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Global Technology | North America

The Morgan Stanley AI Guidebook: Fourth Edition

We highlight ~30 new AI notes across Morgan Stanley Global Research. We focus on AI diffusion winners, macro productivity gains, healthcare, financial and education sector impacts. We also detail work on the software stack, gaming, Edge AI and our deep dive on Gen AI private companies.

The Morgan Stanley AI Guidebook, Fourth Edition (January, 2024) Following [Global Technology: Introducing The Morgan Stanley AI Guidebook \(14 Jun 2023\)](#), [Global Technology: The Morgan Stanley AI Guidebook: Second Edition \(24 Jul 2023\)](#), and [Global Technology: The Morgan Stanley AI Guidebook: Third Edition \(18 Oct 2023\)](#), today we publish our latest edition of the Morgan Stanley AI Guidebook.

AI Diffusion and Equity Market Implications Are Coming into Greater Focus... In 2023, the largest investment returns came from AI Enablers¹, which on average returned 111%. In 2024, our Thematics team argues that investors should focus on the Adopters, a group that rose only 6% in 2023. While our latest CIO survey indicates an AI investment ramp starting in 2H24, we see the potential for AI-driven productivity gains to start being priced throughout 2024. Here, we believe the stocks with the greatest re-rating potential fall in the Adopter category... which we've identified through a global survey of all Morgan Stanley research analysts ([see here](#)). Beyond sector and stock level implications, our Equity Strategy team expects AI to start positively impacting S&P earnings in 2025 ([see here](#)) following an investment ramp in '24. We see further evidence of increasing investment in our latest CIO Survey, as AI/ML rose to the top of the CIO priority list for the first time ([see here](#)). Tech-driven productivity growth in line with what we saw during the early to mid 1990s, which is the most historically analogous period, contributes ~30bps to our strategy team's 2025 net margin estimate and supports above consensus 2025 EPS growth of 16% (vs. Street at 12%). In the background, US AI regulation still seems years away, but we expect plenty of headlines in 2024 ([see here](#)).

... as AI Deep Dives in Healthcare, Financial Services, and Education Highlight the Diffusion Opportunity. Generative AI represents a catalyst for increased technology adoption in Healthcare, a market that's bogged down by outdated business practices/processes and inefficiencies. [Here](#), our healthcare teams highlight four of the biggest AI use cases (Care Delivery, Reducing Administrative Burden, Analytics, and Commercial Intelligence) and introduce a scorecard to identify stocks with the greatest potential fundamental impact from AI. Meanwhile, our Banks and Asset/Wealth Management teams believe GenAI will transform the way the industry

1. AI Enablers where AI is "Core to Thesis"

MORGAN STANLEY & CO. LLC

Brian Nowak, CFA
Equity Analyst
Brian.Nowak@morganstanley.com +1 212 761-3365

Kieran Kenny, CFA
Research Associate
Kieran.Kenny@morganstanley.com +1 212 296-5137

Keith Weiss, CFA
Equity Analyst
Keith.Weiss@morganstanley.com +1 212 761-4149

Joseph Moore
Equity Analyst
Joseph.Moore@morganstanley.com +1 212 761-7516

Meta A Marshall
Equity Analyst
Meta.Marshall@morganstanley.com +1 212 761-0430

Erik W Woodring
Equity Analyst
Erik.Woodring@morganstanley.com +1 212 296-8083

MORGAN STANLEY & CO. INTERNATIONAL PLC+

Edward Stanley
Equity Strategist
Edward.Stanley@morganstanley.com +44 20 7425-0840

MORGAN STANLEY & CO. LLC

Stephen C Byrd
Equity Analyst
Stephen.Byrd@morganstanley.com +1 212 761-3865

MORGAN STANLEY ASIA LIMITED+

Shawn Kim
Equity Analyst
Shawn.Kim@morganstanley.com +852 3963-1005

INTERNET
North America
Industry View **Attractive**

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operates, but it is just one part of an integrated strategic approach to drive growth and build resiliency. GenAI has the potential to supercharge efficiency gains across the operating model (Sales and Client Service, Product Development, Investment & Research, Mid-&-Back-Office), which can free up resources to invest in profitable growth areas ([see here](#)). The work from our Education team uncovers a \$200bn impact on the global education sector over the next 3 years, and identifies names best positioned for the coming GenAI wave ([see here](#)).

Meanwhile, AI Debates are Intensifying Across the Technology Sector...

Generative AI is emerging as one of the largest innovation cycles in decades ([see here](#)). While debates are pervasive across software, competition in the infrastructure software stack specifically is heating up as incumbents roll out tools at this layer ([see here](#) and [here](#)). **Edge AI** is becoming a secular growth driver for Tech Hardware and the broader supply chain. Moreover, AI also underpins advancements in **AR/VR/MR** and is poised to unlock new experiences that expand use cases. In **Gaming**, new AI tools look set to change how video games are made, as the cost to build and operate AAA games could fall by up to 15%. That said, lower barriers to entry could also make the industry more competitive. As stock monetization shifts from the enabling technologies (semiconductors) to infrastructure/device providers (consistent with previous computing cycles), investors are attempting to quantify the potential revenue uplift for Public Cloud vendors... which we attempted to size [here](#).

... and the GenAI Private Ecosystem is Evolving Rapidly Aided by Accelerating Corporate Investment. Our analysis of ~150 GenAI privates indicates \$25bn raised in '23, up from \$5bn. A large and growing GenAI opportunity (we estimate ~\$300bn of spend in three years) supports accelerating private investment, which so far mirrors the early SaaS funding trajectory. Corporates contributed 90% of total capital in '23, up from ~40% in prior three years... which is supported by strong strategic rationale. Privates are leveraging Publics for compute resources and distribution. For Publics, investments/partnerships with privates improves their access to incremental tools and capabilities, while also bolstering the competitiveness of their platforms - particularly for Public Cloud vendors. From here, we've identified 12 debates that are likely to reshape each layer of the GenAI software stack... which can have direct implications for both GenAI privates and public (see [here](#)). These debates include model architectures/capabilities, open-source momentum, tooling point solutions, data prep & governance, private vs. incumbent competitive positioning, and user retention.

New AI Macro Research

[Thematics: Mapping AI's Diffusion \(2 Jan 2024\)](#)

- AI has established itself as a critical theme, but we are in the early innings of its diffusion. In a bid to help investors, we have made an initial attempt to analyse AI's impact across the market. 2024 will be the year of the Adopters.

[US Equity Strategy: 2024 US Equities Outlook: The Narrowing Road \(13 Nov 2023\)](#)

- While we believe AI has the potential to drive higher labor productivity as this new technology is diffused across the economy, the near-term economic

impact is more uncertain as it represents more of a cost than a savings for most companies in the short term. Our analysis shows tech driven productivity growth should have a positive impact on profit margins in 2025.

- Our historical analysis of periods where we saw (1) rising tech spend as a percent of total fixed investment, (2) rising productivity growth, and (3) rising profit margins on a 1-year lagged basis implies that tech-driven productivity growth could add an additional 30bps to 2025 net margin at the large cap equity level. This assumption is incorporated into our 2025 EPS estimate of \$266, which represents a strong +16% y/y growth rate.

[Sustainability: The Status of US AI Regulation in 2024 \(5 Jan 2024\)](#)

- Following our conversation with experts from Stanford University on AI regulation, we share key reflections/takeaways from our session. We continue to believe that the development and implementation of AI regulation in the US will not be imminent and discuss multiple hurdles to clear.

[Sustainability: AI & ESG: Biden Executive Order on AI Safety Establishes an Important Framework \(31 Oct 2023\)](#)

- The White House published its highly anticipated executive order on AI safety following voluntary commitments made with leading AI developers earlier this summer. We share five key takeaways. Later this week, we expect to hear additional news at the Global AI Safety Summit in the UK.

New AI Technology Research: Industry Reports

[US Tech: 4Q23 CIO Survey – AI Rises to the Top of the CIO's Priority List \(11 Jan 2024\)](#)

- The expectation for stronger IT spending growth in 2024 sustained in our Q4 CIO survey, and forward indicators see incremental improvement. Matching the investor fervor, CIOs have brought AI/ML to the top of the Priority List, with 68% indicating impacts to their current IT budgets.

[Internet & Software: GenAI Privates: Where Are We Now and 12 Debates From Here \(20 Dec 2023\)](#)

- Our analysis of ~150 GenAI privates finds \$38bn/\$203bn of aggregate funding/valuation to-date, with corporates a prominent force in fund-raising. We detail 30 GenAI privates and 12 key debates across the 3 GenAI layers that will shape each layer and the GenAI tech stack from here.

[Software: 2024 Outlook – In GenAI We Trust \(21 Dec 2023\)](#)

- While multiples significantly rebounded in 2023, with the industry on the precipice of the largest innovation cycle in decades, Software's secular dominance remains firmly intact. Add in improving IT budgets and room for margins, and the sector should continue to be best positioned in '24.

[Internet: Top 10 AI Debates for 2024 \(20 Nov 2023\)](#)

- We highlight 10 key AI questions for 2024: 1) Personal AI Assistants, 2) The Future of Search, 3) AI Creator Tools, 4) SMID AI Winners, 5) AI ASIC Adoption, 6) Regulation, 7) The Future of Foundational Models, 8) Robotics, 9) Healthcare, and 10) Autonomous Vehicles

[Global Technology: Edging Into a Smartphone Upcycle \(9 Nov 2023\)](#)

- Cloud AI burst into the mainstream in 2023 with ChatGPT. We think Edge AI will be the next big thing to take hold, fuelling a new product cycle for smartphones. The completion of de-stocking, rush orders, and Huawei's return to the market could also trigger a cyclical recovery.

[Thematics: Tech Diffusion: Edge AI – Growing Impetus \(7 Nov 2023\)](#)

- To power the killer apps of the AI age, more compute will be pushed to 'Edge' consumer devices. The prize is large – 30 billion devices by decade's end – but so too are the hurdles. 2024 should be a catalyst year for this theme and our 6 global enabler stocks.

[Greater China Technology Hardware: VR/MR Headsets: AI-enabled and Progressing into the Metaverse \(5 Dec 2023\)](#)

- 3D interface, spatial computing, and edge AI have been accelerating VR/MR headset spec advances, evidenced by Apple Vision Pro, Quest 3, and HTC XR Elite. We expect innovative use cases to be available from 2024, driving VR/MR headset sales and the metaverse ecosystem build. Initiate HTC at EW.

[Technology: What Can We Learn from the GPU Math? \(23 Oct 2023\); Software: Feedback on our 'GPU IaaS Math' \(1 Nov 2023\)](#)

- Graphics processing units (GPUs) deliver the foundation for AI training and inference in cloud data centers today. By introducing the MS GPU Monetization Framework and initial NVDA data center unit/pricing estimates, we size up potential revenue and margin impacts for MSFT, AMZN, GOOGL, and ORCL.
- Our note 'What Can We Learn from the GPU Math?' sparked likely debate from investors, primarily around three topics: 1) What will GPU allocations actually look like?, 2) What happens to average GPU pricing longer term?, and 3) Is there enough Gen AI demand to justify this GPU IaaS spend?

[Software: What's New in the 'New Stack'? The Battle for the AI Stack Starts to Heat Up \(27 Nov 2023\); Software: What's New in the 'New Stack'? AWS Throws Its Hat Into the Ring \(15 Dec 2023\)](#)

- Recent announcements from OpenAI and Microsoft signal that competition to own more of the emerging AI stack is heating up. MDB and SNOW remain well positioned given multiple vectors for growth, but RAG use cases are likely to see more competition.

- Building on recent announcements from OpenAI & Microsoft, AWS detailed its vision of the AI stack – we highlight Q, Guardrails, and vector search. While a number of approaches to building Gen AI apps are being introduced, it will take some time before the market settles on a common architecture.

[Global Video Games: How Will AI Change the Game Industry...and Who Could Benefit? \(22 Oct 2023\)](#)

- New AI tools look set to change how games are made, as the cost to build and operate AAA games could fall by up to 15%. That said, lower barriers to entry could also make the industry more competitive. We lay out the bull and bear cases for game publishers and who looks best positioned to benefit.

[Global Technology: US Export Controls Impact \(19 Oct 2023\)](#)

- We view this tightening as a slight setback for AI overall globally, and see risk for some stocks with larger China exposure, but also opportunities for others as the correction appears overdone. Downstream appears more impacted vs. upstream.

[Asia Technology: AI Hardware Supply Chain – Introducing our Interactive on ODMs \(25 Oct 2023\)](#)

- This is a quick follow-up on our deep dive analysis on the value proposition and growth potential across the AI hardware supply chain. In this report, we include a custom-built interactive tool to give you a quick and easy way to assess the revenue and profit impacts to ODMs from AI servers.

New AI Technology Research: Stock Specific Reports

[Salesforce.com: Building a Bridge to Generative AI; Upgrade to OW \(21 Dec 2023\)](#)

- Low investor expectations vs potential top-line upside drivers in price increases, product bundling and Data Cloud adoption frame an attractive risk/reward for CRM. While the ramp in GenAI apps may still be >12 months away, Data Cloud likely proves a bridge to better growth in CY24. Upgrade to OW.

[Amazon.com Inc: AWS re:Invent: Right on Q \(1 Dec 2023\)](#)

- AWS showed its early but broad AI offerings, with its NVDA partnership, Guardrails, Q and vector search notable. The week also re-enforced how early it is in Gen AI adoption/hurdles to clear. We also detail a product-level breakdown of AWS/Azure/GCP Gen AI tools to track platform differentiation.

[Internet: How Large is the GPU IaaS Opportunity for GOOGL and AMZN? \(23 Oct 2023\)](#)

- GPU IaaS represents a meaningful potential driver of AWS/GCP long-term rev and profit. We size the '26 rev opportunity at \$30bn/\$20bn for AWS/

GCP and see 5% potential upside to '26 AMZN/GOOGL company-wide gross profit. It could also help GOOGL's multiple given the material potential GCP upside.

[Apple, Inc.: Gaining an Edge By Enabling Gen AI at 'The Edge' \(7 Nov 2023\)](#)

- We see Apple as an emerging 'Edge AI Enabler', or a beneficiary of compute being pushed to the edge to enable new Gen AI-driven 'killer apps'. 5 different paths to monetizing Gen AI are most likely, with Apple's key competitive advantages being Data, Privacy and Vertical Integration. Reiterate OW.

[Microsoft: Solving for the 'AND' Gate \(21 Nov 2023\)](#)

- While the leadership tumult at OpenAI may create an opportunity for competitors to close the gap to the market-leading GPT model, near-term financial impacts appear limited and Microsoft looks to be taking swift action to mitigate the risks. That said, the situation continues to be fluid.

[Intel Corporation: Intel AI Everywhere Event & Mgmt Meetings \(15 Dec 2023\)](#)

- Launch of Meteor Lake, Emerald Rapids, and early color on Gaudi 3 largely as expected; management meetings around the event highlight the potential to extract value from manufacturing.

[Advanced Micro Devices: AMD Advancing AI Event Highlights AI Opportunity \(7 Dec 2023\)](#)

- The AMD event had an impressive breadth of endorsement of its MI300 architecture, but did not really break new ground in defining the company's role.

[Arista Networks: ANET Analyst Day: Deep Dive on AI Opportunity \(10 Nov 2023\)](#)

- Cloud and AI Innovators Analyst Day presented a deep dive into technology problems created by AI, and solved by Arista. As expected, financial targets laid out were largely as previewed on Q2/Q3 earnings, giving room for eventual new CFO and flexibility given customer concentration. Remain OW.

[Greater China Technology Hardware: Transceivers: A Year of High Growth in 2024; Innolight, Coherent and Marvell best positioned to benefit \(5 Nov 2023\)](#)

- We believe the transceiver industry is likely to enjoy rapid earnings growth in 2024, mainly driven by AI GPU's rapid volume growth. The recent A-share market correction has introduced good investment opportunities, while Coherent and Marvell are best positioned to benefit in the US.

[Global Semiconductors: IP and Design in an AI Era – Initiating Coverage of Arm, Synopsys and Cadence \(10 Nov 2023\)](#)

- AI-related themes are driving sales/margin growth for IP (Arm) and Design

(Synopsys, Cadence). Valuations look fair for Arm and Cadence, despite some risks smouldering off screen, and we see a buying opportunity with Synopsys (Overweight).

[Hon Hai Precision: Technology Day 2023: The Broader Scope of EV Manufacturing – AI Factory + EVs \(18 Oct 2023\)](#)

- EVs were the focus this year with the introduction of the Model N cargo van. Hon Hai is also partnering with NVDA on the 'AI factory' concept, which will transform data into intelligence to create smart cities, smart manufacturing, etc.

[Pearson: Sizing the GenAI opportunity in education \(20 Nov 2023\)](#)

- We see Pearson as one of the better positioned companies globally in the education space, which should see it become a net beneficiary from GenAI.

New AI Non-Tech Research:

[Healthcare Technology: AI Deep Dive: Framing the Use Cases and Investment Opportunities \(24 Oct 2023\)](#)

- Generative AI represents a catalyst for increased adoption of technology in Healthcare, a market that's bogged down by archaic business practices and inefficiencies. It's early innings, but we see the greatest fundamental impact on MODN, DH and RCM, representing optionality for the stocks.

[Asset & Wealth Management: The AI Tipping Point \(4 Oct 2023\); Slide Deck, Video](#)

- Gen AI will transform the way the industry operates, but it is just one part of an integrated strategic approach to drive growth and build resiliency.

[Global Education: More than Meets the Eye: Sizing the GenAI Opportunity in Education \(20 Nov 2023\)](#)

- Generative AI is a game changer in education. The market is debating whether GenAI is a threat or an opportunity, but that's the tip of the iceberg. Our work uncovers a \$200bn impact on the global education sector over the next 3 years. Favored names: Vitru, Afya, Coursera, Docebo, TAL Education.

[Quantitative Equity Research: How LLMs Can Boost Earnings Call Signals \(17 Oct 2023\)](#)

- Using a Google Large Language Model (LLM), we raised the Sharpe ratio of sentiment signals from earnings call transcripts by 80%. We lay out the process of harnessing this cost-effective new technology.

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AI Guidebook: How AI is Set to Transform Technology, Business and the Investing Landscapes

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Key Takeaways

1. We expect tech diffusion to accelerate, which history suggests could lead to faster economic productivity and a broadening of non-tech sector outperformance
2. A 1% increase in Total Factor Productivity could drive a permanent ~5bp increase in GDP levels. In the short-run, GenAI could also result in lower interest rates and disinflation
3. Historical analogs suggest AI driven productivity gains could add 30bps to S&P 500 net margins in '25, which contributes to our above consensus '25 EPS growth of 16% (vs. Street 12%)
4. We expect the AI era to lead to new consumer and enterprise tools and digital capabilities...and ultimately faster digitization of wallets and budgets
5. We see ~\$5tr of offline US consumer spend to move online...and a \$4.1tr labor market opportunity to be impacted through enterprise AI adoption
6. Corporates are becoming a dominant force in GenAI private funding (90% of funds in '23), which is a rapidly evolving ecosystem as 12 key debates re-shape the GenAI software stack
7. Expect consumer adoption to be faster than enterprises due to higher frictions around data sets, ROI/budgeting, required skill sets, and regulatory hurdles
8. We identify 8 unresolved debates and risks...with the early regulatory landscape noisy but murky

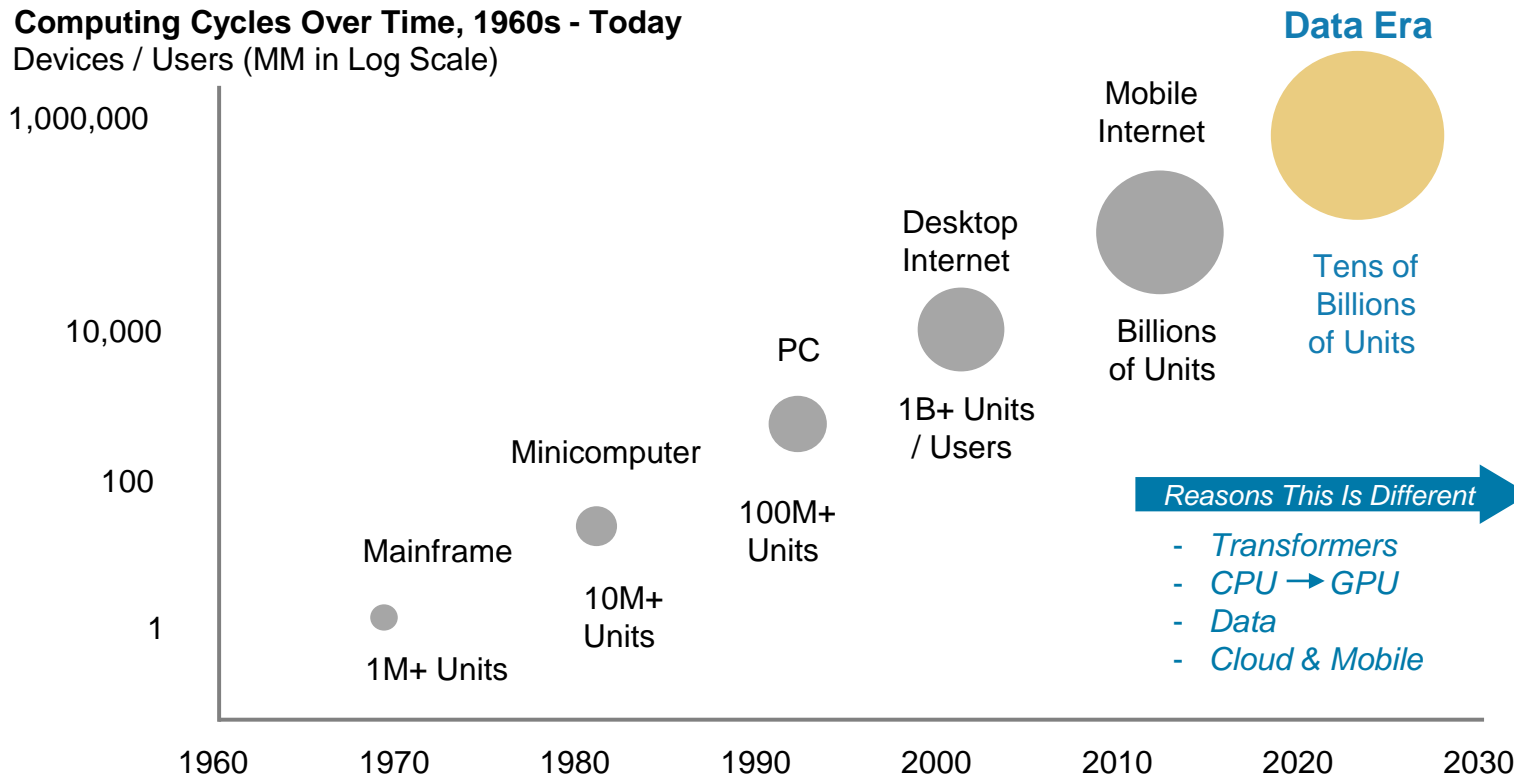
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The Generative AI Technology and Case for Accelerating Diffusion

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Technology and Compute Platforms Have Been Building Upon Themselves For Over 50 Years...



