International Monetary Fund

IMF Middle East Center for Economics and Finance (IMF-CEF)

May 20, 2025

Advances in Artificial Intelligence
Implications for Capital Market Activities

Reference: Chapter 3 of the IMF Oct. 2024 Global Financial Stability Report

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Focus:

- ❖ Capital market activities
- ❖ Generative *and* non-generative AI
- ❖ **Financial stability implications**

Key questions:

- ➢ Will the changes brought by AI be **evolutionary** or **revolutionary**?
- ➢ How will AI impact **market structure** and **market dynamics**?
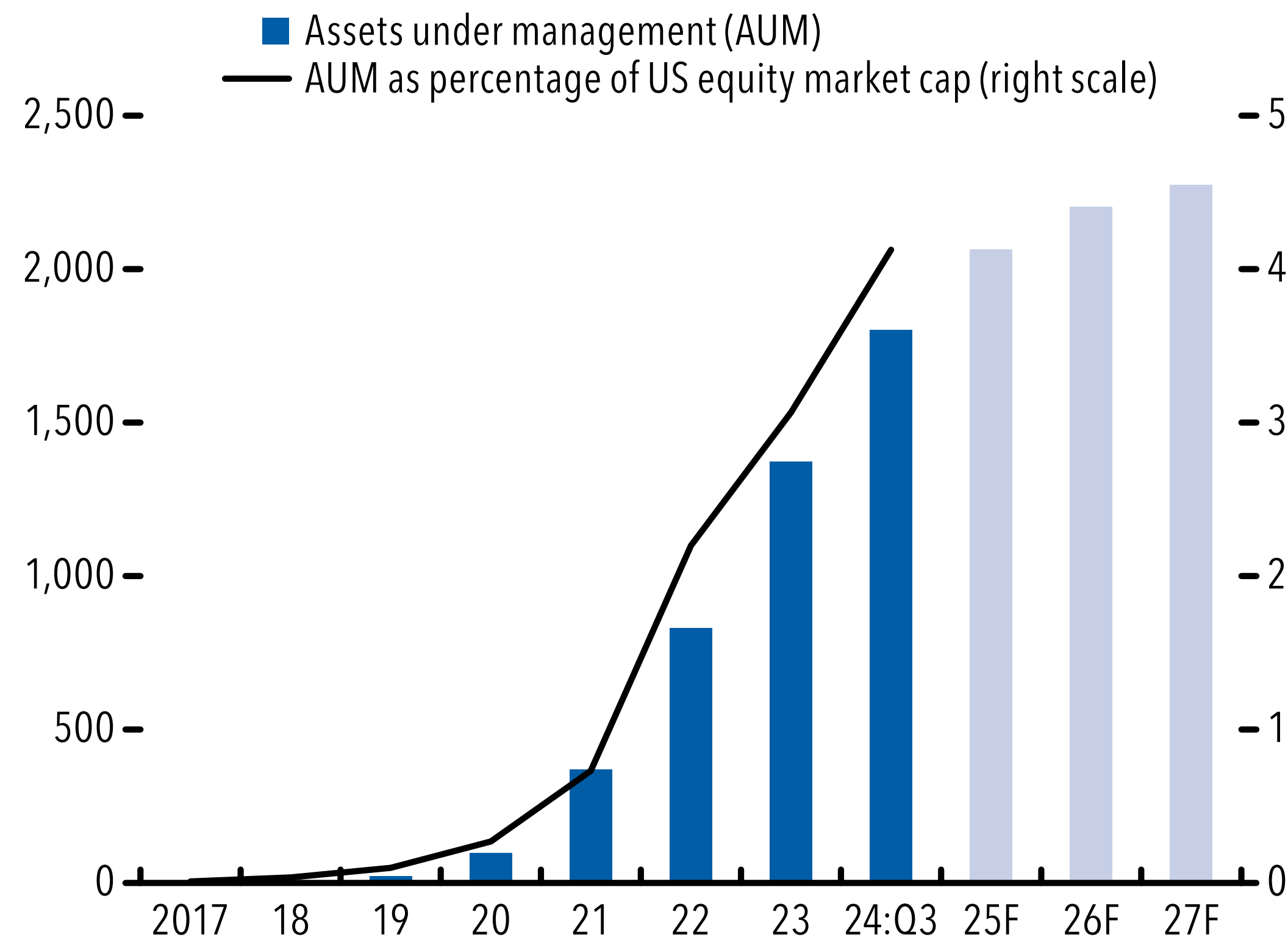- ➢ Can AI **amplify existing risks,** or could **new risks** emerge?

Approach:

| 1. AI Adoption |
| 2. AI Transformation |
| 3. Financial Stability Implications |
| 4. Regulatory Responses & Policy Recommendations |

Robo-advisor assets under management have grown explosively and are projected to grow further.

AI-driven exchange-traded fund (ETF) investment has grown, but it remains tiny compared to the market's size.

Robo-Advisors' Assets Under Management
(Billions of US dollars; share of US equity market cap in percent)

AI-Driven ETF Assets Under Management
(Billions of US dollars; share of US equity market cap in percent)

Sources: Bloomberg Finance L.P.; Statista Digital Market Insights; and IMF staff calculations.
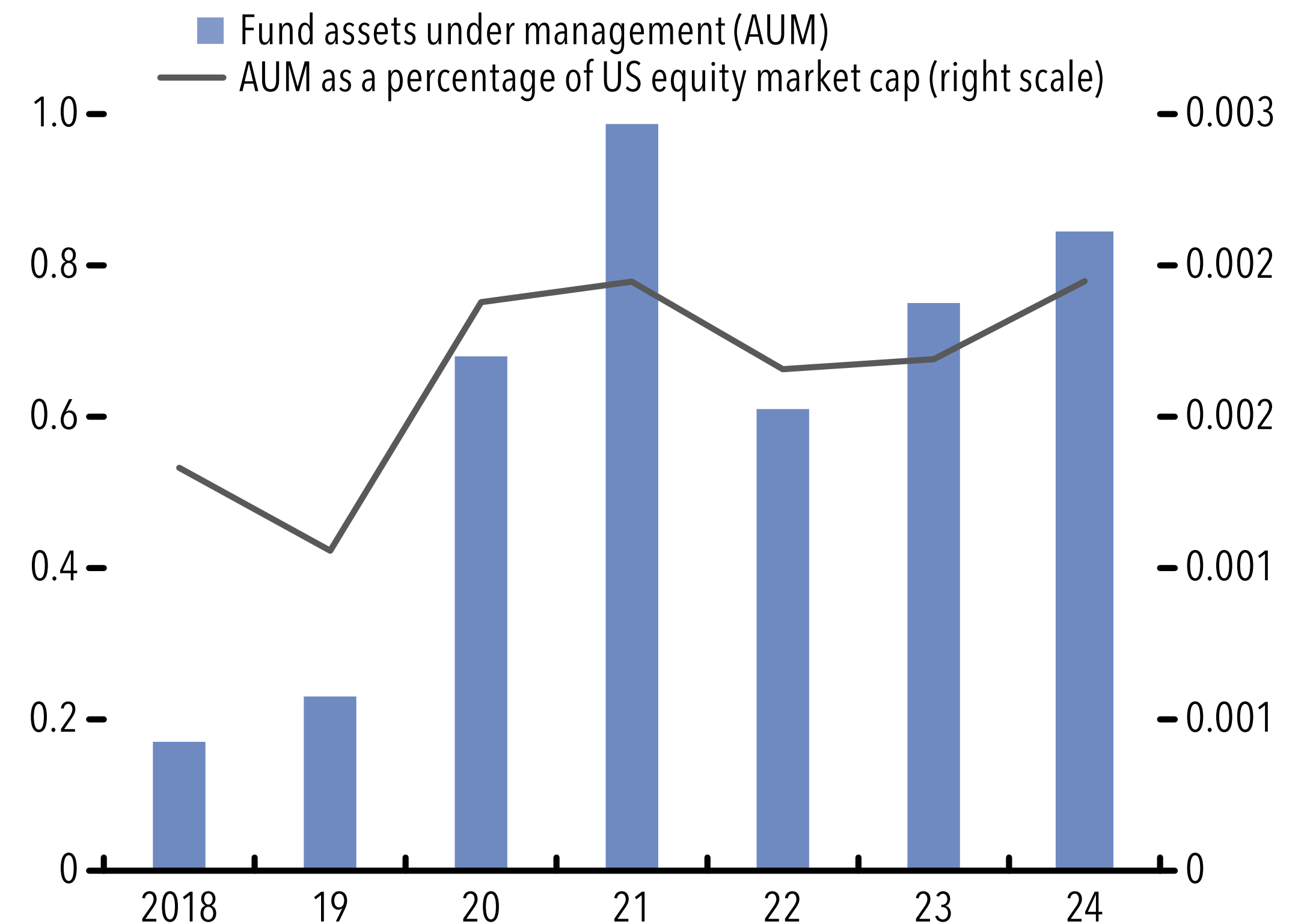
Broad Adoption Of AI, but Use in Core Investment Processes Remains Nascent

Adoption of AI in trading and investment decision making is still nascent.

Adoption of machine learning has not yet penetrated autonomous trading processes.

Use of AI by Investment Managers
(Percent)

Legend:
- Already integrated
- Partly integrated
- Planning to integrate
- Used, but not integrated
- Do not plan to integrate

Category	Already integrated	Partly integrated	Planning to integrate	Used, but not integrated	Do not plan to integrate
Incorporating alternative data sets	43	15	7	6	28
Developing forward-looking indicators	37	11	16	9	27
Analyzing market indicators	33	22	7	6	31
Generating ideas	30	23	9	12	26
Executing investment decisions	11	11	15	4	59
Allocating assets	10	9	12	10	59

Share of Dutch Energy Market Algorithms Based on Machine Learning
(Percent)

