. Column 3 presents the t-statistics of the variables that exhibit statistical significance with $|t|>3$, as recommended by Harvey et al. (2016), and column (4) summarizes the number of significant variables of the cross-sectional regression.

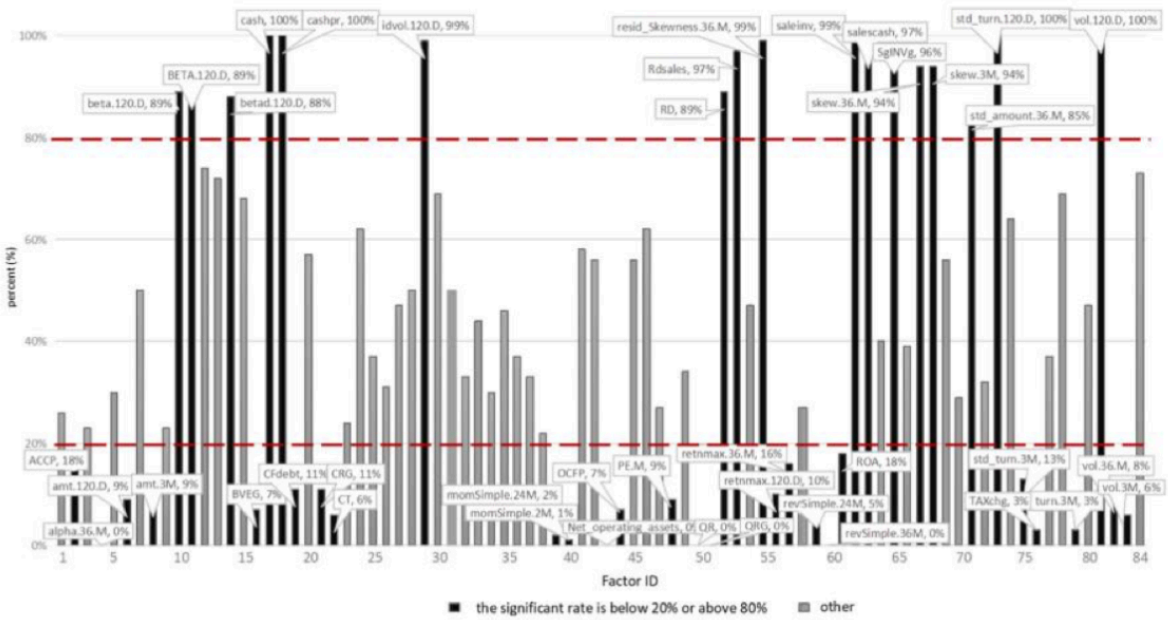

Fig. 5. The Number of Significant Appearance of the 84 Testing Factors in Rolling Regression. Notes: In rolling regression, our rolling window covers the period from June 2011 to September 2019, including 100 rolling months. For each rolling window, we estimate the 84 testing factors based on the 16 benchmark factors. Then, we count the number of times that each factor is statistically significant across all 100 rolling windows. The X-axis of the graph represents each testing factor identified by the factor shortcode, and the black bar indicates the factor in which the significant rate is below 20 % or above 80%.

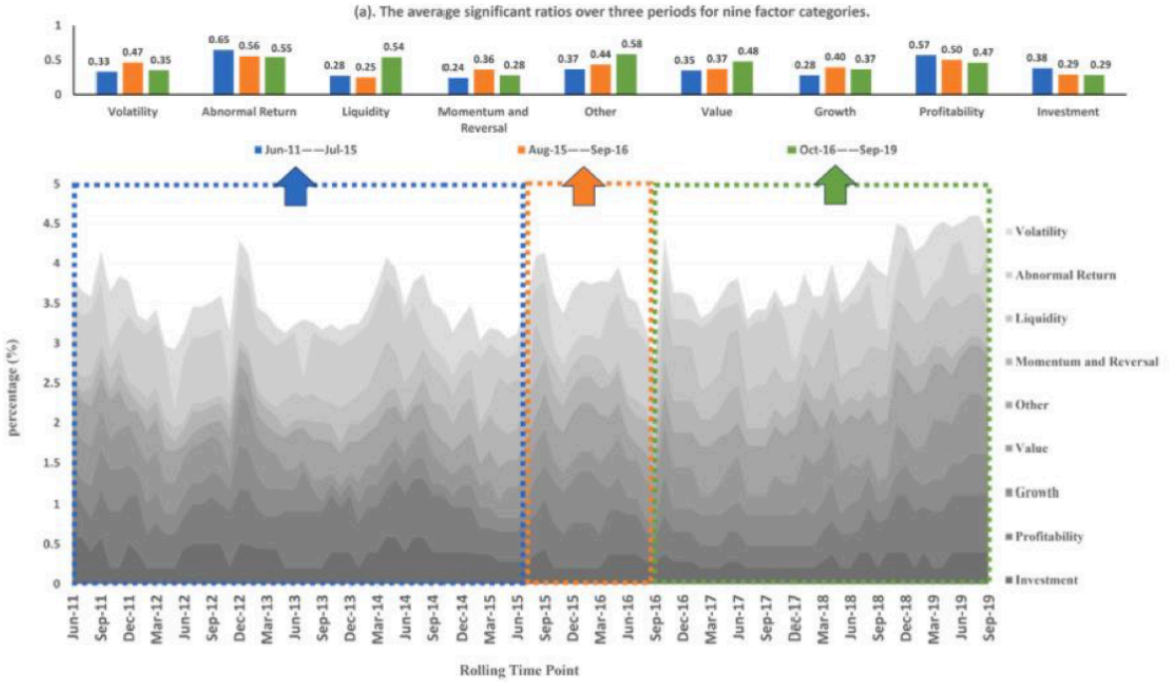

Fig. 6. The Percentage of Significant Factors in Each Group. Notes: We first categorize the risk factors into nine groups (shown in different shades of gray) and then use a stacked area chart to plot the temporal variations in the significant ratio of each factor type, with the horizontal axis representing 100 rolling time points. We also divide the rolling time into three intervals and use a bar chart at the top, i.e., the subplot (a), to illustrate the changes in the mean significant ratio among the three segments: June 2011 to July 2015 (blue), August 2015 to September 2016 (orange), and October 2016 to September 2019 (gray). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

5.2. Estimation based on the publication date of risk factors

In the previous sections, our benchmark factors originate from various assets pricing models. However, these factors are from the literature based on developed markets, and they may not exactly fit the situation of the Chinese stock market. If fewer benchmark factors are related to the Chinese data, then in the second stage of regression, more testing factors would appear statistically significant and not correctly rejected. To ensure the explanatory power of the benchmark factors, we use two methods to construct the benchmark factors group based on the time-recursive order of the publication date: (a) constructing a simple benchmark factor set, and (b) expanding the benchmark factors.

Table 4

The number of significant factors in different specifications about testing factors.

Factor Type	Testing Factor Number			Count of Sig. Factors					Ratio of Sig. Factors				
	Theory based	After 2002	After 2015	Theory based (16/84)			After 2002	After 2015	Theory based (16/84)			After 2002	After 2015
	(16/84)	(50/50)	(82/18)	Pool	Single	Step	(50/50)	(82/18)	Pool	Single	Step	(50/50)	(82/18)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	84	50	18	50	51	56	33	13	60 %	61 %	67 %	66 %	72 %
A. Corporate Financial Fundamentals													
Investment	5	7	4	1	1	1	2	2	2 %	2 %	2 %	6 %	15 %
Profitability	7	8	3	3	5	4	5	3	6 %	10 %	7 %	15 %	23 %
Growth	8	7	2	6	7	7	6	2	12 %	14 %	13 %	18 %	15 %
Value	8	3	1	6	4	7	3	1	12 %	8 %	13 %	9 %	8 %
Other	10	4	2	7	6	7	3	1	14 %	12 %	13 %	9 %	8 %
Total	38	29	12	23	23	26	19	9	46 %	45 %	46 %	58 %	69 %
B. Market Friction													
Momentum Reversal	9	2	0	3	6	4	0	0	6 %	12 %	7 %	0 %	0 %
Liquidity	11	3	1	6	6	7	2	0	12 %	12 %	13 %	6 %	0 %
Abnormal Return	4	4	2	2	4	2	2	1	4 %	8 %	4 %	6 %	8 %
Volatility	22	12	3	16	12	17	10	3	32 %	24 %	30 %	30 %	23 %
Total	46	21	6	27	28	30	14	4	54 %	55 %	54 %	42 %	31 %

Notes: This table summarizes the significant factors by factor type according to the robustness analysis on the testing factors compositions. We examine the impact of the proportion of testing factors in the estimation and the methods for their inclusion. First, we change the ratio of benchmark factors to test factors, as shown in parentheses. Compared to the split ratio based on the theoretical analysis (16:84), we also analyze the post-2002 (50:50) and post-2015 (82:18) test factors. Second, beyond the pooled regression model ("Pool"), we also use single-added variable regression ("Single") and AIC-based forward stepwise regression ("Step") to mitigate multicollinearity. The stepwise method selects 71 out of 84 testing factors, yielding stable results regardless of the order of variable addition.

Table 5

The effectiveness of new testing factors ranked by the year of publication.