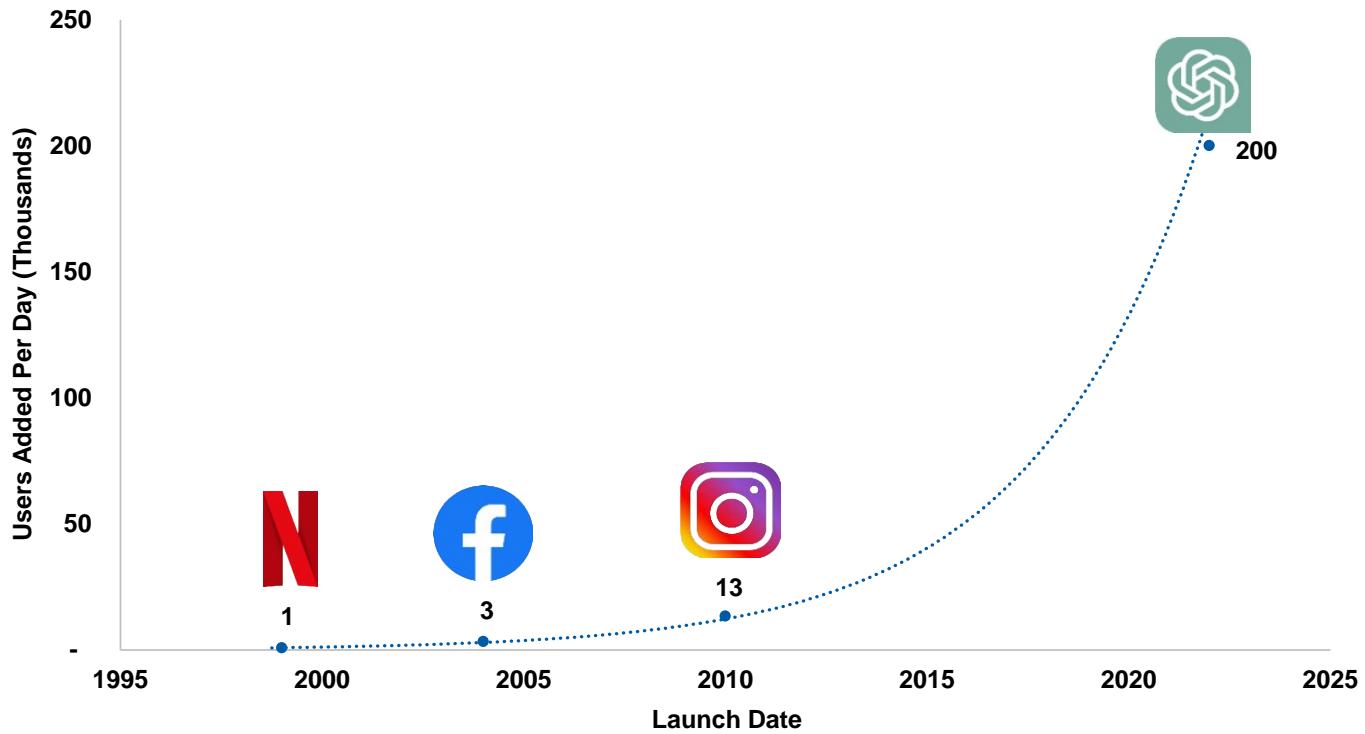
Source: Morgan Stanley Research

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...Driving an Inflection in AI Adoption as the Data Era Gains Momentum

Users Added Per Day From Launch to One Million Users

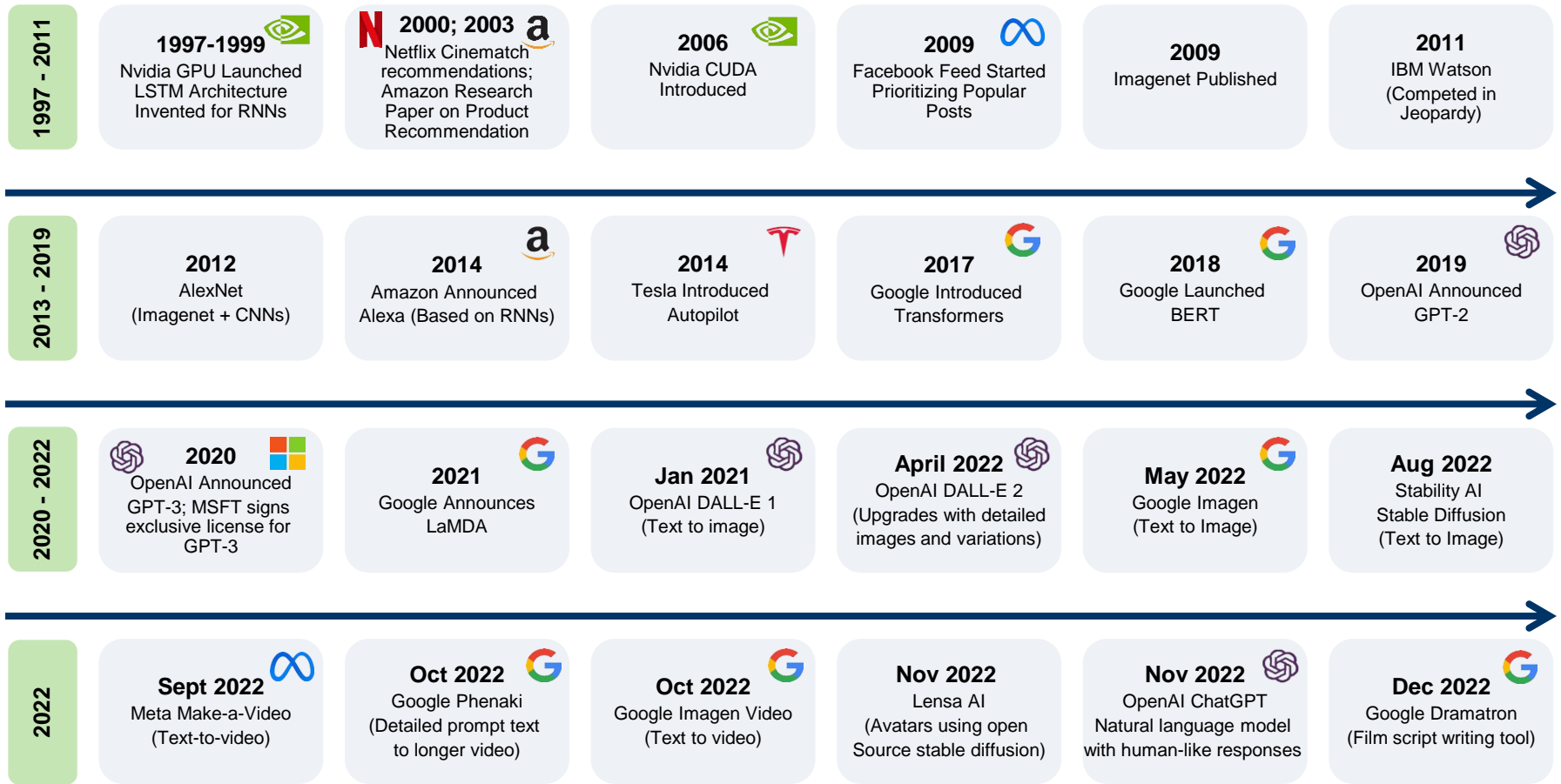


Source: Company data, Statista, Morgan Stanley Research

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The Concept of AI Isn't New...It's Been Building for Years as Compute Cycles Advance



Source: Various websites, Morgan Stanley Research

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Fundamentally AI is Built Upon 1) Silicon and Compute Power, 2) Machine Learning, and 3) Deep Learning

Artificial Intelligence

Machines that can perform tasks that typically require human intelligence like understanding, reasoning, learning, decision making etc.

Machine Learning

Involves training algorithms to make predictions based on data

Deep Learning

Involves training neural networks to perform tasks like image recognition

Transformers

Input data is transformed into a sequence of vectors, and then the vectors predict an output sequence (translation, summary, or answer to a question)

General Adversarial Networks (GANs)

Used to generate new images or videos that are similar to a given set of input data. GANs pre-date Transformers

Recurrent Neural Networks (RNNs)

Process and analyze data sequentially (time series, speech, natural language)

Convolutional Neural Networks (CNNs)

Process and analyze data that has a grid-like structure (images and videos)

Software

PyTorch and TensorFlow

Compute

GPUs and TPUs

Source: Morgan Stanley Research

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Transformers Are Foundational to Generative AI and Emerging State-of-the-Art AI Models

Transformers

A type of Deep Learning model where input data is transformed into a sequence of vectors, and then the vectors predict an output sequence

Generative AI

A type of AI model designed to generate new, synthetic data based on patterns learned from existing data (i.e. text, images, videos, and audio)

Large Language Models (LLMs)

A type of natural language processing (NLP) that uses deep learning techniques to process and analyze human language at scale

Diffusion Models

A type of generative model that is based on the idea of iteratively diffusing noise through a set of transformations to generate realistic samples

Computer Vision Models (CV)

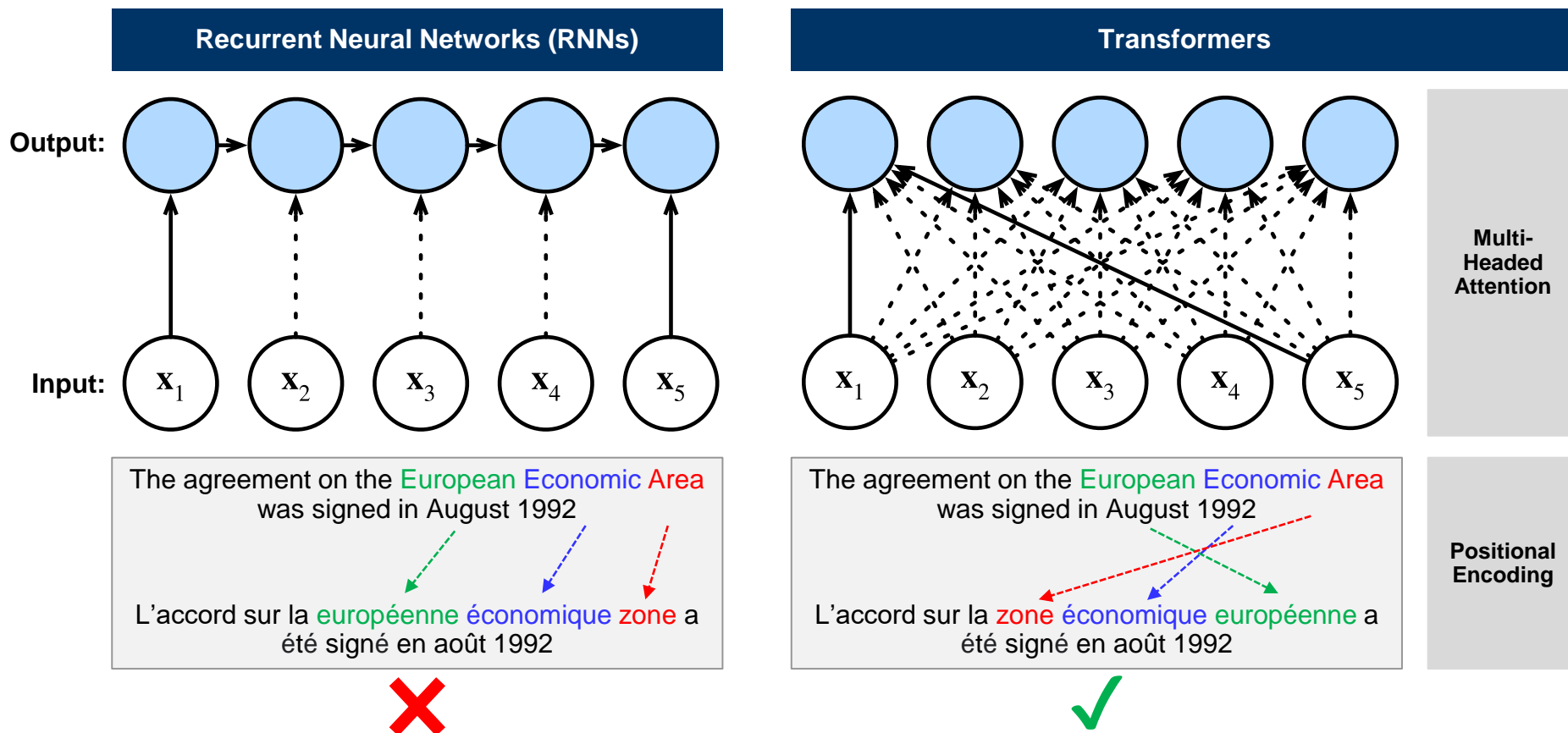
CV models enable machines to interpret and understand the visual world, such as images and videos

Multimodal Models

AI models that combine information from multiple modalities/data such as images, text, and audio

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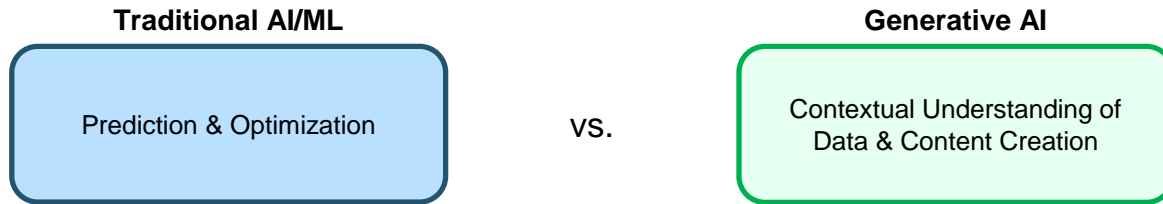
As Multi-Headed Attention and Positional Encoding Create Stronger Contextual Understanding...



Source: Dive into Deep Learning, ArsTechnica, Morgan Stanley Research

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... Contributing to a Step Function Change in AI Capabilities

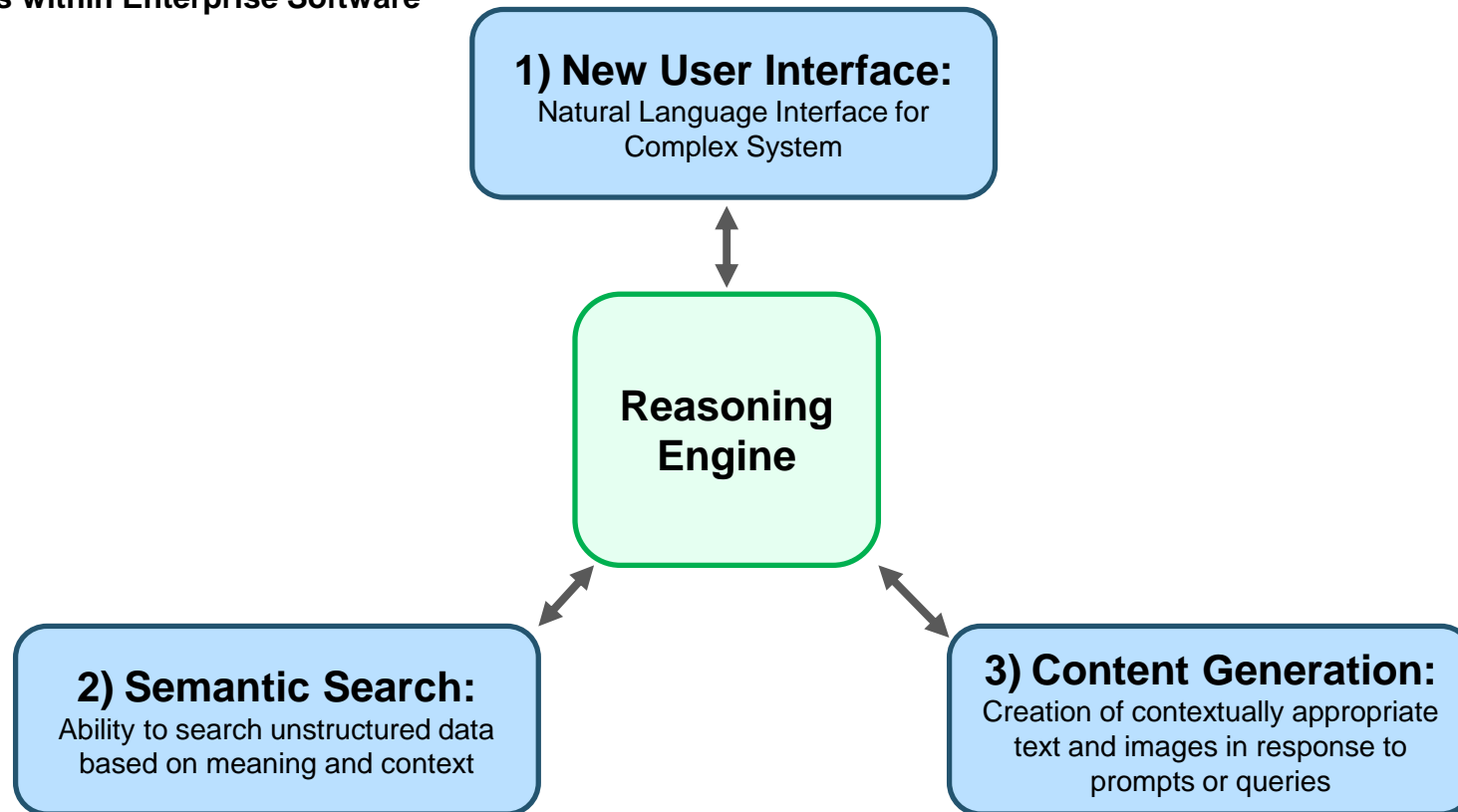


	Traditional "Predictive" AI	Generative AI
What is it?	<ul style="list-style-type: none"> Algorithmic processes that identify patterns and trends in structured, time series data sets that might predict future behavior Rules-based programs to perform specific tasks 	<ul style="list-style-type: none"> The application of foundational models in order to create original content Uncovers hidden patterns that may not be evident through predictive AI
AI Strengths	<ul style="list-style-type: none"> Classification, anomaly detection, prediction Solve analytical tasks faster Predictable, traceable, controllable 	<ul style="list-style-type: none"> Unstructured data, which is then classified Creating new content No/few-shot training
Applications	<ul style="list-style-type: none"> Quantitative analysis Risk modeling Predictions Portfolio optimization Robotic process automation (RPA) (Rules-based) Conversational AI 	<ul style="list-style-type: none"> Question answering Sentiment analysis Information extraction and search Content generation Object recognition Summarization

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Generative AI Adds a Reasoning Engine to Software Tool Kit

By Representing the Relationships Between Words and Images in Numbers, Generative AI Enables Three Core Functions within Enterprise Software

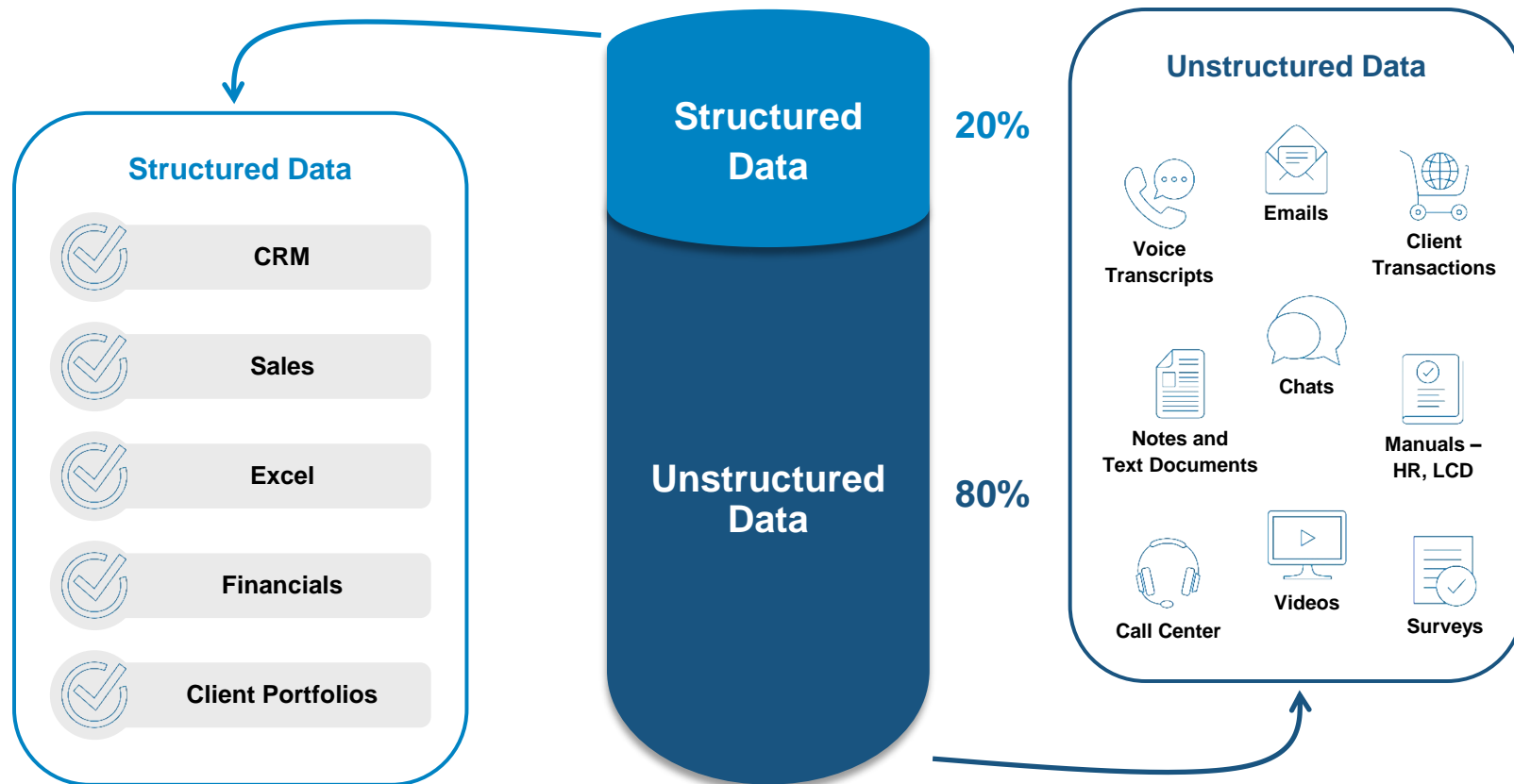


Source: Morgan Stanley Research

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Generative AI Unlocks Insights from Unstructured Data...



Source: ORI, Morgan Stanley Research

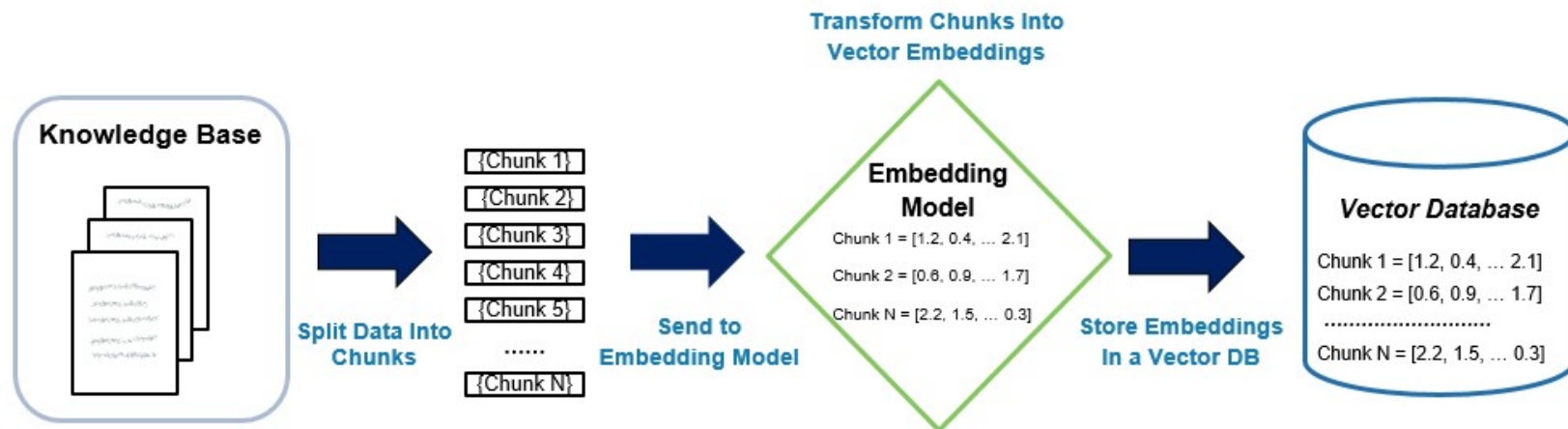
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... Using Embedding Models and Vector Databases...