Legend:
- Share of algorithms based on ML
- Not based on ML

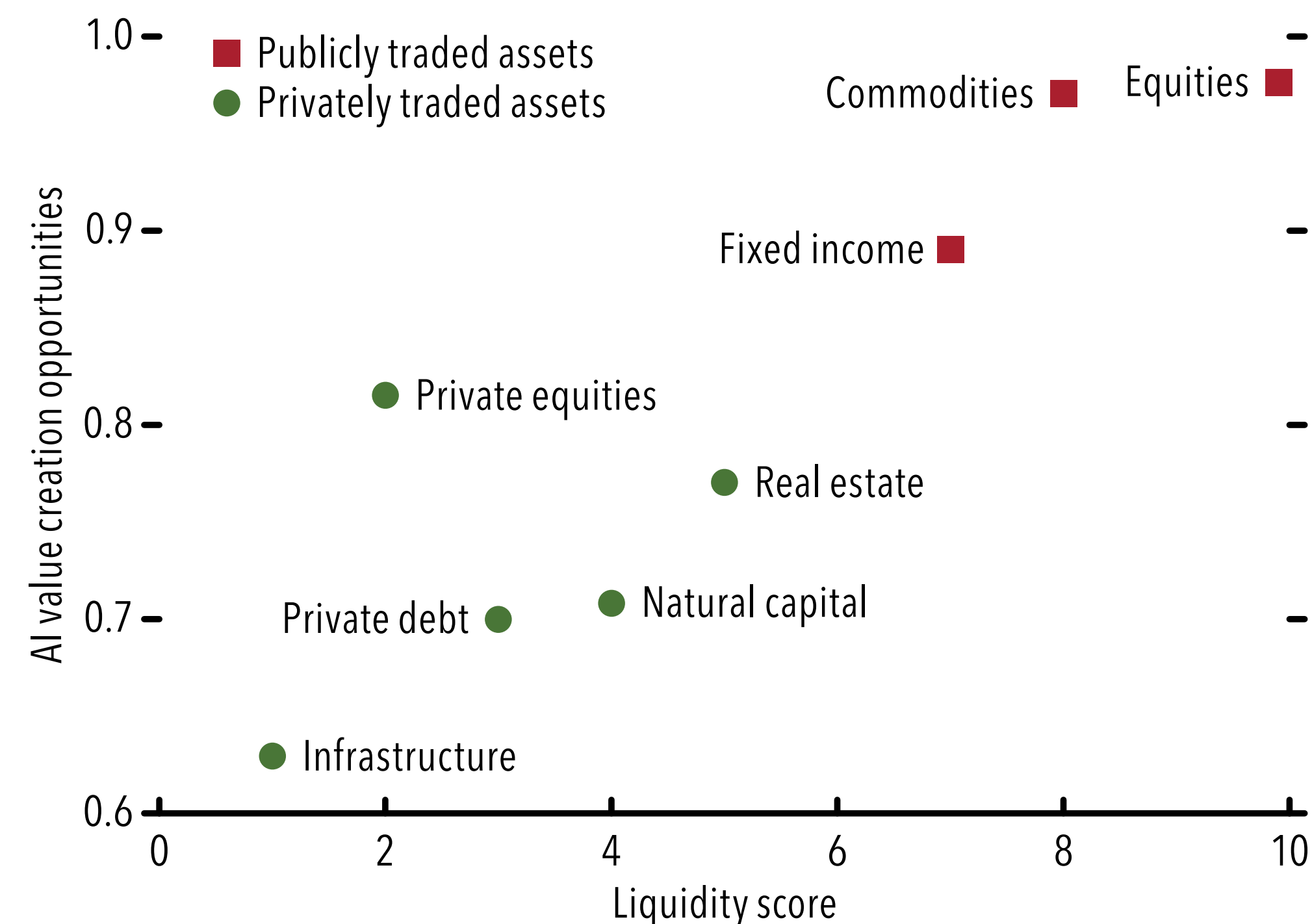(Bar chart: Signal generator, Trading algorithm, Execution algorithm)

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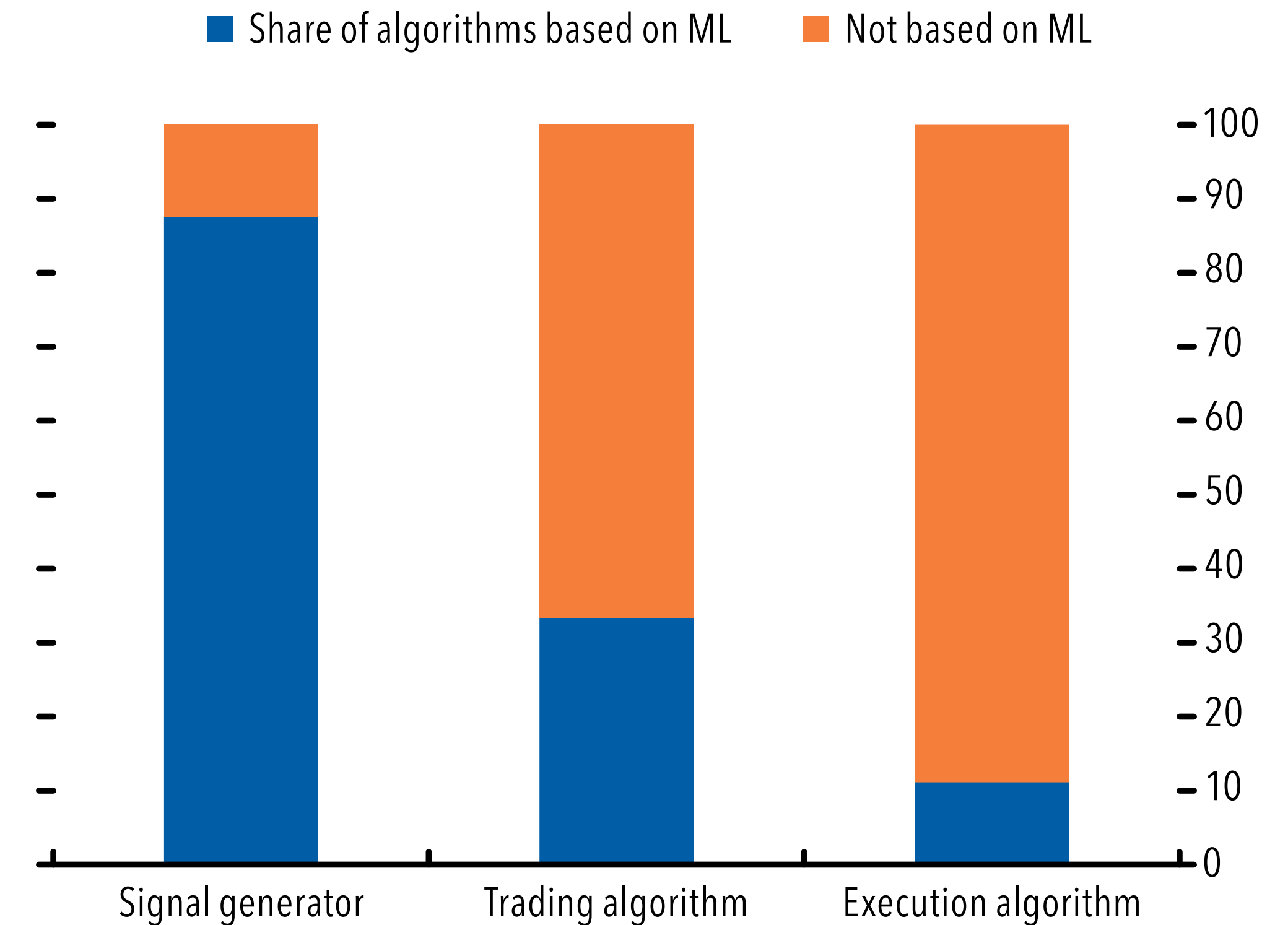
Filings relating to high-frequency or algorithmic trading incorporating AI/ML are increasing

Patents Related to High-Frequency/Algorithmic Trading
(Number of patents; percent of patents)

Legend:
- Algo/HFT
- of which contains AI/ML term
- AI/ML-share (right scale)
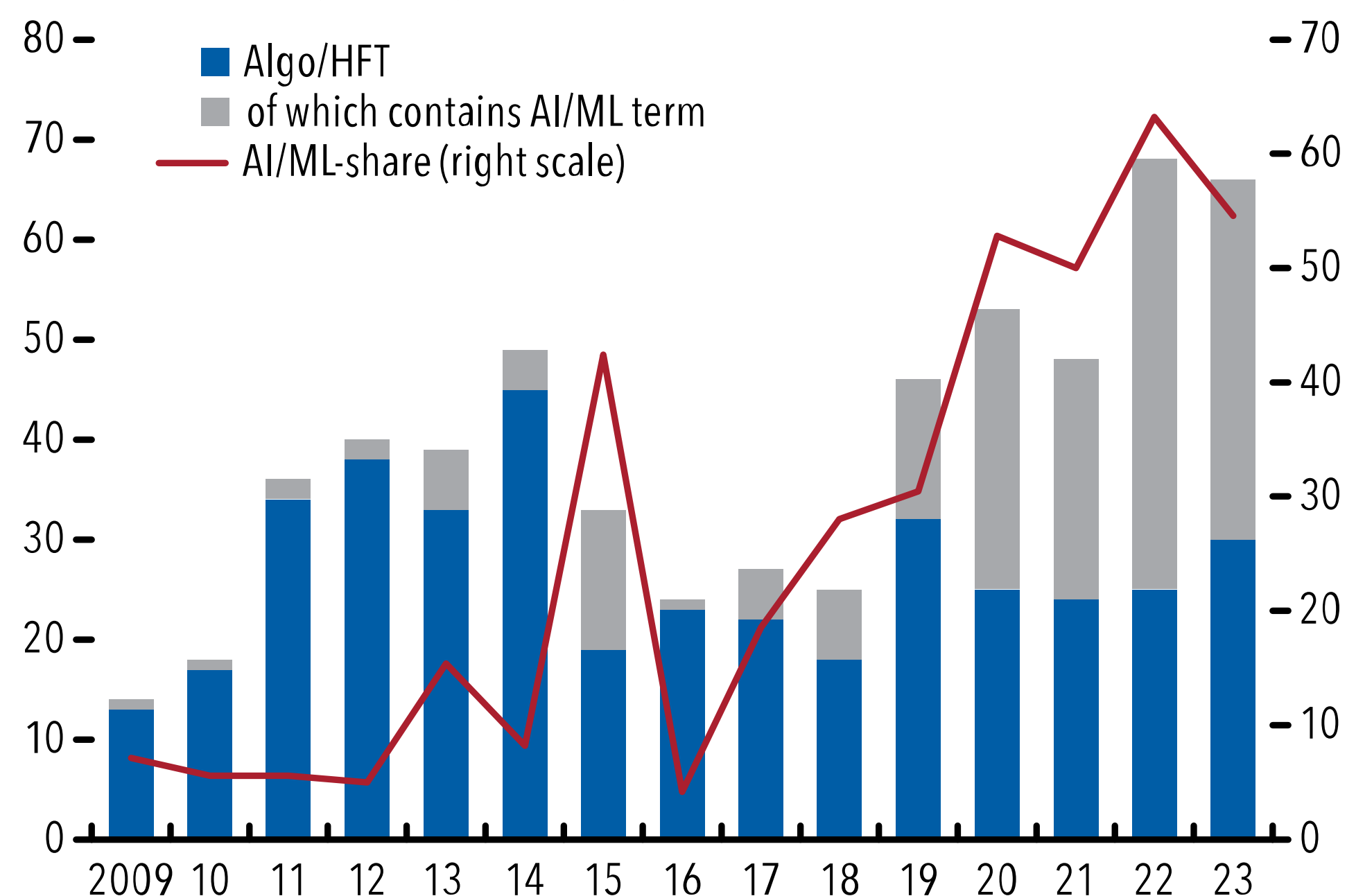
Strong correlation between market liquidity and AI value creation opportunities seen by investment managers.

