Global Economics Analyst

The AI Transition One Year Later: On Track, but Macro Impact Still Several Years Off (Briggs/Kodnani)

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- Over the last year, we have argued that generative artificial intelligence (AI) could raise DM labor productivity growth by 1½pp per year over a 10-year period (or cumulatively raise labor productivity by around 15%) following a wave of investment and widespread adoption. In this *Global Economics Analyst,* we check on the status of the AI transition, finding that it is well underway but that significant macroeconomic impacts are still likely several years off.

- Investment in AI-related hardware has surged, with revenues of semiconductor manufacturers rising by over 50% since early 2023 and company-level revenue forecast revisions implying an incremental $250bn in annual AI hardware investment (1% of US GDP) through 2025. This increased investment is not yet visible in official national accounts data that are relevant for GDP, but shipments for some AI-related components have recently picked up.

- Actual adoption of AI has only modestly increased so far, with less than 5% of companies reporting use of generative AI in regular production. And while adoption is higher in industries that we estimate will benefit the most from AI—including computing and data infrastructure, information services, and motion picture and sound production—and is expected to rise going forward, adoption remains well below levels necessary to see large aggregate productivity gains.

- Low adoption has limited the labor market impact, but preliminary evidence suggests that AI is modestly raising labor demand while driving negligible job loss, thereby creating a slightly positive impulse to net hiring.

- Finally, emerging evidence from early adopters points to large increases in labor productivity. While early estimates should be interpreted cautiously given selection and reporting biases, recent academic studies imply an average 25% increase in labor productivity (16% median) following AI adoption, with anecdotal company reports suggesting similarly large efficiency gains.

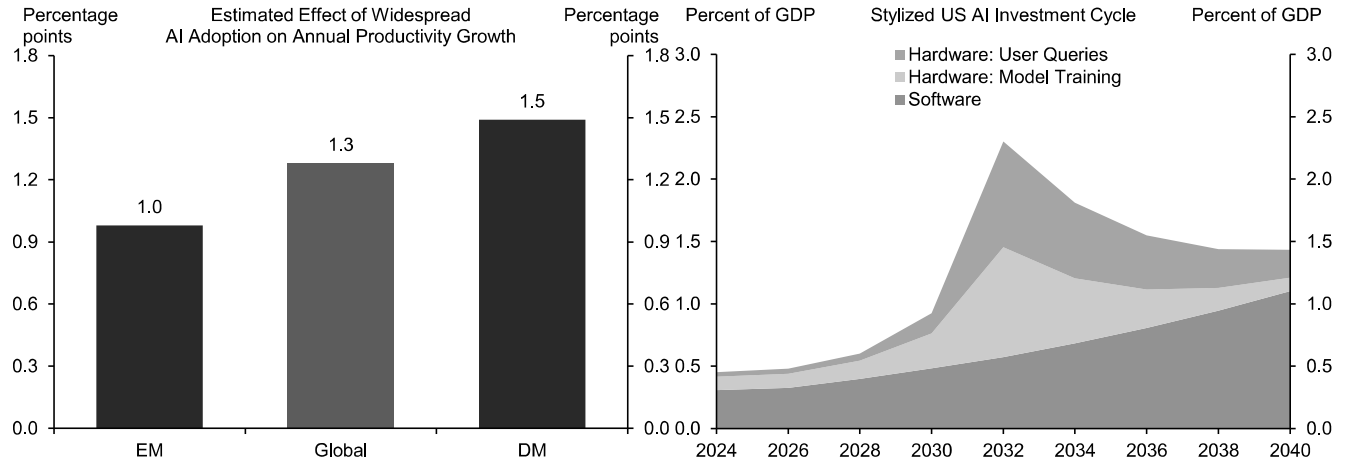
- The sizable increase in AI-related investment and large productivity gains among early adopters adds to our confidence that generative AI poses meaningful economic upside, while the slow adoption pace suggests that sizable macroeconomic impacts are still several years off. Going forward, we will update this analysis each quarter to track the economic impact of generative AI.

The AI Transition One Year Later: On Track, but Macro Impact Still Several Years Off

Over the last year, we have argued in a series of publications that generative artificial intelligence (AI) could raise labor productivity and global growth, primarily from its ability to automate a large share of work tasks.

The economic upside implied by our analysis is quite large. We estimate that generative AI could raise DM labor productivity growth by 1½pp per year over a 10-year adoption period (implying a cumulative increase in labor productivity levels of around 15%; left chart, Exhibit 1), and forecast a net 0.4pp boost to DM potential GDP growth by the end of forecast horizon after accounting for the overlap with current technology-driven productivity gains and a slowing underlying productivity growth trend. However, these benefits depend crucially on widespread adoption of the technology and a surge in AI-related investment, both of which we have noted could take several years to fully materialize (right panel, Exhibit 1).

Exhibit 1: Our Research Suggests that AI Could Be a Major Driver of Labor Productivity Growth, and that the AI Transition Could Require a Sizable Investment Cycle



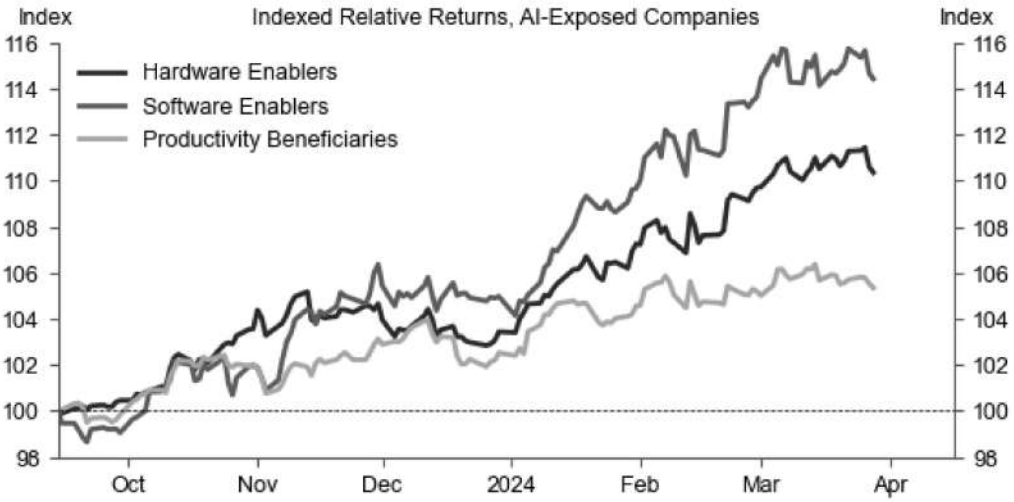
Note: Composites based on market FX GDP country weights. Estimates are not forecasts and represent stylized scenarios in which AI productivity gains are realized over a 10-year period following widespread adoption.

Note: Estimates are not forecasts and instead represent a stylized scenario under a set of plausible assumptions for AI model development, compute costs, and adoption.

Source: Goldman Sachs Global Investment Research

Financial markets have similarly assessed AI as a milestone technology that could drive investment (first) and productivity gains (later). As Exhibit 2 shows, over the past 6 months, equity market gains have disproportionately been concentrated in AI hardware enablers (e.g., semiconductor companies) and software enablers (e.g., cloud providers) that stand to benefit from early increases in AI-related investment, while likely AI productivity beneficiaries have eked out more modest gains relative to the broader S&P 500. As our US portfolio strategy team has emphasized, many of these gains (particularly for hardware companies) reflect higher realized revenues rather than higher valuations, as demand for GPUs and datacenter-related spend have increased substantially.