3 Important Capabilities Get Unlocked By Embedding Models & Vectorization

1. A new way to search – by **meaning** versus by **keyword**
2. Ability to provide large language models (LLM) with **memory**
3. When combined with a **vector database**, vectorization opens the opportunity for **enterprises to build their own LLM applications** using their proprietary data sets

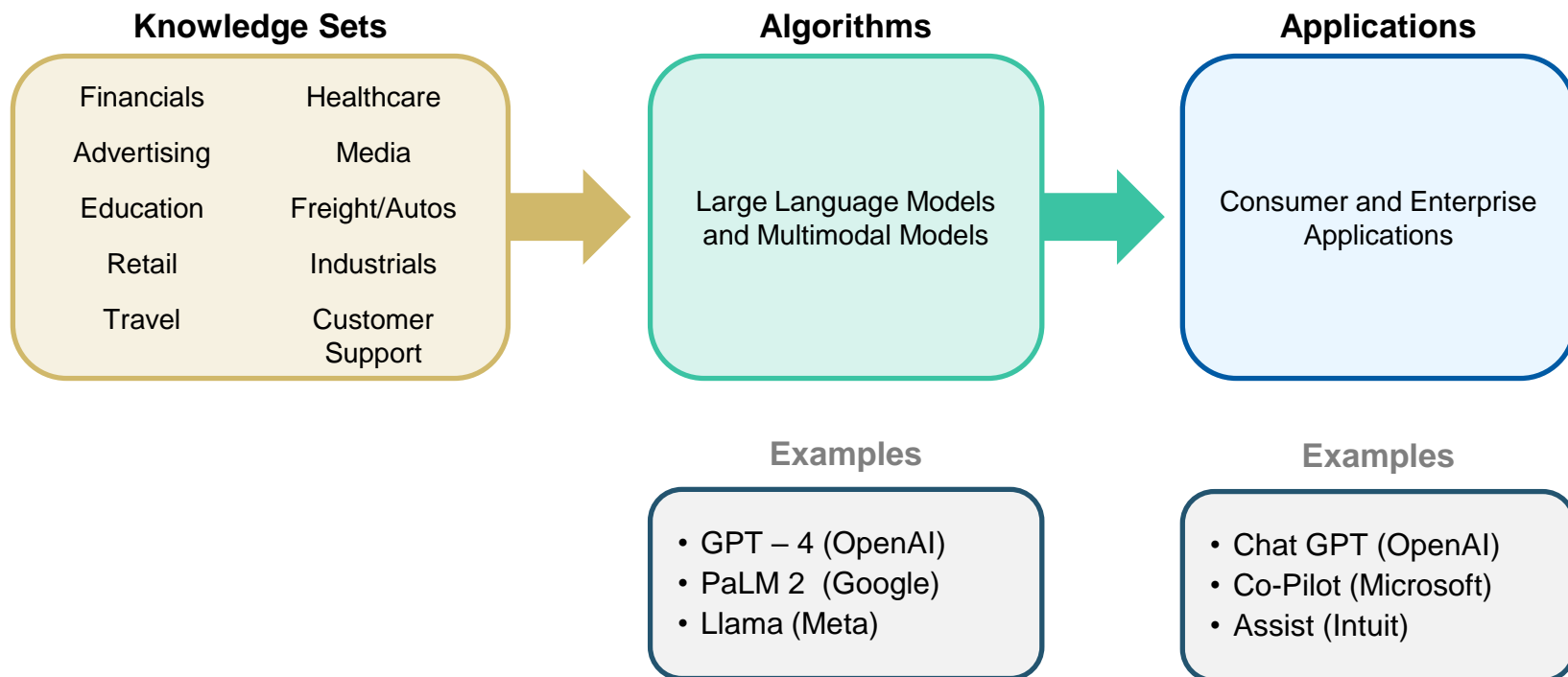


Source: Morgan Stanley Research

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... Which Enable Knowledge to be Embedded into Algorithms that Scale

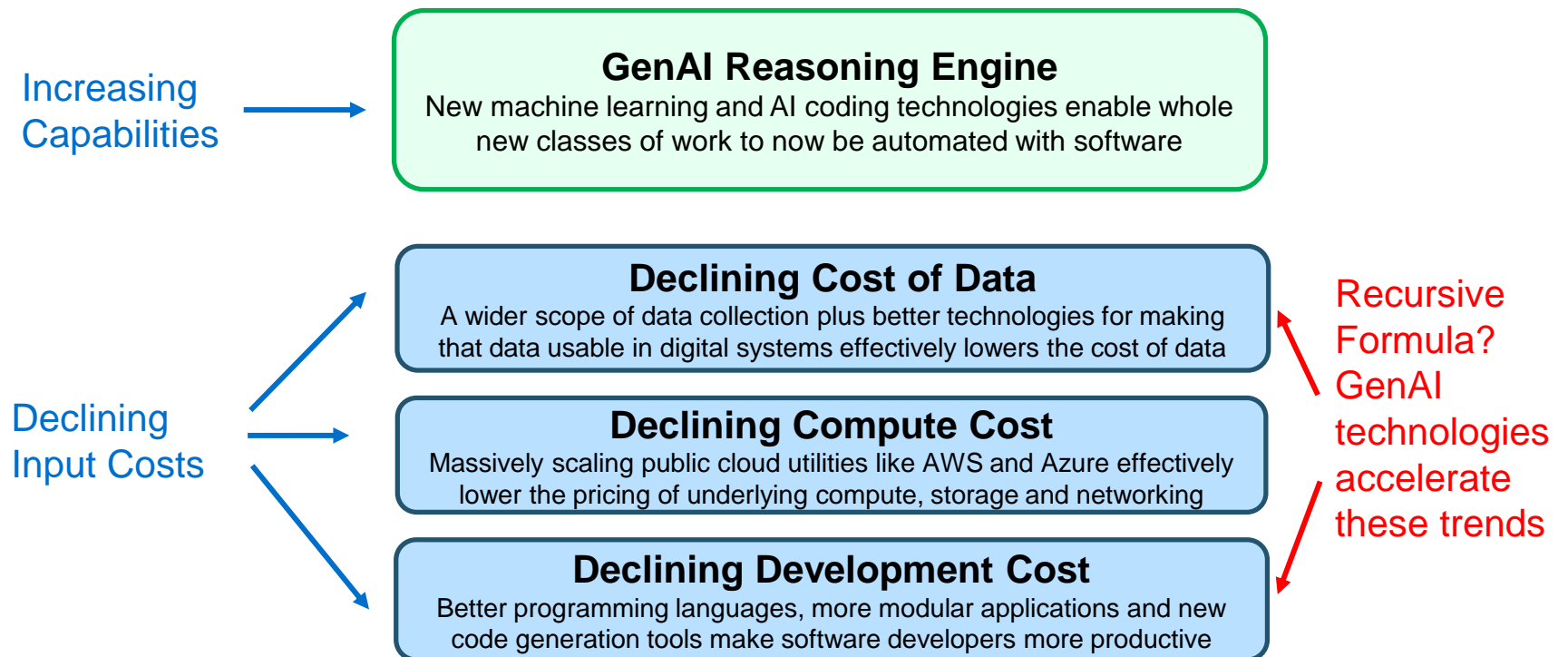


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Converging Technologies, Declining Cost Curves Underlie Broadening Capabilities

Converging Technologies & Declining Cost Curves Underlying Broadening Capabilities

The equation for a massively expansionary cycle within Enterprise Software

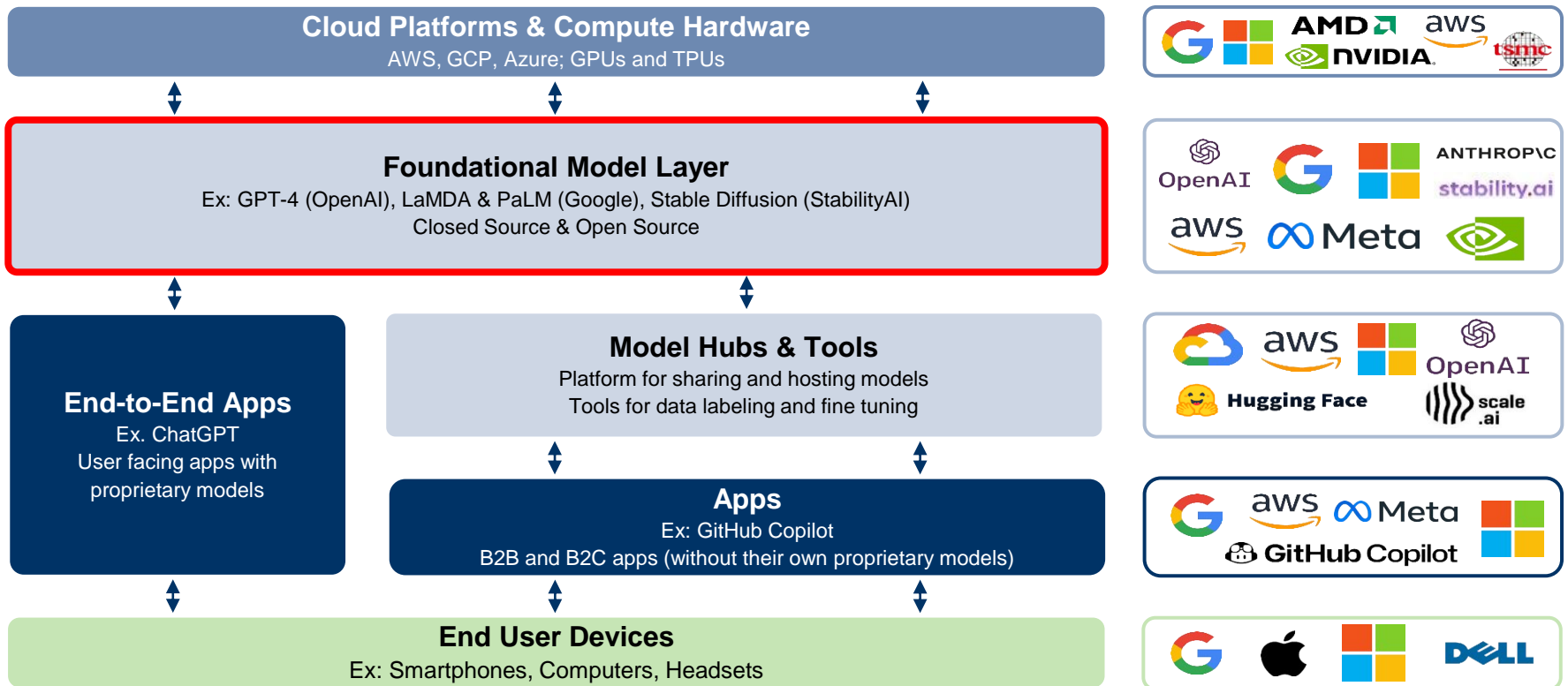


Source: Morgan Stanley Research

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The AI Ecosystem: Large Language Models Set to Drive Faster Consumer and Enterprise Digitization



Source: a16z, Morgan Stanley Research

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12 Key Debates Are Likely To Shape the GenAI Tech Stack From Here

Foundational Models

- **Scaling Laws and Model Architectures:** Will scaling laws result in diminishing returns? Which new model architectures and training techniques show promise in expanding model capabilities?
- **Model Capabilities:** How will model capabilities evolve over the coming years and what are the implications?
- **Pace of Cost Reductions:** Will the pace of software and hardware innovation continue to drive costs lower, or will new advancements be required?
- **Open vs. Closed Source:** Will open-source model capabilities catch up to proprietary (closed-source) models? What are the implications for leading model companies and application builders?

Technology & Tools

- **Point Solutions vs. Platforms:** Will incumbent model providers and/or CSPs move up the stack to subsume the tech and tools layer? What drives differentiation for point solutions?
- **Customization of AI Apps:** What model customization techniques will become standard for developers (RAG, fine-tuning, prompt engineering, etc.)?
- **Data Preparation and Governance:** What steps are involved in preparing organizations' data for GenAI apps, and which standards are evolving around data prep and governance?
- **Building Apps vs. Building Models:** How will the layer change as the focus shifts to app development vs. model development, where hardware requirements and users may differ?

Applications

- **User Retention and Frequency:** How long does it take and what is required to solve current user retention and frequency issues? Who will be successful removing friction and improving app utility?
- **Enterprise vs. Consumer:** How do the opportunities and risks differ between enterprise and consumer end markets?
- **Privates vs. Publics:** To what extent does GenAI favor the incumbents? How does the opportunity and competitive risk differ between horizontal and vertical applications?
- **Vertical Opportunities:** Which verticals present the largest and most compelling opportunities for GenAI application vendors?

We dive into these debates in: [Internet & Software: GenAI Privates: Where Are We Now and 12 Debates From Here \(20 Dec 2023\)](#)

Source: Morgan Stanley Research

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While Still Early, Productivity Uplifts Are Becoming Clearer...

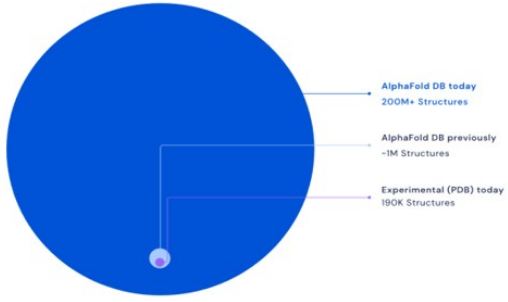

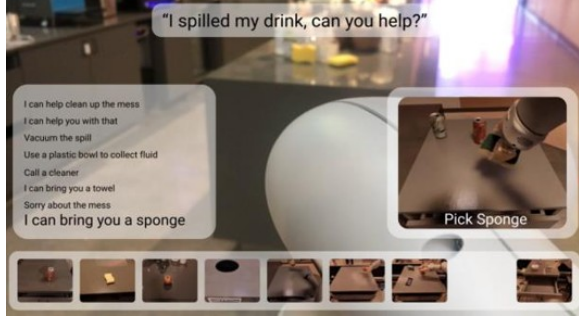
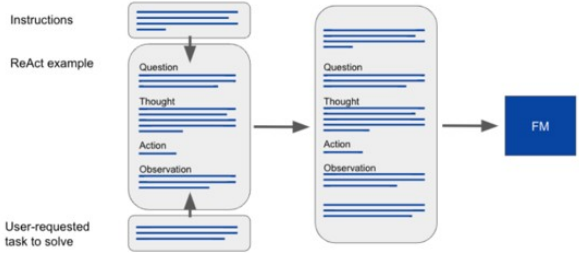


Customer Support	National Bureau of Economic Research	<ul style="list-style-type: none"> • Access to AI-based conversational assistants increases productivity, as measured by issues resolved per hour, by 14% on average, with the greatest impact on novice and low-skilled workers, and minimal impact on experienced and highly skilled workers. 		
AI-Assisted Coding	GitHub Copilot	<ul style="list-style-type: none"> • “We’re now seeing that the developers using GitHub Copilot are 55% more productive on tasks.” – Scott Guthrie, Microsoft EVP of Cloud & AI 	AMZN Code Whisperer	<ul style="list-style-type: none"> • “Internal test showed 57% faster task completion and 27% higher likelihood of success.” – Adam Selipski, AWS CEO
	PayPal	<ul style="list-style-type: none"> • “AI is already making the coding development team 30% more productive and expects similar improvement across front office and back office.” – Dan Schulman, PayPal CEO 		
	Airbnb	<ul style="list-style-type: none"> • “I think our employees could easily be, especially our developers, 30% more productive in the short to medium term and this will allow significantly greater throughput through tools like GitHub’s Copilot.” – Brian Chesky, Airbnb CEO 		
Writing Productivity	MIT Study	<ul style="list-style-type: none"> • Study of 453 college-educated professions show that ChatGPT raises the average productivity of those who used the technology and increased job satisfaction. Average time taken decreased by 40% and output quality rose by 18%. 		
General Productivity	Adobe	<ul style="list-style-type: none"> • Early customer feedback suggests 20% productivity gains from Firefly, saving ~8hrs per week and freeing up time for more high value-add work. 		
	HBS Study	<ul style="list-style-type: none"> • Study of 758 BGC consultants highlights GPT4 productivity gains... consultants using AI completed 12.2% more tasks on average, and 25.1% more quickly, and produced significantly higher quality results (more than 40% higher quality compared to a control group). 		
	Unity	<ul style="list-style-type: none"> • “Now, something that might have taken a group of artists 3 months can now take a server run about 10 minutes. And the interesting point about the 3 months to 10 minutes statistic is that’s not just a productivity uplift per se... originally most people would have looked at the challenge to create new 3D content taking 3 months and go, “we can’t afford that” and so they didn’t do it. Generative AI will allow all those who never started to get there in 10 minutes instead; market expansion.” – Marc Whitten, Unity Create President 		

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Source: Morgan Stanley Research, Company data, [National Bureau of Economic Research](#), [Erik Brynjolfsson](#), [MIT \(Evidence on the Productivity Effects of Generative Artificial Intelligence\)](#), [Harvard Business School](#)

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...As Generative AI Early Use Cases Are Emerging For Enterprises and Consumers

<p>Protein Folding</p> <p>DeepMind's AlphaFold can predict the structure of nearly all known proteins</p> 	<p>Cancer Detection</p> <p>Microsoft & Paige are building the world's largest image-based AI model to Fight Cancer</p> 	<p>Robotics</p> <p>Google demonstrates that robots can understand and act on human instruction using LLMs</p> 
<p>Agentic AI</p> <p>Amazon announced tools that enable models to complete tasks based on user instructions</p> 	<p>Universal Translation</p> <p>Meta unveiled the first all-in-one multilingual multimodal AI translation and transcription model</p> <p>Hindi/Telugu ► English</p> <p>TEXT TRANSLATION I can speak Hindi, Telugu and English. Sometimes I use all three languages in one conversation.</p> <p>SPEECH TRANSLATION</p> 	<p>Text to Digital Video</p> <p>Fable's Showrunner AI showcases ability to create episodes of TV shows with a prompt</p> 

Source: Company websites, [Venture Beat](#), Morgan Stanley Research. Note: MSFT is covered by Keith Weiss. Fable is not covered.

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Over Time, We See Broad-based AI Applications Set to Drive Productivity

The broad-based nature of Generative AI and ML use cases demonstrates the ‘general-purpose’ nature of the technology. In all, we see AI anchoring a host of new technologies and more efficient processes which overtime can increase labor productivity.





Healthcare	Financials	Advertising & Digital Content	Retail & Freight	Energy & Industrials	Customer Service	Business Intelligence
Smart Implants (Ex: Hip & Knee)	AI Thematic Fund Offerings	Marketing Efficiency	3D Shopping & Product Try On	AI Tools for Pipelines	Customer Analytics	Developer Tools & Assisted Code
Medical Imaging	New Trade Pricing Tools	Enhanced Ad Targeting	Sidewalk Robots for Deliveries	Geological Models	Insurance Claims and Records	AI-Related Consulting
Pathology Detection	Generate Client Portfolio Reviews	Recommendation Engine	Supply Chain Efficiency	AI-Enabled Microgrid Tools	Transcribe and Summarize	Integrated Smart Home Interface
Personalized Medicine	Automated Trade Prices, Execution	Higher Ad Conversion	Inventory Management	Energy Usage Analytics	Client Onboarding	Automate Back Office Tasks
Identify Biomarkers	AI Portfolio Management	Ad Auction Dynamics	Demand Prediction	Energy Trading Enhancements		Fraud Prevention and Protection
New Drug Development	Increase Trading Velocity	Content Creation	Truck Routing Capabilities	Labor Scheduling		Cybersecurity Capabilities
Analysis of Genomic Data	AI Hedging Strategies	Customized Travel Itineraries	Higher Fleet Utilization	Reservoir Optimization		Risk Assessment & Management
Physician Point of Service Tools		Video Game Development	Autonomous Fleet Networks	Leak Detection & Track Emissions		Accelerated Data Analysis
						Predictive Modeling

Source: Company data, Morgan Stanley Research

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The Investment Community Tends to Underestimate The Size of New Markets

On average, Wall Street estimates underestimated the size of the PC, Internet, Mobile, and Cloud opportunity by 38%

Compute Cycle	Initial Forecast	Actual	% Underestimation	10 YR CAGR*	Initial Forecast Date
 PC	225mn <i>PC Users in 2000</i>	354mn <i>PC Users in 2000</i>	36%	14% <i>1995-2005</i>	February 1996
 Internet	152mn <i>Internet Users in 2000</i>	361mn <i>Internet Users in 2000</i>	58%	41% <i>1996-2006</i>	February 1996
 Mobile	657mn <i>Smartphones Shipments in 2013</i>	1,019mn <i>Smartphones Shipments in 2013</i>	36%	15% <i>2010-2020</i>	January 2010
 Cloud	\$90.2bn <i>Top 3 Cloud Provider Revenue in 2020</i>	\$115.6bn <i>Top 3 Cloud Provider Revenue in 2020</i>	22%	30% <i>2017-2026</i>	March 2017

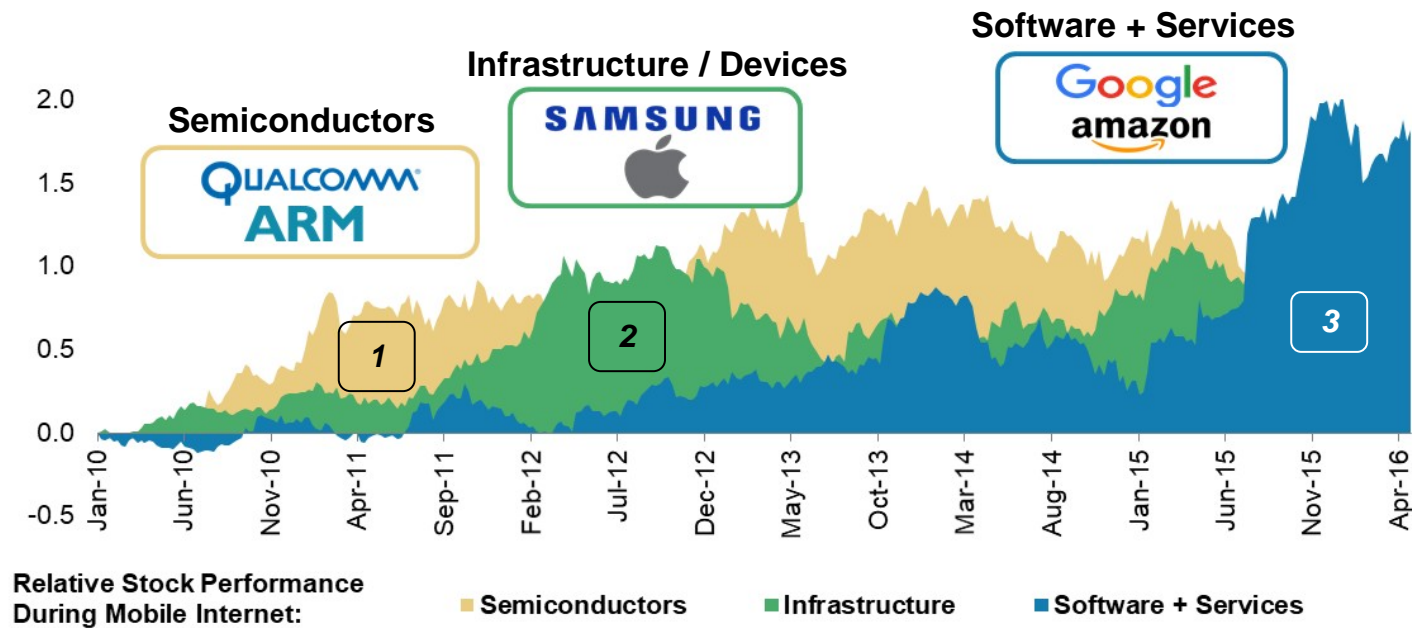
Average Underestimation: 38%

Source: Morgan Stanley Research. *Note: Cloud CAGR measured over 9 years as we do not currently estimate MSFT cloud revenue in CY27

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The Roadmap to Monetizing Cycles: The Mobile Internet as a Case Study

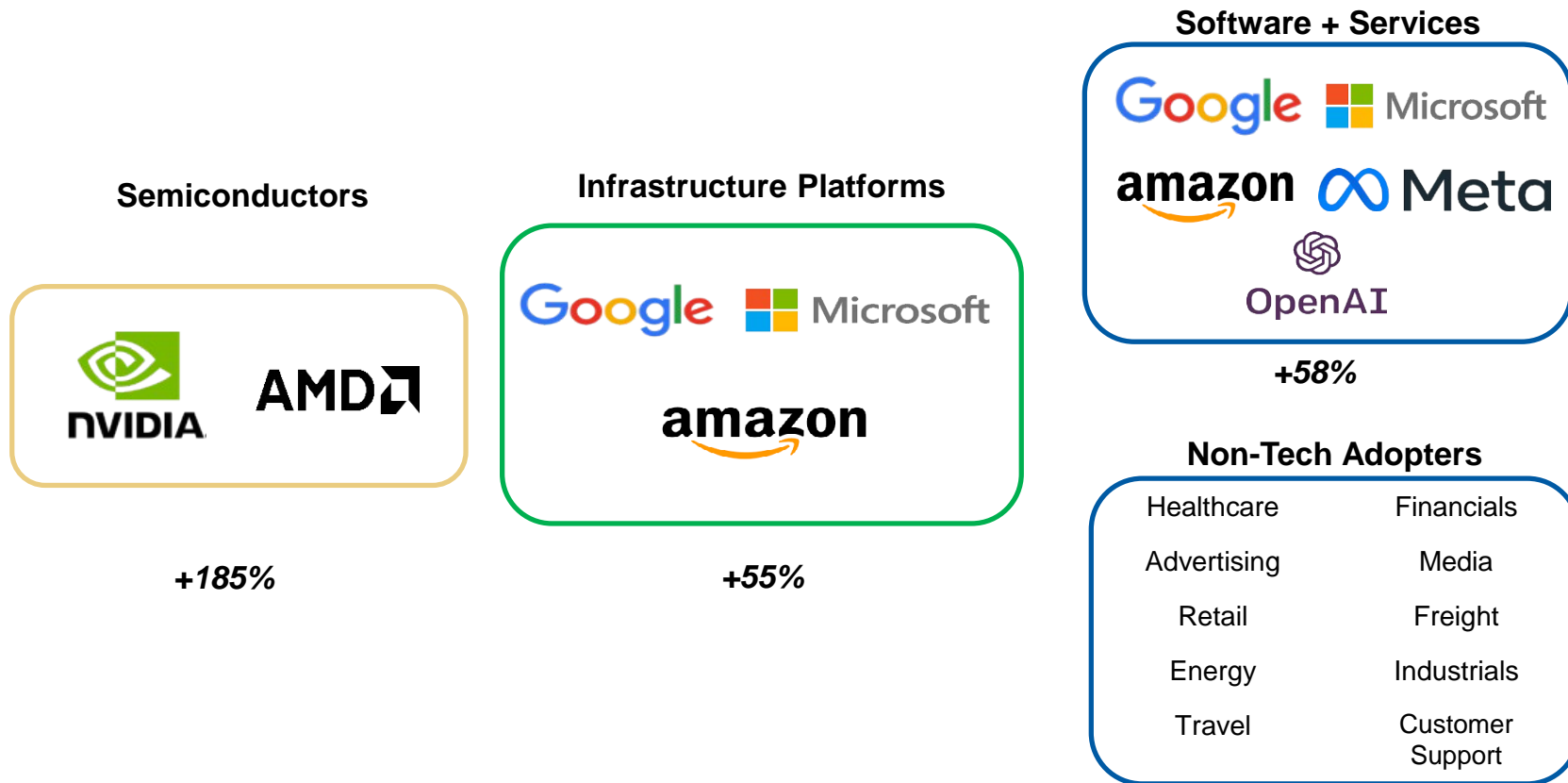
- Mobile Internet Cycle Stock Performance
- Indexed Performance Relative to S&P 500



Source: Factset, Morgan Stanley Research

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AI Following Similar Monetization Roadmap, with Semiconductors Leading



Source: Factset, Morgan Stanley Research. Note: YTD performance represent the median return from 11/30/22 (ChatGPT Launch) to 1/22/24 and excludes OpenAI given its private status.