AI Opportunities and Asset Class Liquidity
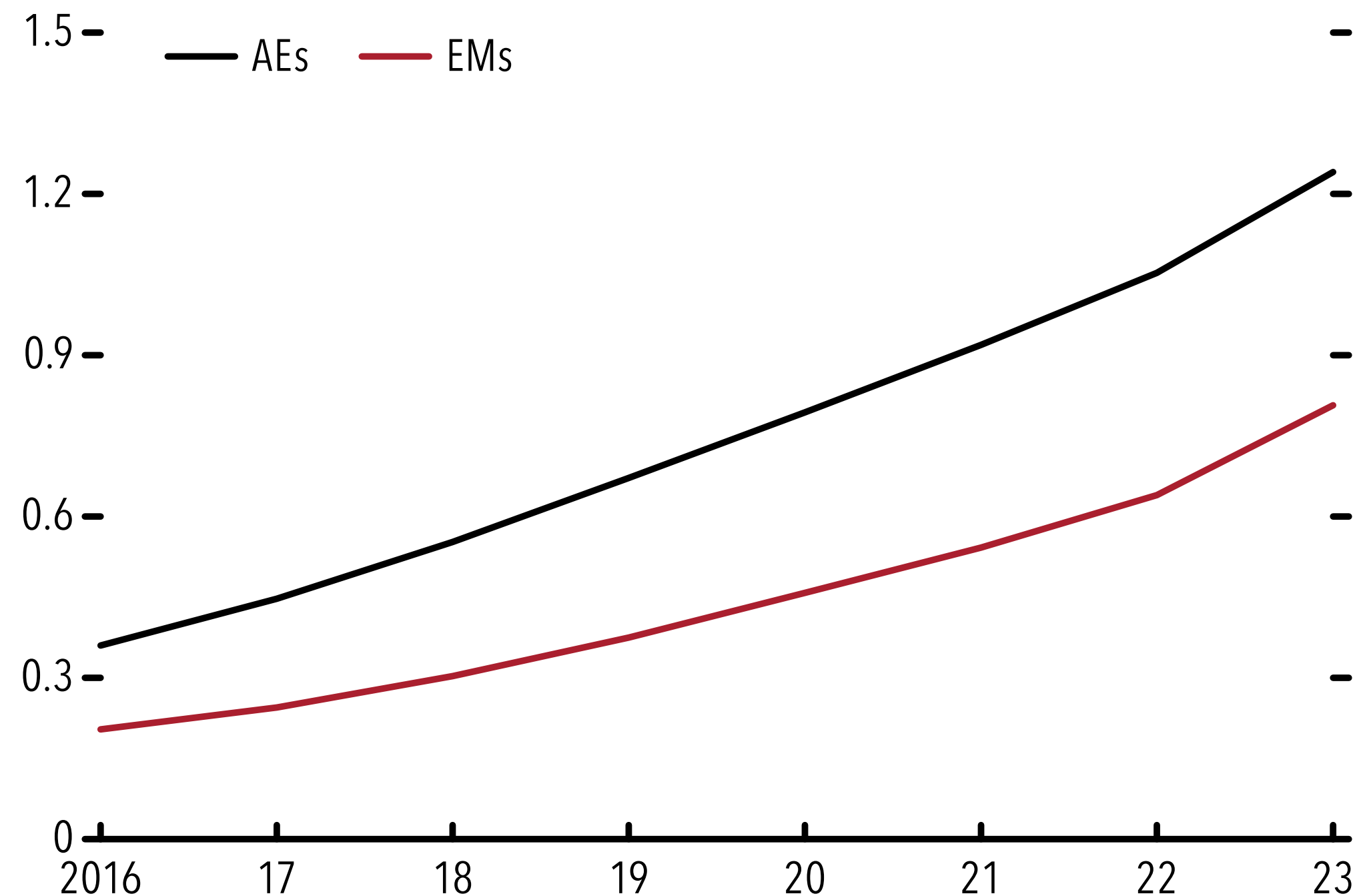(Value creation opportunity index; liquidity score)

Legend:
- Publicly traded assets
- Privately traded assets

Data points:
- Commodities
- Equities
- Fixed income
- Private equities
- Real estate
- Private debt
- Natural capital
- Infrastructure

Y-axis: AI value creation opportunities
X-axis: Liquidity score

While the existing workforce in the broader industry is steadily adopting AI skillsets ...

... demand for these skills has increased in recent years and appears to outpace job postings of the broader US economy

Concentration of LinkedIn Members in the Financial Services Industry with AI Skills
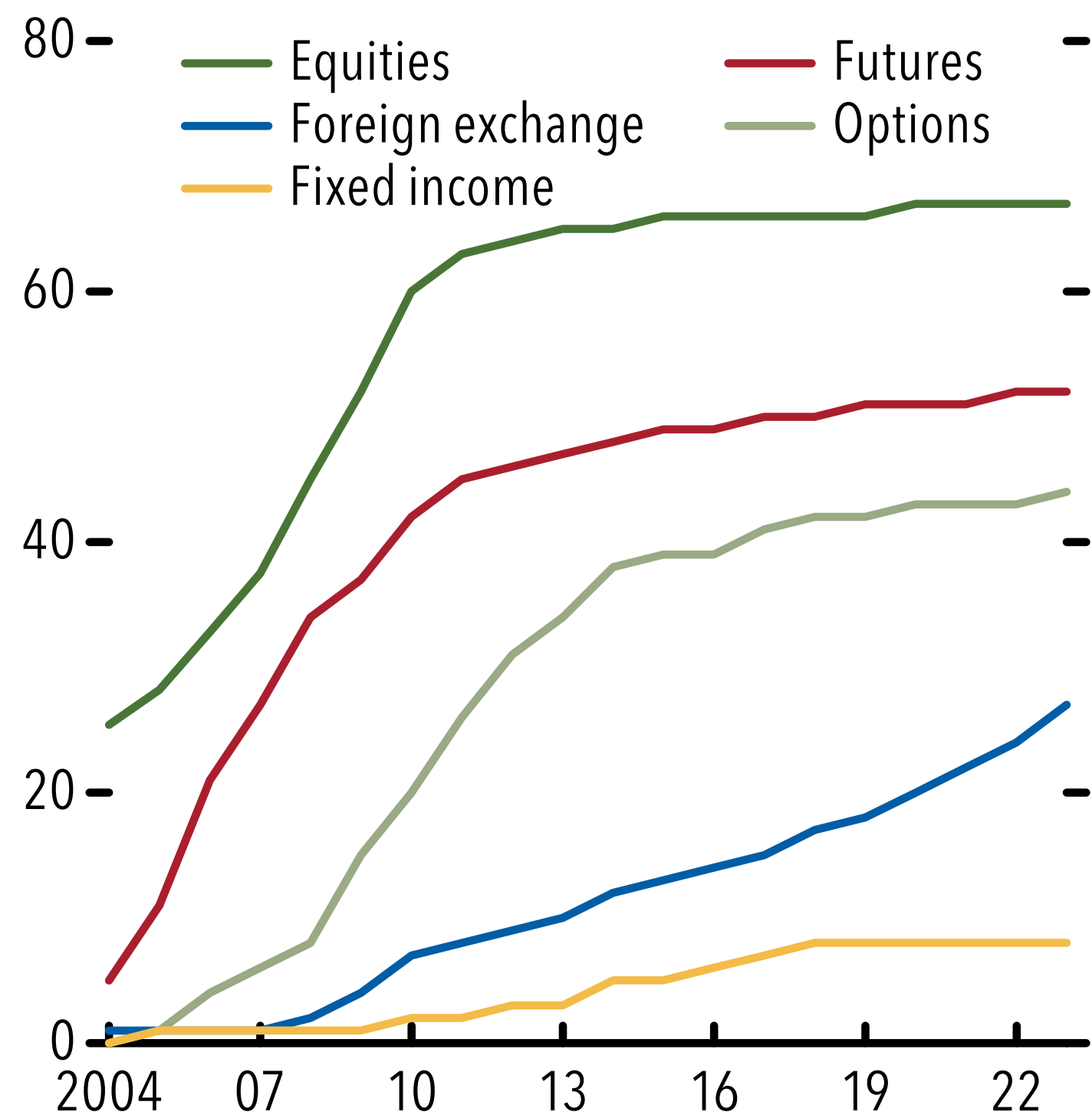(Average percent of aggregated country profiles)

Job Postings Containing AI Skills and the Share of AI Talent
(Average monthly percent of total job postings, percent of total members)
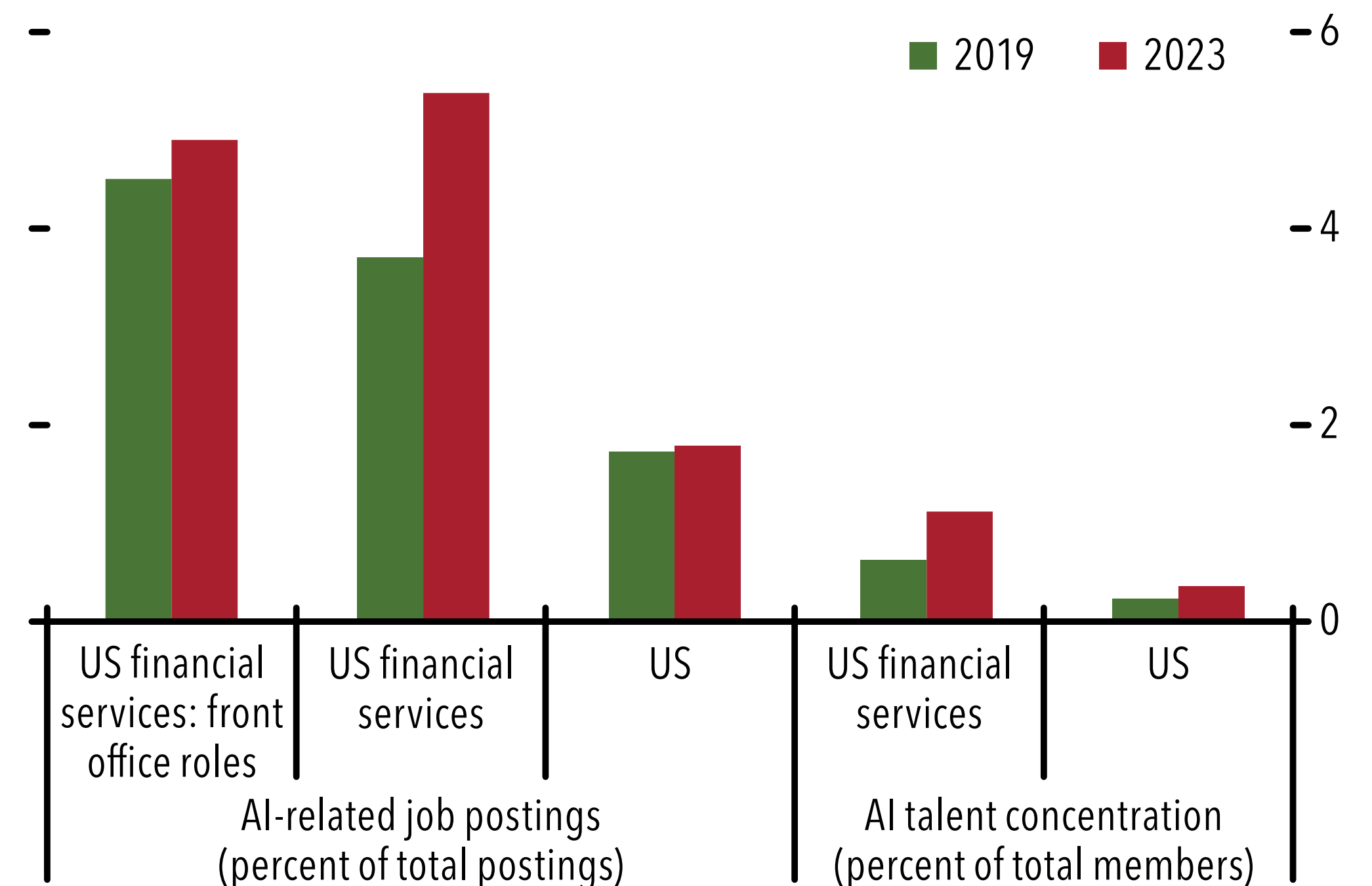
Sources: Indeed Hiring Lab; LinkedIn Economic Graph; and IMF staff calculations

Algorithmic trading has expanded across asset classes.

Activity in markets dominated by algorithmic trading tends to be concentrated.