Year	Num.	Serial Number of New Testing Factors										
(1)	(2)	(3)										
2001	39	40 (5.195)	41 (−6.305)	42	43	44	45	46	47 (3.249)	48	49 (−14.197)	50 (9.070)
2002	50	51 (−6.610)	52	53	54 (−4.674)							
2004	54	55	56 (−6.717)	57 (−8.184)								
2005	57	58	59 (3.996)									
2006	59	60	61	62 (8.789)	63	64	65	66	67 (−4.183)	68 (−9.918)		
2008	68	69 (4.183)										
2009	69	70	71 (−14.785)	72 (4.558)								
2010	72	73 (7.922)										
2011	73	74	75	76	77 (3.624)	78	79 (−6.410)					
2012	79	80										
2013	80	81 (−3.554)	82 (−3.694)									
2015	82	83 (−5.020)	84 (14.688)	85	86 (7.810)	87	88 (−4.038)	89 (−11.485)	90 (−5.491)			
2016	90	91	92									
2017	92	93 (3.476)	94 (−5.349)									
2018	94	95 (−4.899)	96	97 (−11.929)	98 (4.138)	99	100 (3.894)					

Types of New Testing Factors (33/61)	Corporate Financial Fundamentals (18/29)					Market Friction (15/32)			
	Investment (4/7)	Profitability (5/8)	Growth (4/7)	Value (3/3)	Other (2/4)	Momentum & Reversal (0/2)	Liquidity (4/8)	Abnormal Return (1/4)	Volatility (10/18)

Notes: The table reports the results of the simple time-recursive analysis, from 2001 to 2018. For each year *t* in column (1), column (2) reports the number of controls available in the year *t*, and column (3) shows the serial numbers of the new factors that were published with data up to that year. We then test whether each new factor contributes to explaining asset prices relative to the factors published in previous years. Significant factors are underlined, with t-stats in parentheses. At the bottom, we summaries all the factors that are marginally valid in terms of factor groups.

5.2.1. The simple time-recursive analysis

For the time-recursive-order analysis, we first rank all risk factors based on their publication date, and use the factors published before year t as the benchmarks, to test the marginal effectiveness of the factors published after year t. For example, the market factor (Rm-Rf) was published before 1977, along with other 4 risk factors. We form the benchmark factors with those original 5 factors to test new factors published thereafter. Based on DS LASSO, we select a proper union set of control variables. As the number of added

factors increases, DS LASSO can significantly reduce the number of benchmark factors. At last, we run cross-section regression to test the marginal effect of any newly added factors. This method allows us to judge whether a newly added factor is effective or redundant, while drawing reference from factors published in old days. Since our data period starts from year 2001, the 39 original factors must be included as control variables in our testing, leaving the rest 61 factors as testing variables.

Table 5 presents the DS LASSO regression result based on time recursive order. Of the 61 factors tested, 33 appear to be statistically significant with an absolute value of t-stat greater than 3. This result is in stark contrast with Feng et al. (2020)'s research on the U.S. stock market, in which only 17 out of 125 new factors are statistically significant. It is mostly likely because the young Chinese market is associated with weak trading system and institutional regulation as well as low participation of rational investors, and thus so many market anomalies exist.

We also summaries all the factors that are marginally valid in Table 8 column (4) and (6). We divide all the factors into different categories, and find that 18 financial factors and 15 price and market friction factors are statistically significant. For the financial factors, the highest percentage of significant factors in each category are the value factors and profitability factors (100 % and 63 %, respectively). For the price and market friction factors, the highest percentage of significant factors in each category are the volatility factors (56 %), and then the liquidity factors (50 %).

Table 6

The recursive selection of augmented benchmark factors by publication year.

Year	Num.	Serial Number of New Testing Factors										Factor Name (the most Sig. with the largest |t| value)
(1)	(2)	(3)										(4)
1994	26	27										SG
1996	27	28	29	30								CT
1997	30	31	32									UMD.FF
1998	32	33	34	35	36	37	38	39				turnover.M
2001	39	40	41	42	43	44	45	46	47	48	49	50	std_turn.3M
2002	50	51	52	53	54								illq.120.D
2004	54	55	56	57									Net_operating_assets
2005	57	58	59										BVEG
2006	59	60	61	62	63	64	65	66	67	68			idvol.36.M
2008	68	69											\
2009	69	70	71	72									\
2010	72	73											\
2011	73	74	75	76	77	78	79						imom.36.M
2012	79	80											\
2013	80	81	82										HML.m
2015	82	83	84	85	86	87	88	89	90				SMB.HXZ
2016	90	91	92										alpha.36.M
2017	92	93	94										PERF
2018	94	95	96	97	98	99	100						SMB_CN

Notes: Column (1) shows the year in which the new risk factor was proposed; Column (2) reports the total number of control variables in that year; Column (3) and (4) show the serial numbers of the newly proposed risk factors and the factor with the highest significant marginal effectiveness ranked according to the absolute value of the t-stat, respectively. Factors with underscores represent factors that are statistically significant in cross-sectional regression analysis, 46 factors in total.

5.2.2. Recursively expanding the benchmark factors

Restrictions can be imposed to retain specific risk factors during the parameter estimation based on DS LASSO, and thus the important prior information could be incorporated to adjust the benchmark risk factor group during the selection process. The disadvantage, however, is that the benchmark risk factors used as control variables in the cross sectional regression may be different for all the risk factors that remain to be tested. We can start with a set of risk factors from asset pricing theories as our benchmark set in a time-recursive order, and then expand the initial benchmark group by iteratively screening out the marginal efficient risk factors. In this case, it is possible to combine asset pricing theory with statistical methods of variable selection to find the optimal benchmark factors as control variables.

The empirical analysis for expanding the benchmark factors set can be divided into two steps. In the first step, the set of augmented benchmark risk factors is determined. We choose 1994 as the starting point when already 26 factors have already been found, and then verify the marginal validity of the new factors in a time-recursive order. New factors with marginal effective information are added to the benchmark set each year. Given that the market factor (Rm_Rf), the size factor (SMB. FF), and the value factor (HML.FF) are of paramount importance to explaining cross-sectional expected returns by Fama and French (1993), we impose extra restrictions to ensure that these factors are in the benchmark group when constructing the benchmark from the 26 factors based on DS LASSO.

Next, the augmented benchmark factors are used as control variables in a cross- sectional regression to verify the marginal effectiveness of the newly proposed operating income growth factor (i.e., the 27th factor SG) for the following year. If several newly proposed factors are found in the same year, the most significant factors among them will be selected and ranked by the absolute value of the t-stat, and the newly selected risk factors are also subjected to restrictions in order to verify the marginal effectiveness of other newly proposed factors in the subsequent recursive process. Finally, a set of factors with optimal marginal

effectiveness can be obtained as the augmented benchmark factors set after recursively testing all the risk factors according to the publication time.

Table 6 shows the selection results of the benchmark risk factors based on the time- recursive-order of the publication dates. Obviously, not all of the newly proposed factors in the following years prove to be marginal effective in the cross-sectional regression based on the time recursive-order of the publication date, such as in 2008 – 2010 and 2012. These most significant risk factors, together with the Fama-French 3-factors, form the augmented benchmark set with up to 18 factors. The result indicates that the cross- section of returns cannot be explained by the simple muti-factor model.

Table 7

Comparison of benchmark factors: Data-augmented V.S. Theory-Based.

Augmented benchmark factors (18)			Theory-Based benchmark factors (16)		
Name	Code	Type	Name	Code	Type
Fama-French Size Factor	SMB.FF	Growth	Fama-French Size Factor	SMB.FF	Growth
HXZ Market Cap Factor	SMB.HXZ		HXZ Market Cap Factor	SMB.HXZ	
Size Factor in China	SMB_CN		Size Factor in China	SMB_CN	
Growth of Book Value of Equity	BVEG				
Sales Growth	SG				
12-month Momentum Factor	UMD.FF	Momentum and Reversal	12-month Momentum Factor	UMD.FF	Momentum and Reversal
36-month Momentum	imom.36.M				
Monthly Book-to-Market Ratio	HML.m	Value	Monthly Book-to-Market Ratio	HML.m	Value
Fama-French Value Factor	HML.FF		Fama-French Value Factor	HML.FF	
			Value Factor with Shell	PE_CN	
Market Factor	Rm_Rf	Abnormal Return	Market Factor	Rm_Rf	Abnormal Return
36-month Alpha for Pricing Error	alpha.36.M				
120-day Illiquidity	illq.120.D	Liquidity	Turnover with Shell Contamination	Turn_CN	Liquidity
Monthly Turnover	turnover.M				
Performance Factor	PERF	Other	Performance Factor	PERF	Other
		Financials	Management Factor	MGMT	Financials
Capital Turnover Ratio	CT	Profitability	HXZ Earnings Factor	ROE.HXZ	Profitability
			Fama-French Profitability Factor	RMW.FF	
Net operating assets	Net_operating_assets	Investment	Fama-French Investment Factor	CMA.FF	Investment
			HXZ Investment Factor	R_IA.HXZ	
			Expected investment growth factor	Expected_dIA	
36-month Idiosyncratic Volatility	idvol.36.M	Volatility			
3-month Std of Turnover	std_turn.3M				

Notes: This table compares the augmented benchmark factors with the factors selected based on the theoretical model in section 5.1. In each column, we show name, code and type of the selected benchmark factors.

Moreover, Table 7 compares the benchmark factors with the factors selected based on the theoretical model in Section 5.1. The results show significant differences in the factors benchmark based on different selection methods, especially for liquidity, profitability, and investment factor categories. Besides, the augmented benchmark identifies volatility type factors that are not considered in the theoretical models, indicating that the volatility factors seem to be more important in China, quite different from the existing literature of the developed markets.

In the next step, we test the marginal effectiveness of the remaining 82 risk factors using the augmented benchmark factors as control variables. The empirical results are shown in Table 8 column 5. Table 9 column 5 and 7 summarize the results in terms of factor categories. Overall, 55 risk factors are tested to be marginally effective among the total 82 risk factors, even though the benchmark factors group as control variables already incorporates the prior information.

In terms of factor classification, factors related to firm financials and market trading frictions show the similar significance level. Specifically, the growth and the value factors have higher proportion of significant factors in the category of financial factors. The volatility factors serve as the most important sources for stock risk premium among all the market factors. The empirical results are very similar based on different selection methods, regardless of whether any prior information is imposed or not. However, there seems to be some differences in the subcategories of significant risk factors based on different benchmark factors set.

In summary, our findings based on the time-recursive-order of the publication date show that there are a large number of risk factors that determine the cross-sectional returns in China's A-share stock markets, and thus it is quite difficult to explain the expected returns based only on a simple multi-factor model. Considering the benchmark factors, 55 out of 82 risk factors still contain independent information. Despite small differences in specific categories, financials factors and market trading factors have the similar significance levels, suggesting that these factors are of great importance in influencing the stock returns in China.