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Macro: How GenAI May Reshape Labor, the Economy, and Impact the Equity Markets

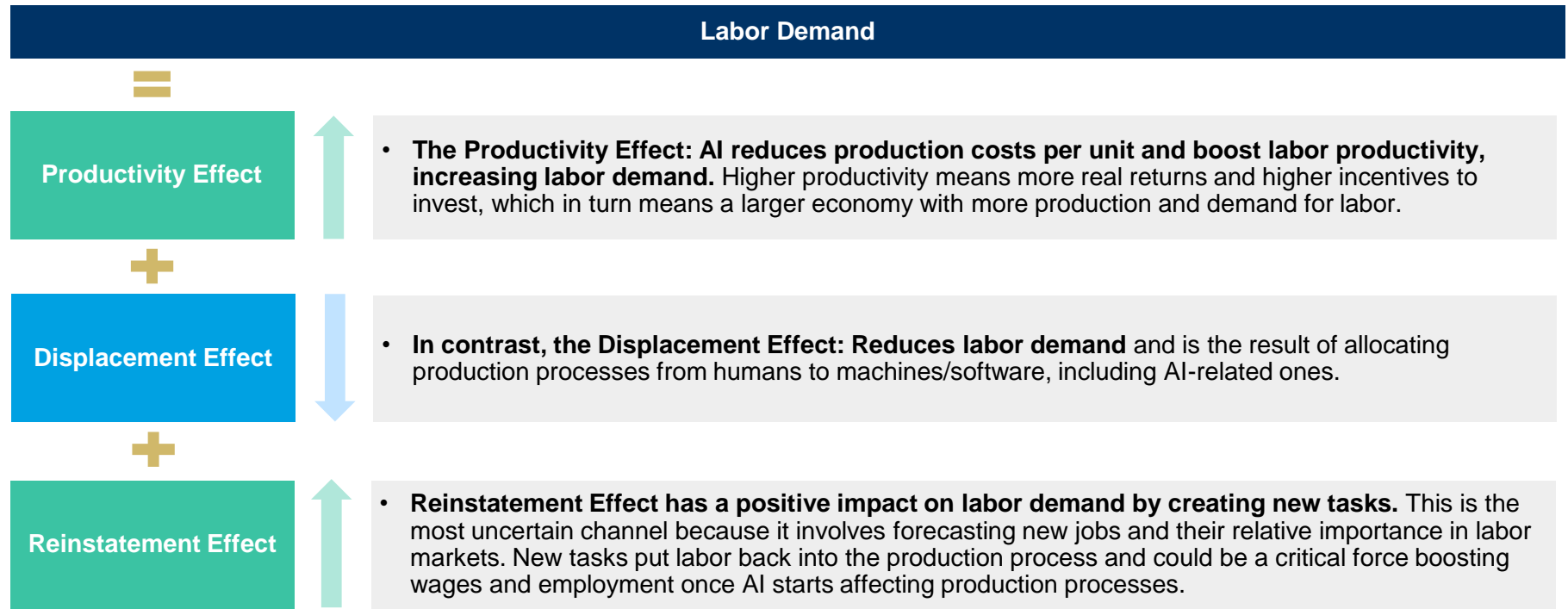
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Key Findings

- In the short run, we expect an increase in labor productivity likely will result in lower inflation and lower interest rates.
- Medium term, once inflation returns to target, interest rates may rise as higher productivity growth powers an upswing in the neutral interest rate (r^*).
- The correlation of growth and inflation historically turns negative in times of significant technology diffusion. We expect GenAI to follow this pattern, which could bring stock and bond performance back into alignment.
- Assuming tech-driven productivity growth in line with what we saw during the historically analogous period (early-to-mid 1990s) added an additional ~30bps to our 2025 net margin estimate of 13.0% and took our 2025 EPS growth estimate to 16% which is above the street at ~12%.
- Our AI Index implies an outsized need to reskill displaced workers, requiring both public-private partnerships and broader government support.
- Thinking about GenAI and the future of work, we see skills outweighing credentials in the areas most affected by displacements.

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AI's Impact on Labor Demand Can be Broken into Three Forces

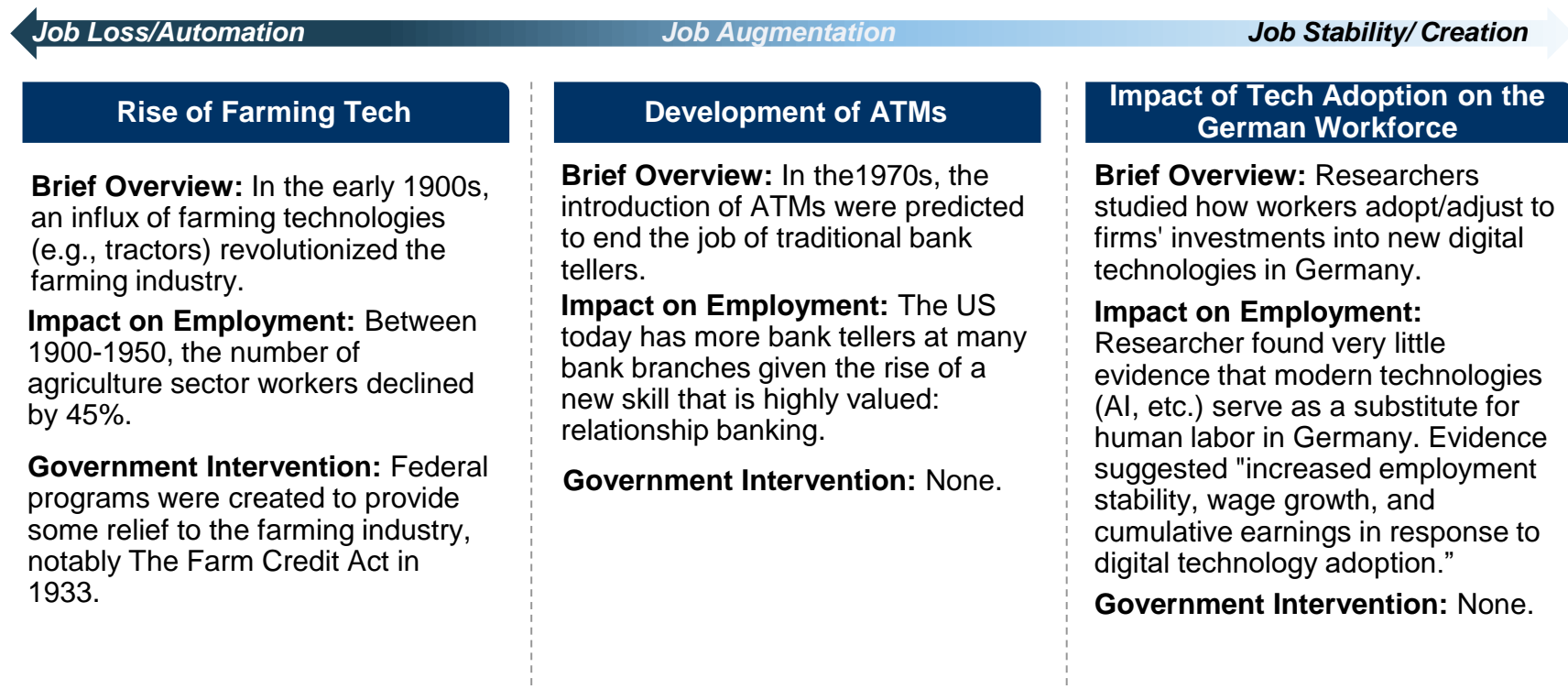


If the Displacement Effect is Stronger than the sum of the Productivity and Reinstatement Effects, then labor demand will fall and there will be downward pressure on real wages. Wages are generally sticky and, as a result, a drop in labor demand is associated with rising unemployment and a slowdown in payroll prints at least in the short term.

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Displacement and Reinstatement Effects are Too Early to Predict...

We continue to believe that it is too early to make any definitive claims on the number of jobs that will be replaced and created by generative AI. As a result, it's difficult to assess the Displacement and Reinstatement Effects.



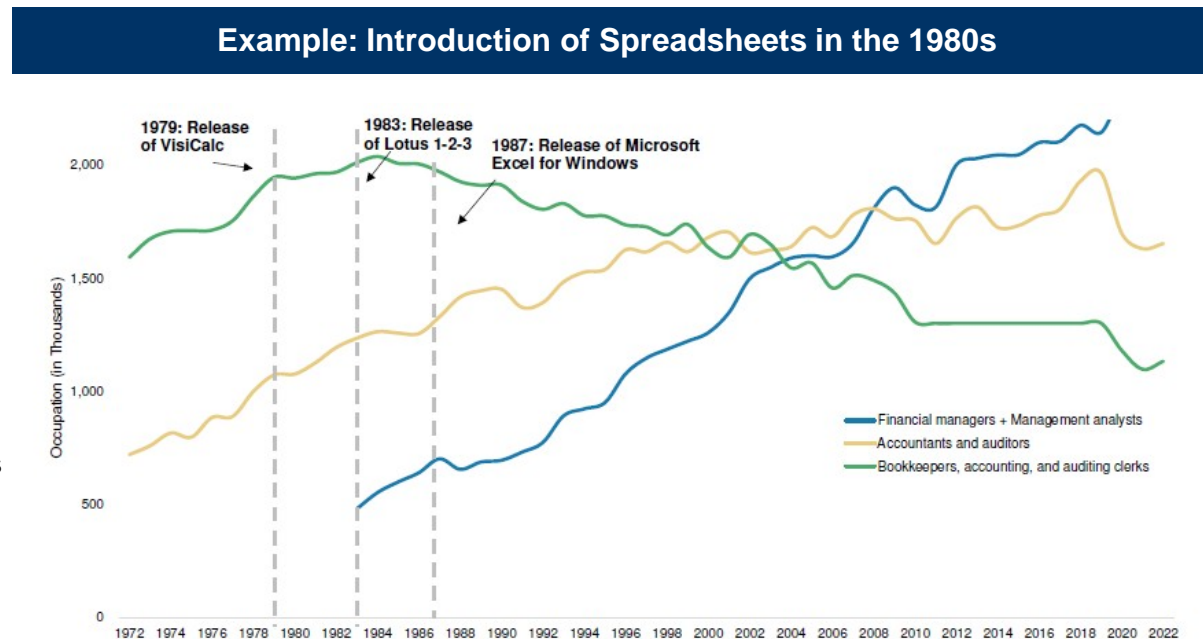
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Source: [The Impact of Artificial Intelligence on The Future Of Workforces In The European Union And The United States Of America, How Do Workers Adjust When Firms Adopt New Technologies?](#)_Morgan Stanley Research

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Lump of Labor Fallacy: The Strongest Counter Argument to AI Job Loss Fears

- Many periods of rapid technological innovation resulted in significant economic growth and net job creation, which in our view is the fundamentally strongest counter-argument to the view that GenAI will be a major destroyer of jobs.
- **Lump of Labor Fallacy:** there is a fixed volume of labor that will be performed within an economy. During many prior periods of technological innovation, there have been predictions of tremendous job losses, and broadly what we have seen is the opposite driven by increased productivity, lower prices and also entirely new products and services.
- As adoption of **spreadsheets** grew, the number of auditing clerks dropped from ~2 million in 1987 to just above 1.5 million by 2000; while the number of Americans employed as accountants/auditors and management analysts & financial managers significant increased.

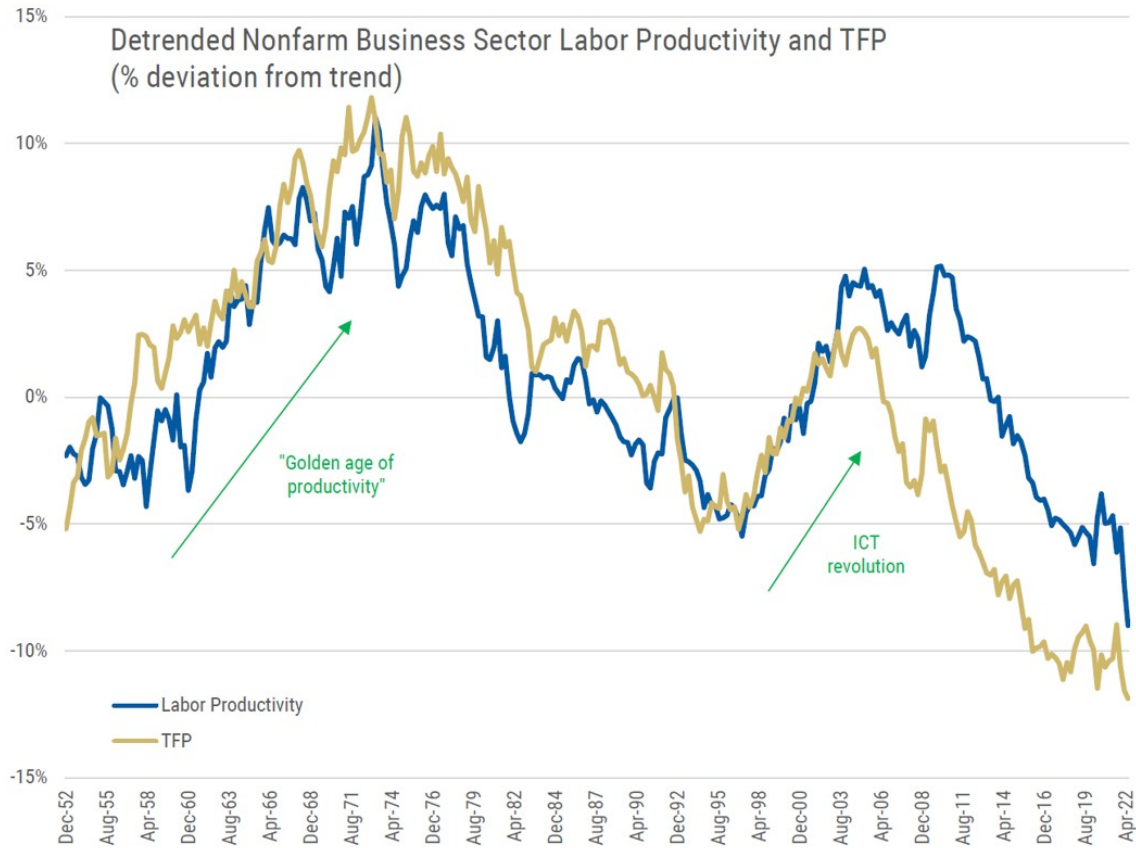


Source: Bureau of Labor Statistics, Morgan Stanley Research. Note: Data for Financial managers or Management analysts is unavailable prior to 1983. Given changes in occupational definitions, data is not strictly comparable across time.

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Adoption of New Technologies Accelerates Productivity Growth



Source: BEA, SF Fed, Morgan Stanley Research

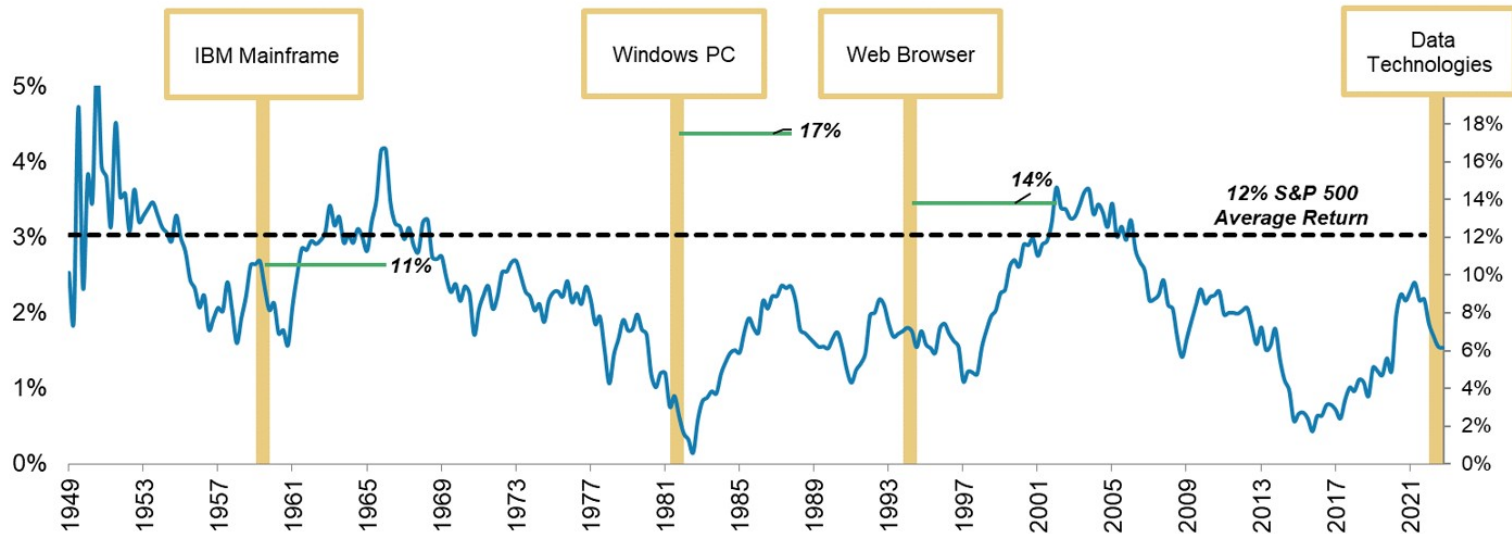
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AI Could Lead to a 4th Period of IT Driven Productivity Growth

- New AI-based technologies can drive incremental productivity
- Historical periods of IT driven productivity gains coincided with periods of strong market returns

US Nonfarm Business Sector Output Per Hour (YY, 5 Yr. Rolling Avg) vs. S&P 500 Annualized Returns



Source: FRED, Morgan Stanley Research. Note: Annualized performance is based on the time period between the technology introduction and peak 5yr rolling avg. productivity growth.

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We See Broad-based Emerging AI Applications Set to Drive Productivity and Efficiency

The broad-based nature of Generative AI and ML use cases demonstrates the ‘general-purpose’ nature of the technology. In all, we see AI anchoring a host of new technologies and more efficient processes which overtime can increase labor productivity.

Healthcare	Financials	Advertising & Digital Content	Retail & Freight	Energy & Industrials	Customer Service	Business Intelligence
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Analysis of Genomic Data	AI Hedging Strategies	Customized Travel Itineraries	Higher Fleet Utilization	Reservoir Optimization		Risk Assessment & Management
Physician Point of Service Tools		Video Game Development	Autonomous Fleet Networks	Leak Detection & Track Emissions		Accelerated Data Analysis
						Predictive Modeling

Source: Company data, Morgan Stanley Research

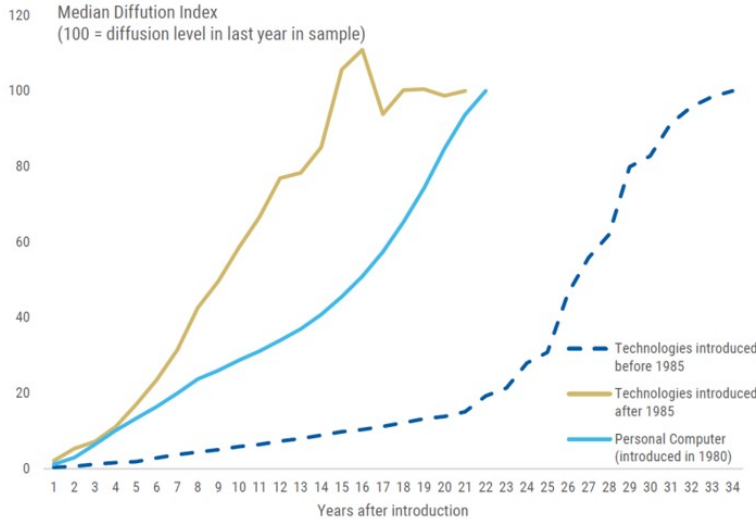
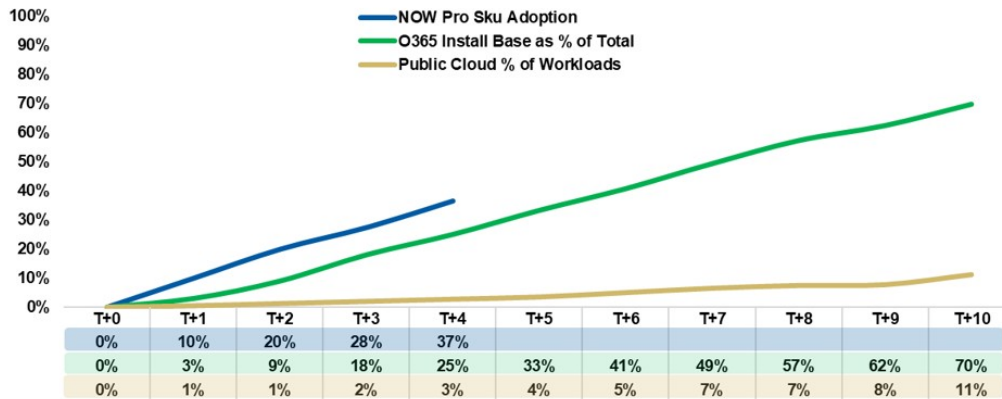
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Adoption Is Important as it Influences the Magnitude and Timing of Productivity Gains

We Forecast ~20% Enterprise GenAI Workload Adoption in 3 Years

Adoption of Recent Technologies Hit Critical Mass in 10 Years... but Adoption Curves are Steepening

Adoption Curve: NOW Pro Sku, O365, and Public Cloud



- Our analysis of prior enterprise technology adoption curves and three factors that could impact AI adoption (ROI, Friction, Budget), suggest that Enterprise GenAI adoption could approach 20% in the next three years.