Liquidity and algorithmic trading may be "flighty" under stress.

Share of Algorithmic Trading Activity by Asset Class (US) (Percent)

Euronext Equity Market Trading Activity by Most Active Participants (Percent)

Cancellation and Hidden Order Rates (Ratio versus executed trades)

Sources: Authority for Consumers and Markets; Datos Insights; US Securities and Exchange Commission, Market Information Data Analytics System; and IMF staff calculations
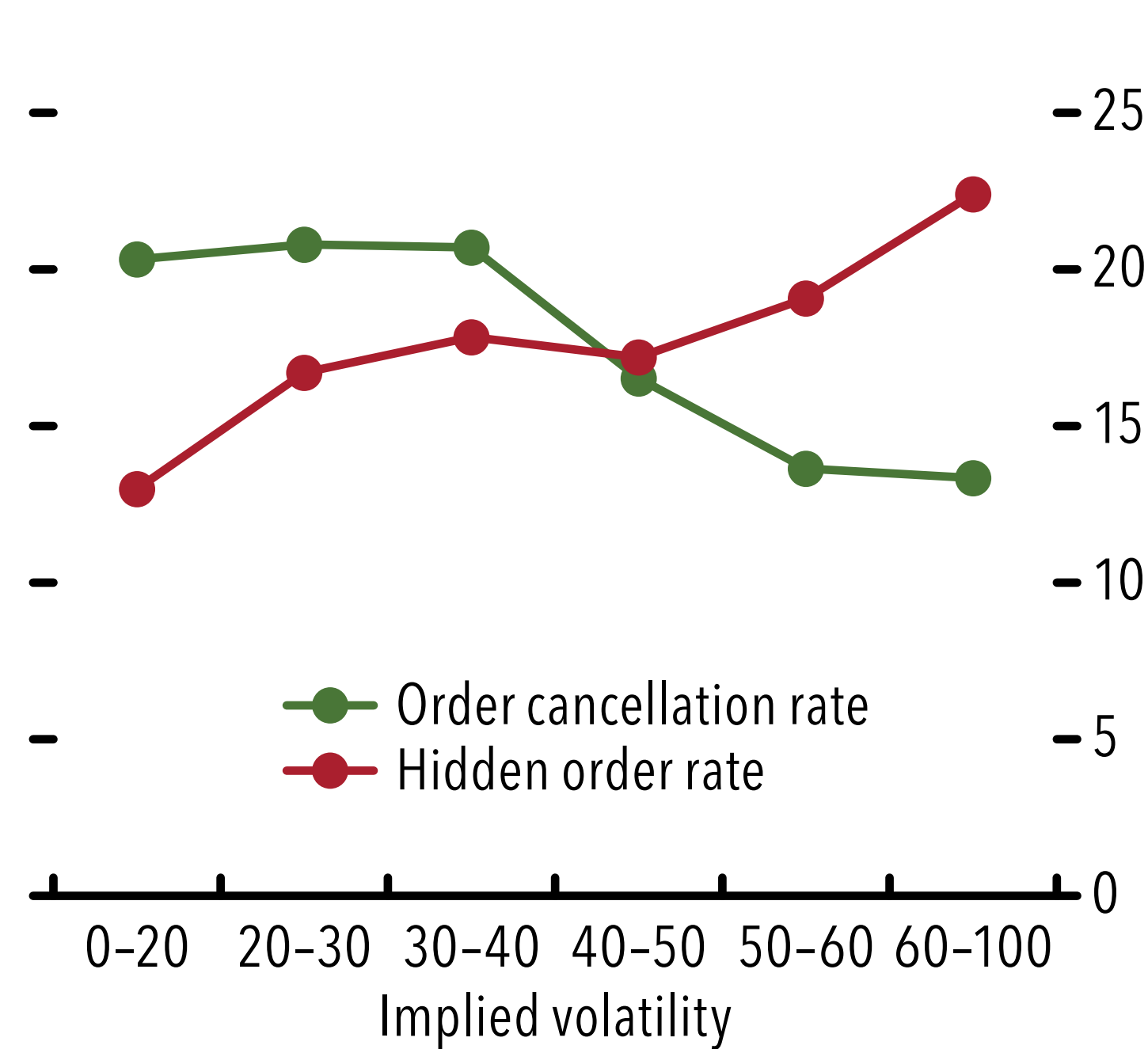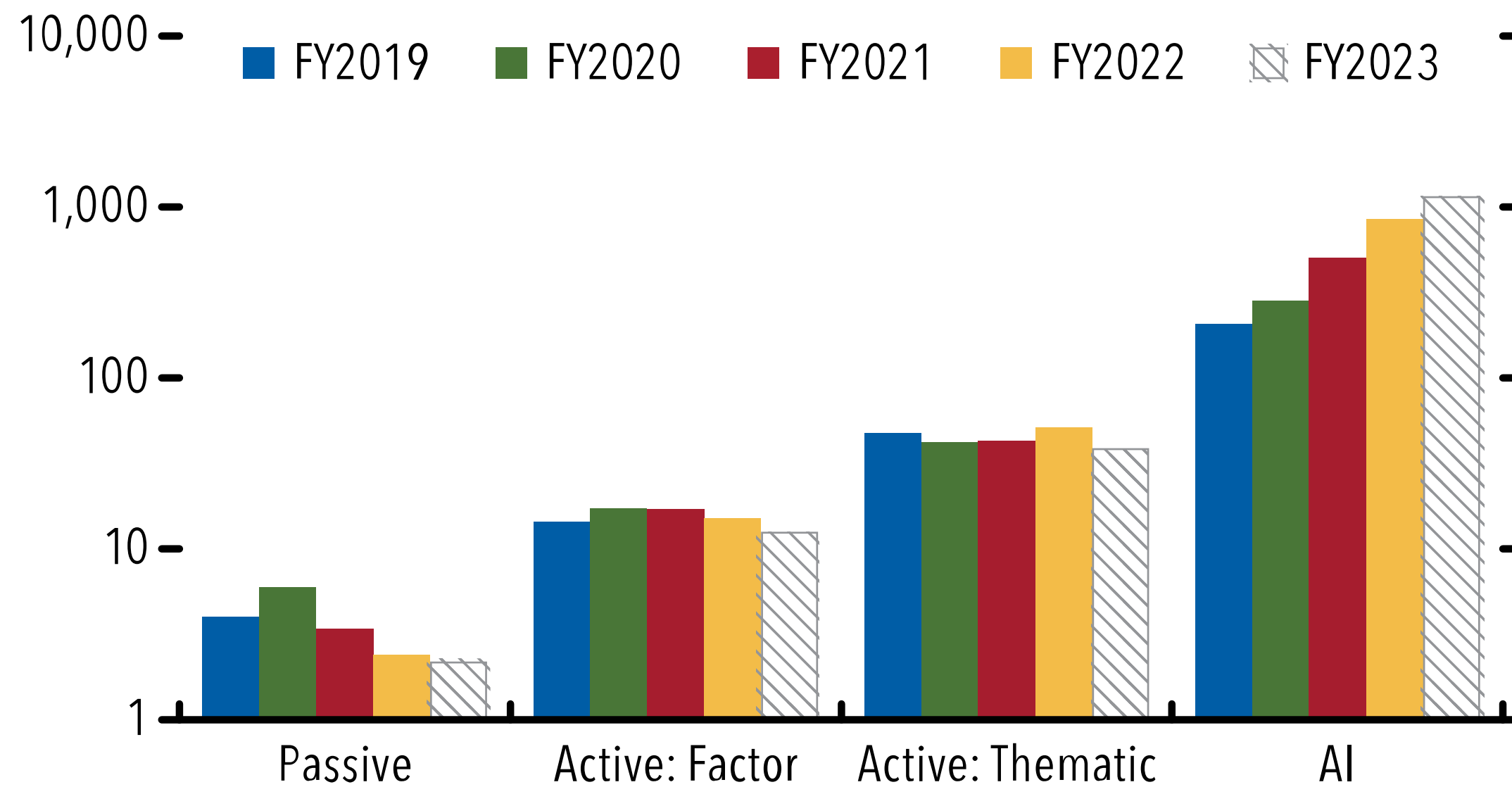
New Dynamics: Higher Trading Volumes and Faster Adjustments

The annual turnover of AI ETFs outstrips that of other active ETFs by over 50x

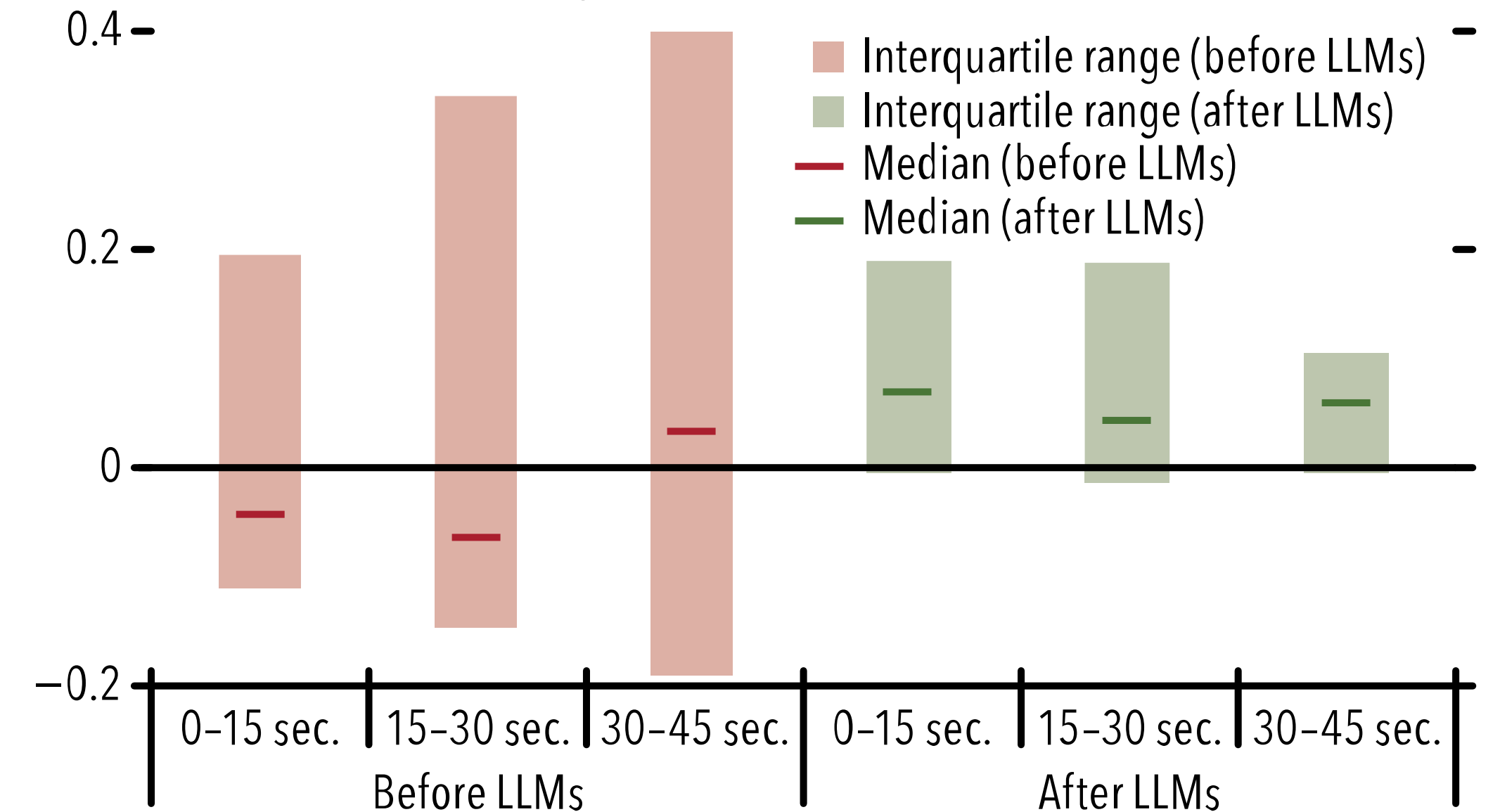*Preliminary evidence points to markets absorbing complex information more quickly*

Portfolio Turnover of ETFs
(Percent of assets under management)

S&P 500 Normalized Market Reaction after Release of Fed Minutes
(Proportion of price change at the 15-minute point)

Sources: Bloomberg Finance L.P.; US Securities and Exchange Commission Filings; and IMF staff calculations.