5.3. Robust analysis

5.3.1. Different regularization methods

In this section, we explore the robustness of our results with respect to the machine learning methodology used to select the control factors. As before, we focus our robustness tests on the evaluation of 84 factors

based on 16 theoretical benchmark factors. The optimal method depends on specific model assumptions. Feng et al. (2020) recommend using LASSO regression for model selection. However, Elastic Net, which combines the penalty mechanisms of LASSO and ridge regression, rep resents a reasonable alternative. Following Kozak et al. (2020), we also implemented a PCA- LASSO approach that first applies principal component analysis to the benchmark factors and then applies LASSO to the principal components.

Table 10 reports the results evaluating the marginal contributions of target factors using three methodologies: DS-LASSO, PCA-LASSO (abbreviated as PCA), and Elastic Net[12]. The results demonstrate the persistence of our findings across different dimensionality reduction techniques. Among 84 tested factors, PCA and Elastic Net respectively identified 58 and 56 statistically significant factors in cross-sectional regressions, closely aligning with DS LASSO estimates. The distribution of significant factors across different categories also exhibits consistency. This evidence confirms that Chinese stock returns are indeed influenced by multiple risk factors beyond those captured by existing benchmark pricing models.

Table 8

The results of double LASSO regression with recursive benchmark factors (stepwise regression).

Type	Code	Year	T-statistics		Type	Code	Year	T-statistics	
			Simple	Expand				Simple	Expand
(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
A. Investment (8)	CMA.FF	2015	−5.020		**A. Value (11)**	HML.FF	1993		
	R_IA.HXZ	2015	7.810	10.883		DP	1982		5.344
	dPPE_and_inventory	2004				PE.M	1977		
	Net_operating_assets	2004	−6.717			PB.M	1985		−6.983
	dIA	2018				PE_CN	2018	−4.899	−4.957
	ACC	1996		6.292		EP	1997		−3.794
	ACCP	2011				SP	1996		3.649
	Expected_dIA	2018	4.138	4.965		OCFP	2004	−8.184	4.661
	Num of Sig.		*4*	*3*		HML.M	2013	−3.554	
A.Profitability (9)	RMW.FF	2015	14.668	8.241		LEV	1988		5.847
	ROE.HXZ	2015		−8.607		AM	1988		5.135
	dROE	2018	3.894	4.869		*Num of Sig.*		*3*	*8*
	PA	2013	−3.694		**A. Other Financials (12)**	Oscore	1998		6.817
	gross_profit	2008	4.183			MGMT	2017	−5.349	
	cashpr	2009		−10.072		CR	1989		−8.529
	cash	2012		7.648		CRG	1989		−5.603
	CT	1996				QR	1989		
	ROA	2010	7.922			QRG	1989		4.054
	Num of Sig.		*5*	*5*		CFdebt	1989		
A.Growth (11)	SMB.FF	1993				RD	2006		−9.384
	SMB.HXZ	2015				Rdsales	2006		10.697
	INVGchg	2002	−4.674	−5.246		PERF	2017	3.476	
	INVG	2002		7.545		saleinv	1989		−11.161
	LG	2005	3.996	6.210		salescash	1989		
	BVEG	2005				*Num of Sig.*		*2*	*7*
	SMB_CN	2018	−11.929		**B. Abnormal Return (5)**	Rm_Rf	1964		
	TAXchg	2011	−6.410	−6.409		alpha.120.D	2016		
	PMG	1998		10.654		retnmax.120.D	2011	3.624	
	SG	1994				alpha.36.M	2016		
	SgINVg	1998		9.085		retnmax.36.M	2011		7.843
	Num of Sig.		*4*	*6*		*Num of Sig.*		*1*	*1*
B.Momentum and Reversal (10)	imom.120.D	2011			**B. Volatility (22)**	BETA.120.D	1973		−7.387
	revSimple.1M	1993				resid_Skewness.120.D	2009	−14.785	−4.317
	momSimple.24M	1990		−8.163		std_amount.120.D	2001		−3.029
	revSimple.24M	1993				std_turn.120.D	2001	3.249	−6.858
	momSimple.2M	1990				skew.120.D	2015	−4.038	−6.882
	revSimple.36M	1993				idvol.120.D	2006	8.789	10.032
	imom.36.M	2011				beta.120.D	1973		−7.387
	momSimple.3M	1990		−3.235		betad.120.D	2006		6.901
	momSimple.6M	1993		9.165		vol.120.D	2006		−7.840
	UMD.FF	1997				BETA.36.M	1973		−9.638
	Num of Sig.		*0*	*3*		resid_Skewness.36.M	2009	4.558	8.693
B. Liquidity (12)	illq.120.D	2002	−6.610			std_amount.36.M	2001		−7.358
	turn.120.D	1998		−5.420		std_turn.36.M	2001		
	amt.120.D	2001	5.195	3.596		skew.36.M	2015	−11.485	−11.799
	illq.36.M	2002		6.960		idvol.36.M	2006		
	turn.36.M	1998				beta.36.M	1973		−9.638
	amt.36.M	2001	−6.305	−4.356		betad.36.M	2006		
	turn.3M	1998				vol.36.M	2006	−4.183	
	amt.3.M	2001				std_amount.3M	2001		
	Turn_CN	2018				std_turn.3M	2001	−14.197	
	turnover.M	1998				skew.3M	2015	−5.491	−8.073
	volume.M	2001	9.070	8.224		vol.3M	2006	−9.918	−8.427
	amt.M	2001		−3.934		*Num of Sig.*		*10*	*16*
	Num of Sig.		*4*	*6*					

Notes: Two ways to construct the benchmark factors by the time-recursive order of the publication date: a simple benchmark (Simple); the expanding benchmark (Expand). Columns (1)–(3): factor group, shortcode and publication year. Columns (4)–(5): the t-stat and the number of significant factors (Num of Sig.). Category A-B: Corporate Financial Fundamentals, Market Friction.

5.3.2. Different testing portfolios

The formation of testing portfolio could affect the outcome of the analysis. Instead of using the previous 5 × 5 sort, we also conduct 2 × 3 and 10 × 10 sorts to form portfolio returns as dependent variable in the LASSO regression, to detect if the main results still hold when the sample size changes with different portfolio formation methods. In addition, we also divide our sample into two subperiod with the break year of 2009, because during this year the Chinese stock market experienced large volatilities due to ownership reform and global financial crisis.

[12] For the detailed t-statistics, see Table E1 in Appendix E.

Table 9

The number of significant factors in time-recursive models (stepwise regression).

Factor Group		Factor Number		Number of Sig. Factors		Ratio of Sig. Factors	
(1)		Simple	Expand	Simple	Expand	Simple	Expand
		(2)	(3)	(4)	(5)	(6)	(7)
All Testing Factors		61	82	33	55	54 %	67 %
Firm Financials	Investment	7	7	4	3	57 %	43 %
	Profitability	8	8	5	5	**63 %**	63 %
	Growth	7	6	4	6	57 %	**100 %**
	Value	3	9	3	8	**100 %**	**89 %**
	Other	4	11	2	7	50 %	64 %
	Total	29	41	18	29	62 %	71 %
Market Friction	Momentum and Reversal	2	8	0	3	0 %	38 %
	Liquidity	8	10	4	6	**50 %**	**60 %**
	Abnormal Return	4	2	1	1	25 %	33 %
	Volatility	18	20	10	16	**56 %**	**80 %**
	Total	32	41	15	26	47 %	63 %

Notes: This table is the summary of the significant factors in terms of factor type according to Table 8. Column (1) shows factor categories and subgroups. Columns (2)–(3) lists the number of testing factors for each type using two time-recursive models. Columns (4)–(7) detail the number and ratio of significant variables identified in each regression.

Table 10

The number of significant factors in different regularization methods with 16 theoretical benchmark factors (stepwise regression).

Factor Type	Testing Factor Number	Count of Sig. Factors			Ratio of Sig. Factors		
		DS LASSO	PCA	Elastic Net	DS LASSO	PCA	Elastic Net
	84	56	58	56	67 %	69 %	67 %
A. Corporate Financial Fundamentals							
Investment	5	1	1	3	2 %	2 %	5 %
Profitability	7	4	4	5	7 %	8 %	9 %
Growth	8	7	8	2	13 %	16 %	4 %
Value	8	7	7	6	13 %	14 %	11 %
Other	10	7	7	10	13 %	14 %	18 %
Total	38	26	27	26	46 %	53 %	46 %
B. Market Friction							
Momentum and Reversal	9	4	4	3	7 %	8 %	5 %
Liquidity	11	7	8	6	13 %	16 %	11 %
Abnormal Return	4	2	2	2	4 %	4 %	4 %
Volatility	22	17	17	19	30 %	33 %	34 %
Total	46	30	31	30	54 %	61 %	54 %

Notes: This table is the summary of the significant factors in terms of factor type according to the robustness tests in four specifications, i.e., using Elastic Net and PCA. The first two columns show category and number of testing factors per type. The last two columns provide the number and ratio of the significant variables identified in each model specification.

Table 11

The Number of Significant Factors in Different testing portfolios with 16 Theoretical Benchmark Factors (Stepwise Regression).

Factor Type	Testing Factor Number	Count of Sig. Factors					Ratio of Sig. Factors				
		Standard Model	2 × 3 Sort	10 × 10 Sort	Before 2009	After2009	Standard Model	2 × 3 Sort	10 × 10 Sort	Before 2009	After2009
	84	56	29	58	72	58	67 %	35 %	69 %	86 %	69 %
A. Corporate Financial Fundamentals											
Investment	5	1	2	4	5	4	2 %	7 %	7 %	7 %	7 %
Profitability	7	4	3	4	5	7	7 %	10 %	7 %	7 %	12 %
Growth	8	7	4	8	7	7	13 %	14 %	14 %	10 %	12 %
Value	8	7	1	5	7	7	13 %	3 %	9 %	10 %	12 %
Other	10	7	5	8	7	9	13 %	17 %	14 %	10 %	16 %
Total	38	26	15	29	31	34	46 %	52 %	50 %	43 %	59 %
B. Market Friction											
Momentum and Reversal	9	4	1	6	7	5	7 %	3 %	10 %	10 %	9 %
Liquidity	11	7	5	5	10	4	13 %	17 %	9 %	14 %	7 %
Abnormal Return	4	2	1	4	4	2	4 %	3 %	7 %	6 %	3 %
Volatility	22	17	7	14	20	13	30 %	24 %	24 %	28 %	22 %
Total	46	30	14	29	41	24	54 %	48 %	50 %	57 %	41 %

Notes: This table is the summary of the significant factors in terms of factor type according to the robustness tests in four specifications, i.e., using bivariate-sorted 2 × 3 and 10 × 10 portfolios, samples with the break year of 2009. The first two columns show category and number of testing factors per type. The last two columns provide the number and ratio of the significant variables identified in each model specification.