Exhibit 2: Equity Market Gains Over the Last Six Months Have Been Disproportionately Driven by AI-Exposed Companies

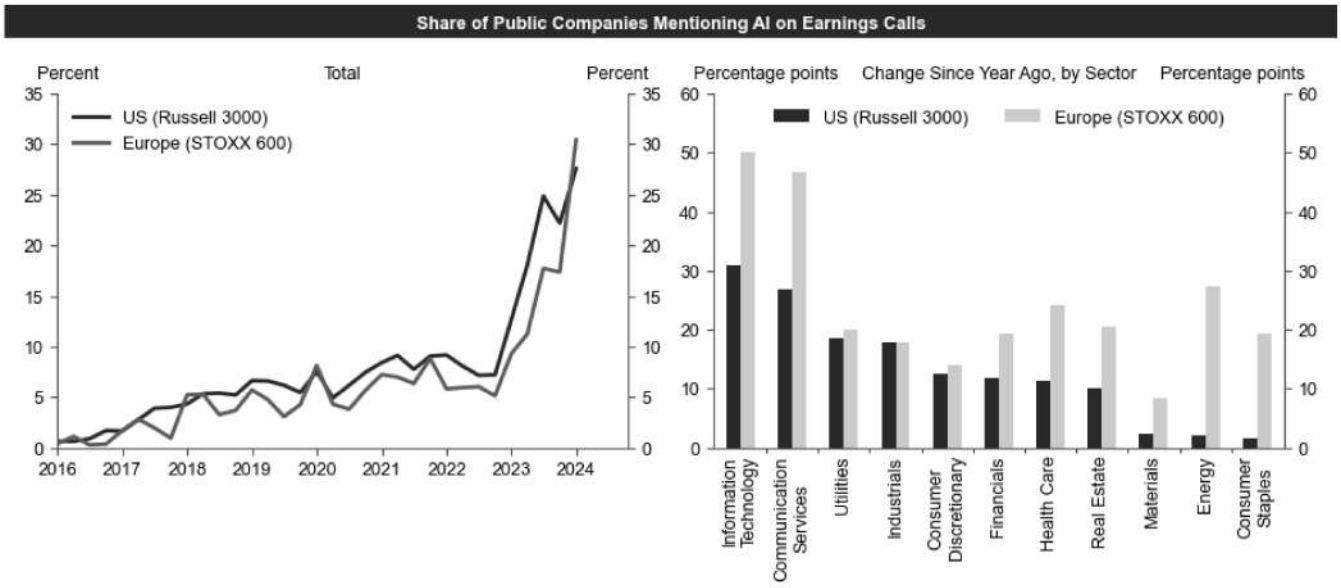


Note: AI hardware and software enablers indexed to sector returns; AI productivity beneficiaries (sector-neutral basket) indexed to S&P 500.

Source: FactSet, Goldman Sachs Global Investment Research

While technology companies are poised to be the earliest beneficiaries of AI adoption, company guidance around AI has broadened over the past year, suggesting that a wider set of industries are thinking about AI as part of their business plans. Indeed, as Exhibit 3 shows, the share of companies mentioning AI on public earnings calls has surged in both the US and Europe over the past year, not just in IT and communications categories but also across industrial, consumer, financial, and health care companies where AI applications could eventually drive efficiency gains.

Exhibit 3: Mentions of AI on Public Earnings Calls Have Continued to Surge, Particularly Among Information Technology, Industrial, Consumer, Financial, and Healthcare Companies



Source: GS Data Works, Goldman Sachs Global Investment Research

Given these early signals, in this *Global Economics Analyst,* we introduce a set of tools to track the status of the AI transition as it unfolds. We find evidence that the early

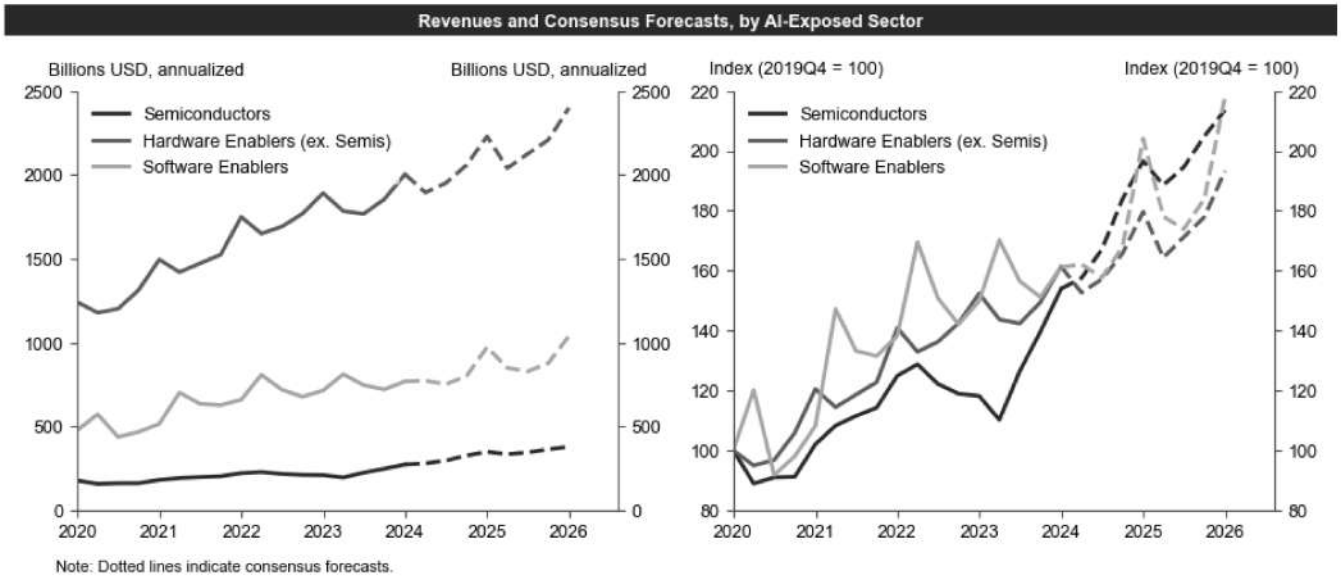
stages of the transition are well underway but that the largest macroeconomic impacts likely remain years away.

Early Signs of an AI Investment Cycle

Investment in AI—first in AI-enabling hardware, such as semiconductors and datacenters used to train and query models, then in AI-enabled software used to apply AI—is likely to rise substantially as models become increasingly sophisticated and AI adoption rises. As this investment is a precursor to the widespread integration of AI into business processes, we expect such an investment cycle (which we have estimated could peak at 2-2½% of GDP) to be the first measurable gauge of AI adoption.

As Exhibit 4 shows, early signs of such an investment boom are already visible among AI-enabling companies. Specifically, AI enabler company revenues (or, equivalently, investment expenditures by purchasers of their products) have grown at a rapid clip over the past few years, with semiconductor companies in particular experiencing a 50% surge in revenues since early 2023, largely due to an over 200% increase in quarterly revenues for NVIDIA.

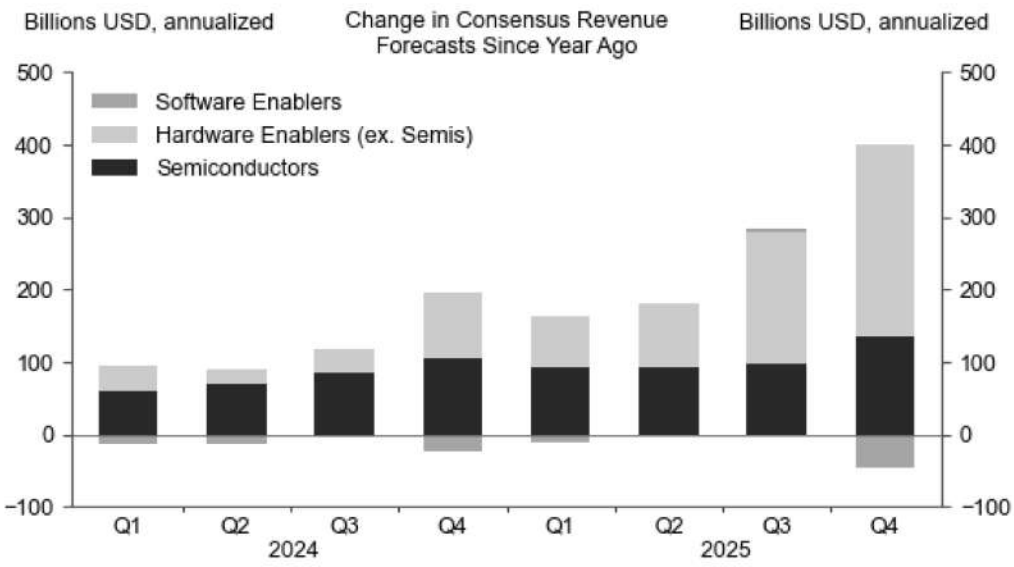
Exhibit 4: Company Revenues Have Picked Up, Particularly Among Semiconductor Producers



Source: FactSet, Goldman Sachs Global Investment Research

This pickup in revenue growth has coincided with an even larger upgrade to analysts' expectations of AI-related investment in the coming years. As Exhibit 5 shows, revenue forecasts for AI enablers have increased substantially since a year ago—entirely in AI hardware rather than software companies—with larger increases occurring farther out in the forecast horizon.