IT infrastructure remains strongly concentrated, and the AI software services market is becoming more concentrated.
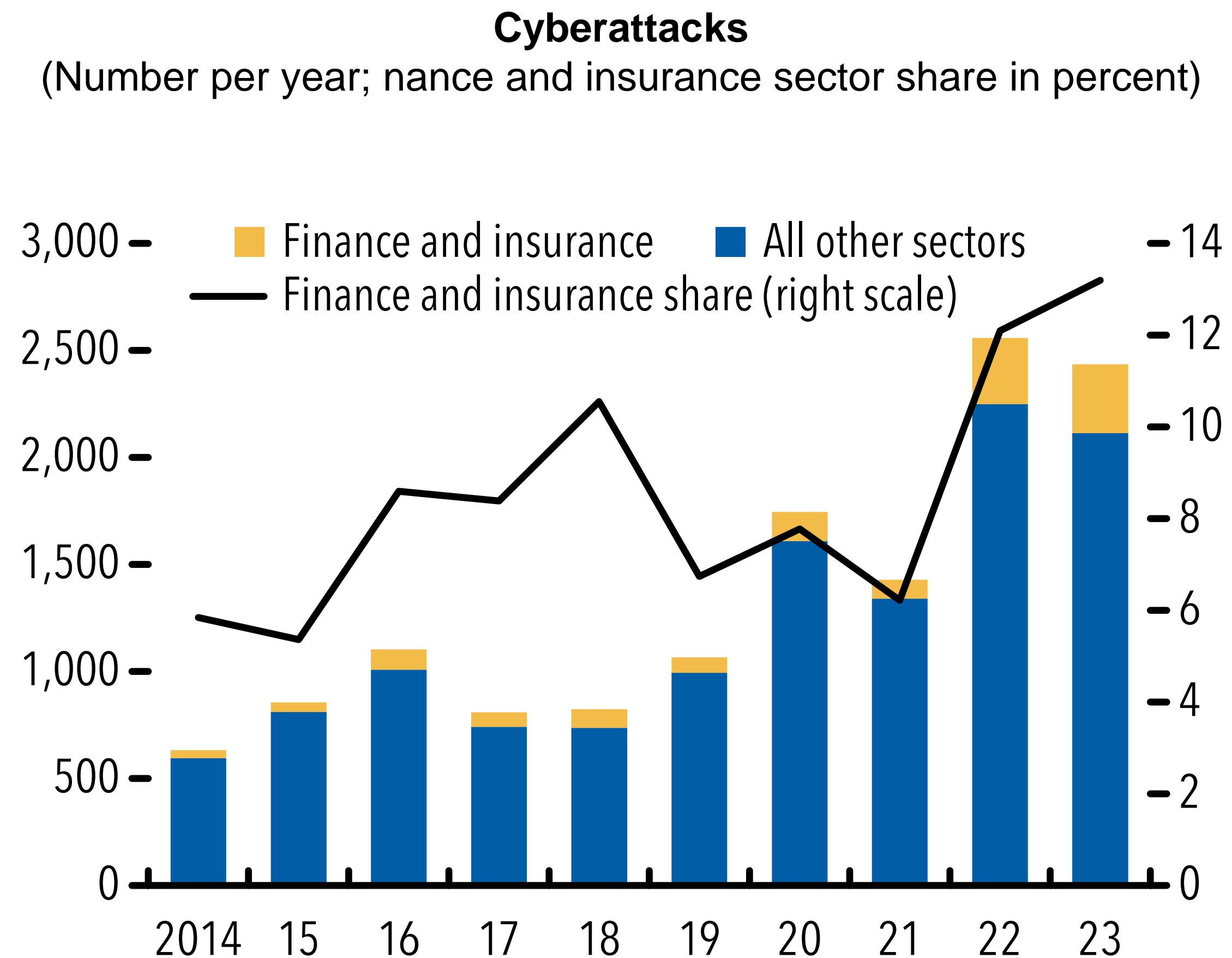
Market Share of Cloud Services and AI Software Platforms
(Percent; right scale: revenue in billions of US dollars)

Legend:
- Market share–No.3
- Market share–No.2
- Market share–No.1
- ◆ Total revenue in billions of US dollars (right scale)
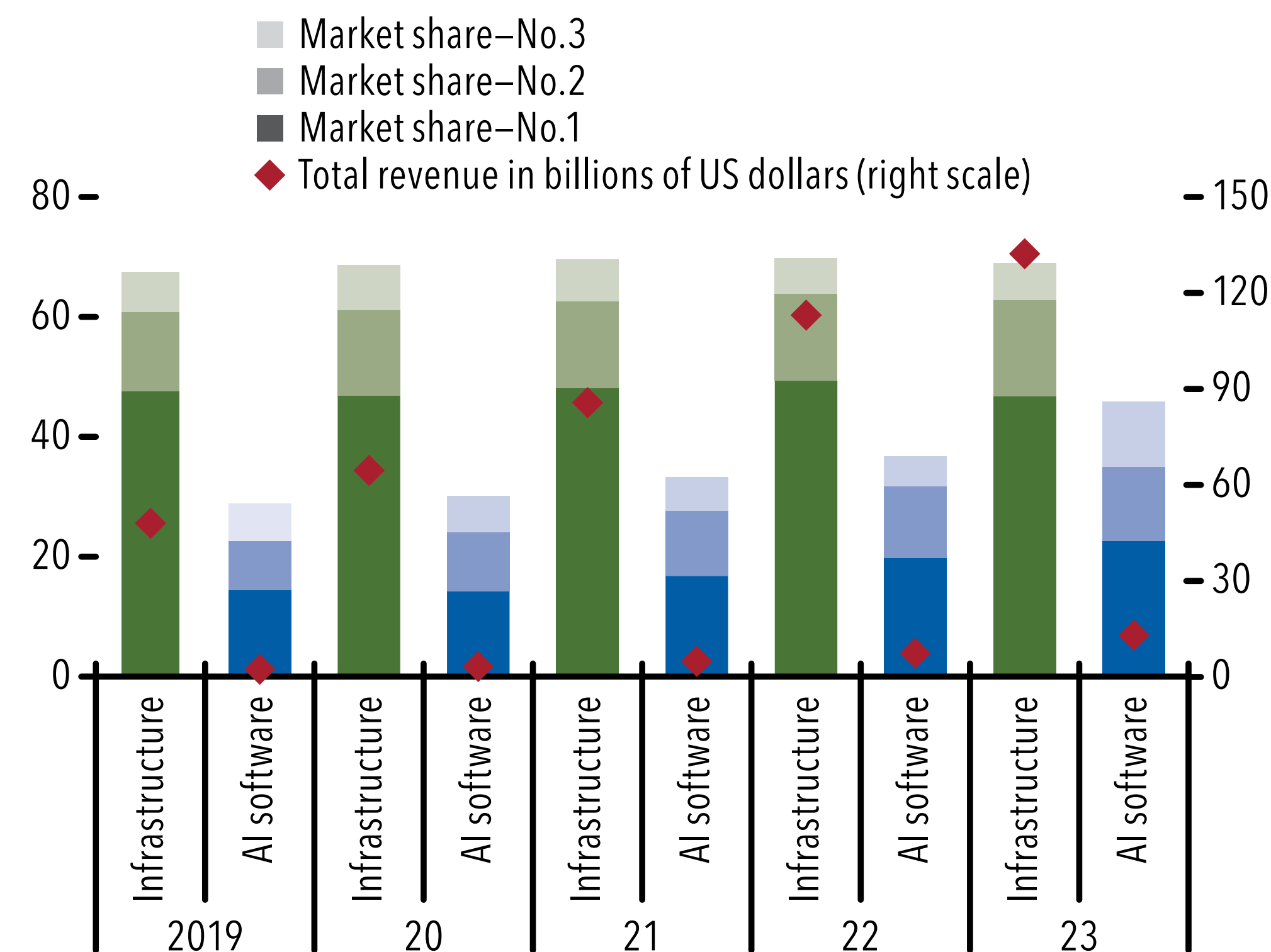
Sources: Bloomberg Intelligence; Parametrix Insurance; and IMF staff calculations

Cyberattacks have increased, with the financial sector share rising as well.

Cyberattacks
(Number per year; nance and insurance sector share in percent)

Sources: AI, Algorithmic, and Automation Incidents and Controversies (AIAAIC); University of Maryland Center for International and Security Studies; and IMF staff calculations.
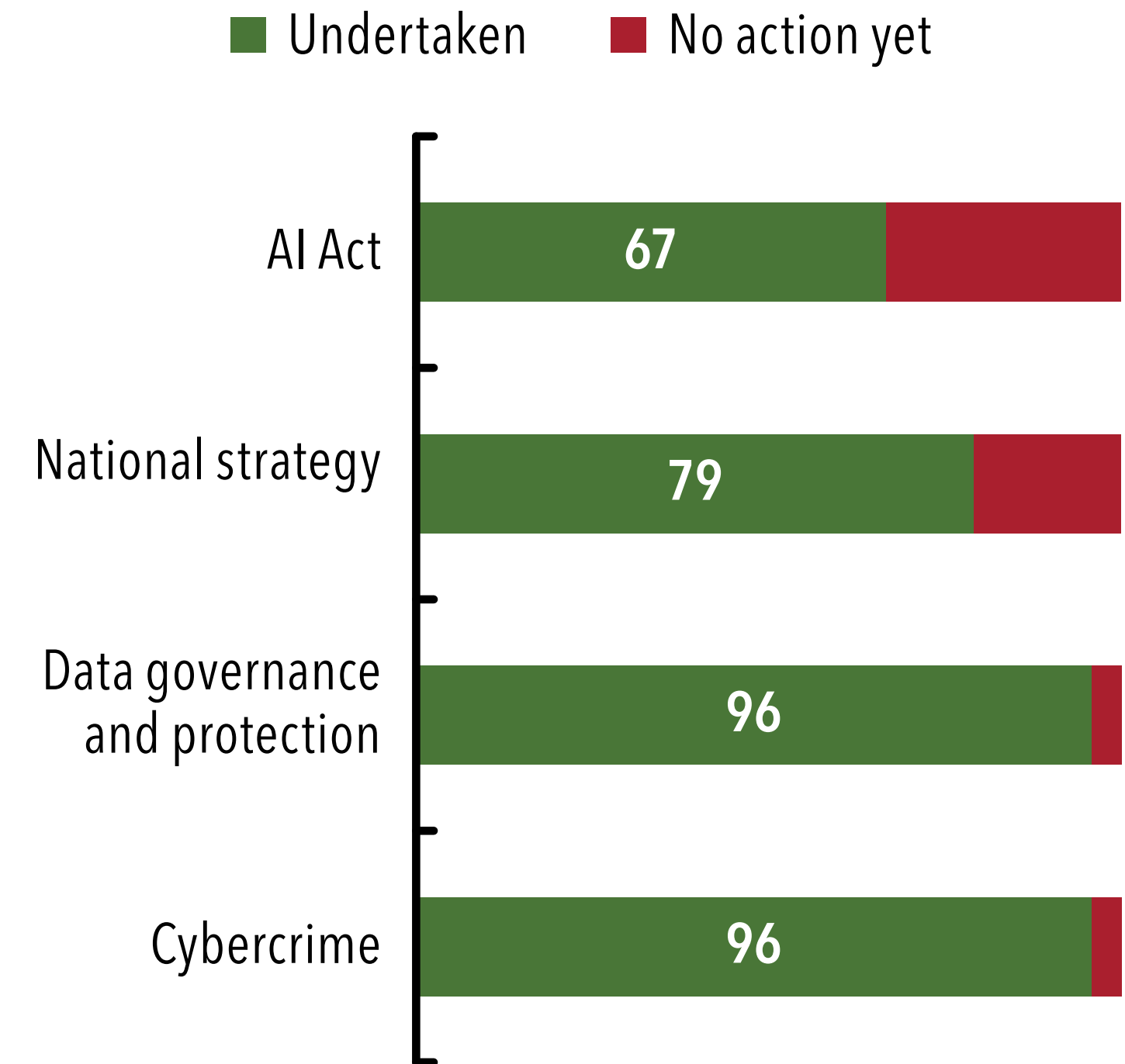
Standard-setting bodies are designing frameworks by building on accepted practices, while considering their application to AI.