Table 11 summarizes the DS LASSO regression results for the portfolio returns formed from 2 × 3 and 10 × 10 sorts. It also shows the results before and after the year 2009[13]. When stocks are sorted on a 2 × 3 basis, the sample contains less observations of portfolio returns (97× 2 × 3 = 582 compared to 2425 observations from the 5× 5 sort). Indeed, when the number of returns reduces, less factors could affect cross section of returns. Out of the 84 testing factors, only 29 appear significant in the model, half of the number based on 5

[13] For the detailed t-statistics, see Table E2 in Appendix E.

× 5 or 10× 10 sort. When the number of returns expands due to the 10 × 10 sort, the results appear the same as 5 × 5 sort. Across different specifications, the factors related to firm financials and market friction stand the same in terms of the number of significant factors. The most significant factors from this test are volatility, growth, value and other accounting information.

For the subsamples later than 2009, the number of significant risk factors drop from 72 to 58. The structure of significant factors also shifts. In particular, the factors related to firm financials increase from 31 to 34, while the factors related to market friction drop from 41 to 24. The result indicates that the stock prices incorporate more information related to firm fundamentals and are less affected by trade noises. In sum, over 60 % of the risk factors still make marginal contribution in explaining stock returns, when the returns are sorted in different ways and for different period, although slightly less factors appear significant after 2009. The main results discovered in this study stay robust.

6. Conclusion

Over the past three decades, the Chinese stock market has become one of the largest stock markets in the world. Despite its importance, current research has yet to establish a consensus on the factors truly influencing cross-sectional returns in the Chinese stock market. As the literature continues to unveil more risk factors, there is a pressing need for a systematic approach to pinpoint the factors determining cross sectional return variation. In this paper, we aim to comprehensively review studies related to market anomalies or risk factors. Our objective is to construct a factor zoo comprising 100 risk factors across various domains, including investment, profitability, growth, value, other firm financials, momentum, liquidity, volatility, and more.

Since the traditional approach is subject to statistical flaws such as data snooping bias or P-hacking problems, we follow the new methodology developed by Feng et al. (2020) in the process of screening factors. Specifically, we adopt the framework of stochastic discount factor and use double selection LASSO method to perform the empirical test. During the variable selection process, we either take classic risk factors with theoretical foundation as benchmark factors, or select them recursively by the publication year.

We select 16 classic factors as control variables from the established literature, and then test the marginal contribution of the rest 84 risk factors. Among them, the amount of significant risk factors related to firm's financial fundamentals is almost the same as factors related to market trading friction. On average, factors related to growth, value, liquidity, and volatility contain can strongly predict the cross sectional expected returns.

For the detailed t-statistics, see Table E2 in Appendix E. Furthermore, we show that the marginal importance of risk factors varies with time periods. But 16 of the 84 testing factors appear to be stable throughout the entire data period in their marginal contribution. Among others, the factors related to value, other financial variables, and liquidity become increasingly important after year 2016; growth and volatility factors are more important during the stock bubble period between 2015 and 2016.

In our recursive testing of factors based on publication dates, we employ two distinct methods. Firstly, we utilize all risk factors previously published as benchmarks to assess newly introduced factors in the current publication year. Secondly, we begin with an initial set of benchmark factors and recursively expand it with the addition of the factor that contributes the most incremental explanatory power. Both methods consistently reveal that a majority of the tested risk factors exhibit statistical significance. As we systematically broaden our benchmark factors with imposed restrictions, it becomes evident that factors associated with profitability, value, growth, and volatility assume greater importance in influencing cross-sectional returns.

Our study has several implications as well as contributions to the current literature. First, in the Chinese market, a substantial majority of the newly discovered risk factors (over 60 %) offer incremental information for stock returns, even when accounting for the benchmark factors. Consequently, each newly discovered factor is linked to a market anomaly, directly influencing the marginal utility of investors. Furthermore, some risk factors are documented to be effective in the U.S. market but appear insignificant determinants of Chinese stock returns, especially liquidity, profitability, and investment factors.

This discovery sheds new light on the intricate relationship between cross-section of stock returns and the financial market structure, given the notable differences in the trading system and market participant structure in China and the United States. In the Chinese stock market, retail investors account for over 50 % of A-share transaction volumes (Tan et al., 2024); thus, volatility and friction factors matter more, unlike U.S. markets dominated by institutions focused on long-term profitability. Therefore, as global interest in emerging market asset allocation surges, our findings help domestic and foreign investors avoid misallocating (e.g., investment and pure momentum factors) that underperform in China. Taken together, we take a step forward by using to Double Selection LASSO (DS LASSO) method to discipline the China Factor

Zoo, and our findings answer the questions raised in Cochrane (2011) in explaining cross section of stock returns.

Funding

This work was supported by the National Social Science Fund of China (24BJL053), Strategic Economy Interdisciplinarity (Beijing Universities Advanced Disciplines Initiative. No. GII2019163).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We deeply appreciate the comments from Professor Mallick, the Editor of Economic Modelling, and two anonymous referees, who generously helped us improve our paper. Furthermore, we are grateful for financial support from the financial support from the National Social Science Fund of China (24BJL053), Strategic Economy Inter disciplinarity (Beijing Universities Advanced Disciplines Initiative. No. GII2019163). All authors are in alphabetical order and contributed equally to the paper and could be treated as the joint first author.

Appendix

Appendix A. Descriptive Statistics

Table A. 1

Descriptive Statistics of All Testing Portfolios.