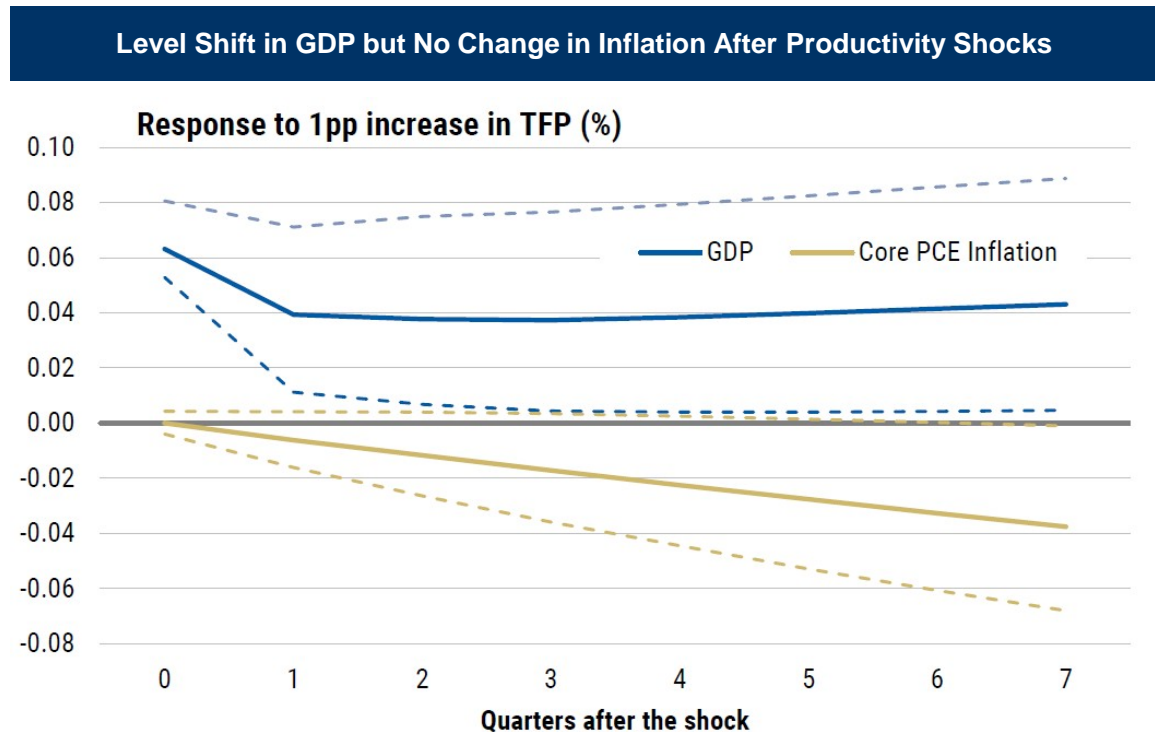
- Stepping back, we find that technology adoption is not linear and that new technologies generally take 10 years to reach critical mass... suggesting it could take time to see productivity impacts.

Source: Company data, Technology diffusion data from Comin and Hobijn (2020), Morgan Stanley Research

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Higher GDP Growth and Disinflation Follow Productivity Booms

- We created a model to assess the short-run effect of Total Factor Productivity (TFP) shocks on GDP and core inflation (core PCE) and our dynamic model shows that higher GDP growth and disinflation follow productivity booms.
- These shocks are changes in TFP as measured by John Fernald's TFP series from SF Fed's website. **We find that TFP shocks are basically level shifts in GDP; a 1% increase in TFP is associated with a permanent ~5bp increase in GDP levels.**
- The short-run response on inflation depends on how aggregate demand and production capacity reacts. Historically, the boost in economic activity is not inflationary and indeed our model predicts a drop in inflation rates over time.



Source: Morgan Stanley Research. Impulse response functions coming from a VAR model with Fernald's TFP, GDP, PCE inflation and EffectiveFed Funds Rate (EFFR). TFP shocks come from a Cholesky decomposition ordering TFP first. Dashed lines are 68% confidence intervals

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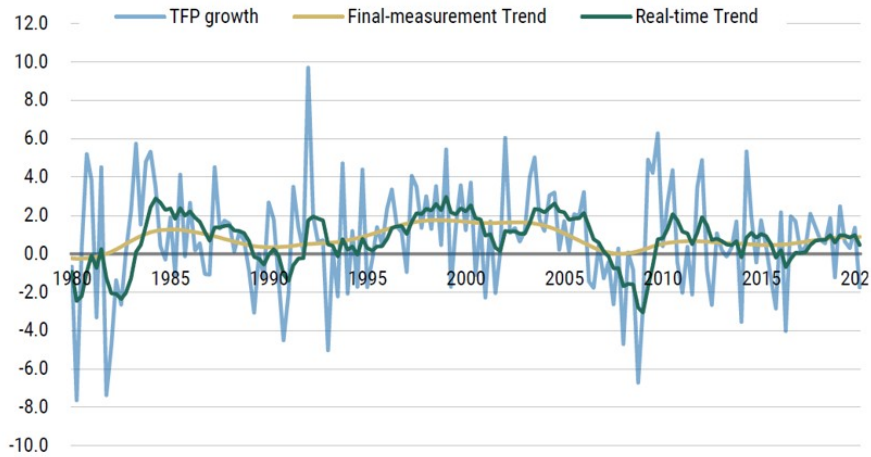
Implications for Interest Rates and Inflation

- **Short Run: Lower Inflation & Lower Interest Rates.** In our view, GenAI will increase labor productivity resulting in lower inflation and lower interest rates. Interest rates could decrease in the short run as inflation comes down or the Fed identifies a decreasing output gap.
 1. **If productivity gains are quickly identified**, the Fed might reduce rates because of a lower output gap. Higher productivity means more production capacity and potential output, and under this scenario the Fed might want boost the economy to potential levels.
 2. **If productivity gains are identified with a delay**, inflation will decline and the Fed will eventually reduce rates too. Lower rates likely come later and disinflation is more pronounced under the assumption that productivity gains are identified with delay.
- **Long-Run: Persistent Upswing in Neutral Interest Rate.** Better return on capital and higher potential economic growth from GenAI could cause a persistent upswing in r^* (interest rate required for economic growth at potential and inflation at target).

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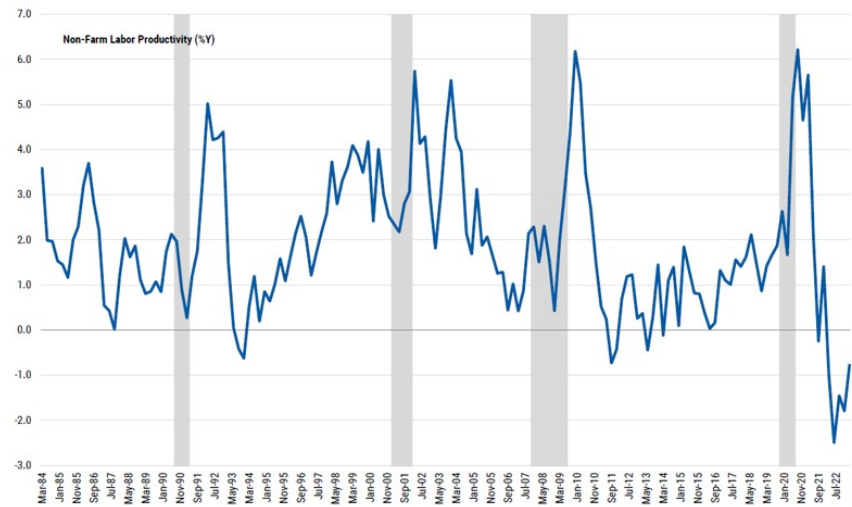
Measurement Issues and Macro May Make AI Productivity Gains Elusive

It Could be Difficult to Accurately Assess AI Productivity Gains in Real Time



- **Statistics might not show productivity gains in the short run due to measurement issues.** And even if productivity series capture AI gains, challenges remain. Productivity series are generally noisy and identifying structural breaks or a change in the trend in real time is hard.

Labor Productivity Tends to Slow During Slowdowns



- **We might not see a boost in labor productivity in the short run because of labor hoarding.** Labor productivity is cyclical, it falls during slowdowns and recessions, and one of the reasons behind this fact is labor hoarding. Put simply, firms tend to hold on to their workers while economic activity cools, which means deceleration in labor productivity or output per hours worked

Source: SF Fed, BEA, Morgan Stanley Research

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Implications for US Equity Markets

Methodology

We isolated historical periods where we saw a combination of (1) rising tech spending as a share of total fixed investment, (2) Rising productivity growth...and then... (3) a subsequent rise in profit margins.

Over time, we found that rising tech spend as a share of total fixed investment and rising productivity growth tend to move fairly coincidentally over time; the impact on profit margins for large cap US corporates then tends to flow through about 4 quarters later.

We then used a multiple regression based on data from the isolated periods to calculate the predicted impact of tech-driven productivity growth on the rate of change in net margin above what the normal business cycle explained. In other words, how much of the margin lift was driven by tech investment.

Key Takeaways

1. The early to mid 1990s appear to be the most compelling historical period based on the approach above.
2. As alluded to before, change in profit margins tends to lag the rate of change in tech driven productivity growth by 1 year. So if 2024 marks a broader AI investment ramp, the margin impact should be more visible in 2025 and beyond that. This fits with our general view that 2025 will represent a cyclical inflection that's aided by secular tailwinds.
3. We found it interesting that the balance of non-resi fixed investment outside of tech capex actually exhibits a negative correlation vs. productivity growth over time. So fixed investment ex-tech over time has not been productivity enhancing.
4. **The bottom line for our US Equity Outlook: Assuming tech-driven productivity growth in line with what we saw during the historically analogous period added an additional ~30bps to our 2025 net margin estimate of 13.0% and took our 2025 EPS growth estimate to 16% which is above the street at ~12%.**

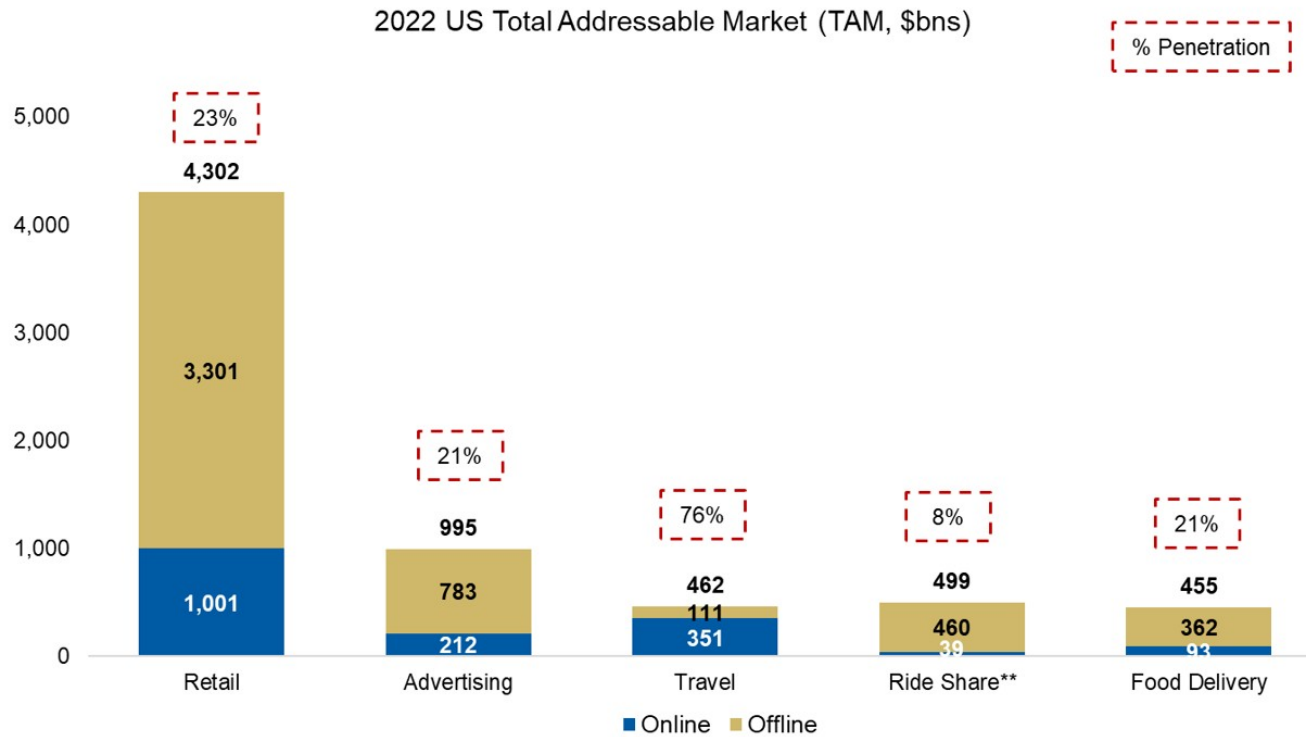
Source: Morgan Stanley Research ([US Equity Strategy: 2024 US Equities Outlook: The Narrowing Road \(13 Nov 2023\)](#))

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US Internet: Sizing the \$5 Trillion Dollar AI Internet Opportunity and Who Will Capture It

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We See a ~\$5tr Bucket of US Offline Consumer Spend Set to Continue To Be Digitized Through AI and Next Generation Tools*

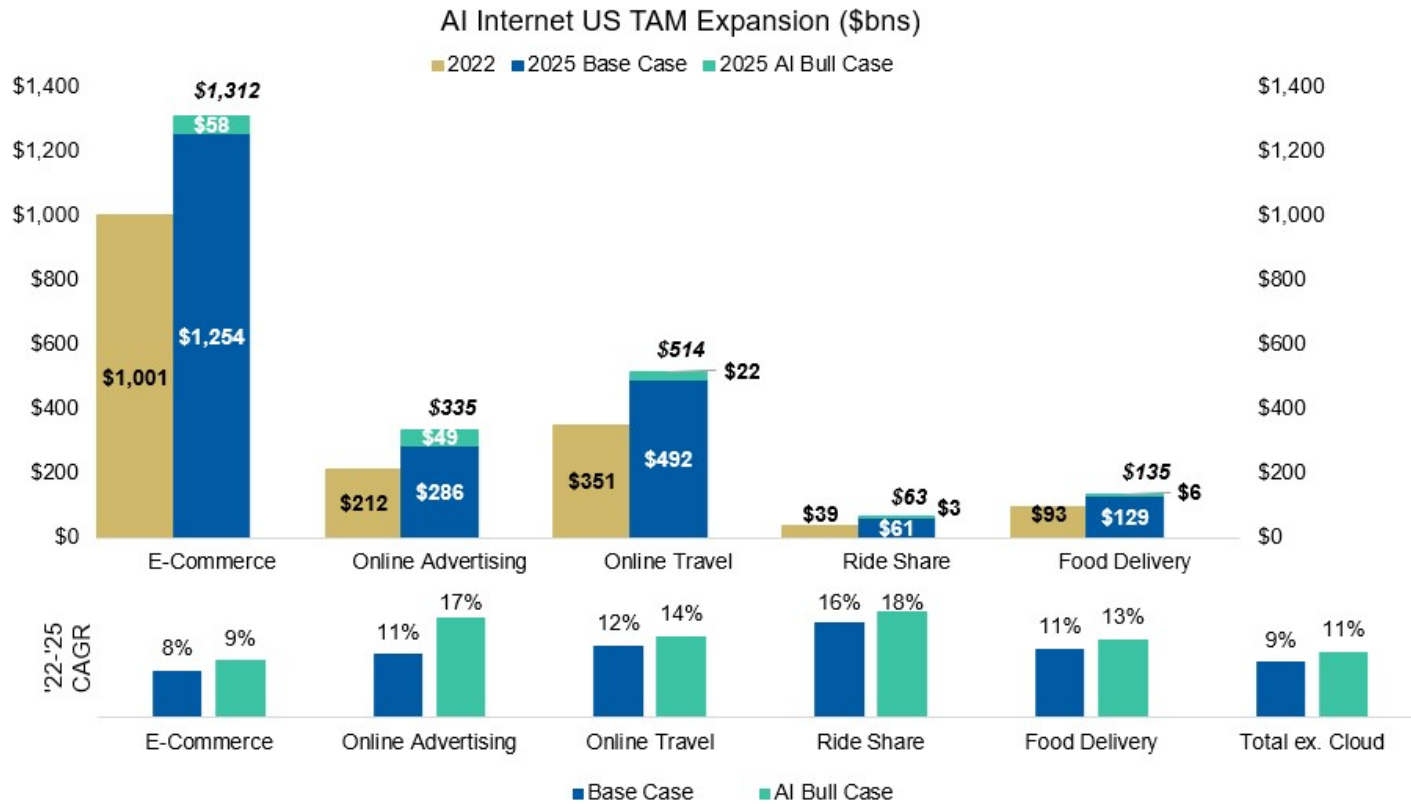


Source: IDC, Euromonitor, Morgan Stanley Research; Note: *Total TAM excludes Public Cloud. Online advertising includes CTV and streaming audio. **We calculate the Rideshare TAM by taking the frequency of the top 10% of users (~25x per month) and multiplying it by the number of addressable users and average Gross Bookings per ride to get to a total potential TAM

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...With AI Likely Driving an Inflection in the Digital Growth Curves

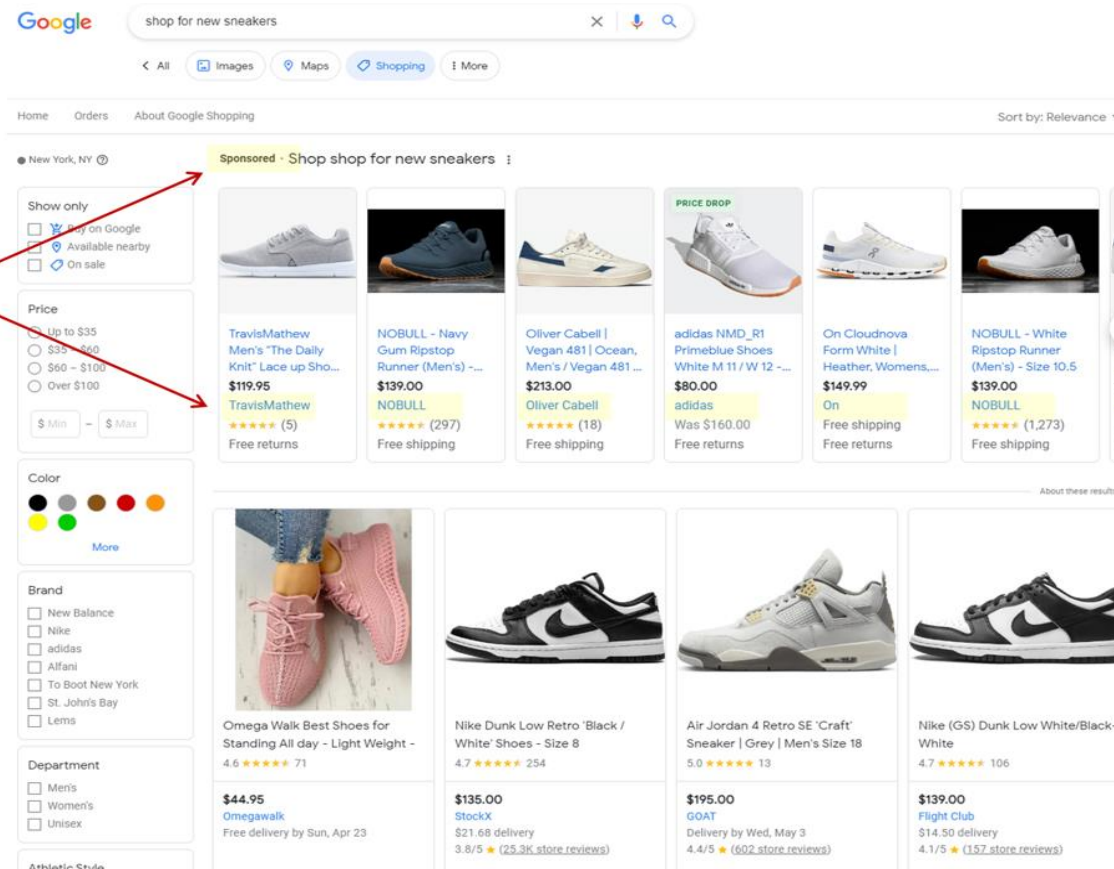


Source: IDC, Census Bureau, Euromonitor, Morgan Stanley Research.

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Two Examples: We See AI Potentially Further Collapsing the E-commerce Shopping Funnel...

Generative AI could enhance search pages by creating 3D features, immersive experiences and allowing for one-to-one advertising, which would enhance personalization, improve recommendations and ultimately should increase engagement and conversion rates



Source: Google, Morgan Stanley Research

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...Improving the Utility of Online Travel Research...

Bard Can Now Find Flights Based on Recent Hotel Bookings in Gmail

@Google Flights @Gmail Can you find me flights that match my trip to Colorado?
✎

Google Workspace & 1 more
Regenerate draft

ⓘ Bard doesn't always get it right. Be sure to check the following flight details:

Round trip · New York (JFK, LGA + 1 more) - Colorado (DEN, COS + 12 more) · Oct 4 - Oct 8 · 1 adult

You have an upcoming trip to Colorado from October 4th to 8th, 2023. You will be staying at the Viceroy Snowmass.

Here are some round trip flights from New York (JFK, LGA, EWR) to Colorado (DEN, COS, ASE, GJT, DRO, EGE, BJC, MTJ, HDN, PUB, GUC, CEZ, ALS, TEX) departing on October 4th and returning on October 8th:

- Delta from JFK to DEN, priced from \$318 (round trip) will take 4 hours and 35 minutes.
- United from EWR to DEN, priced from \$338 (round trip) will take 4 hours and 20 minutes.
- JetBlue from JFK to DEN, priced from \$338 (round trip) will take 4 hours and 27 minutes.
- Multiple Airlines from EWR to DEN, priced from \$235 (round trip) will take 11 hours and 10 minutes.

You can find more details on [Google Flights](#)

Google Flights Round trip · New York (JFK, LGA + 1 more) - Colorado (DEN, COS + 12 more) · Oct 4 - Oct 8 · 1 adult

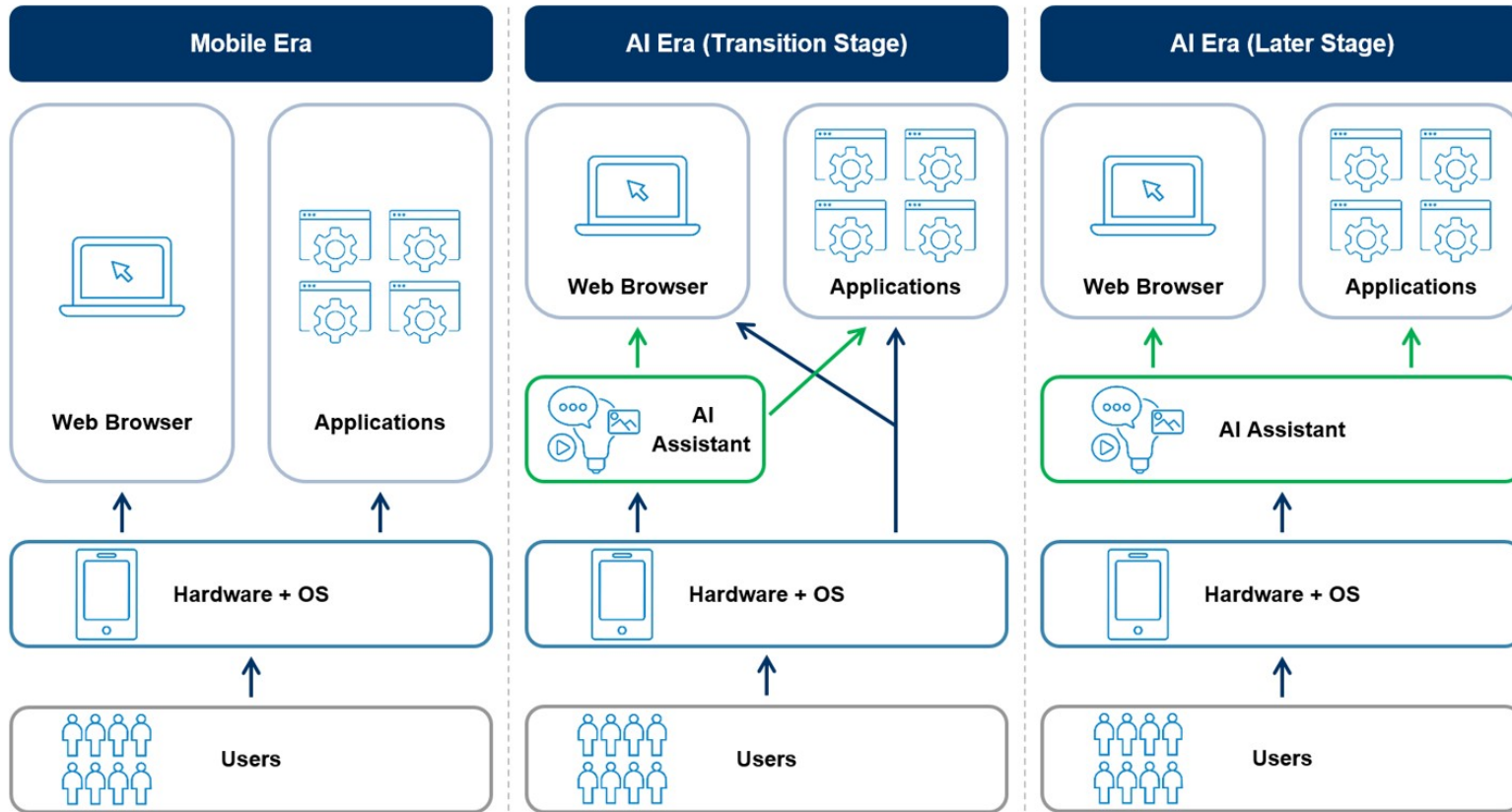
	Delta	8:00 AM - 10:35 AM	4 hr 35 min JFK - DEN	Nonstop	from \$318 round trip
	United	6:05 AM - 8:25 AM	4 hr 20 min EWR - DEN	Nonstop	from \$338 round trip
	JetBlue	8:30 PM - 10:57 PM	4 hr 27 min JFK - DEN	Nonstop	from \$338 round trip