Standard-Setting Body Response

Governments with large capital markets are leveraging cyber and data frameworks to pivot to AI strategies ...

National Response
(Percent)

■ Undertaken   ■ No action yet

AI Act	67
National strategy	79
Data governance and protection	96
Cybercrime	96

... whereas financial supervisors are cautious and respond through targeted outreach and clarification of existing standards

Supervisory Response
(Percent)

■ Undertaken   ■ No action yet

Enforcement	4
Principle based	12
Clarification	65
Outreach	69
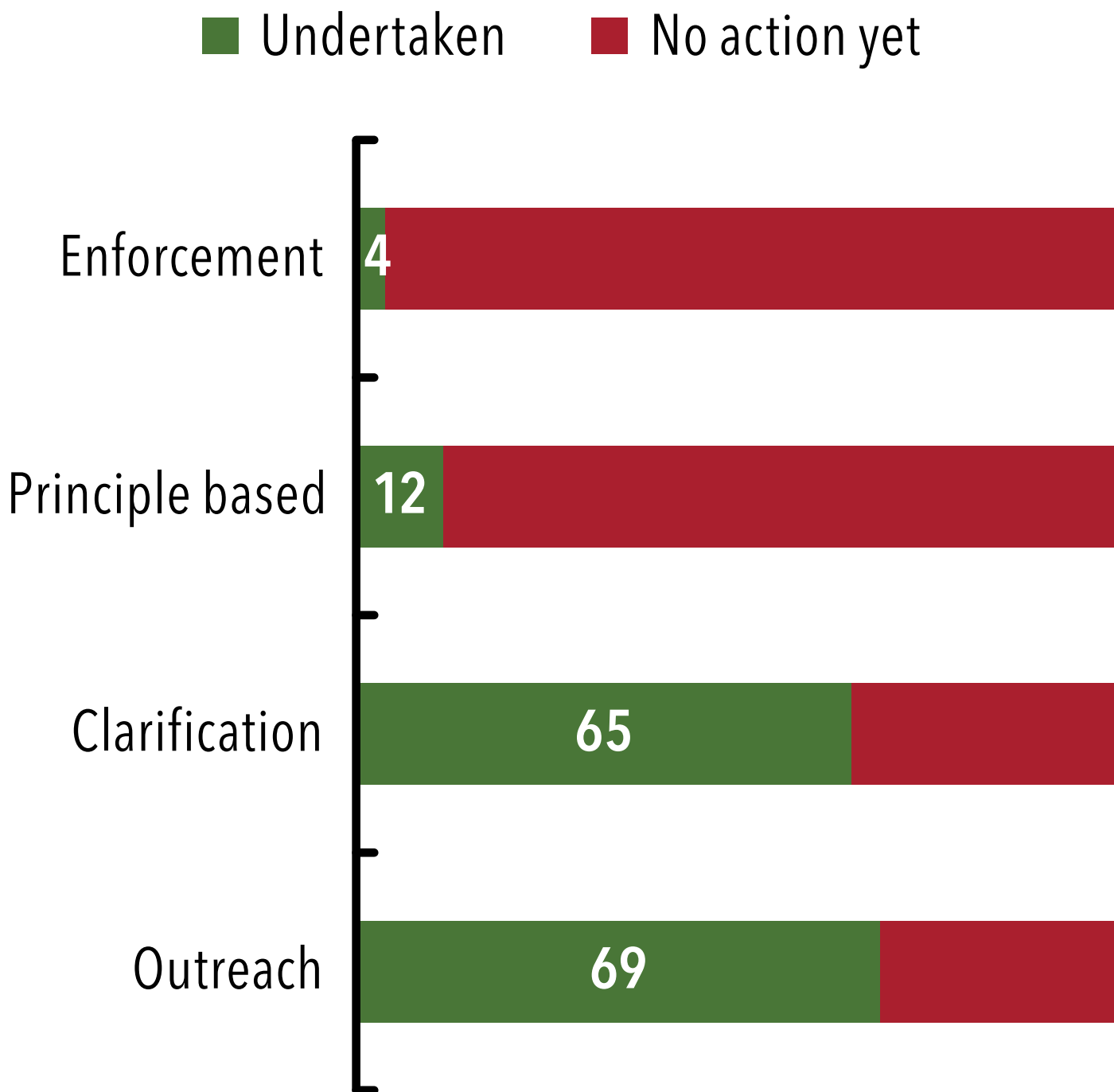
Sources: Panel 1: IMF staff literature review of international standards and regulatory and supervisory publications. Panels 2 and 3: UN Institute for Disarmament Research AI Policy Portal; UN data protection and privacy legislation worldwide; and IMF staff analysis and review of AI-related initiatives taken by financial sector authorities. Note: The analysis covers the jurisdictions with stock exchange operators with a market capitalization of listed companies exceeding $1 trillion as of March 2024. The sample consists of 24 jurisdictions, of which 11 are members of the European Economic Area, and 26 financial market authorities, of which 11 are from the European Economic Area and 3 are from the United States. AI = artificial intelligence.

FSB: Financial Stability Implications of AI (Nov 2024)
- ✓ Emphasizes how market manipulation risks are amplified by increased market correlations due to widespread use of common AI models, manifesting in synchronized trading patterns, lending decisions, and pricing strategies.

ESMA report on AI in EU investment funds (Feb 2025)
- ✓ Investment funds that promote their use of AI still represent a minor share of the industry
- ✓ Asset managers use generative AI and tools based on large language models primarily to support human-driven investment decisions.

IOSCO consultation on AI in Capital Markets: Use Cases, Risks, and Challenges & Neo-Brokers
- ✓ Firms increasingly using AI to support decision-making processes in applications and functions such as robo-advising, algorithmic trading, investment research, and sentiment analysis. AI is also being used to enhance surveillance and compliance functions, particularly in AML and CFT measures.
- ✓ Risks most commonly cited with respect to the use of AI systems in the financial sector include malicious uses of AI; AI model and data considerations; concentration, outsourcing, and third-party dependency; and interactions between humans and AI systems.
- ✓ The IOSCO Consultation Report on Neo-Brokers examines the risks and opportunities posed by online-only brokers, focusing on conflicts of interest, IT infrastructure robustness, and the need for transparent fee disclosures to enhance retail investor protection.

Selection of Initiatives by Regulators and Standard Setting Bodies

[Artificial Intelligence Consortium | Bank of England](#)
- ✓ Platform for public-private engagement to gather input from stakeholders on the capabilities, development, deployment and use of AI in UK financial services.

[MAS-led Industry Consortium Releases Toolkit for Responsible Use of AI in the Financial Sector](#)
- ✓ Help financial institutions carry out the assessment methodologies for the Fairness, Ethics, Accountability and Transparency (FEAT). The FEAT principles provide guidance to firms offering financial products and services on the responsible use of AI and data analytics

[HKMA Sandbox](#)
- ✓ A risk-controlled environment for firms to develop, test, and pilot innovative AI-based solutions in real-world banking scenarios
- ✓ 15 use cases, from 10 banks and four technology partners selected as inaugural participants in the Sandbox from over 40 proposals received - use cases : enhancing risk management, anti-fraud measures and customer experience.

[FCA, UK AI Live Testing](#)
- ✓ launch AI Live Testing, as part of the existing AI Lab. Testing to support the safe and responsible deployment of AI by firms and achieve positive outcomes for UK consumers and markets.

[Federal Reserve Board's Artificial Intelligence (AI) Program](#)
- ✓ Artificial intelligence (AI) program for its staff to promote responsible use of AI and enables AI-related innovation. Accompanied by a detailed AI Use Case Inventory

Key Financial Stability Benefits, Risks and Recommendations

Benefits and Risks

Recommendations

AI may reduce financial stability risks:

- ✓ superior risk management,
- ✓ improved market liquidity
- ✓ improved market monitoring capabilities for both participants and regulators.

But it also brings potential risks:

- ❖ increased market speed and volatility under stress
- ❖ greater opacity and migration of activities to NBFIs
- ❖ increased service provider operational risks
- ❖ increased cyber and market manipulation risks

➢ review margining requirements and calibration of circuit breakers

➢ enhance monitoring and data collection, including NBFIs.