Portfolio	Mean%	Median%	Std	Kurtosis	Skewness	Min%	Max%	Obs	AR(12)	AR(24)	Portfolio	Mean%	Median%	Std	Kurtosis	Skewness	Min%	Max%	Obs	AR(12)	AR(24)
All Portfolios	1.05	0.28	0.09	0.90	0.19	−27.81	33.78	224	0.01	−0.06											
Portfolios for each firm characteristic (in descending order of the average return)																					
Accruals	1.37	1.26	0.09	0.68	0.22	−24.98	33.78	204	0.03	−0.06	Rdsales	1.08	0.30	0.09	0.87	0.19	−28.06	33.94	214	0.01	−0.05
O-score	1.27	1.50	0.10	0.34	0.20	−24.89	33.67	150	−0.01	−0.03	saleinv	1.08	0.28	0.09	0.88	0.19	−27.96	33.99	214	0.02	−0.05
TAXchg	1.20	0.73	0.09	0.86	0.18	−27.51	34.28	208	0.02	−0.04	gross_profit	1.08	0.29	0.09	0.91	0.19	−27.79	34.30	214	0.02	−0.05
ACC	1.20	0.56	0.09	0.82	0.15	−27.55	33.40	208	0.02	−0.04	investment.FF	1.08	0.50	0.09	0.92	0.19	−27.63	34.27	224	0.03	−0.04
Net_operating_assets	1.20	0.42	0.09	0.84	0.16	−27.53	33.84	208	0.03	−0.04	momSimple.3M	1.08	0.27	0.09	0.97	0.20	−27.89	34.35	224	0.02	−0.04
cash	1.19	0.54	0.09	0.85	0.17	−27.68	34.11	208	0.02	−0.04	PA	1.08	0.29	0.09	0.88	0.19	−27.73	33.47	214	0.01	−0.06
Expected_dIA	1.18	0.58	0.09	0.82	0.18	−27.46	33.80	202	0.02	−0.03	momSimple.6M	1.08	0.38	0.09	0.86	0.19	−27.30	33.09	224	0.03	−0.04
dIA	1.18	0.60	0.09	0.84	0.18	−27.57	34.02	202	0.02	−0.03	vol.120.D	1.08	0.28	0.09	0.89	0.17	−28.38	33.80	224	0.02	−0.05
dROE	1.18	0.50	0.09	0.82	0.16	−27.59	33.52	208	0.02	−0.04	alpha.36.M	1.07	0.65	0.09	0.95	0.21	−27.70	34.51	224	0.02	−0.04
INVG	1.18	0.48	0.09	0.85	0.17	−27.72	34.18	208	0.02	−0.04	momSimple.2M	1.07	0.25	0.09	0.96	0.20	−27.66	34.55	224	0.02	−0.04
SgINVg	1.18	0.41	0.09	0.85	0.16	−27.82	34.05	208	0.02	−0.04	momSimple.24M	1.07	0.48	0.09	0.88	0.21	−27.60	34.26	224	0.02	−0.04
LG	1.17	0.42	0.09	0.82	0.17	−27.53	33.81	208	0.03	−0.04	turn.36.M	1.07	0.56	0.09	0.92	0.19	−28.36	34.92	224	0.02	−0.04
INVGchg	1.17	0.42	0.09	0.83	0.17	−27.51	33.97	208	0.02	−0.04	BETA.120.D	1.07	0.33	0.09	0.87	0.18	−27.99	33.33	224	0.02	−0.05
QRG	1.17	0.47	0.09	0.84	0.16	−27.92	33.83	208	0.02	−0.04	beta.120.D	1.07	0.33	0.09	0.87	0.18	−27.99	33.33	224	0.02	−0.05
CRG	1.17	0.46	0.09	0.84	0.17	−27.89	33.93	208	0.02	−0.04	PE.M	1.07	0.29	0.09	0.88	0.18	−27.60	33.60	214	0.01	−0.06
dPPE_and_inventory	1.17	0.40	0.09	0.86	0.17	−27.64	34.16	208	0.03	−0.04	std_turn.36.M	1.06	0.47	0.09	0.95	0.20	−28.17	35.27	224	0.02	−0.04
SG	1.17	0.43	0.09	0.87	0.19	−27.75	34.56	208	0.02	−0.04	PERF	1.06	0.23	0.09	0.91	0.19	−27.57	34.05	224	0.02	−0.04
CT	1.17	0.40	0.09	0.88	0.18	−27.78	34.42	208	0.02	−0.04	skew.120.D	1.06	0.27	0.09	0.91	0.17	−27.86	33.67	224	0.02	−0.04
CFdebt	1.17	0.46	0.09	0.84	0.18	−27.69	33.57	208	0.02	−0.04	imom.120.D	1.06	0.20	0.09	0.89	0.17	−27.55	33.52	224	0.02	−0.05
ROA	1.17	0.45	0.09	0.84	0.17	−27.74	33.59	208	0.02	−0.04	operating_margin	1.06	0.26	0.09	0.91	0.20	−27.92	34.16	214	0.02	−0.05
investment	1.16	0.48	0.09	0.83	0.17	−27.43	33.81	208	0.03	−0.04	resid_Skewness.120.D	1.06	0.23	0.09	0.91	0.17	−27.87	33.51	224	0.02	−0.05
AG	1.16	0.48	0.09	0.83	0.17	−27.43	33.81	208	0.03	−0.04	betad.120.D	1.06	0.30	0.09	0.85	0.17	−27.92	33.25	224	0.02	−0.05
PMG	1.15	0.56	0.09	0.89	0.18	−27.78	34.61	208	0.03	−0.04	retnmax.120.D	1.06	0.34	0.09	0.90	0.18	−27.77	33.65	224	0.02	−0.05
BVEG	1.14	0.50	0.09	0.85	0.17	−27.63	33.76	208	0.03	−0.04	momSimple.12M	1.05	0.36	0.09	0.90	0.18	−27.75	33.76	224	0.03	−0.04
ROE	1.14	0.56	0.09	0.87	0.19	−27.63	34.32	208	0.03	−0.04	EP	1.04	0.24	0.09	0.90	0.21	−27.91	34.26	214	0.02	−0.06
revSimple.1M	1.12	0.31	0.09	0.90	0.20	−27.44	34.09	224	0.02	−0.05	skew.3M	1.04	0.32	0.09	0.93	0.16	−28.35	33.53	224	0.03	−0.05
beta.36.M	1.12	0.66	0.09	0.90	0.20	−27.56	34.10	224	0.02	−0.04	turnover.M	1.04	0.22	0.09	0.96	0.18	−29.37	34.65	224	0.02	−0.04
BETA.36.M	1.12	0.66	0.09	0.90	0.20	−27.55	34.09	224	0.02	−0.04	HML.FF	1.04	0.38	0.09	0.89	0.17	−28.05	33.38	224	0.02	−0.05
ACCP	1.11	0.28	0.09	0.90	0.17	−27.87	33.66	214	0.01	−0.06	MGMT	1.04	0.33	0.09	0.90	0.18	−27.51	33.88	224	0.02	−0.05
retnmax.36.M	1.11	0.60	0.09	0.95	0.19	−27.59	34.69	224	0.02	−0.04	std_turn.120.D	1.02	0.37	0.09	0.95	0.19	−28.82	34.95	224	0.03	−0.04
revSimple.24M	1.11	0.57	0.09	0.89	0.21	−27.48	34.16	224	0.02	−0.04	operating_margin.FF	1.01	0.14	0.09	1.02	0.21	−27.98	35.38	224	0.03	−0.05
LEV	1.11	0.40	0.09	0.90	0.17	−28.12	33.64	214	0.01	−0.05	turn.120.D	1.01	0.36	0.09	0.93	0.17	−29.06	34.41	224	0.02	−0.05
vol.36.M	1.11	0.64	0.09	0.93	0.19	−27.86	34.79	224	0.02	−0.04	std_turn.3M	1.01	0.27	0.09	0.95	0.19	−29.06	34.91	224	0.03	−0.04
skew.36.M	1.11	0.61	0.09	0.92	0.18	−27.48	34.17	224	0.02	−0.04	turn.3M	1.01	0.24	0.09	0.97	0.19	−29.34	34.97	224	0.02	−0.05
OCFP	1.10	0.23	0.09	0.90	0.19	−28.01	34.07	214	0.01	−0.06	illq.36.M	1.01	0.34	0.09	0.95	0.21	−28.48	33.61	224	0.02	−0.05
HML.M	1.10	0.25	0.09	0.87	0.18	−27.95	33.60	214	0.01	−0.06	amt.36.M	1.00	0.25	0.09	0.81	0.22	−27.34	31.63	224	0.02	−0.04
PB.M	1.10	0.14	0.09	0.90	0.19	−27.81	33.99	214	0.01	−0.05	std_amount.36.M	1.00	0.32	0.09	0.73	0.18	−26.87	28.64	224	0.02	−0.04

(*continued on next page*)

Table A. 1 (*continued*)

AM	1.10	0.24	0.09	0.88	0.17	−28.15	33.66	214	0.01	−0.05	std_amount.3M	0.97	0.39	0.09	0.87	0.20	−27.74	31.70	224	0.03	−0.06
betad.36.M	1.10	0.59	0.09	0.89	0.19	−27.86	34.13	224	0.02	−0.04	std_amount.120.D	0.97	0.39	0.09	0.91	0.24	−27.53	33.21	224	0.03	−0.06
idvol.36.M	1.10	0.56	0.09	0.92	0.19	−28.04	34.62	224	0.02	−0.04	amt.3M	0.95	0.32	0.09	0.86	0.23	−27.49	31.98	224	0.04	−0.06
alpha.120.D	1.10	0.36	0.09	0.92	0.18	−27.83	33.77	224	0.03	−0.04	amt.120.D	0.93	0.15	0.09	0.69	0.20	−27.28	28.84	224	0.03	−0.06
resid_Skewness.36.M	1.10	0.63	0.09	0.91	0.18	−27.52	34.22	224	0.02	−0.04	volume.M	0.90	0.46	0.09	0.81	0.20	−26.83	31.83	224	0.02	−0.04
CR	1.10	0.42	0.09	0.88	0.18	−27.82	33.83	214	0.01	−0.05	amt.M	0.83	0.21	0.09	0.75	0.21	−27.04	29.69	224	0.03	−0.05
RD	1.10	0.34	0.09	0.90	0.18	−27.59	34.07	214	0.02	−0.05	illq.120.D	0.77	0.01	0.09	0.68	0.17	−28.66	31.17	224	0.02	−0.06
inom.36.M	1.10	0.64	0.09	0.92	0.19	−27.37	34.39	224	0.02	−0.04											
QR	1.09	0.31	0.09	0.88	0.18	−27.86	33.76	214	0.01	−0.05											
DP	1.09	0.66	0.09	0.86	0.15	−27.66	34.00	210	0.01	−0.06											
salescash	1.09	0.38	0.09	0.90	0.18	−27.84	34.19	214	0.02	−0.05											
vol.3M	1.09	0.45	0.09	0.85	0.18	−27.87	33.24	224	0.02	−0.04											
idvol.120.D	1.09	0.31	0.09	0.90	0.17	−28.18	33.91	224	0.02	−0.04											
cashpr	1.09	0.30	0.09	0.90	0.17	−28.39	33.90	214	0.02	−0.05											
revSimple.36M	1.09	0.64	0.09	1.04	0.24	−27.42	36.02	224	0.02	−0.04											
SP	1.09	0.27	0.09	0.91	0.19	−27.96	34.31	214	0.02	−0.05											

Notes: This table shows the return distribution for the testing portfolios formed based on different characteristics. The summary statistics include means, medians, standard deviations, kurtosis, skewness, minimums, maximums, observation, and autoregression coefficients. In total, we have 2425 bivariate-sorted portfolio returns for 224 months, and the statistics for all portfolios is shown in the first row. Each row in the rest of the table reports the returns of the portfolios formed on one characteristic plus size. The factors in Table 3 are sorted based on the average return in descending order.

Table A. 2
Descriptive Statistics of Risk Factors.

Panel A: 16 Benchmark Factors											
Benchmark Factors	Mean%	Sig. at 5 %	Median%	Std	Kurtosis	Skewness	Min%	Max%	Obs	AR(12)	AR(24)
HML_m	0.77	Sig	0.39	0.04	3.91	0.82	−13.03	20.38	214	0.07	0.02
SMB_HXZ	0.73	Sig	0.53	0.04	4.79	−0.06	−20.33	20.35	208	0.03	0.02
SMB_FF	0.52	NotSig	0.51	0.04	1.41	−0.20	−17.92	15.91	224	0.09	0.02
HML_FF	0.45	NotSig	0.27	0.04	4.74	0.08	−17.28	19.10	224	0.05	0.08
Expected_dIA	0.32	Sig	0.29	0.02	1.53	0.08	−4.70	6.29	202	0.00	−0.01
ROE_HXZ	0.29	NotSig	0.32	0.03	1.87	−0.09	−11.80	13.16	208	0.18	0.14
Rm_Rf	0.25	NotSig	0.31	0.08	1.36	−0.09	−24.93	27.24	224	−0.08	−0.09
RMW_FF	0.22	NotSig	−0.04	0.03	1.86	−0.10	−12.41	11.74	224	0.15	0.05
SMB_CN	0.21	NotSig	0.28	0.04	2.52	−0.26	−19.19	16.99	214	0.10	0.03
MGMT	0.15	NotSig	0.17	0.02	1.12	0.20	−4.81	6.29	224	0.08	0.13
CMA_FF	0.09	NotSig	−0.03	0.02	0.63	0.04	−6.59	7.38	224	−0.04	0.07
PERF.	−0.01	NotSig	0.09	0.03	3.06	−0.67	−16.11	11.08	224	0.06	−0.04
UMD_FF	−0.14	NotSig	0.03	0.04	0.74	−0.30	−15.30	10.42	224	0.19	0.06

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Table A. 2 (*continued*)