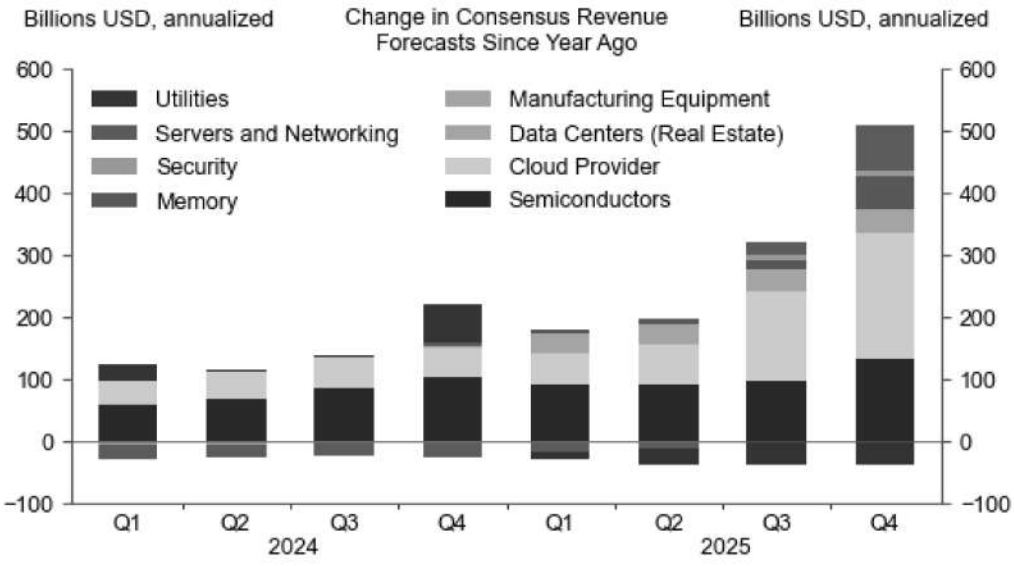
Exhibit 5: Revenue Forecasts for AI Hardware Enablers Have Been Materially Upgraded Over the Last Year



Source: FactSet, Goldman Sachs Global Investment Research

Taken at face value, these upgrades imply an additional $250bn of annual AI hardware investment in 2025, equivalent to 9% of US business investment or roughly 1% of US GDP and in line with our previously published estimate. Across AI hardware verticals, these upgrades have been concentrated among semiconductor companies (with NVIDIA alone accounting for over 75% of the upward revision for semiconductor producers[1]) and cloud providers, with somewhat smaller increases in demand for servers, networking equipment, memory, and real estate (Exhibit 6).

Exhibit 6: The Upgrade to Hardware Investment is Primarily Driven by Increased Investment in Semiconductors and Cloud

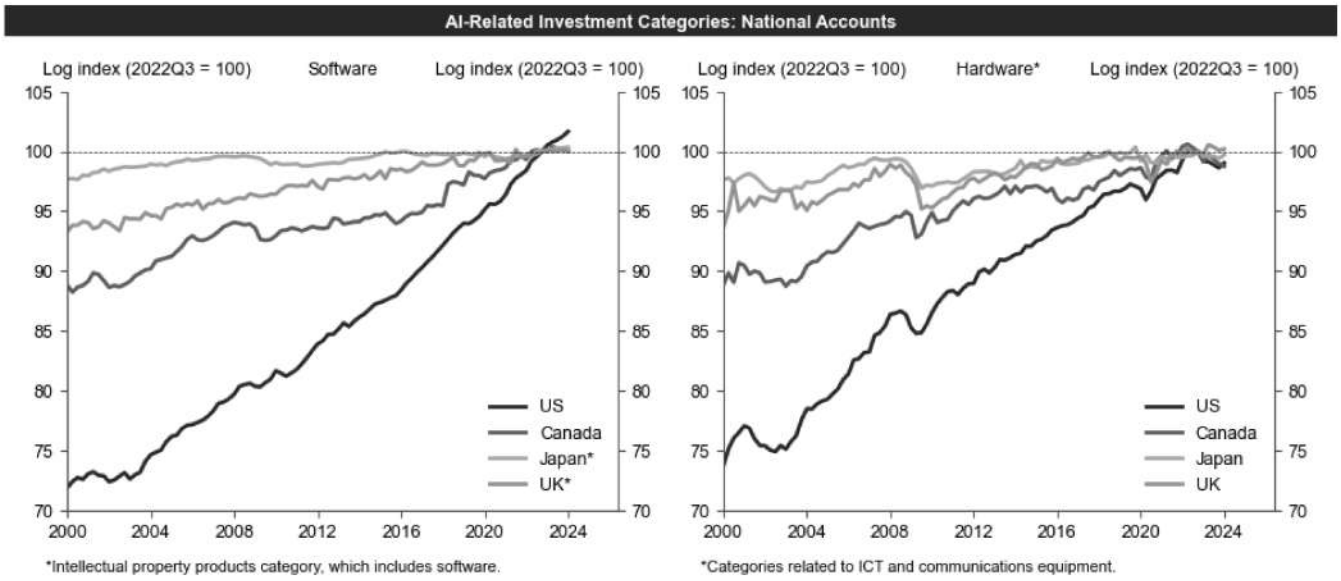


Source: FactSet, Goldman Sachs Global Investment Research

[1] See our equity analysts' report framing the medium-term market opportunity for NVIDIA driven by elevated semiconductor demand related to generative AI, and the more recent update on NVIDIA's Blackwell platform.

While equity market data provides an encouraging signal that the AI investment cycle is underway, we have yet to see a sufficiently large increase in investment in the official national accounts data, which is the key benchmark from a GDP perspective. As Exhibit 7 shows, quarterly investment data from major DMs in both software and hardware categories has yet to visibly diverge from its longer-run trends (and in some cases has actually decreased), suggesting that other factors—including demand for non-AI technologies and cyclical factors—are currently playing a larger role than AI in shaping the aggregate capex outlook.

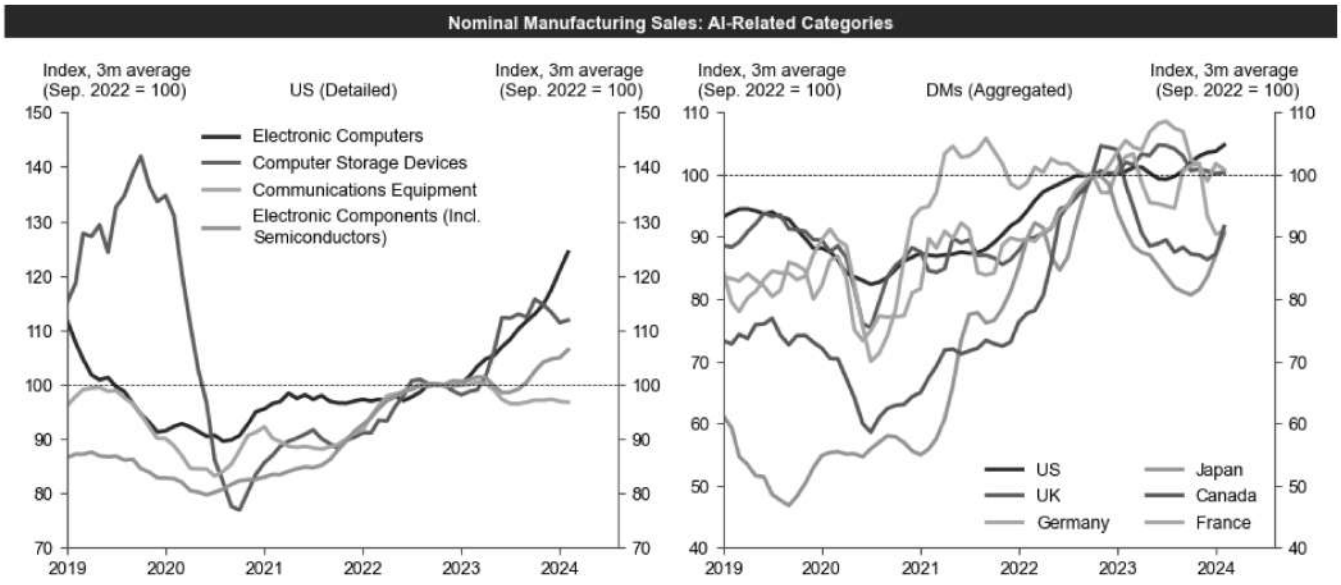
Exhibit 7: No Clear Change in the Investment Trend Visible in National Accounts Data Yet