Source: Google Bard, Morgan Stanley Research

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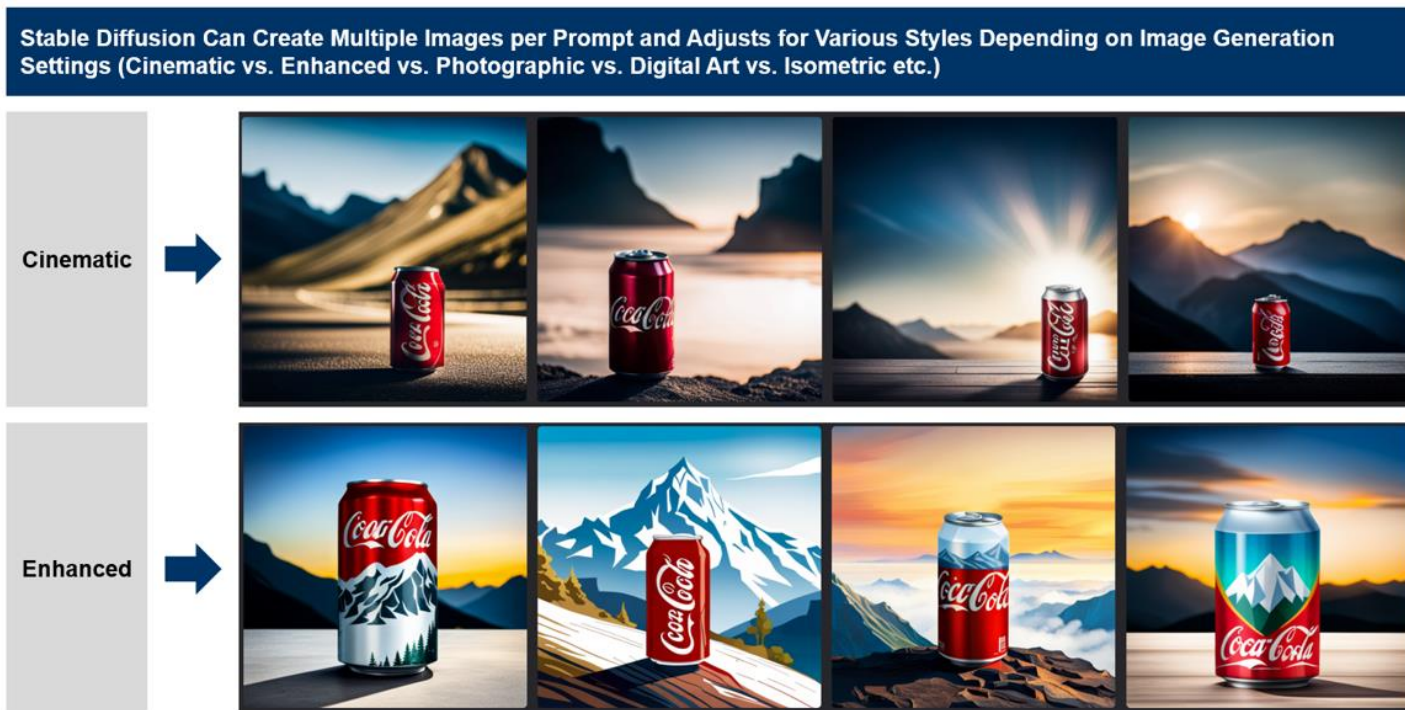
...As An Intelligent Middle Layer Is Emerging



Source: Morgan Stanley Research

Morgan Stanley

Generative AI Is Also Leading to More Personalized and Higher Converting Ads for Advertisers of All Sizes

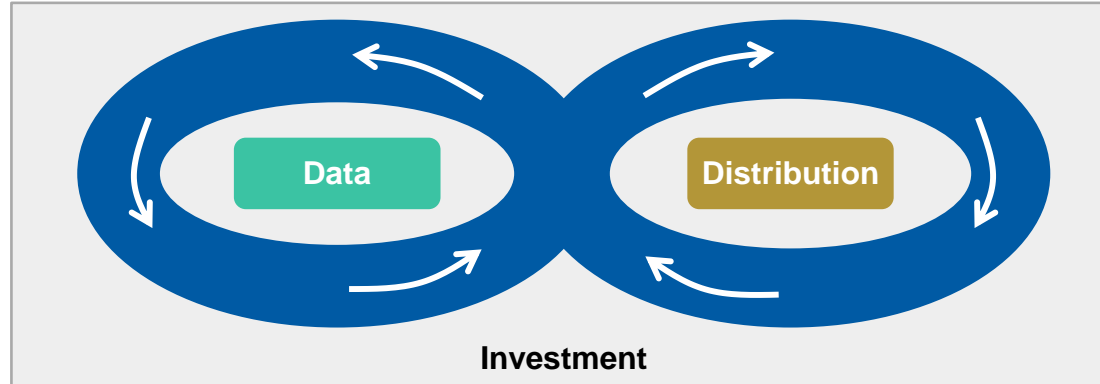


Source: Stable Diffusion, Morgan Stanley Research

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As AI Re-enforces the “Fly-Wheeling” Impact of Data, Distribution and Investment









	Google	Meta	amazon
Data	<p>+2bn users on 6 apps, +500mn users on 15 services; Search queries, Gmail, shopper & inventory data (35bn listings & 1.8bn updates to shopping graph per hour)</p>	<p>+3bn daily active people across Family of Apps; Interest and engagement data More than 10mn advertisers globally</p>	<p>~250mn Prime Members, ~25bn units sold annually, 175mn Prime Video viewers, millions of AWS customers; ~2mn sellers</p>
Distribution	Reach audience across full product offering (Gmail, Search, Cloud etc.)	Access to users across social and messaging channels (Instagram, WhatsApp etc.)	Access to global shopper base and millions of AWS customers.
Investment	~\$25bn/\$28bn in '23E/'24E Tech Infrastructure Capex	~\$25bn/\$27bn in '23E/'24E Infrastructure Capex	~\$37bn/\$42bn in '23E/'24E Infrastructure Capex

Source: Company data, Morgan Stanley Research

Morgan Stanley

The Six Major AI Enablers

Company Offering						
Data Center Hardware	✓	✓	✓	✓	✓	
Public Cloud Offering	✓	✓	✓	✓		
In-House Silicon	✓	✓		✓		✓
Models & Apps	✓	✓	✓	✓	✓	✓
End User Devices	✓	✓	✓		✓	✓
Partnerships	✓	✓	✓	✓	✓	

Source: Company Data, Morgan Stanley Research; Note: NVDA is covered by Joe Moore, MSFT is covered by Keith Weiss and AAPL is covered by Erik Woodring

Morgan Stanley

10 Companies Where the AI Impact is More Uncertain and Open for Debate

Social Media



Travel



Streaming



E-Commerce



Gaming



Source: Company data, Morgan Stanley Research; Note: SPOT and NFLX are covered by Ben Swinburne, EBAY is covered by Lauren Schenk and EA and TTWO are covered by Matt Cost.

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Enterprise Software: Mapping the \$4 Trillion Enterprise Impact

Morgan Stanley

Mapping the \$4 Trillion Impact of Generative AI

What's the Opportunity?

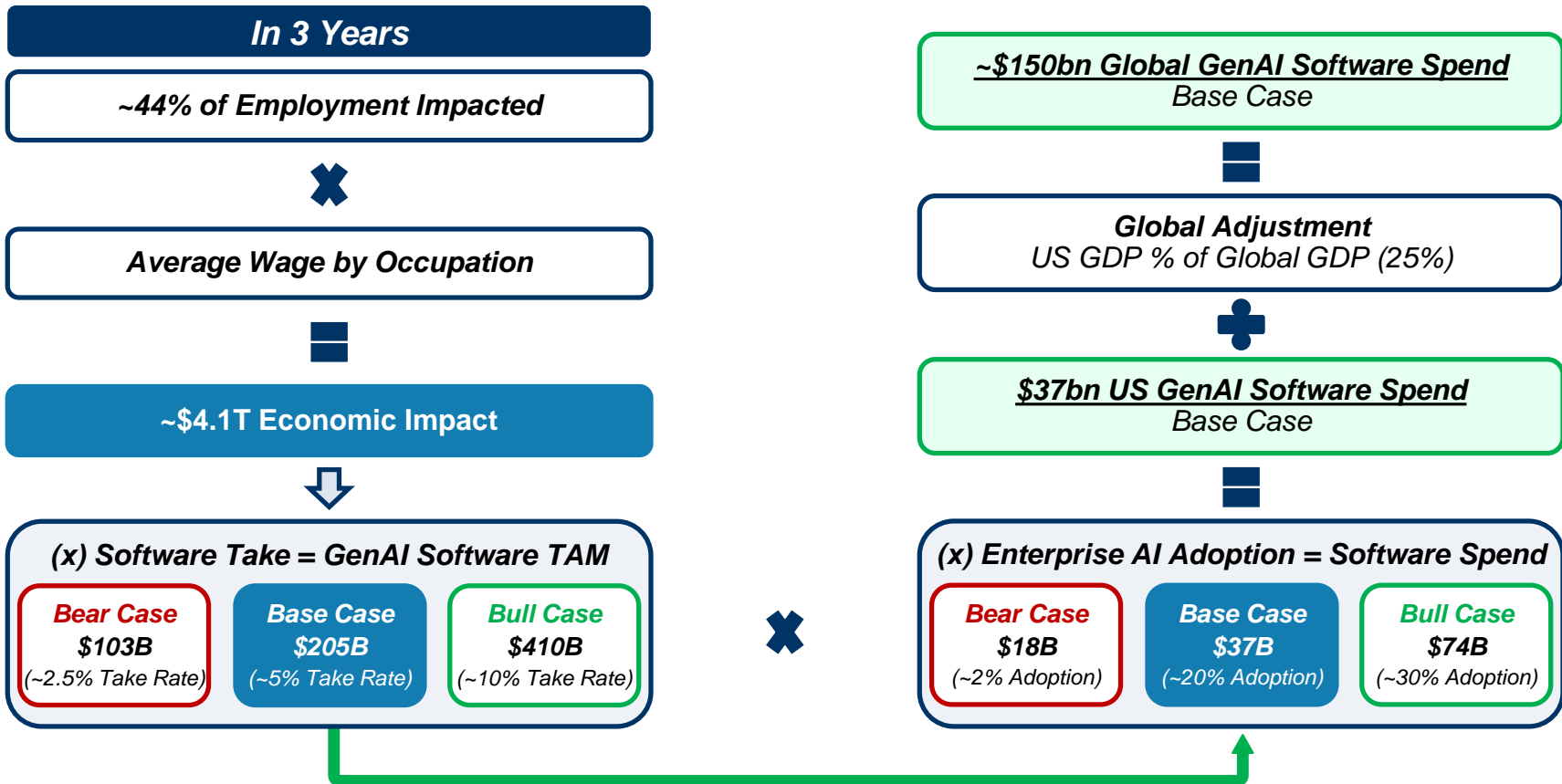
- Generative AI expands the scope of business processes that can be automated with enterprise software. At the same time, the input costs supporting Generative AI functionality are rapidly falling enabling a strongly inflationary impact to software production
- Our analysis of current Generative AI technology suggests **25% of labor today can be impacted by Generative AI today, likely rising to 44% of labor within three years**
- This suggests **Generative AI technologies will impact the \$2.1 trillion of labor costs attached to those jobs today, expanding to \$4.1 trillion in three years in the US alone**

Where's the Opportunity?

- Combining the degree of Generative AI impact to specific jobs with the cumulative wages associated with those jobs suggests the biggest potential wage impacts today in: General and Operations Managers (\$83 billion in wages impacted), Office Clerks (\$46B) and Registered Nurses (\$43B)
- Looking out three years the biggest impacts look to be among General and Operations Managers (\$188B), Registered Nurses (\$106B), Software Developers (\$103B), Accountants and Auditors (\$61bn), and Customer Service Reps (\$61B)
- Industries with the biggest wage impact today include Health Care & Social Assistance (\$271B), Professional, Scientific & Technical Services (\$211B) and Educational Services (\$184B)

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AI Index: What's the Enterprise Software Opportunity?

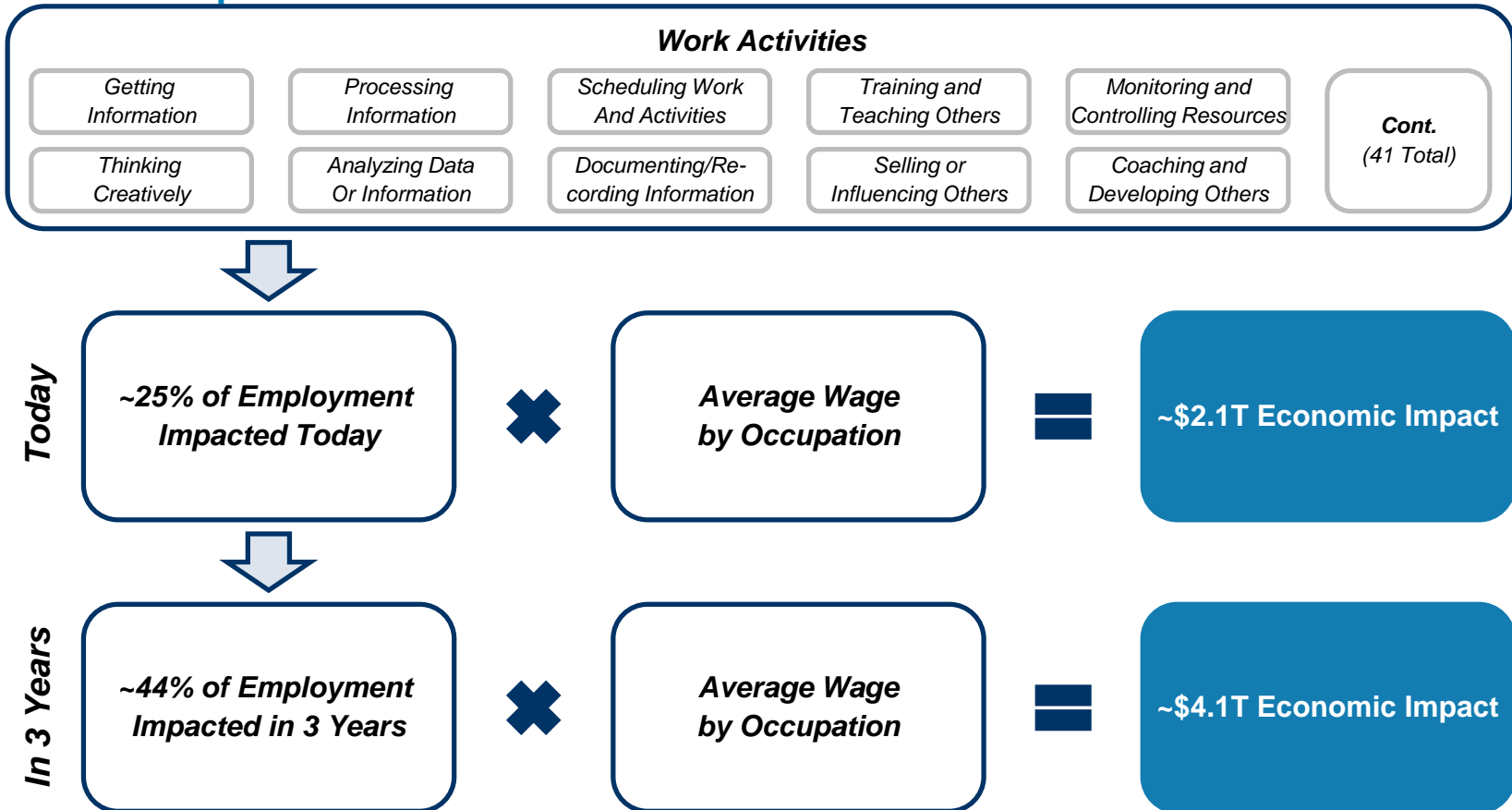


Source: Morgan Stanley Research

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From a Labor Market Perspective, Generative AI Presents a Potential \$4.1T Economic Impact in Three Years...



Source: Morgan Stanley Research

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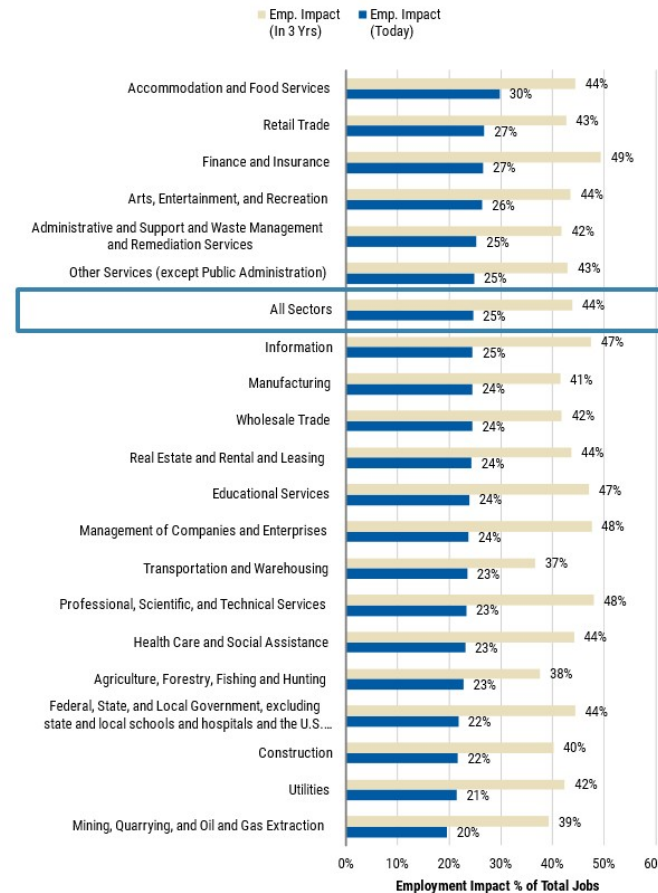
... With Impacts of Varying Degrees Expected Across All Industries

In 3 Years, the Employment Impact Could Expand to ~44% Based on Our Estimates

- We calculate the employment impact by summing the percentage of jobs impacted by Generative AI across sectors

Several Sectors Are Potentially More Exposed at First, Before Impacts Broaden Out

- Accommodation and Food Services (~30%), Retail Trade (~27%), and Finance and Insurance (~27%) are the three sectors expected to be most impacted today



Source: Morgan Stanley Research

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Expect ~20% Enterprise Adoption in Three Years...

Enterprise AI Adoption: Generative AI workload penetration within enterprises; % of enterprise production applications that embed Generative AI foundational models (LLMs, Diffusion models, Multimodal models).

Bull Case: ServiceNow Pro

- “Plug and Play”
- 28% adoption in 3 years

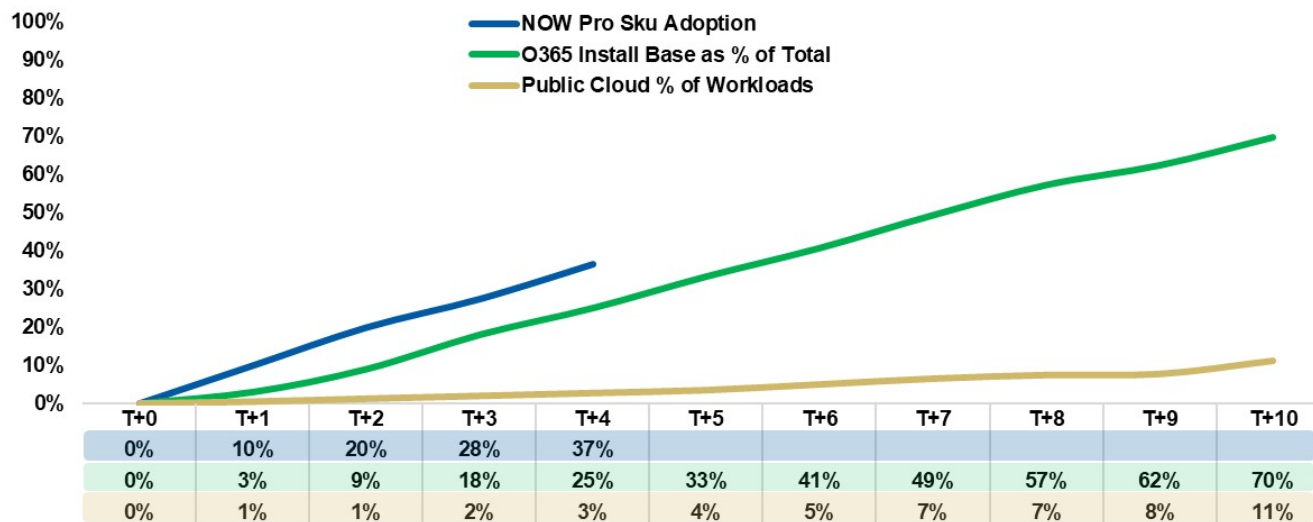
Base Case: Office 365

- “Platform Transition”
- 18% adoption in 3 years

Bear Case: Public Cloud

- “New Platform”
- 2% adoption in 3 years

Adoption Curve: NOW Pro Sku, O365, and Public Cloud



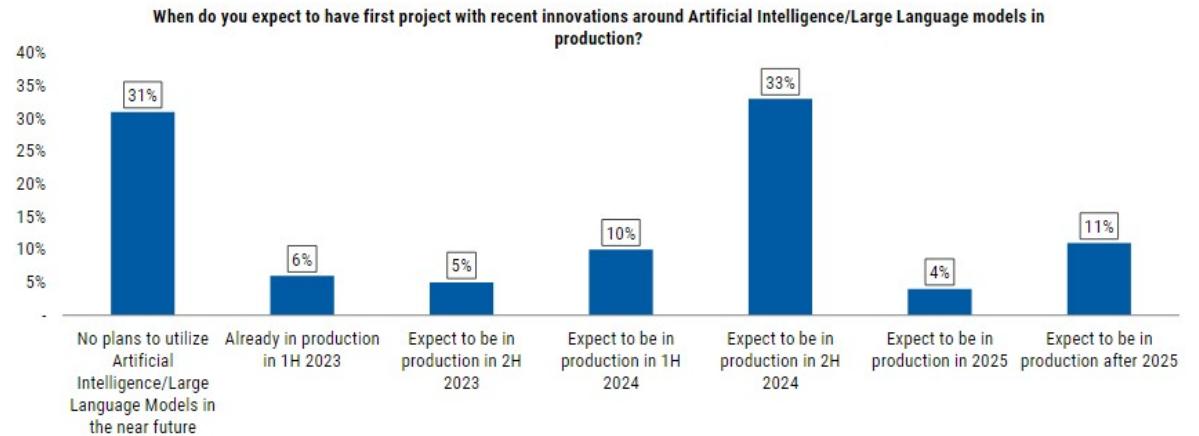
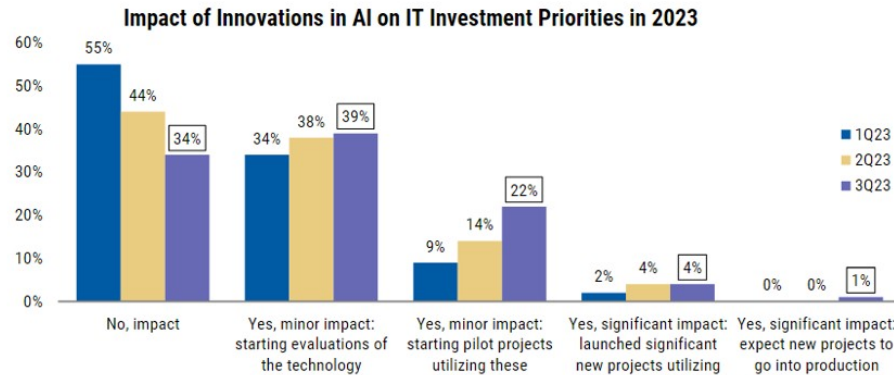
Source: Company data, Morgan Stanley Research

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Enterprise Adoption – Early Indications

Generative AI remains top of mind for CIOs with 66% reporting an impact to 2023 IT investment priorities...