Panel A: 16 Benchmark Factors

Benchmark Factors	Mean%	Sig. at 5 %	Median%	Std	Kurtosis	Skewness	Min%	Max%	Obs	AR(12)	AR(24)
R_IA.HXZ	−0.19	NotSig	−0.25	0.02	0.49	−0.01	−6.76	5.60	208	−0.02	0.12
PE_CN	−0.60	Sig	−0.67	0.04	1.96	−0.08	−15.55	12.87	214	0.02	−0.03
Turn_CN	−1.08	Sig	−1.41	0.04	3.14	0.12	−20.05	16.48	214	0.09	−0.10

Panel B: 84 Testing Risk Factors

Testing Factors	Mean %	Sig.at5 %	Median %	Std	Kurtosis	Skewness	Min %	Max %	Obs	AR (12)	AR (24)	Testing Factors	Mean %	Sig. at 5 %	Median %	Std	Kurtosis	Skewness	Min %	Max %	Obs	AR (12)	AR (24)
turnover.M	1.21	Sig	1.42	0.04	2.32	−0.30	−14.37	16.67	224	0.11	−0.01	illq.36.M	0.09	NotSig	0.04	0.03	4.23	−0.13	−16.44	12.45	224	0.10	−0.05
revSimple.1M	1.21	Sig	1.08	0.04	2.36	0.30	−13.03	17.78	224	−0.02	0.02	Oscore	0.09	NotSig	−0.15	0.04	3.46	0.87	−12.15	14.53	150	0.08	0.04
turn.3M	1.18	Sig	1.31	0.04	2.85	−0.01	−15.00	19.07	224	0.15	−0.03	revSimple.24M	0.08	NotSig	−0.01	0.03	4.74	0.42	−15.38	17.46	224	−0.04	−0.04
turn.120.D	0.98	Sig	1.04	0.04	1.94	0.15	−13.49	16.67	224	0.15	−0.01	saleinv	0.00	NotSig	−0.03	0.02	0.51	0.22	−6.08	6.93	214	0.12	0.13
idvol.120.D	0.92	Sig	1.01	0.04	2.62	0.05	−16.33	17.90	224	0.04	−0.07	DP	−0.01	NotSig	−0.16	0.02	3.24	−0.26	−6.84	5.98	210	0.05	−0.05
vol.3M	0.90	Sig	1.46	0.05	1.56	−0.43	−17.70	15.82	224	0.08	−0.12	salescash	−0.05	NotSig	−0.07	0.02	2.56	−0.13	−9.93	6.62	214	0.09	−0.02
vol.120.D	0.86	Sig	1.21	0.04	1.15	−0.52	−16.59	13.68	224	0.06	−0.08	QRG	−0.06	NotSig	−0.04	0.01	1.34	0.13	−5.36	4.68	208	0.06	0.03
illq.120.D	0.64	Sig	0.40	0.04	2.58	0.33	−13.40	17.39	224	0.07	0.09	ACC	−0.09	NotSig	−0.16	0.02	2.52	−0.21	−10.30	8.49	208	0.00	−0.05
idvol.36.M	0.58	Sig	0.51	0.04	4.96	0.62	−12.30	18.31	224	0.04	0.02	imom.120.D	−0.15	NotSig	−0.17	0.01	0.88	0.23	−4.16	4.92	224	−0.04	−0.13
vol.36.M	0.56	Sig	0.54	0.03	2.43	0.25	−9.63	17.04	224	0.06	−0.02	LEV	−0.15	NotSig	−0.24	0.04	5.20	−0.39	−20.37	15.41	214	0.06	0.03
AM	0.55	Sig	0.46	0.04	3.89	0.35	−16.63	20.60	214	0.09	0.03	CRG	−0.16	NotSig	−0.13	0.01	0.94	0.21	−3.80	4.99	208	−0.01	0.07
OCFP	0.51	Sig	0.38	0.03	5.50	0.83	−10.88	15.41	214	0.19	0.10	imom.36.M	−0.20	NotSig	−0.06	0.02	2.40	−0.33	−7.10	4.95	224	0.03	0.01
EP	0.50	NotSig	0.12	0.04	1.02	0.18	−11.21	14.14	214	0.22	0.17	ACCP	−0.26	NotSig	−0.19	0.02	3.71	−0.26	−8.62	8.18	214	0.12	0.07
SG	0.45	Sig	0.37	0.02	0.67	−0.09	−6.50	8.37	208	0.00	0.05	betad.36.M	−0.28	NotSig	0.00	0.03	3.35	−0.96	−15.33	6.04	224	0.09	−0.06
PMG	0.45	Sig	0.63	0.03	1.28	−0.19	−7.98	9.02	208	0.05	0.07	BVEG	−0.32	NotSig	−0.28	0.03	2.20	0.19	−11.80	10.60	208	0.06	0.04
TAXchg	0.41	Sig	0.43	0.02	1.66	−0.14	−7.18	6.99	208	0.13	0.10	momSimple.24M	−0.32	NotSig	−0.19	0.04	2.27	−0.72	−22.14	9.62	224	0.08	0.02
turn.36.M	0.40	NotSig	0.42	0.03	3.08	0.05	−14.42	15.93	224	0.14	0.02	skew.3M	−0.33	Sig	−0.47	0.02	4.85	1.26	−6.96	11.69	224	−0.01	0.12
RD	0.39	Sig	0.36	0.02	1.19	0.01	−6.87	5.81	214	0.16	−0.01	resid_Skewness.36.M	−0.37	Sig	−0.25	0.02	2.47	−0.09	−8.55	6.48	224	0.12	0.12
LG	0.38	Sig	0.35	0.02	0.96	−0.05	−6.69	6.51	208	0.00	0.03	cashpr	−0.37	NotSig	−0.32	0.03	6.71	−0.80	−20.38	12.78	214	0.10	0.03
dROE	0.37	Sig	0.31	0.02	2.05	−0.31	−7.08	7.53	208	0.17	0.17	resid_Skewness.120.D	−0.41	Sig	−0.56	0.02	5.69	0.91	−8.89	11.84	224	0.01	−0.05
cash	0.37	Sig	0.45	0.03	1.35	0.02	−8.64	10.30	208	0.05	−0.12	PE.M	−0.43	Sig	−0.39	0.03	2.09	−0.03	−13.80	11.75	214	0.02	−0.07
beta.36.M	0.36	NotSig	0.50	0.03	1.53	−0.04	−9.43	12.00	224	0.08	−0.03	skew.36.M	−0.44	Sig	−0.28	0.02	1.26	−0.34	−8.22	5.37	224	−0.03	−0.02
BETA.36.M	0.36	NotSig	0.50	0.03	1.52	−0.02	−9.43	12.08	224	0.08	−0.03	skew.120.D	−0.45	Sig	−0.40	0.03	4.20	0.63	−9.81	11.47	224	0.08	0.10
CT	0.36	Sig	0.37	0.02	0.45	0.11	−5.99	7.54	208	0.22	0.14	PB.M	−0.48	Sig	−0.33	0.03	4.96	−0.66	−17.48	12.19	214	0.04	−0.02
SP	0.31	NotSig	0.32	0.03	3.75	0.30	−12.23	14.92	214	0.10	0.07	momSimple.6M	−0.51	Sig	−0.37	0.04	0.12	−0.30	−11.01	8.23	224	0.15	0.06
revSimple.36M	0.29	NotSig	0.43	0.03	2.32	−0.29	−13.02	12.00	224	−0.01	0.02	momSimple.2M	−0.57	Sig	−0.57	0.03	2.25	−0.21	−16.10	10.13	224	−0.12	0.00
dIA	0.28	Sig	0.22	0.02	1.43	−0.37	−5.37	4.30	202	0.02	−0.11	momSimple.3M	−0.59	Sig	−0.23	0.04	1.33	−0.30	−15.51	11.15	224	0.07	0.00
CR	0.27	NotSig	0.24	0.03	3.28	−0.21	−12.26	12.79	214	0.03	0.00	std_turn.36.M	−0.60	Sig	−0.62	0.03	2.94	−0.46	−16.62	10.78	224	0.16	0.03
CFdebt	0.26	NotSig	0.57	0.03	0.04	0.06	−8.00	9.01	208	0.16	0.09	retnmax.36.M	−0.61	Sig	−0.53	0.03	3.79	−0.61	−15.17	6.81	224	0.06	−0.02
PA	0.26	NotSig	0.50	0.03	0.01	−0.01	−7.59	8.47	214	0.22	0.08	amt.36.M	−0.66	Sig	−0.64	0.03	3.64	−0.21	−16.49	11.92	224	0.03	−0.05
gross_profit	0.25	NotSig	0.41	0.03	0.44	−0.46	−8.15	6.55	214	0.11	0.00	alpha.36.M	−0.74	Sig	−0.43	0.04	1.14	−0.16	−15.41	13.46	224	0.07	0.06
ROA	0.25	NotSig	0.55	0.03	0.02	−0.04	−8.05	8.96	208	0.15	0.11	retnmax.120.D	−0.76	Sig	−0.96	0.03	1.56	0.29	−11.53	12.25	224	0.11	−0.09
SgINVg	0.24	Sig	0.24	0.01	0.72	0.26	−3.18	5.41	208	0.15	−0.01	alpha.120.D	−0.77	Sig	−0.47	0.04	1.93	−0.52	−20.36	9.57	224	0.09	0.03
QR	0.23	NotSig	0.09	0.03	5.13	0.04	−14.23	15.12	214	0.05	0.05	std_amount.36.M	−0.90	Sig	−0.77	0.03	3.41	−0.41	−16.64	12.30	224	−0.02	−0.04
dPPE_and_inventory	0.23	NotSig	0.42	0.02	3.15	−0.47	−9.61	6.22	208	0.03	0.08	std_turn.120.D	−1.13	Sig	−1.37	0.04	4.64	−0.33	−22.72	15.27	224	0.15	−0.03
INVGchg	0.23	NotSig	0.43	0.02	1.41	−0.30	−6.19	5.94	208	−0.05	−0.03	amt.120.D	−1.18	Sig	−1.03	0.04	3.17	−0.50	−16.72	13.09	224	−0.02	0.02
BETA.120.D	0.21	NotSig	0.61	0.04	2.72	0.03	−12.71	20.52	224	0.07	−0.02	volume.M	−1.18	Sig	−1.14	0.04	4.39	−0.61	−23.29	13.27	224	0.09	−0.06
beta.120.D	0.21	NotSig	0.59	0.04	2.72	0.03	−12.71	20.52	224	0.07	−0.02	std_amount.120.D	−1.24	Sig	−1.16	0.04	2.32	−0.58	−16.67	9.08	224	0.01	−0.01
INVG	0.18	NotSig	0.20	0.02	1.96	−0.11	−6.40	7.16	208	0.01	0.03	amt.3M	−1.29	Sig	−1.18	0.04	2.53	−0.52	−16.12	10.78	224	−0.04	0.01
Net_operating_assets	0.18	NotSig	0.26	0.02	0.33	−0.02	−5.32	5.30	208	−0.04	−0.08	std_turn.3M	−1.45	Sig	−1.59	0.04	3.68	−0.03	−20.51	14.97	224	0.14	−0.02
betad.120.D	0.14	NotSig	0.34	0.04	1.69	−0.21	−10.79	15.89	224	0.07	−0.02	amt.M	−1.49	Sig	−1.11	0.04	2.99	−0.51	−21.60	13.71	224	0.00	−0.10
Rdsales	0.12	NotSig	−0.02	0.03	3.24	−0.12	−13.66	12.37	214	0.10	0.06	std_amount.3M	−1.50	Sig	−1.27	0.04	2.52	−0.60	−17.32	10.22	224	0.00	−0.04