➢ conduct risks mappings to understanding interdependencies

➢ coordinate approach on critical AI third-party service providers

➢ further enhance cyberattack protocols
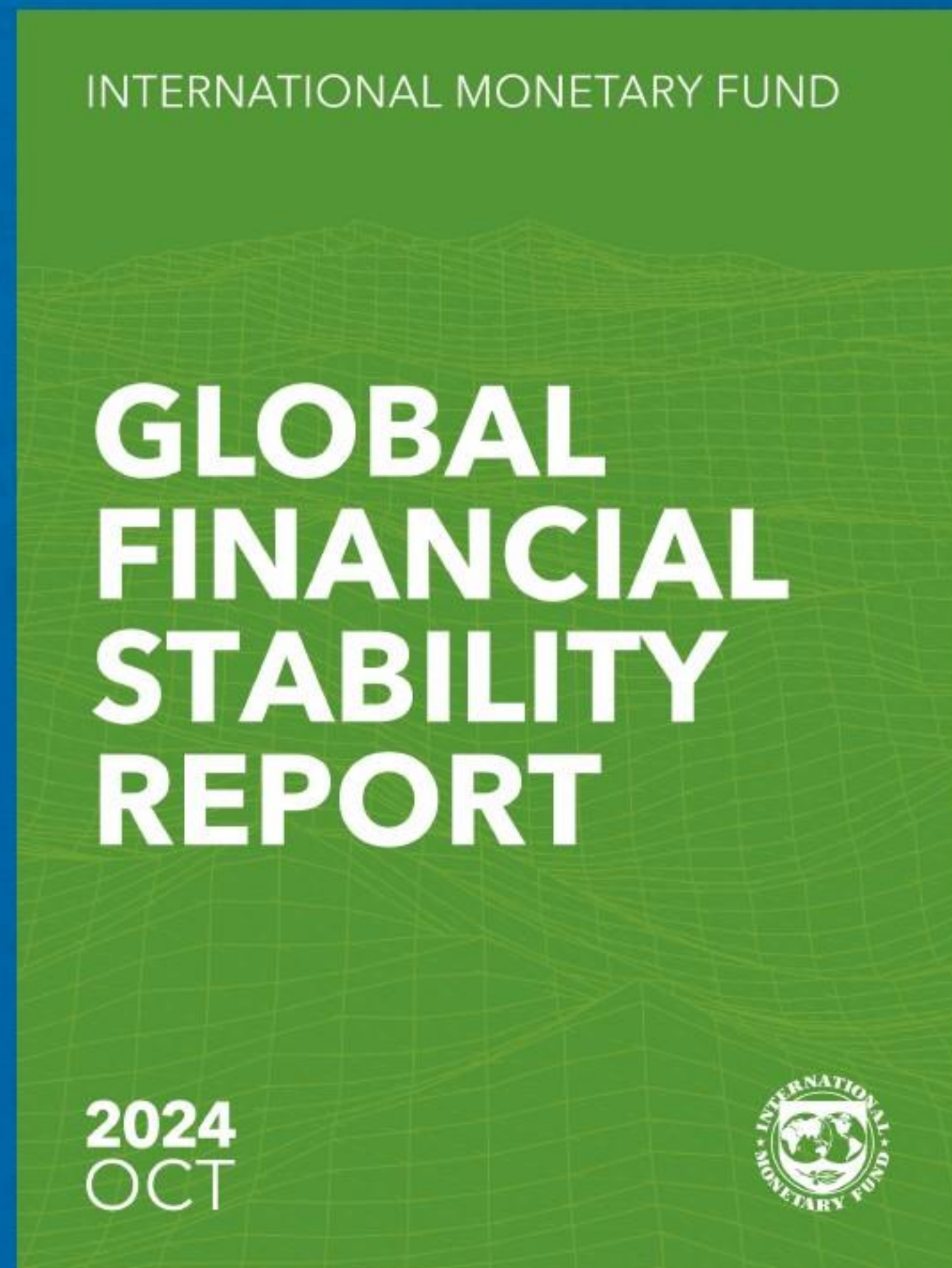
Background Slides

Some of the largest risks involve herding and market concentration as well as model explainability

What Risks Are Associated with Using Generative AI?
(Share of participants)

Key Risks

- Herding and market concentration
- Vendor concentration
- Market fragility and manipulation
- Cyber risks
- Job replacement

Other Risks

- Model explainability
- Hallucinations
- High costs
- Unauthorized data
- Reputational risks
- EMDE fragmentation

Most market participants agree that regulators should ensure market integrity through monitoring and maintain human oversight

How Do You Expect Regulatory Authorities to Respond to the Risks of Generative AI?

Bank/dealer
Asset manager
Infrastructure
Other

Market integrity and monitoring
Human oversight
Transparency and disclosures
Managing model risk
Balance consumer protections and innovation
Enhance regulatory capacity
Cyber resilience

Sources: IMF, October 2024 Global Financial Stability Report market intelligence; and IMF staff calculations.
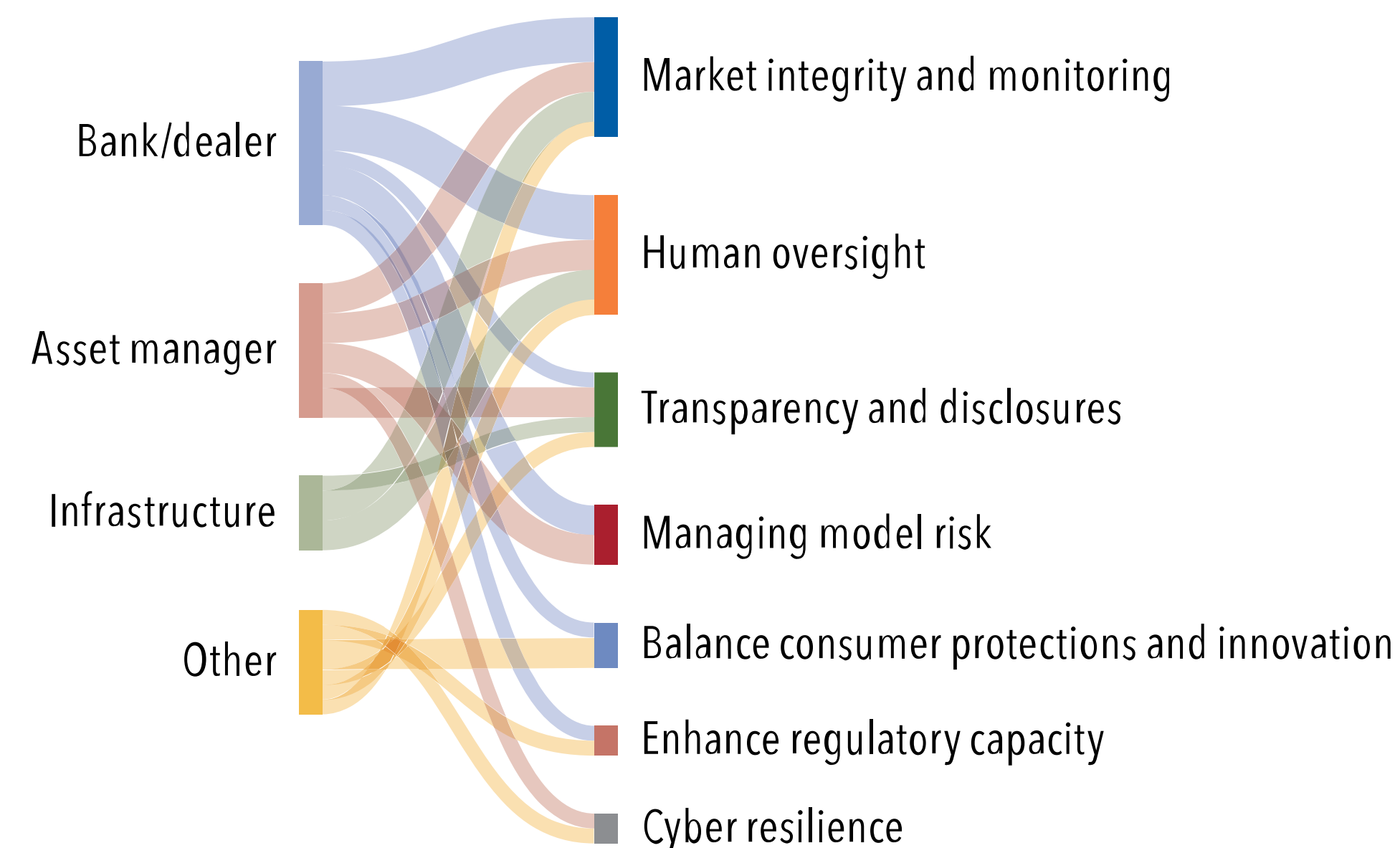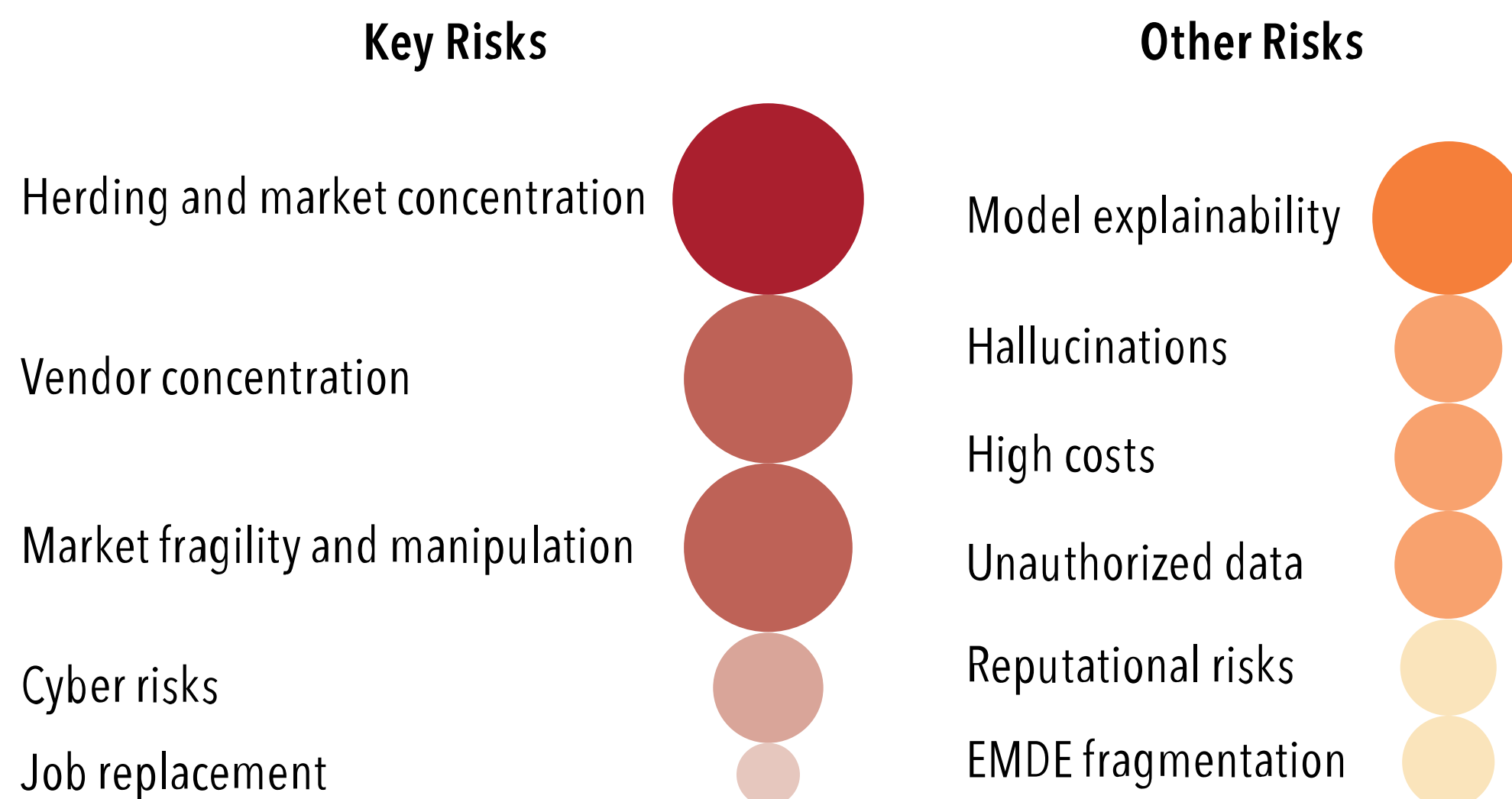
Use Cases for Artificial Intelligence in Capital Market Activities