... but the majority of CIOs expect initial projects to be in production in 2H24 and beyond



Source: AlphaWise, Morgan Stanley Research. n=100 (US and EU data)

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...With Adoption Impacted by Three Factors

The Factors That Determine Adoption Can be Bucketed into (1) ROI, (2) Friction, and (3) Budget

1) ROI

- **Productivity Growth vs. Cost:** Confidence & visibility into the ROI, and the estimated size of ROI will impact the adoption rate.
- Early learnings indicate strong productivity gains. Meanwhile, costs are falling quickly.

2) Friction

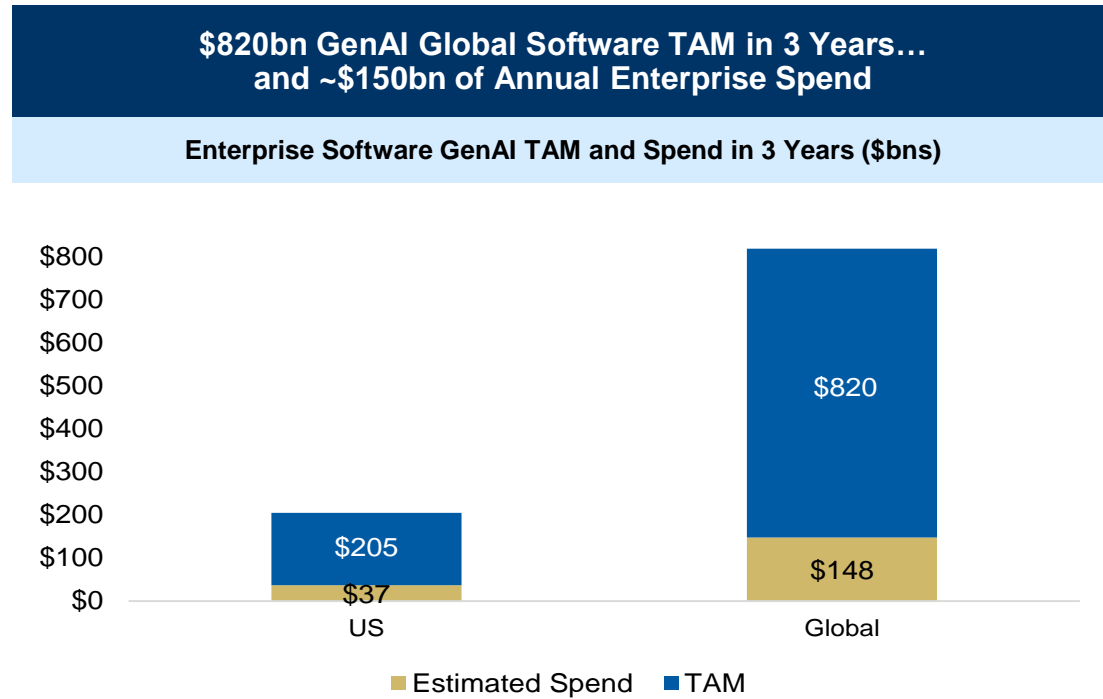
- **Data:** Enterprises need to develop robust data organization, classification, and privacy standards.
- **Skill Sets:** Strong internal and/or external (i.e. consultants, system integrators) expertise is required.
- **Legal & Regulatory:** The AI legal and regulatory environment are uncertain today, which could limit the pace of adoption.

3) Budget

- **Macro Environment:** The macro environment impacts IT budgets, and by extension, AI spend.
- **Funding Sources:** How will businesses fund the investment? Will companies de-prioritize other areas of IT investment (shift within budgets) or fund it by reducing non-IT investment (expanding budgets).

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Leading to \$150bn of Enterprise Software Spend



Source: Morgan Stanley Research

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Picking the Beneficiaries in Generative AI

- **Software:** Given the broad scope of functionality enabled by Generative AI and multitude of avenues to delivering the functionality via software, there is no easy screen for beneficiaries and challenged players in software. Rather we utilize the following four questions to assess relative positioning: 1) does the vendor have GenAI solutions today? 2) do they address significant GenAI market opportunity?, 3) are they well able to monetize the opportunity? And 4) when will investors see the impacts?
 - **Best positioned include: MSFT, ADBE, MDB, DDOG, PANW, CRWD, DCBO, NICE, FIVN, SAP, and Dassault Systemes**
- **Internet:** AI expands scale advantages for market leaders, as the value of large, differentiated, first-party data sets, leading distribution, and the ability to invest rises. That said, smaller platforms with leading data sets are also likely to see improved execution from the ability to analyze/utilize unstructured data in their product development and operations. In all, we see AI accelerating forward digital adoption curves across consumer Internet.
 - **Best positioned include: META, GOOGL, AMZN**
- **Semiconductors:** Semiconductors are the key enablers of these new Generative AI workloads, and the high capital intensity, particularly on the training side, is now a major part of the calculus for the largest companies in technology. We see the supplier concentration in the high-end training GPU market persisting for the next several years with NVDA retaining its dominant position, but as deployment scales significant opportunities should emerge for those who can provide compelling inference performance at low costs.
 - **Best positioned include: NVDA, AMD, INTC**
- **IT Services:** IT Service providers will play an integral role in shaping and implementing the Generative AI opportunity, particularly as providers leverage global partnerships in delivering scaled solutions to clients. As a result, we believe IT Service providers that are able to supply technical talent at scale will succeed in the Generative AI era. More broadly, as the pace of innovation accelerates, we continue to favor names in our coverage that employ a robust M&A-focused capital allocation strategy in order to stay at the leading edge of technology. Continuously upskilling talent, while investing in AI-focused talent will remain important as providers increasingly anchor their capabilities around AI. As the Generative AI narrative take shape, we continue to track the commercial constructs that emerge from early, proof of concept engagements as a proxy for how the client-provider relationship will evolve, and more importantly, drive company financials.
 - **Best positioned include: ACN**

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Mapping AI's Diffusion

January 2024

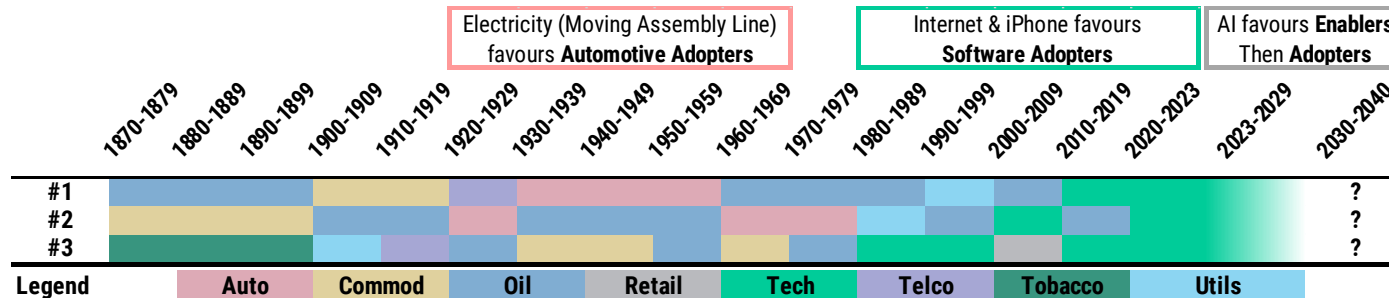
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Mapping AI's Diffusion Across Our 3,000+ Stock Coverage

- AI has established itself as a critical theme, but we are in the early innings of its diffusion. 2024 is likely the year of the Adopters.

This tech shift is progressing faster than any before it. Companies that best adopt new technology to scale their businesses while maintaining robust barriers to entry accrue most value.

- 2024 – the year of the Adopters:** The *Enablers* gained >\$6tn of market cap in 2023. Our analysts see less upside for these names near term. In '24, we argue that investors focus on the *Adopters*, a group that rose only c6% in '23. If *Adopter* companies were to lever up to 2x EBITDA for AI investments, they could spend >\$3tn. *Adopters* hold the keys to their own product ramp as well as fundamentals of the *Enablers*.
- AI rate of change will be important for re-ratings:** In 2023, the *Enablers* where AI was considered *Moderately* important to the stock debate increased their total market cap by c28%. If this group were to continue to mix shift towards *Core To Thesis* materiality, it could add another 41% or \$900bn to market caps of this group based on 2023 performance.
- Companies enumerating AI spend or gains tend to be rewarded:** Companies enumerating AI spend or gains tend to be rewarded: During 2023, only 15% of 316 companies over \$10bn market cap gave quantified AI disclosure (i.e. dollar spend, revenue impact, percentage productivity gains). While this may not be entirely attributable to the AI impact, those that did give disclosure outperformed those that didn't.



Source: Reuters, Morgan Stanley Research

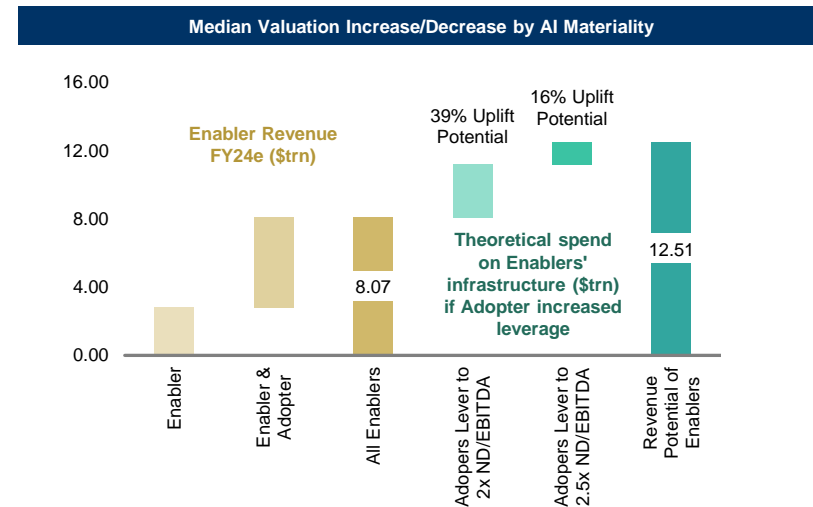
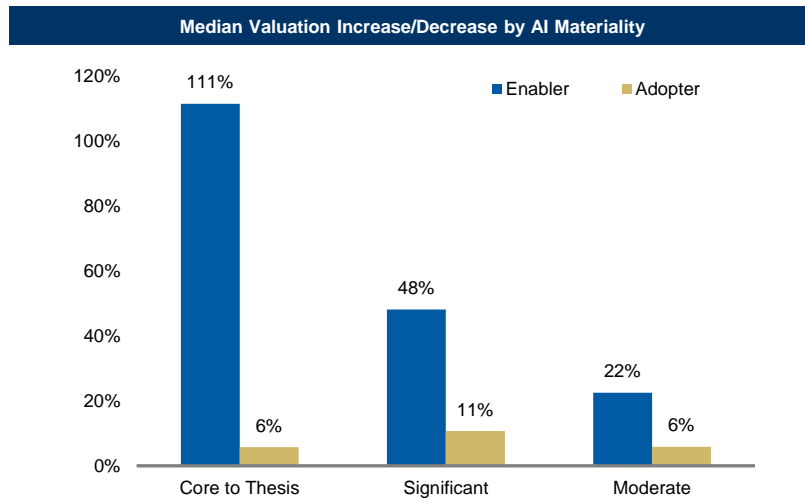
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Adopters Hold the Keys From Here

- **Core to Thesis Enablers AI stocks are +111% in 2023. By contrast, Adopters – even those Core to Thesis – are up only 6% in 2023.**

If this Adopter group continues to experiment with and integrate AI, these stocks could begin to be priced more actively in 2024. This would likely require a step-up in capex. **If the Adopters were to lever up to 2x Net Debt/EBITDA – using MS FY24e EBITDA forecasts for the companies included – the hypothetical additional capital raised could amount to >\$3tn for AI/digital transformation spend.**

On timing, most CIOs (33%) in [our recent survey](#) expect their first AI/LLM projects to be in production in 2H2024. 15% of CIOs expect projects to be in production in or after 2025.



Source: Reuters, Morgan Stanley Research

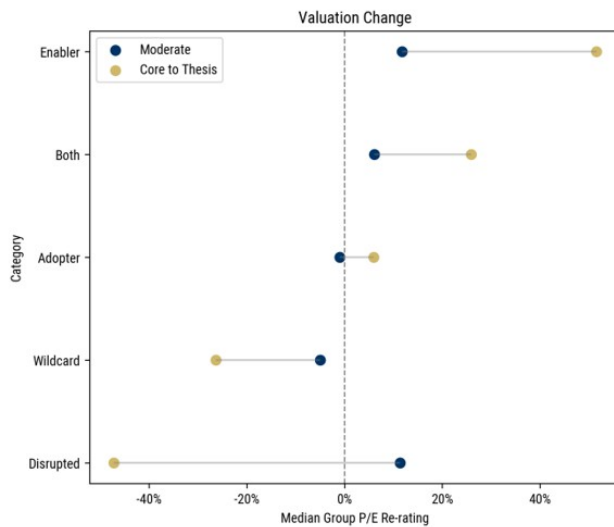
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Rate of Change Matters

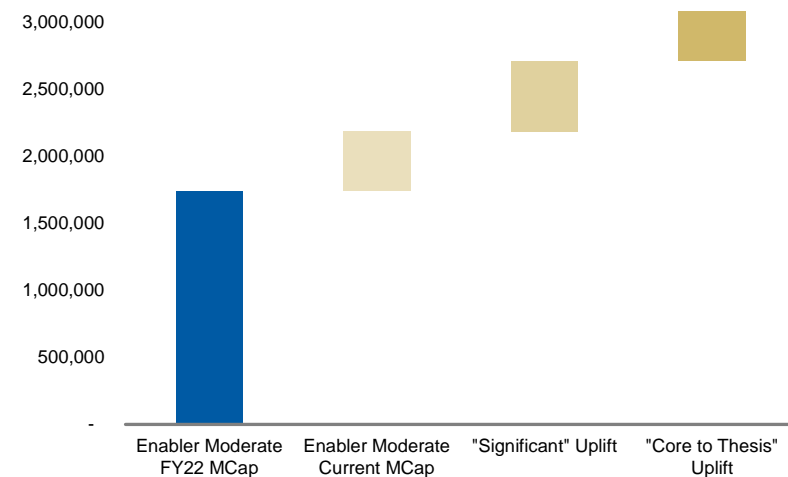
- Thesis materiality has driven wide divergence even within individual categories.

In 2023, the **Enablers where AI is Moderately** important to the stock debate **increased their total market cap by c28%**. If this group were to continue to mix **shift towards Core to Thesis** materiality, it **could add another 41% or \$900bn** to market caps of this group **based on 2023 performance**.

Median Valuation Increase/Decrease by AI Materiality



Median Valuation Increase/Decrease by AI Materiality



Source: Reuters, Morgan Stanley Research

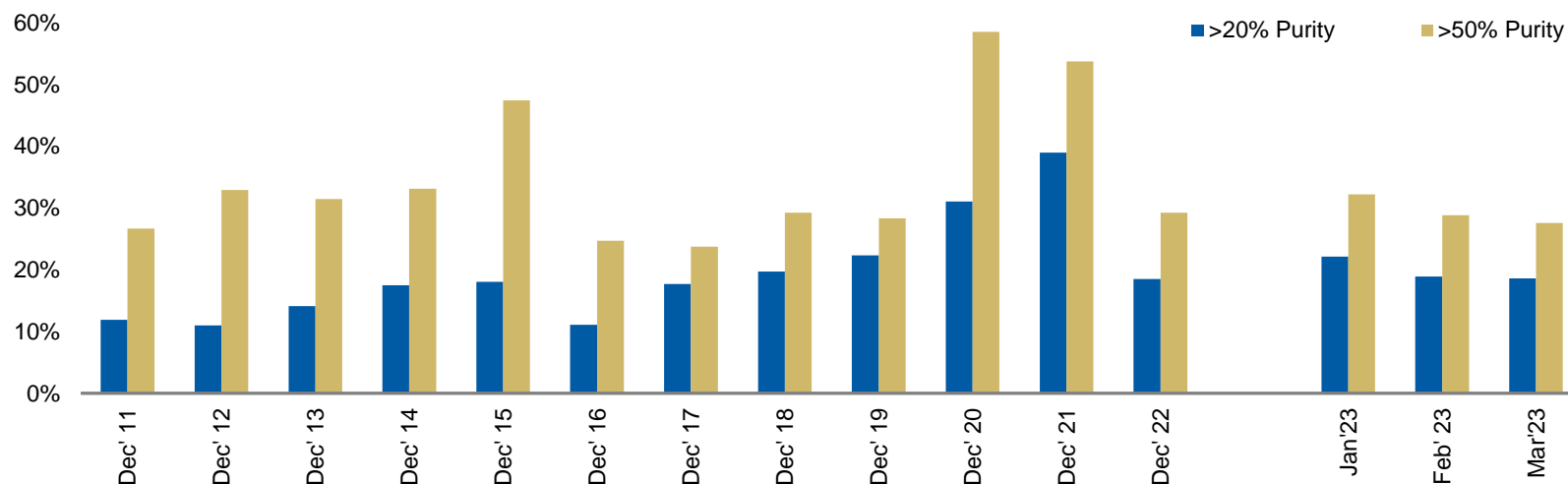
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The Price of Purity Opportunity

- Thematic alignment can drive valuation premiums, creating an opportunity for Co’s to win in a ‘sparsely populated’ AI Adopter field.

Thematic Purity x GenAI: The more a company can tie itself to a secular theme – particularly a technology-enabled one, both in its profit mix but also its quantified disclosure – the greater the re-rating that history suggests could accrue to a stock over time. As a rule of thumb, our analysis suggests that for every 1% incremental revenue exposure a company has to a theme, the stock experiences a c.1.2% re-rating (see [here](#)).

Average valuation upside resulting from thematic purity >20% and >50% company revenue exposure to a theme



Source: Reuters, Morgan Stanley Research. Note: Average of 12-month-forward EV/Sales, EV/EBITDA, P/E on 31st Dec of each year

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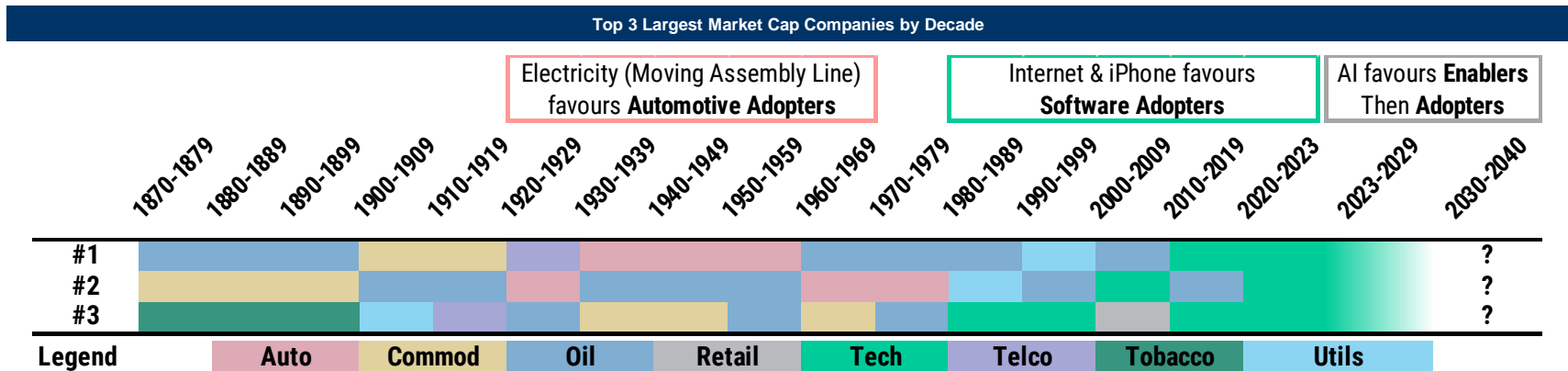
What History Tells Us About Tech Adopters

- There is a clear order of value accretion in secular technology shifts. *Adopters* move after *Enablers*.

History tells us that:

1. Despite enterprise adoption curves progressing slower than consumer ones, this AI technology shift in aggregate is already progressing substantially faster than any before it
2. Over the past 150 years, companies and sectors that best adopt and scale new technology – pass price declines on to their customers while maintaining high margins and barriers to entry – tend to accrue most value.

These adopters, leveraging the best technology available, have tended to force consolidation in their industries. This occurred with the moving assembly line for Ford and GM and more recently with software companies that have leveraged the internet but also the iPhone platform.



Source: Reuters, Morgan Stanley Research

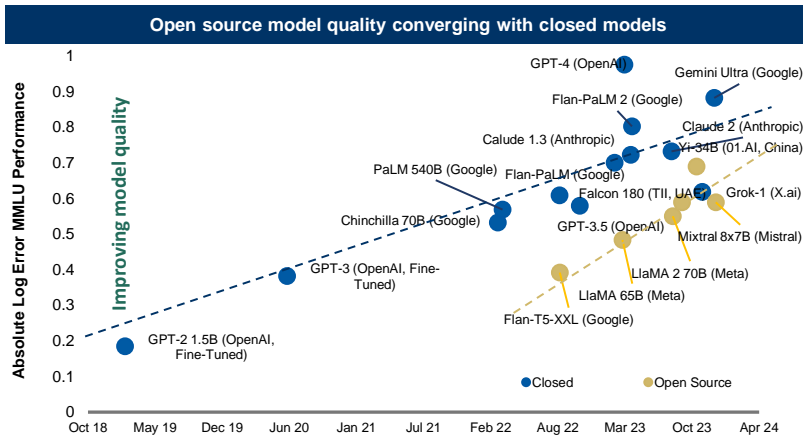
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Tracking Adoption Progress

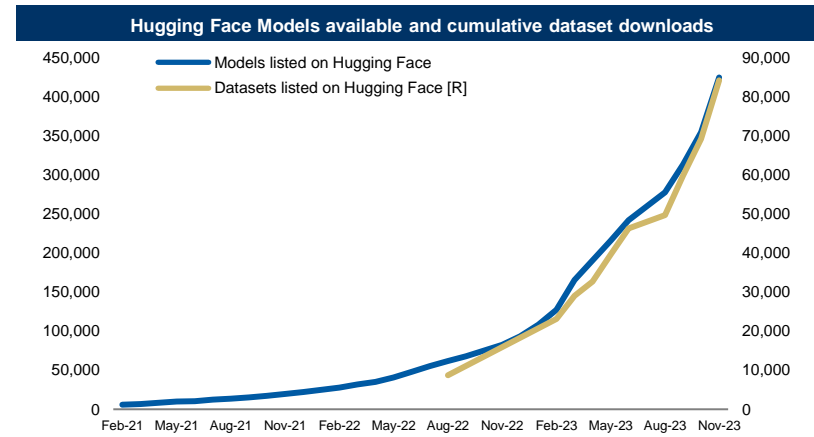
- We look to 1) AI model quality, 2) downloads and 3) our sector analysts' views to track how companies are adopting & leveraging AI.

We watch three metrics:

1. **Model quality:** Model tests show a rapid convergence in the quality of Open and Closed source models. Increased democratisation (open source) should fuel adoption.
2. **Downloads:** Model downloads in November 2023 were c5x higher YoY and 20x higher over 2 years. We view downloads as a proxy for breadth of use.
3. **Analyst views:** Our analysts have indexed 1165 stocks as *Adopters* across all sectors and regions. We will continue to survey our analysts to track companies and sectors at the forefront of AI adoption.