Notes: This table shows the summary statistics of the 100 risk factors, including means, the significance different from 0 at 5 %, medians, standard deviations, kurtosis, skewness, minimums, maximums, observation, and autoregression coefficients. The factors in each panel are sorted based on the mean value in descending order.

Appendix B. Robustness of LASSO Variable Selection

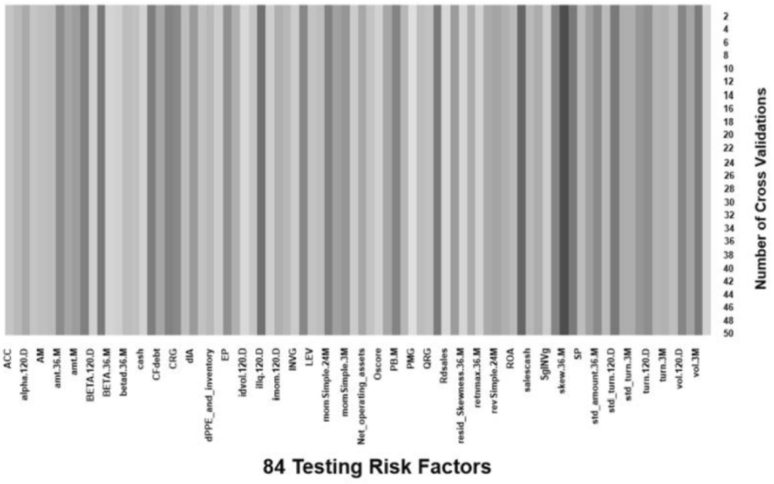

Fig. B. 1. The T-statistics of 84 Testing Factors in the Robustness Test of the LASSO Estimator based on Theoretical Benchmark Factors.

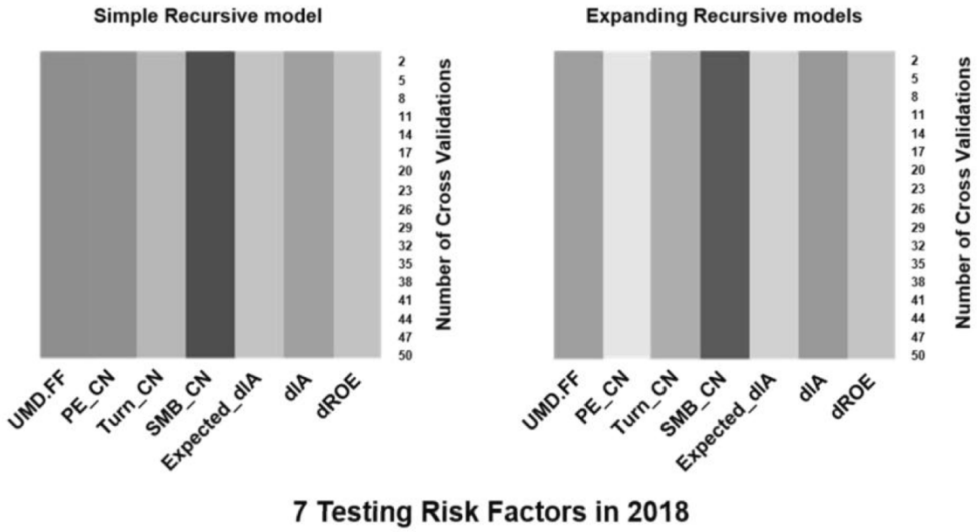

Fig. B. 2. The T-statistics of 7 Testing Factors (in 2018) in the Robustness Test of the LASSO Estimator based on the Publication Date of Risk Factors: simple Recursive (left) and expanding Recursive models (right).

Notes: In Appendix B, Fig. B1 is the visualization of t-statistics of each factor using a heat map. The horizontal axis represents the 84 factors under consideration, while the vertical axis represents the model's cross-validation rounds (total of 50 rounds). Different shades of gray indicate the variation in t-values for each factor. The t-values for each factor form vertical lines, suggesting that the t-values remain unchanged when different penalty parameters are selected. This indicates that the cross-validation results of LASSO do not affect the final assessment of factor effectiveness. The same applies to Fig. B2.

Appendix C. The Selection Radio of benchmark factors for testing Factors in the 2nd step of LASSO Regression

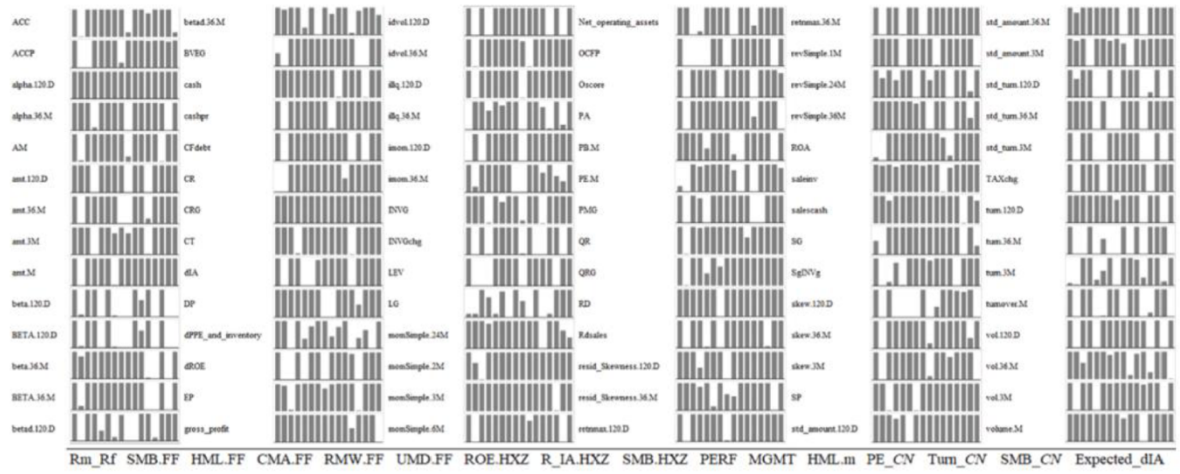

Fig. C. 1. The T-statistics of 84 Testing Factors based on Theoretical Benchmark Factors. Notes: Each subplot features one of the 84 testing factors on the Y axis and 16 benchmark factors on the shared X axis. The plot for every testing factor shows the fraction of times the benchmark factor was chosen in the second LASSO step of the double-selection procedure in 50 cross-examinations.

Appendix D. The Heat Map of T-Statistics of the 100 Risk Factors Across 100 Rolling Time

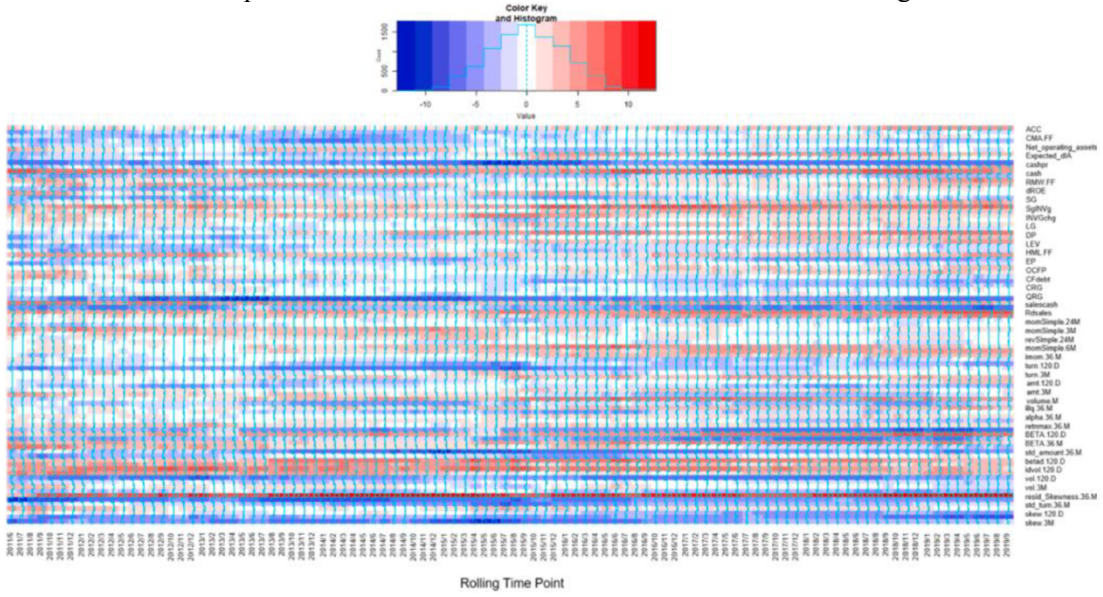

Fig. D. 1. The Heat Map of T-Statistics of the 100 Risk Factors Across Rolling Time. Notes: This plot displays the t-statistics of all factors in 100 rolling windows, with the vertical axis representing the 100 risk factors and the horizontal axis depicting the 100 rolling periods. The heat charts use darker colors to indicate higher levels of significance and lighter colors to indicate lower levels of significance. A gradual change of color across periods indicates a smooth change of parameter significance.