Source: Haver Analytics, Goldman Sachs Global Investment Research

As demand for AI hardware and software grows, we would expect some of it to eventually show up in macroeconomic aggregates. And indeed, as Exhibit 8 shows, manufacturers' shipments for some AI-related components—measured at a more granular level than the national accounts data—have started to pick up, although the increase has not been uniform across all countries (e.g., Germany has seen a decline since 2021).

Exhibit 8: Manufacturers' Shipments for Some AI-Related Components Have Started to Pick Up



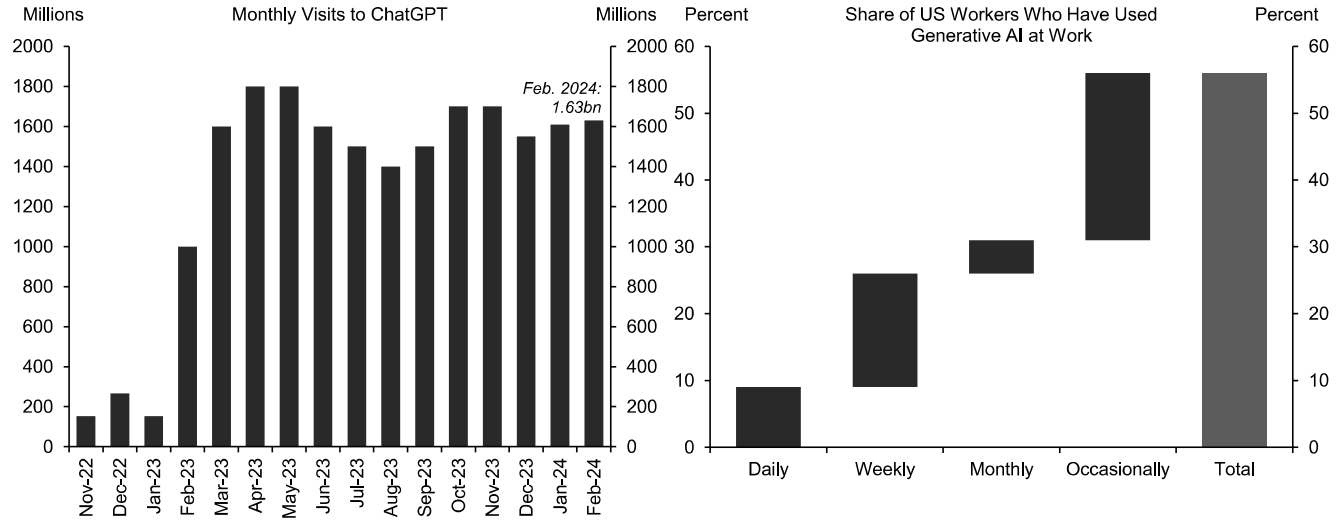
Source: Haver Analytics, Goldman Sachs Global Investment Research

Taken together, these findings suggest that an increase in AI-related investment is underway, but that the AI investment cycle still remains in its early days.

Adoption Among Higher-Tech Industries, but Barriers Remain to Wider Use

The accessibility and ease-of-use of new AI models has raised the prospect of rapid and widespread adoption across a broad set of use cases. As Exhibit 9 shows, the number of visits to ChatGPT surpassed 1bn monthly in early 2023 and remained elevated (albeit with little incremental growth in visits) over the past year, and the majority of US workers have experimented with generative AI in a professional context, with over a quarter informally using AI tools at least weekly.

Exhibit 9: Casual Use of Large Language Models Has Exploded, and Most Workers Are Using AI Tools At Work at Least Occasionally

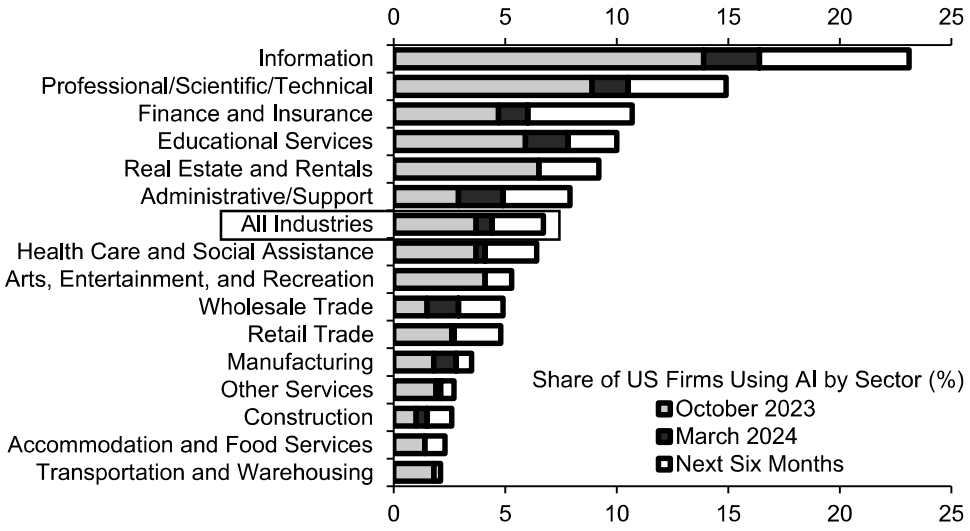


Source: Similarweb, Conference Board, Goldman Sachs Global Investment Research

Despite this surge, formal adoption of AI by firms remains low outside of a few specific high-skilled industries. Using the newly introduced AI supplement to the Census Bureau's Business Trends and Outlook Survey[2], we find that less than 5% of firms are formally using generative AI to produce goods and services, although this share is 2-3 times as high among information, professional services, and financial firms (Exhibit 10). However, firms say that they expect the growth pace to pick up over the next six months across most industries.

[2] See Breaux, Cory et al., "Tracking Firm Use of AI in Real Time: A Snapshot from the Business Trends and Outlook Survey," U.S. Census Bureau Center for Economic Studies, March 2024.

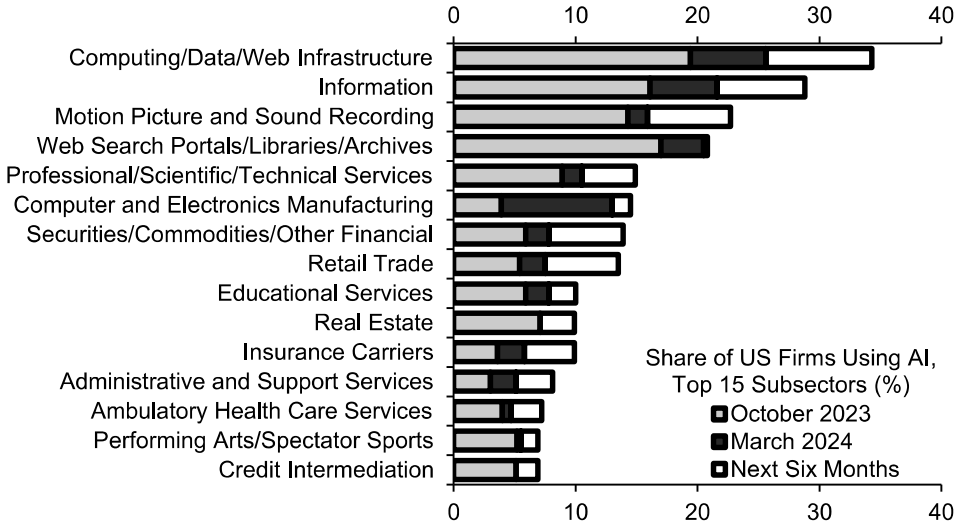
Exhibit 10: Under 5% of Companies Are Formally Using Generative AI to Produce Goods and Services, Although the Share Is 2-3x as High Among Information and Professional Services Firms



Source: Census Bureau, Goldman Sachs Global Investment Research

Within a more granular set of subsectors, adoption rates range more widely, with over 20% of firms using generative AI tools for production in technology industries and higher current and expected adoption rates in other digitally enabled fields, such as movie and sound production (Exhibit 11).