Potential benefits include enhanced accuracy, efficiency, and market insights through multidimensional analysis from unstructured data sources, delivering customized, and actionable outputs
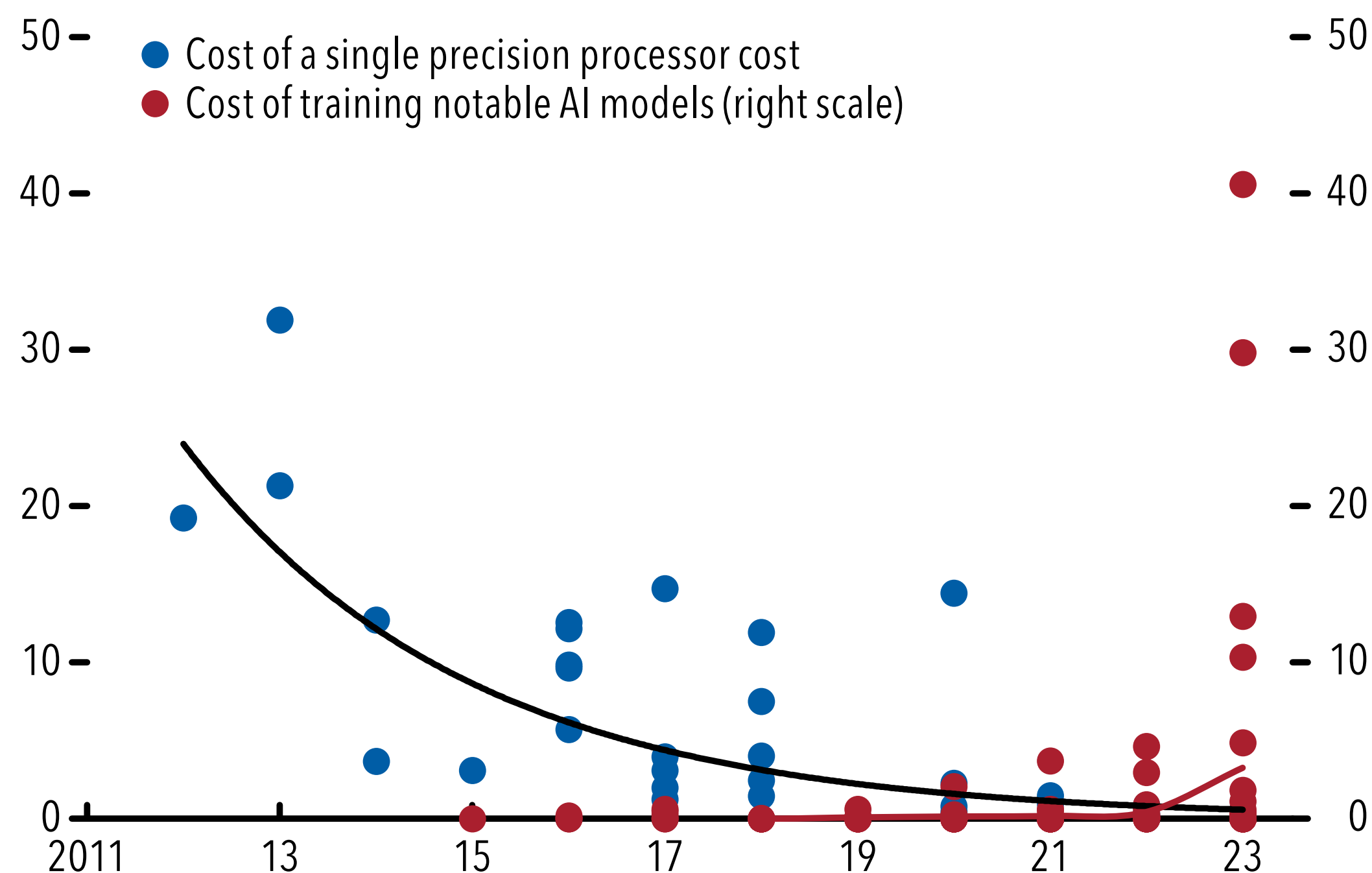
Key Processes	Client/Institution Profiling	Asset Allocation			Trading	Risk Management	
	Identification of Needs and Constraints	Asset Class Allocation	Sectoral Allocation	Security Selection	Orders Placement and Execution	Risk Monitoring	Reporting
Potential Benefits from Adopting AI	**Enhance client's profile assessment** • Analyze unstructured or alternative clients' data to understand unique objectives, idiosyncratic needs, and risk preference • Generate simulated scenarios and visualization of potential outcomes of different asset mix	**Enhance optimization and forecast techniques for strategic allocation** • High dimensional forecasting and predictor selections • Deep learning methodologies for dynamic multiperiod portfolio optimization • Clustering/network analysis to analyze multidimensional interactions/ correlations **Derive signals from unstructured and alternative data** • Natural language processing models for sentiment analysis to identify thematic opportunities • Polarity detection, microtext analysis, aspect extraction, or sarcasm detection to improve signal quality		**Improve analysis precision** • Feature extraction (beta, momentum, and so on) • Network/ multidimension analysis for relative value analysis and identify price dislocation	**Minimize market impact** • Structured trade execution algorithms to minimize market impact • Analyzing unstructured data and cross-market indicators to identify prevailing liquidity conditions **Assist price discovery** • Modelling executable prices for illiquid securities through multiple market indicators **Improve liquidity management efficiency** • Forecast liquidity needs (margin management, collateral, etc.) through clustering/network analysis	**Dynamic risk sensing** • Generate risk hypothesis • To identify performance drivers and anomalies through multidimensional analysis **Generate risk scenario** • Value-at-risk estimation through generative adversarial networks to capture temporal dynamics in time-series data	**Customize insights** • Customized content generation, reports, and dashboards • Chatbot **Ease compliance monitoring** • Screening, flagging, and reporting of anomalies

Cost per unit of calculation has declined but models are increasingly complicated ...

... but most large, foundation models are being developed by a concentrated number of countries.

Cost of a Compute and Training Cost for Notable AI Models
(Inflation-adjusted 2023 US dollars per exa floating point operation; millions of inflation-adjusted 2023 US dollars, right scale)

National Affiliation of Foundation Models and Access Type
(Trailing six-month count of published models; trailing six-month percentage of open-source models, right scale)

Sources: Epoch AI; Stanford University's Ecosystem Graphs; and IMF staff calculations.
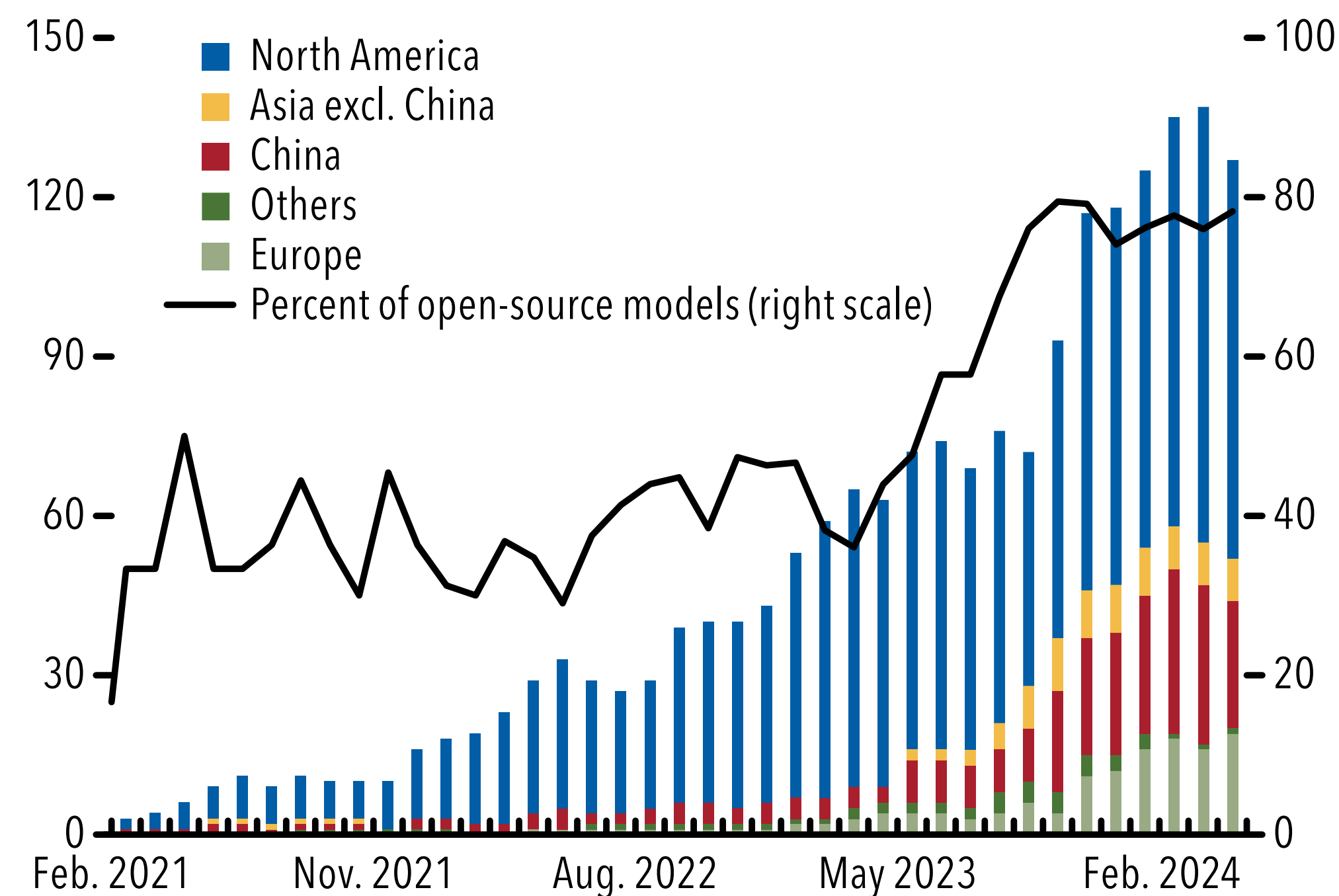
Potential Impact of the Adoption of Artificial Intelligence in Algorithmic Trading

With the adoption of AI in core investment processes still being nascent, there are both negative and positive scenarios for the potential impact of the further adoption in algorithmic trading

Potential Impact of the Adoption of Artificial Intelligence in Algorithmic Trading

	Negative Scenario	Positive Scenario
Market liquidity	**AI magnifies existing risks related to algorithmic trading by facilitating its growth**. AI could "democratize" and expand algorithmic trading activity to a broader set of assets and geographic areas. This could exacerbate risks related to sudden liquidity withdrawal under stressed conditions	**AI increases the stability of algorithmic trading under stressed conditions**. AI-driven algorithms could operate in a wider set of market conditions than traditional algorithms, with lower flash-crash risk, and reduced liquidity-withdrawal under stress.
Leverage	**AI-driven strategies boost short-term leverage**. As arbitrage opportunities are exploited more efficiently by more advanced algorithms, remaining opportunities might require higher leverage to deliver similar returns	**AI improves the management of leverage and related risks**. AI could facilitate more frequent and automated management of leveraged positions, based on more inputs, and mitigate operational lags
Interconnectedness	**AI increases interconnectedness**. AI could proliferate algorithmic trading to other asset classes, geographic regions, and trading venues, and also operate in between different market segments; that is, in a multi-asset and multitrading venue approach.	
	Increased interconnectedness leads to higher correlations between capital market segments, facilitating spillovers and transmission of stress	Market access, efficiency, and liquidity improve for some market segments, including emerging markets

Source: IMF staff assessment. Note: AI = artificial intelligence.