Appendix E. Robustness Test Results

Table E. 1
Results of Baseline Regression Model in Different Regularization Methods (Stepwise Regression).

Type	Code	T-statistics			Type	Code	T-statistics		
		DS LASSO	PCA	Elastic Net			DS LASSO	PCA	Elastic Net
A. Investment (5)	dPPE_and_inventory			−4.551	**A. Value Factor (8)**	DP	5.344	5.526	5.818
	Net_operating_assets					PE.M			
	dIA					PB.M	−6.983	−7.103	−10.604
	ACC	6.292	6.070	−3.210		EP	−3.794	−3.688	−4.269
	ACCP			4.213		SP	3.649	3.748	5.677
	Num of Sig.	*1*	*1*	*3*		OCFP	4.661	4.590	
A. Profitability (7)	dROE	4.869	4.750	−4.972		LEV	5.847	5.900	14.964
	PA			−4.535		AM	5.135	5.364	8.216
	gross_profit			7.682		*Num of Sig.*	*7*	*7*	*6*
	cashpr	−10.072	−10.482		**A. Other Financials (10)**	Oscore	6.817	6.651	7.556
	cash	7.648	7.929	4.051		CR	−8.529	−8.615	−10.103
	CT	3.271	3.098			CRG	−5.603	−5.587	−7.518
	ROA			11.962		QR			3.849
	Num of Sig.	*4*	*4*	*5*		QRG	4.054	4.105	4.092
A. Growth Factor (8)	INVGchg	−5.246	−5.295			CFdebt			−8.719
	INVG	7.545	7.449	3.964		saleinv	−11.161	−11.173	−11.662
	LG	6.210	6.085			salescash			4.790
	BVEG	3.420	3.314			RD	−9.384	−9.384	−11.238
	TAXchg	−6.409	−5.856			Rdsales	10.697	10.063	7.899
	PMG	10.653	10.562	21.433		*Num of Sig.*	*7*	*7*	*10*
	SG		−3.001		**B. Volatility (22)**	BETA.120.D	7.408	7.623	9.789
	SgINVg	9.085	9.012			resid_Skewness.120.D	−4.317	−4.343	−4.238
	Num of Sig.	*7*	*8*	*2*		std_amount.120.D	−3.028	−3.020	−4.525
B. Momentum and Reversal (9)	imom.120.D			5.179		std_turn.120.D	−6.858	−7.008	−4.330
	revSimple.1M			−9.441		skew.120.D	−6.882	−7.136	−13.959
	momSimple.24M	−8.163	−8.188			idvol.120.D	10.032	9.544	16.851
	revSimple.24M					beta.120.D	−7.387	−7.602	−9.739
	momSimple.2M					betad.120.D	6.901	6.864	
	revSimple.36M					vol.120.D	−7.840	−7.517	−8.047
	imom.36.M	3.407	3.356			BETA.36.M	9.779	9.503	7.716
	momSimple.3M	−3.235	−3.358	3.409		resid_Skewness.36.M	8.693	8.750	8.261
	momSimple.6M	9.165	9.579	5.945		std_amount.36.M	−7.358	−7.481	−5.565
	Num of Sig.	*4*	*4*	*3*		std_turn.36.M			6.731
B. Liquidity (11)	illq.120.D	−8.532	−8.222			skew.36.M	−11.799	−12.041	−14.426
	turn.120.D	−5.420	−5.501	−7.878		idvol.36.M	4.566	4.618	4.175
	amt.120.D	3.596	3.494			beta.36.M	9.779	−9.361	−7.558
	illq.36.M	6.960	7.181			betad.36.M			
	turn.36.M		3.036	8.492		vol.36.M			−7.408
	amt.36.M	−4.356	−4.362	−10.602		std_amount.3M			−3.208
	turn.3M					std_turn.3M			−6.573
	amt.3.M			8.551		skew.3M	−8.073	−8.028	
	turnover.M			6.515		vol.3M	−8.427	−8.694	−14.982
	volume.M	8.224	8.266	16.711		*Num of Sig.*	*17*	*17*	*19*
	amt.M	−3.934	−3.992		**B. Abnormal Return (4)**	alpha.120.D			
	Num of Sig.	*7*	*8*	*6*		retnmax.120.D			
						alpha.36.M	6.330	6.131	4.582
						retnmax.36.M	7.843	8.072	5.018
						Num of Sig.	*2*	*2*	*2*

Notes: This table presents the results of stepwise regression model estimations conducted during robustness tests across various specifications. These include Elastic Net and PCA. We provide the t-statistics of the variables from these three specifications and summarize the number of variables that are statistically significant with |t-stat|>3 (see row Num of Sig.). Category A: Corporate Financial Fundamentals Factors (38 variables); Category B: Market Friction Factors (46 variables).

Table E. 2
Results of Baseline Regression Model in Different Testing Portfolios (Stepwise Regression).

Type	Code	T-statistics			Type	Code	T-statistics		
		2009	2 × 3	10 × 10			2009	2 × 3	10 × 10
A.Investment (5)	dPPE_and_inventory	10.138	5.691	−15.586	**A.Value Factor (8)**	DP	−14.268		
	Net_operating_assets	−10.958		−3.484		PE.M			17.589
	dIA	6.548				PB.M	11.267		−14.801
	ACC		8.448	8.791		EP	6.716		
	ACCP	−6.845		−5.009		SP	−10.951		3.333
	Num of Sig.	*4*	*2*	*4*		OCFP	−6.370	12.347	
A.Profitability (7)	dROE	6.437	3.571			LEV	−14.157		4.566
	PA	−8.703	−4.182	3.222		AM	−12.146		−3.333

(continued on next page)

Table E. 2 (*continued*)

Type	Code	T-statistics			Type	Code	T-statistics		
		2009	2 × 3	10 × 10			2009	2 × 3	10 × 10
	gross_profit	−10.364		−6.755		*Num of Sig.*	*7*	*1*	*5*
	cashpr	−9.090	−6.437	−11.055	**A.Other Financials**	Oscore	−12.303	7.679	7.475
	cash	−4.667			**(10)**	CR	11.515		−6.440
	CT	12.010				CRG			−10.007
	ROA	−12.737		5.022		QR	−11.499	−3.170	3.056
	Num of Sig.	*7*	*3*	*4*		QRG	10.596	−3.364	7.996
A.Growth Factor (8)	INVGchg	−15.943	−3.461	8.539		CFdebt	13.977		−4.054
	INVG	17.061	3.355	12.129		saleinv	−4.401	−9.795	−14.581
	LG	10.778	−4.841	5.133		salescash	−11.460		
	BVEG	13.306		13.455		RD	9.890		
	TAXchg			−11.487		Rdsales	−10.396	9.683	8.666
	PMG	13.600		20.753		*Num of Sig.*	*9*	*5*	*8*
	SG	−5.556		−14.037	**B.Volatility (22)**	BETA.120.D	11.661		16.813
	SgINVg	−14.185	7.529	11.532		resid_Skewness.120.D	10.072		
	Num of Sig.	*7*	*4*	*8*		std_amount.120.D			−6.497
B.Momentum and Reversal	imom.120.D			3.800		std_turn.120.D			−5.812
(9)	revSimple.1M	13.179	4.270	−7.367		skew.120.D	−10.214	−5.366	−16.480
	momSimple.24M	−5.824				idvol.120.D	14.480		20.531
	revSimple.24M			13.850		beta.120.D	−11.707		−16.788
	momSimple.2M	16.541		5.091		betad.120.D	10.220		
	revSimple.36M					vol.120.D			−11.337
	imom.36.M			−4.827		BETA.36.M	13.452		12.003
	momSimple.3M	−13.203				resid_Skewness.36.M	5.772	6.187	12.461
	momSimple.6M	11.716		13.465		std_amount.36.M		−5.215	−6.019
	Num of Sig.	*5*	*1*	*6*		std_turn.36.M			
B.Liquidity (11)	illq.120.D					skew.36.M	−9.591		−26.908
	turn.120.D			−5.174		idvol.36.M	5.145	6.694	
	amt.120.D	−16.745				beta.36.M	−13.512	3.659	−11.277
	illq.36.M	−10.325	5.676			betad.36.M	10.299		−9.079
	turn.36.M			11.220		vol.36.M		−6.134	
	amt.36.M	9.514	3.131	−3.406		std_amount.3M		4.922	
	turn.3M		4.280	10.457		std_turn.3M			
	amt.3.M					skew.3M	10.650		
	turnover.M					vol.3M			−7.291
	volume.M		6.435			*Num of Sig.*	*13*	*7*	*14*
	amt.M	13.820	−5.201	22.367	**B.Abnormal Return**	alpha.120.D		4.601	−6.085
	Num of Sig.	*4*	*5*	*5*	**(4)**	retnmax.120.D	15.433		−6.884
						alpha.36.M			12.645
						retnmax.36.M	6.160		17.172
						Num of Sig.	*2*	*1*	*4*

Notes: This table presents the results of stepwise regression model estimations conducted during robustness tests across various specifications. These include bivariate-sorted 2 × 3 and 10 × 10 portfolios, as well as the subperiod post-2009. We provide the t-statistics of the variables from these three specifications and summarize the number of variables that are statistically significant with |t-stat|>3 (see row Num of Sig.), as recommended by Harvey et al. (2016). Category A: Corporate Financial Fundamentals Factors (38 variables); Category B: Market Friction Factors (46 variables).

Data availability

I have shared the link to my data/code at the Attach File step.

Replication Folder for "Disciplining the Factor Zoo: Identifying Pricing Factors in the Chinese Stock Market" (Original data) (Mendeley Data)

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刊　　名：International Monetary Review
刊　　期：季刊
主办单位：中国人民大学国际货币研究所
出版单位：《International Monetary Review》编辑部
主　　编：贲圣林
联席主编：Herbert Poenisch
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