Exhibit 11: Higher Adoption Rates Among Computing Infrastructure Providers, Web Search, Information, and Movie Production Companies

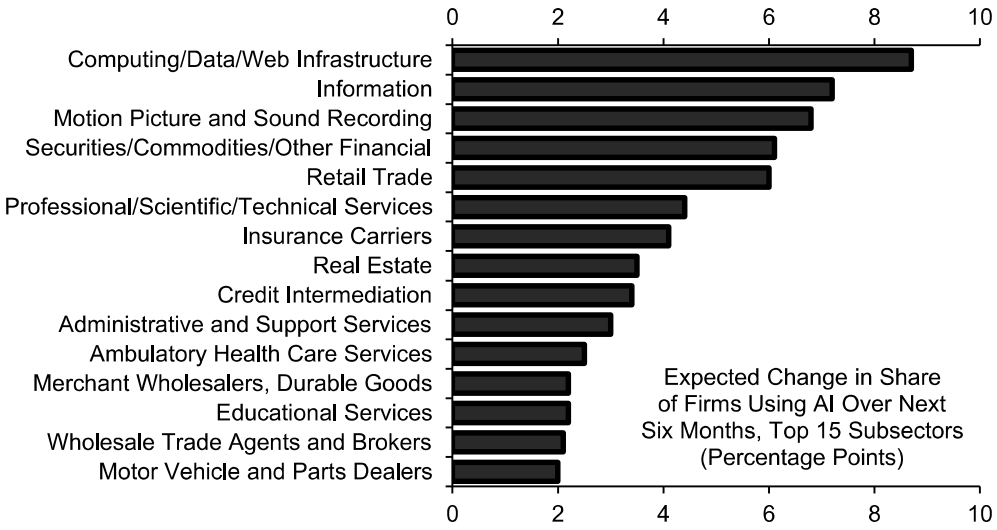


Source: Census Bureau, Goldman Sachs Global Investment Research

As Exhibit 12 shows, unsurprisingly, the industries where adoption rates are already high tend to be those where adoption rates are also expected to increase the most over the next six months. Taken together, these patterns suggest that the first wave of AI adoption is likely to be highly concentrated in higher-skilled, more digitally-enabled

industries (see our equity analysts' note on the impact of generative AI on business services industries), while adoption by less technical fields will likely take longer.

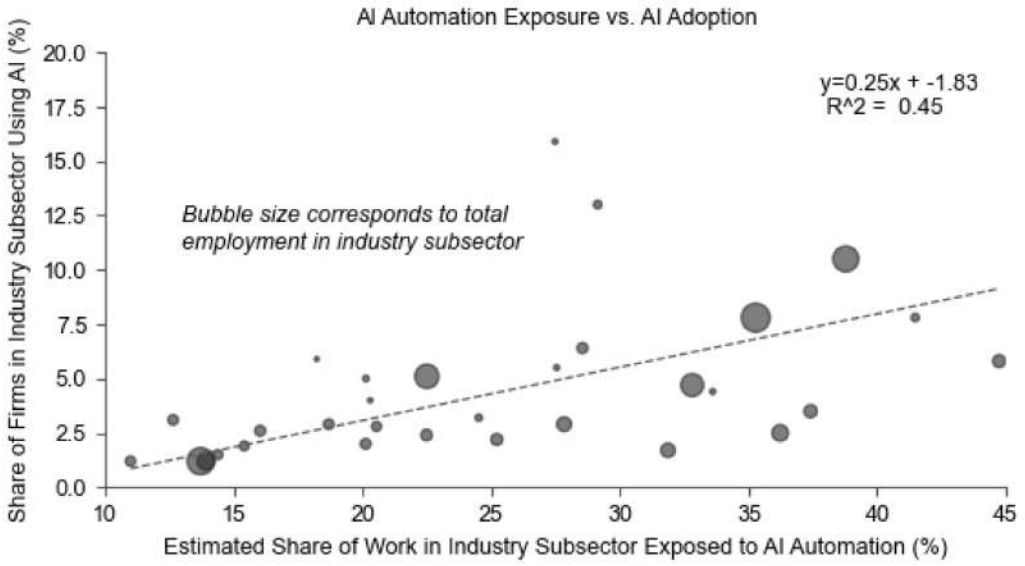
Exhibit 12: Companies in Industries Where Adoption Rates Are Already High Report the Largest Share of Expected New Adopters Over the Next 6 Months



Source: Census Bureau, Goldman Sachs Global Investment Research

These patterns are intuitive and consistent with our previously established framework, which estimated the productivity benefits from AI adoption as a function of the share of work tasks that are potentially automatable by AI. As Exhibit 13 shows, early adopting industries tend to be those where our estimated AI exposures are higher, i.e., those which have more to gain from adopting AI and thus a greater incentive to move first.

Exhibit 13: Our Estimates of AI Automation Exposure Predict Early Adoption Well at the Sector Level

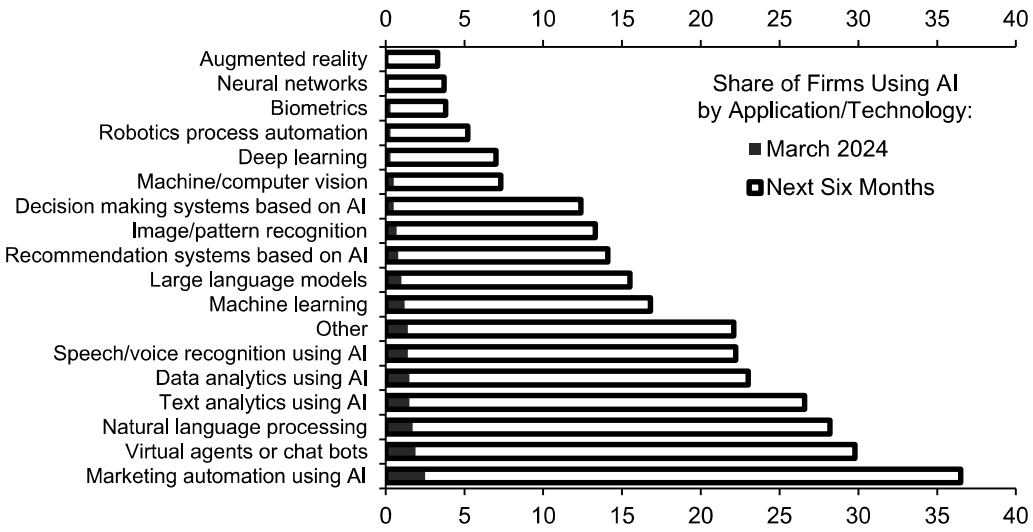


Source: Census Bureau, Goldman Sachs Global Investment Research

Among early adopters, the most commonly cited AI-enabled application is marketing automation, followed closely by chat bots, and speech, text, and data analysis (Exhibit

14). Firms expect these applications to remain the most common over the next six months, suggesting that high-profile use cases will likely remain the driver of AI adoption, at least until more specialized AI business applications are developed.

Exhibit 14: Marketing Automation, Chat Bots, and Text/Data/Speech Analysis Are the Most Commonly Cited Early Use Cases for AI

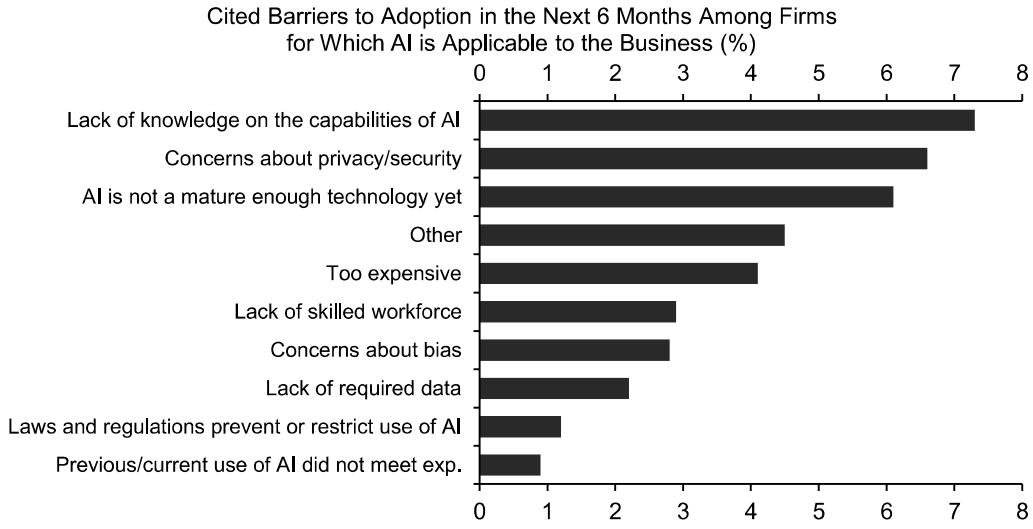


Source: Goldman Sachs Global Investment Research

Companies in the Business Trends and Outlook Survey report several barriers to more widespread usage. As Exhibit 15 shows, firms which currently deem AI applicable to their business cite a lack of knowledge about AI, concerns about privacy and security, and a lack of maturity of the technology as the foremost barriers to adoption. However, many of these factors are short-term and are likely to resolve as regimes for AI product licensing and more sophisticated AI tools develop in the second half of this decade.[3]

[3] For example, see our equity analysts' latest note on the outlook for Microsoft's AI suite, which shows a healthy pace of expansion (steady growth and high retention, but faster than prior product adoption cycles).

Exhibit 15: The Most Commonly Cited Barriers to Early AI Adoption Are Mostly Short-Term Factors Such as Lack of Knowledge, Privacy Concerns, and Technology Maturity



Source: Census Bureau, Goldman Sachs Global Investment Research

Other surveys of businesses and workers generally confirm the message from the Business Trends and Outlook Survey. As Exhibit 16 shows, a majority of surveyed individuals across a wide range of surveys generally report either using AI in some capacity or express some intention to use AI, although implementation into concrete applications remains limited outside of technical industries. However, many businesses are making investments into production-grade AI applications for use in the next few years, and business leaders generally cite short-term concerns such as inaccuracy, security, and data privacy as the principal barriers to broader adoption. Indeed, our equity research team's own IT spending survey indicates that while just 12% of surveyed CIOs plan to spend 5% or more of IT budgets on generative AI applications over the next year, half of CIOs expect to spend that much within the next three years, with the average IT budget share allocated to generative AI expected to more than double in that time.

Exhibit 16: Industry Surveys Suggest that the Largest Labor Market Impacts and Fastest Adoption Will Occur Over the Next 3-5 Years

Source	Date	Current Adoption	Future Adoption
Goldman Sachs Equity Research	March 2024	In the coming year, 30% of CIOs do not expect to spend on generative AI applications and 58% expect to spend 1-5% of their IT budgets on them. On average, CIOs expect to spend 3% of IT budgets on generative AI products during this period.	Over the next three years, a much larger share of CIOs (50%) intend to spend at least 5% of IT budgets on generative AI products, with 10% intending to spend 15-30% of their IT budgets on them. At this horizon, CIOs expect to spend 7% of IT budgets on average on generative AI. Usage of Microsoft Office Copilot in particular is expected to grow from 3% of users to 13% of users during this time.
PwC	March 2024	73% of young company leaders believe AI will be transformative for their business, but the vast majority of those which have adopted are still in the exploration phase, with only 7% of businesses having AI applications actively deployed in their operations.	58% of businesses are increasing their investments into AI. 64% are concerned about cybersecurity risk from AI, and roughly half are concerned about misinformation and legal and reputational risk.
O'Reilly	November 2023	67% of technology professionals say that their companies are currently using generative AI, with the majority of users (54%) expecting that AI adoption will lead to productivity improvements while only 4% expect lower headcounts. The most common cited use cases are programming (77%), data analysis (70%), and customer-facing applications (65%).	Most adopters are still at the proof-of-concept or product development phase, with only 18% of total respondents already having AI applications in production. The top cited barriers to implementation are identifying appropriate use cases (53%) and a combination of legal issues, risk, and compliance (38%).
Conference Board	September 2023	56% of workers report using AI tools for work tasks, with 46% saying management is fully aware of their use another 38% saying management is only partially aware or unaware. Most workers (55%) say the quality of AI output matches that of an experienced worker or better.	33% of workers say AI will replace elements of their job in a positive way (e.g., freing up time for other tasks), while just 4% say AI will replace elements of their job in a negative way (e.g., threatening their jobs). 57% of workers say their organization either does not have an AI policy or that one is currently under development, compared to just 26% who say their organization does have one.
Microsoft	September 2023	71% of businesses (sample skewed to technology companies) say their companies are already using AI in some capacity, with 92% of AI deployments taking under one year. The average AI investment takes 14 months to begin to realize returns.	52% of businesses report that a lack of skilled workers is the biggest barrier to implement and scale AI.
McKinsey & Company	August 2023	28% of North American respondents say they regularly use generative AI tools for work, compared to 20% in developing markets. Among AI "top performers" (organizations where 20% of EBIT are attributable to AI use), firms are less likely to cite AI as intended for cost cutting (19%) than among all respondents (33%) and more likely to cite potential revenue and value upside.	The most commonly cited risks for AI adoption are inaccuracy (56%), cybersecurity (53%), and IP infringement (46%), though only a minority of firms say they are actively working to address those risks.
KPMG	June 2023	Most executives in TMT (71%) and healthcare (67% industries believe they have adequately prioritized generative AI, while only 30% in consumer and retail say that it is a priority.	65% of executives believe generative AI will have a high or extremely high impact on their organization in the next 3-5 years, and 60% say they are 1-2 years away from implementing their first generative AI solution.

Source: Goldman Sachs Global Investment Research

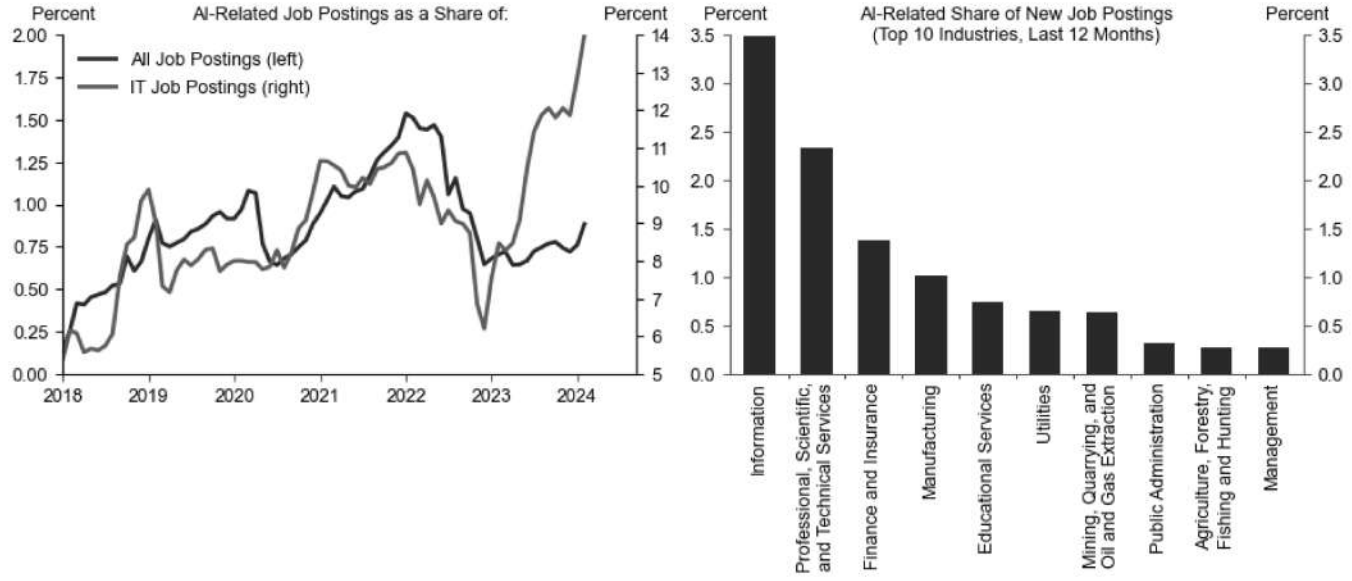
Only Modest Labor Market Impacts Thus Far, Concentrated Among Early Adopters

Our estimates that generative AI could provide significant upside to economic potential are based on our assumption that AI will primarily raise productivity for workers that remain employed, and that while some labor displacement is inevitable, AI will ultimately increase employment by raising aggregate demand and creating new AI-adjacent occupations. Nevertheless, some commentators fear a more negative outcome where widespread adoption of generative AI drives significant labor replacement and increases unemployment.

The modest current adoption rate makes it hard to draw strong inferences from current labor market data. So far, however, generative AI appears to be raising gross labor demand while driving negligible job loss, thereby leading to a modestly positive net impulse to labor demand.

As the left chart in Exhibit 17 shows, the share of AI-related positions declined in 2022 as tech companies pulled back on aggressive hiring after the pandemic, but stabilized in late-2022 following the emergence of ChatGPT and subsequently began to rise in 2023. While overall AI-related hiring demand remains subdued, the share of AI-related job openings in the IT sector has surged over the last year and a half, consistent with an increasing focus on AI in the technology industry. The right chart of Exhibit 17 confirms these patterns, as new job postings referencing AI are highest in the information services sector, with professional and financial services also prioritizing AI-related hiring over the last twelve months.

Exhibit 17: AI-Related Job Openings Have Risen Only Modestly, But They Have Surged as a Share of IT Job Openings and Occupy Larger Shares of Professional and Financial Openings

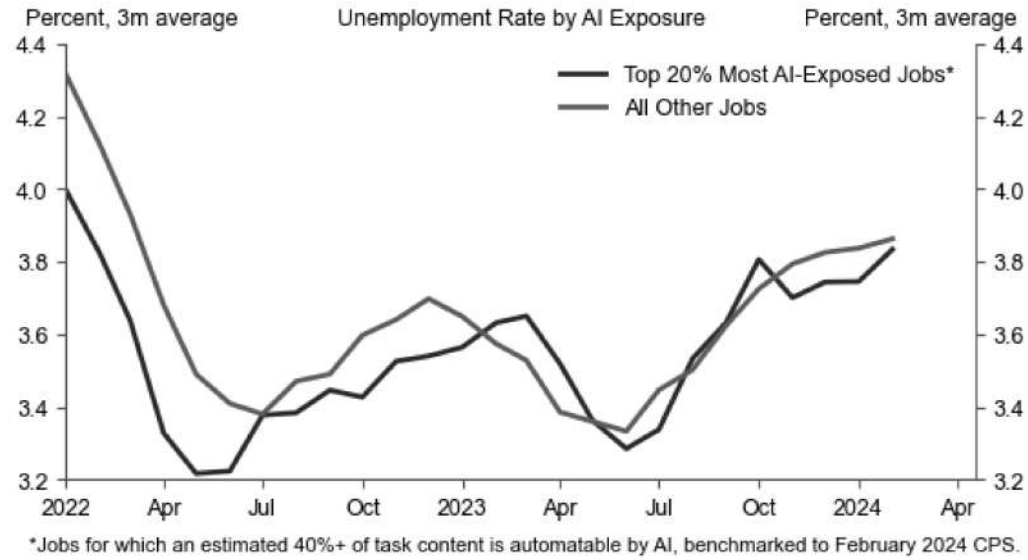


Source: LinkUp, Goldman Sachs Global Investment Research

While AI-related hiring demands have risen modestly, we have yet to see signs of meaningful AI-related layoffs. Exhibit 18 compares the unemployment rates for workers that are most exposed to AI automation (defined as those in the top 20% most AI-exposed occupations) with the rest of the workforce. Unemployment rates across

these groups have tracked each other closely since 2022, suggesting little job loss due to generative AI thus far.

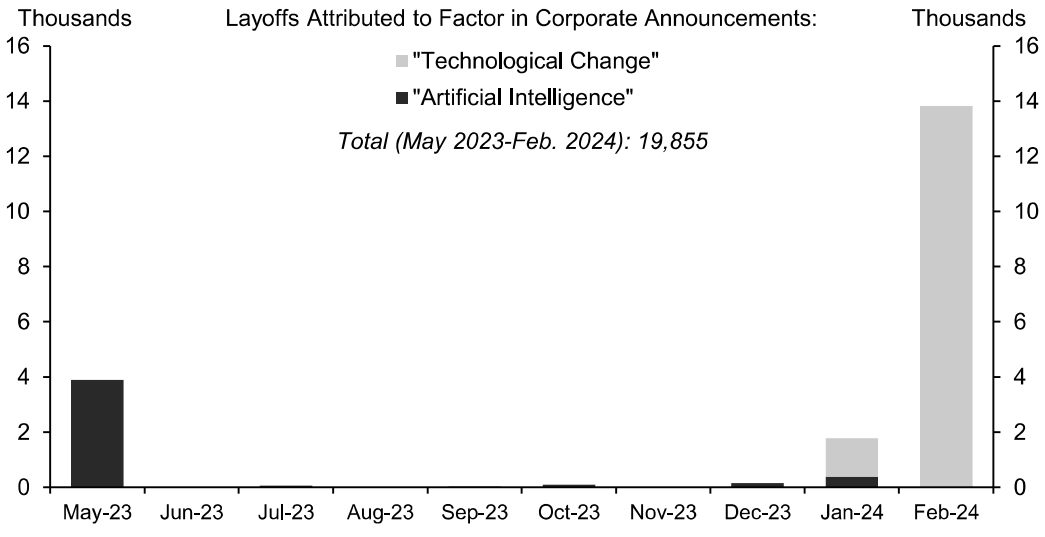
Exhibit 18: AI-Exposed Jobs Have Not Seen an Unusually Large Rise in Unemployment



Source: Census Bureau, IPUMS, Goldman Sachs Global Investment Research

Limited AI-related job loss is confirmed by the Challenger layoff report, which began asking whether announced layoffs were related to AI in May 2023. While some companies may be reluctant to ascribe layoffs to AI automation, layoffs due to AI or technological change more broadly remained very limited at 20k (or 0.1% of total layoffs) over this period, although technology-related layoffs have modestly accelerated recently (Exhibit 19).

Exhibit 19: Thus Far, Mentions of AI in Corporate Layoff Announcements Have Been Limited, Although Technology-Related Layoffs Have Accelerated Recently

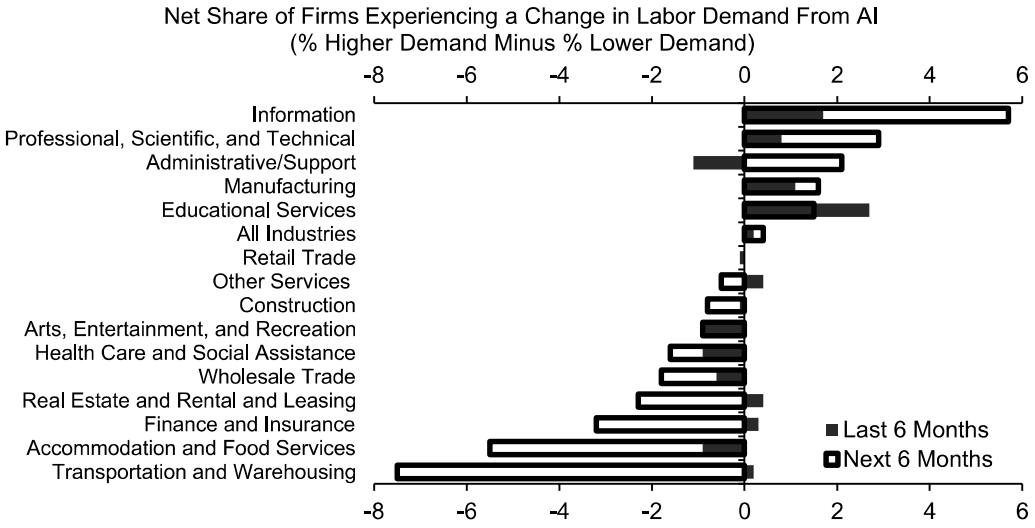


Source: Challenger, Gray & Christmas, Goldman Sachs Global Investment Research

The combination of a clear (albeit modest) increase in labor demand and negligible job

loss due to generative AI suggests that thus far AI is likely creating a slightly positive impulse to labor demand on net. Exhibit 20 confirms this pattern, as the net share of companies citing an impact from generative AI on labor demand in the Business Trends and Outlook Survey is (very modestly) positive across all surveyed businesses, both now and in expectation six months ahead. However, over the next six months, greater divergence in labor market outcomes across sectors is possible, as some sectors (e.g., transportation, accommodation) expect net declines in labor demand while others (e.g., information, professional) expect increases. Taken together, these responses would be consistent with a flat-to-positive overall impulse to labor demand but the possibility of some concentrated job displacement.

Exhibit 20: Most Firms Have Not Adjusted Labor Demand Due to AI and Do Not Anticipate Doing So in the Next 6 Months, but Net Labor Demand Has Increased Slightly in Early-Adopting Industries



Source: Census Bureau, Goldman Sachs Global Investment Research

Productivity Evidence from Early Adopters

Although it is still early in the adoption process and the ultimate effect of widespread AI adoption remains highly uncertain, emerging evidence from early adopters can help benchmark the effect of generative AI on labor productivity. We therefore report all available productivity effect estimates from both peer-reviewed academic studies (which have the advantage of utilizing careful research designs to identify the causal impact of AI on productivity) and company-level reports (which have the advantage of measuring the AI productivity boost in real-world applications) in Exhibit 21.

There are several caveats to interpreting these estimates.

First, companies and workers that benefit the most from new technologies generally adopt them first, resulting in a positive "selection bias" where average effects among early adopters tends to exceed those for a typical worker. Indeed, most of the case studies in our review focus on software coders, customer support workers, and consultants, occupations in which workers spend a disproportionate amount of time on repeated tasks (e.g., drafting and debugging code, answering common client questions, formatting documents and PowerPoints) that are particularly-well suited for AI automation. These initial estimates of AI-related productivity gains could therefore ultimately prove overly optimistic.

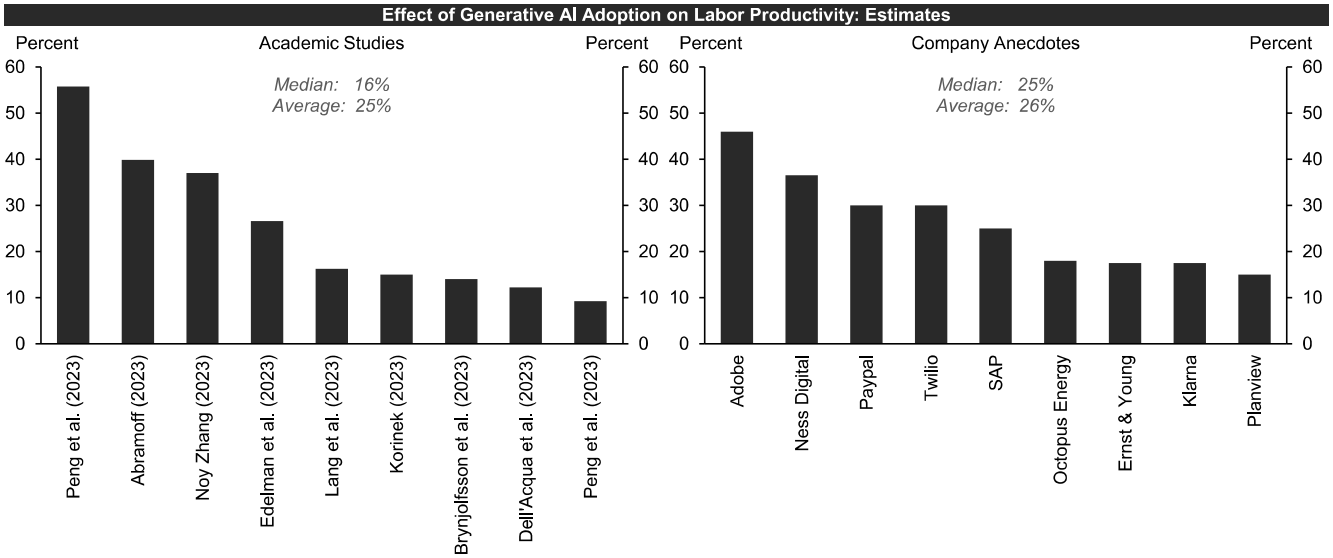
Second, publication and reporting biases could lead to an overstatement of productivity gains. Academic journals are much less likely to publish studies that find no significant effects for a given treatment,[4] and it is unlikely that many companies would publicly announce that they found no efficiency gains from AI-related investments given the market's current focus on AI-related upside.

However, it is also possible that these early estimates may understate the efficiency gains from generative AI. The case studies in Exhibit 21 consider the automation of only a few specific tasks for studied workers, and there is presumably incremental upside if other work-related tasks were also automated. As a result, these estimates likely provide a lower bound on the productivity upside for the workers *in these studies*, and overall efficiency gains may be higher once the application build out that will enable automation of a broader set of tasks is further underway.

Despite these caveats, early estimates generally support our view that adoption of generative AI is likely to drive large efficiency gains. Academic studies thus far have found increases in labor productivity ranging from 9-56%, with the median study implying 16% upside and the average study implying 25% upside. Estimates from company anecdotes are generally similar, with companies reporting productivity gains ranging from 15-46%, a median boost of 25%, and an average boost of 26%.

[4] Chopra, F., Haaland, I., Roth, C. and Stegmann, A., 2024. The null result penalty. The Economic Journal, 134(657), pp.193-219.

Exhibit 21: Early Evidence From Academic Studies and Company Reports Suggests Labor Productivity Increases by Around 25% Following AI Adoption on Average



Source: Goldman Sachs Global Investment Research

In addition to finding a sizable increase in overall productivity, several academic studies provide other insights that are relevant for benchmarking the impact of generative AI. First, in addition to raising output, several studies (e.g., Dell'Acqua et al. (2023)) found that AI improved the quality of work. Second, Brynjolfsson, Li, and Raymond (2023) noted that labor productivity improvements were much larger for novice than experienced workers, suggesting that AI might speed up learning but be less beneficial for workers that are already effective at their jobs. Third, one of the largest treatment effect estimates came from a study considering the effect of AI on medical care providers in Bangladesh (Abramoff et al. (2023)), suggesting that productivity effects could be particularly large in EMs if AI enables more efficient dissemination of information and best practices.

Conclusion

We draw three broad conclusions from these patterns.

First, the large increase in AI-related investment and promising evidence of significant productivity gains among early adopters reinforces our confidence that generative AI will eventually provide a meaningful boost to economic growth.

Second, still relatively limited adoption rates a year and half after generative AI became a major market theme and a year since we first flagged its enormous economic potential supports our long-standing view that any productivity growth boost won't exceed 0.1pp until 2027 in the US and 2028 in other DMs, with the bulk of the boost to global GDP occurring after 2030.

Third, although still very early, the limited number of AI-related job losses so far and expectations of many employers that generative AI will lead to a net increase in hiring adds to our confidence that the macroeconomic impact of generative AI will primarily come via a productivity boost for employed workers rather than widespread job loss.

Of course, the AI transition is still in its early days and there is tremendous uncertainty around the impact of AI on investment, the labor market, productivity, and financial markets, so these views could change as more information and data become available. We will therefore update this analysis on a quarterly basis going forward to help track the effects of generative AI on the US and global economy.

Joseph Briggs

Devesh Kodnani

Disclosure Appendix

Reg AC

We, Jan Hatzius, Joseph Briggs, Devesh Kodnani and Giovanni Pierdomenico, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

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