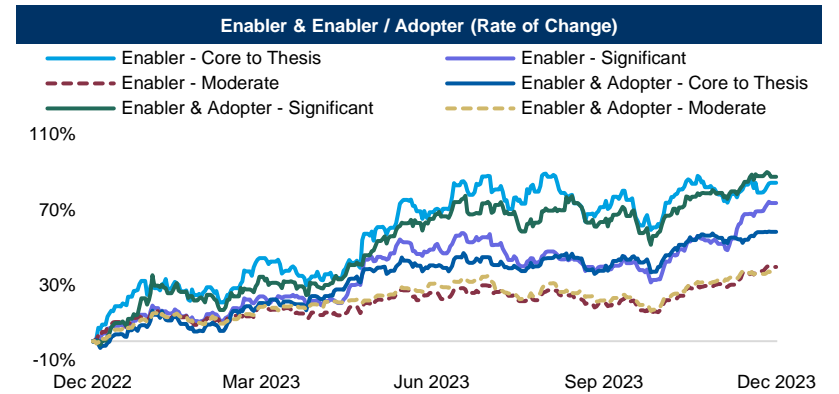
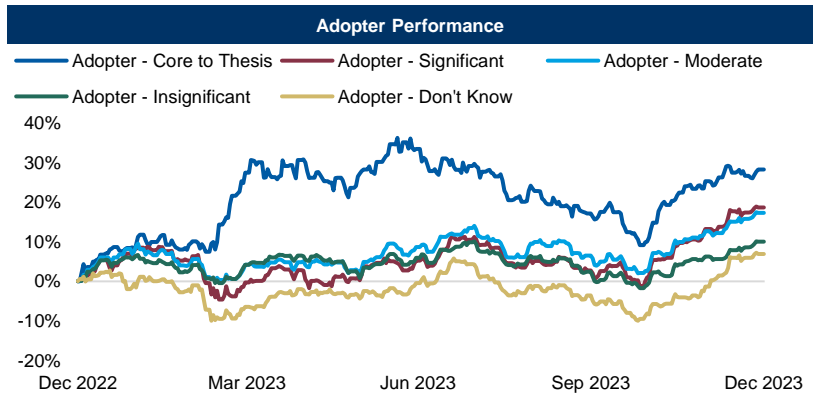
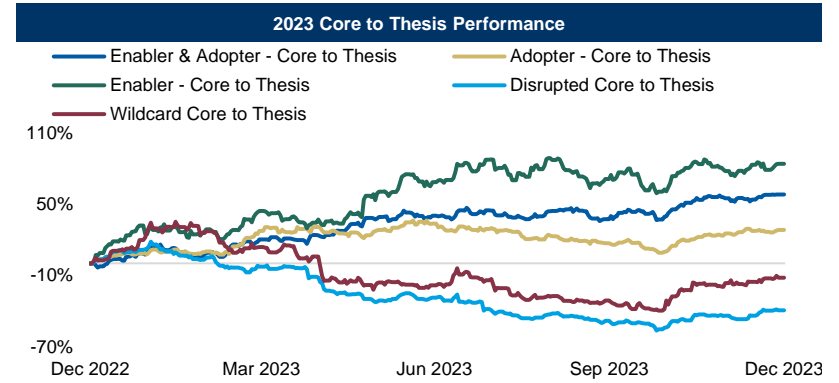
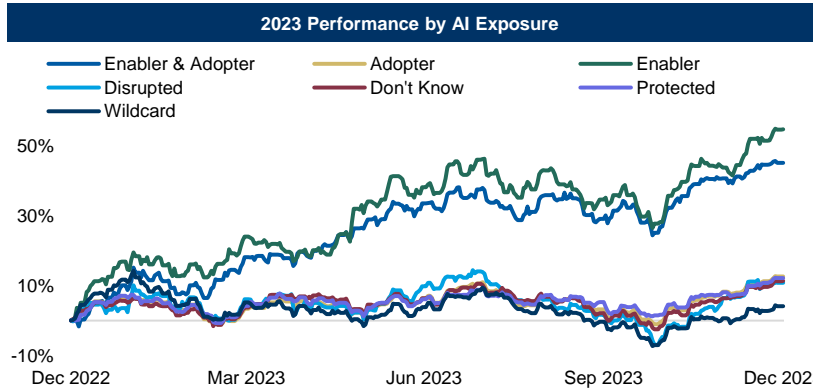


Source: Hugging Face, X, Ark, Morgan Stanley Research. Note: Model performance as 5-shot MMLU Performance



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2023 Total Return by Category



Source: FactSet, Morgan Stanley Research

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GenAI Privates: Where Are We Now and Why Public-Private Partnerships Matter

January 2024

The Private GenAI Ecosystem is Evolving Rapidly

<p>Private GenAI Opportunity</p>	<ul style="list-style-type: none"> • GenAI is a Foundational Technology with Large and Wide-Ranging Opportunities for Builders. GenAI private funding grew 5x Y/Y in '23 reaching \$25bn. A large and growing GenAI opportunity (~\$300bn of spend in 3 years) supports accelerating funding. AI is converging with other next-gen technologies, creating new opportunities for builders. GenAI privates have an opportunity to sell into large existing platforms as they become increasingly AI-enabled, and to sell into/create new emerging platforms such as AI Assistants, AR/VR, Autonomous Vehicles, Robotics, and more.
<p>Privates & Publics</p>	<ul style="list-style-type: none"> • The GenAI Private Ecosystem is Becoming Increasingly Entwined with Publics. Corporate VC represents 90% of private GenAI fundraising in '23, up from 40% in '22. We're also seeing deep partnerships form between Privates and Mega Cap tech companies. Privates are leveraging Publics for compute resources and distribution. Investments/partnerships with privates are driving incremental revenue and bolstering the competitiveness of Public's platforms – particularly for Cloud vendors. These investments/partnerships also help diversify incumbent's bets.
<p>Foundational Models Deep Dive</p>	<ul style="list-style-type: none"> • The End State is Far from Clear Despite Investment Concentration. The FM layer has raised \$23bn to-date representing 60% of funding across the three layers. Within this layer, ~90% of the funding is concentrated within three companies. That said, nearly ~50% of the talent resides outside of these 3 and open-source is gaining momentum. We see the potential for more advanced model architectures and capabilities in 2024 which could reshape the FM leaderboard and extend the scope of possibilities for application builders. We discuss key debates for this layer (scaling laws, capabilities, costs, and open-source) and detail core competencies and risks for the leading FM privates.
<p>Tech & Tools Deep Dive</p>	<ul style="list-style-type: none"> • We See a High Likelihood of Tooling Consolidation Over Time. In aggregate, Tech & Tools privates have raised \$4bn to-date representing 10% of total GenAI funding. Funding is more evenly distributed than the Foundational Model layer. Competition is also heating up from FM vendors and hyperscalers. A high degree of competition and low degree of standardization foreshadows a higher likelihood of consolidation. One of the most important debates from here is whether point solutions can succeed/differentiate as broader end-to-end platforms evolve. We dig into this debate and others (app customization, data prep/governance, app development tools) that should inform investment decisions ahead.
<p>Applications Deep Dive</p>	<ul style="list-style-type: none"> • Expect Most Value Creation in Applications Long Term. Horizontal/Vertical GenAI app vendors have raised \$6.8bn/\$4.1bn to-date (30% of GenAI funding). Investment is relatively concentrated in Text/Chat, Speech/Audio, and Healthcare start-ups (60% of App layer funding). Prior computing cycles suggest most value creation occurs in Applications. While ~70% of all employees at private GenAI start-ups work at application companies, funding has yet to reflect the large and growing opportunity. We expect funding to broaden out to other modalities/verticals and accelerate as models capabilities expand. We dig into core application layer debates and key application vendors.

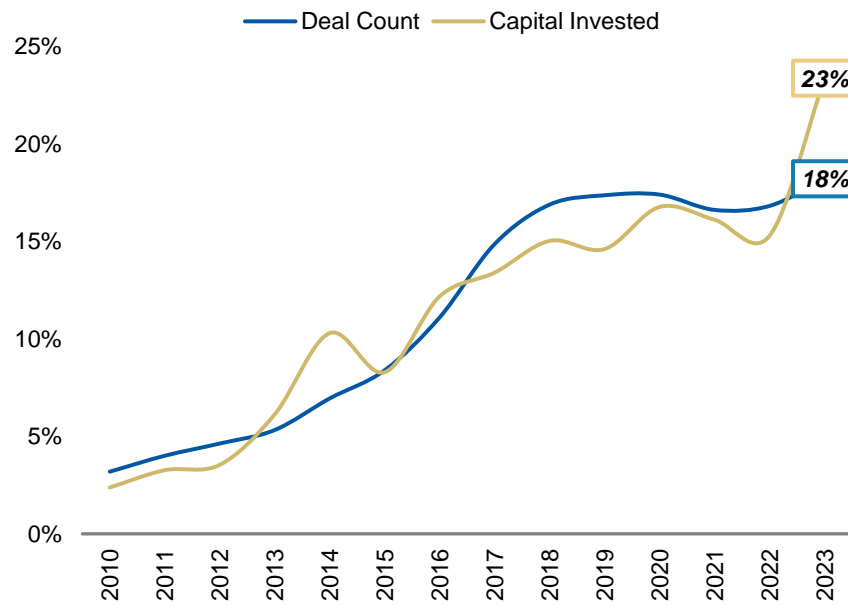
Source: Morgan Stanley Research

AI/ML Venture Investment Remains a Bright Spot In an Otherwise Weak Venture Market

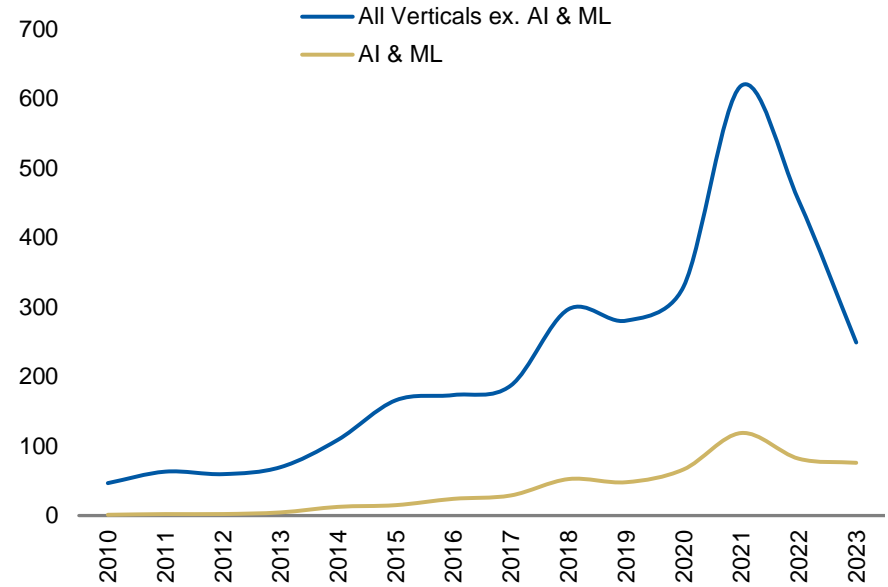
AI/ML Funding

- **Venture firms are increasingly prioritizing AI & ML investments...** AI & ML venture deals/funding as a % of total reached 18%/23%, up from 17%/15% in '22. This includes AI/ML up-starts outside of GenAI.
- **...Despite an otherwise weak funding environment.** Venture funding excluding AI & ML is at a 5-year low. The decline is partly related to higher interest rates and digestion from '21/'22 funding levels.

% of Total Venture Markets Overtime – AI & ML



Venture Capital Invested Annually



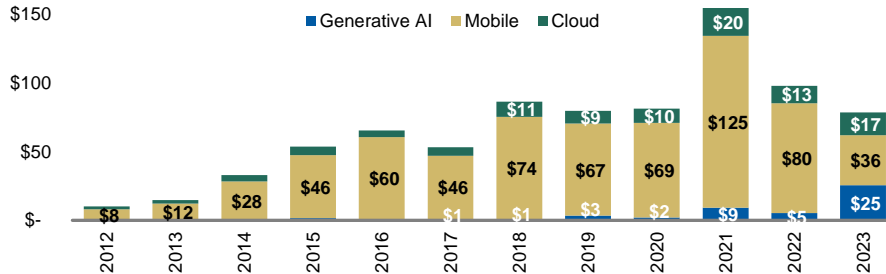
Source: Pitchbook, Morgan Stanley Research.

GenAI Venture Funding Up 5x Y/Y Driven Increasingly by Corporates...

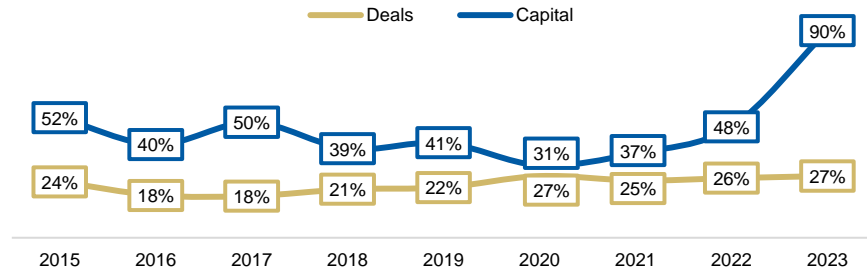
GenAI Funding & SaaS Parallels

- **GenAI Funding Up 5x Y/Y:** Generative AI funding reached ~\$25bn in 2023, up ~5x from 2022. We expect funding to continue ramping in the coming years, similar to the early-mid 2010s with Mobile, Cloud/SaaS.
- **Corporate Investors are now a dominant force in AI deals:** Corporates represented 90% of GenAI private fundraising in '23, up from ~40% on average from '20-'22.
- **Generative AI deal count is similar to the SaaS deal count trajectory in its early days.** The number of venture GenAI deals is tracking closely to SaaS once surpassed 100 deals per quarter.
- **Meanwhile, capital invested is tracking ahead of SaaS** once surpassing \$1bn per quarter, which speaks to the increased capital intensity required for AI start ups – particularly for foundational model companies.

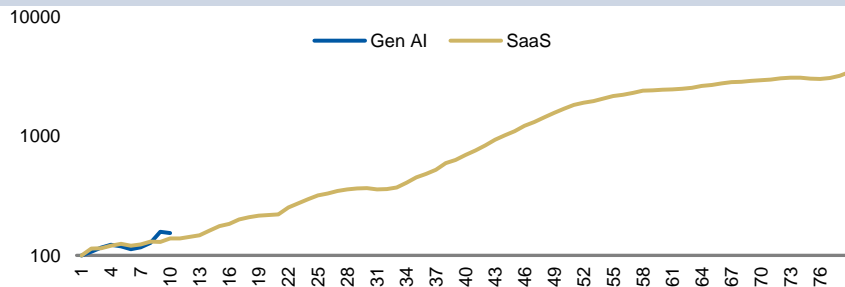
Venture Funding: GenAI, Mobile, Cloud (\$bns)



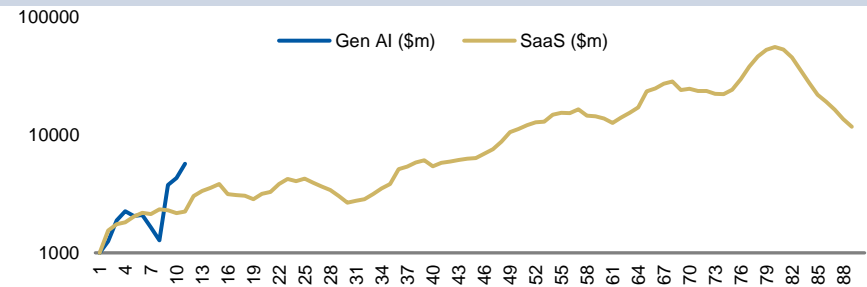
Corporates Represented in ~90% of GenAI Capital Raised in '23



Venture Deals Once Surpassed 100 Per Quarter



Capital Invested Once Surpassed \$1bn Per Quarter (real \$)



Source: Pitchbook, Morgan Stanley Research.

...3 Factors Leading to The Public and Private Partnership Model...

1) Complementary

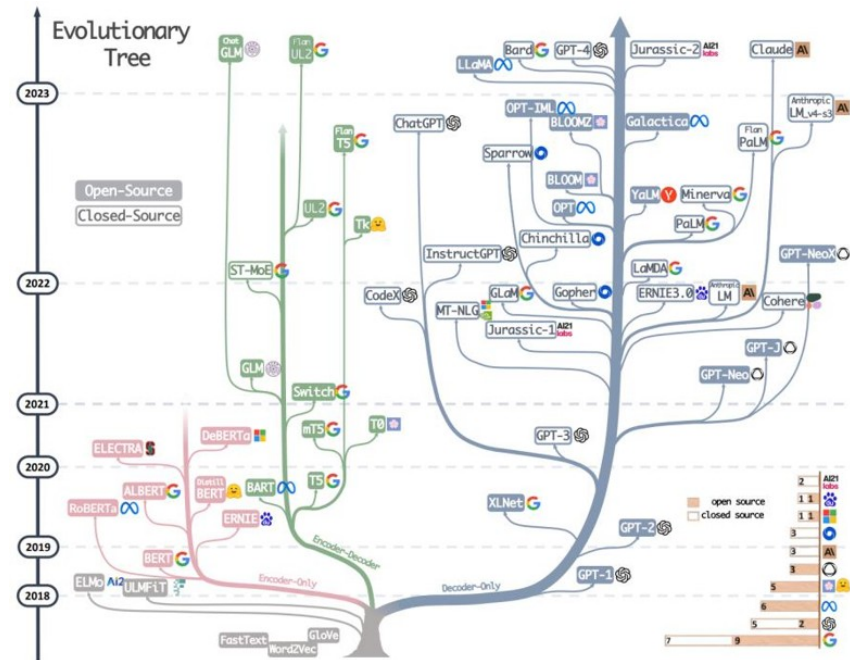
- **Privates are Early Movers:** Privates have extended and advanced early innovations from mega caps, giving them a multi-year development head start and making them attractive partners for publics.
- **Privates Need Compute:** Privates have competitive technology and capable developer teams, but need the hyperscale compute power of AWS, Azure, NVDA, and GCP to progress their software development.
- **Partnerships Improve Public Cloud Competitiveness.** The larger number of high-quality AI partners up and down the stack can make a Cloud provider's offering more attractive to developers.

2) New Revenue Streams for CSPs

- **Funding from CSPs Turns Into Revenue:** Hyperscale funding of foundational model vendors eventually comes back in the form of Cloud revenue, as foundational model vendors rent compute/storage for model training and research.

3) Diversification

- **Spreading Bets:** Publics are diversifying their bets through investment and partnerships with privates.
- **Unclear Which Dev Tools Will Win:** Public AI companies are broadening their developer offerings through partnerships given the lack of uniform standards.

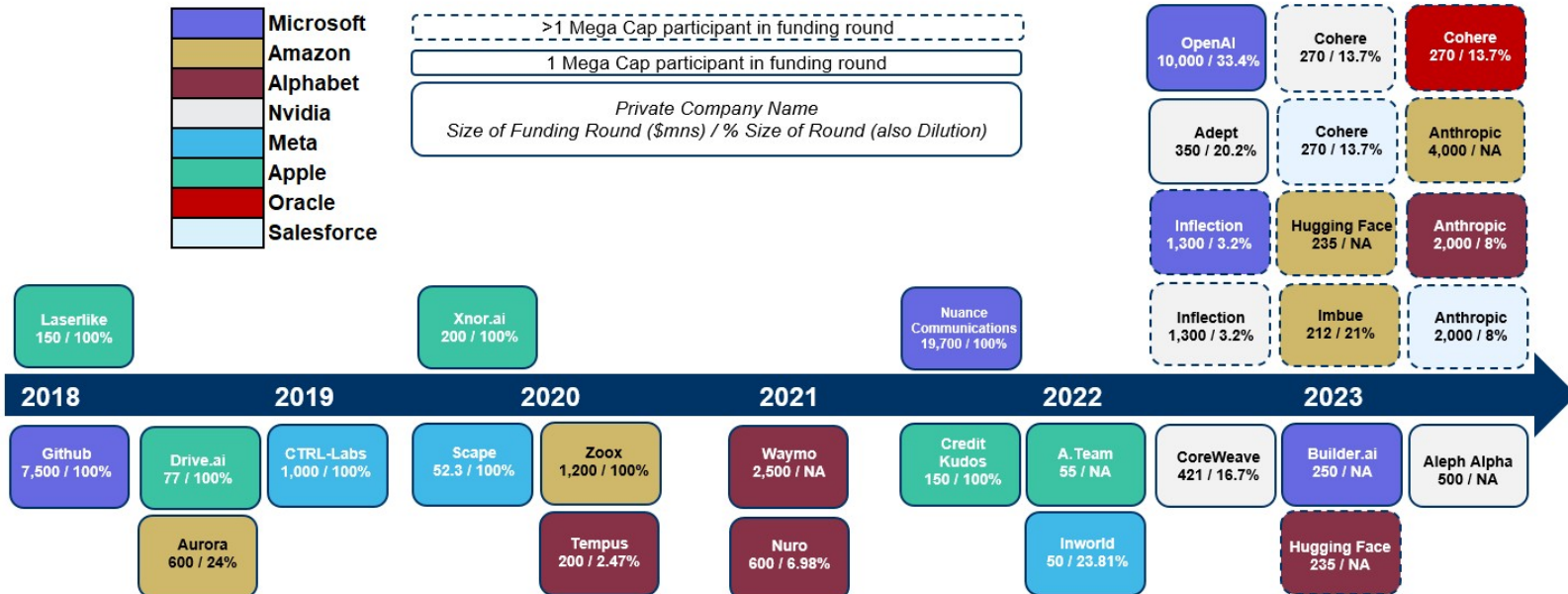


Source: [Harnessing the Power of LLMs in Practice: A Survey on ChatGPT and Beyond](#), Morgan Stanley Research

...As Demand for AI Assets Accelerates...

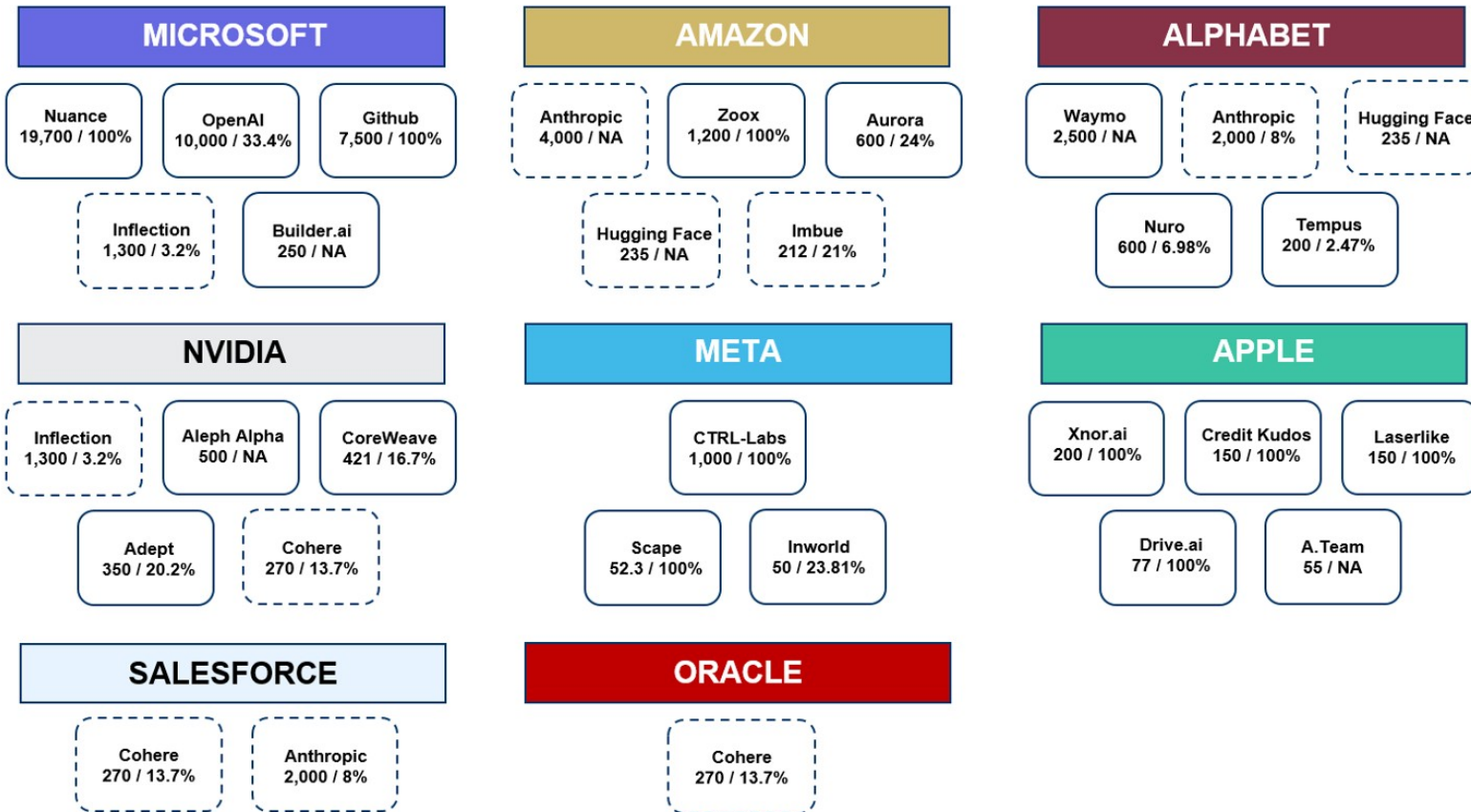
Mega Caps

- Mega Cap Investment into AI Privates Accelerated in '23.** 2023 marked a step up in private AI investment from Mega Cap tech companies. While we haven't seen large scale M&A between Mega Caps and leading GenAI privates, Mega Caps have participated in funding recent funding rounds.



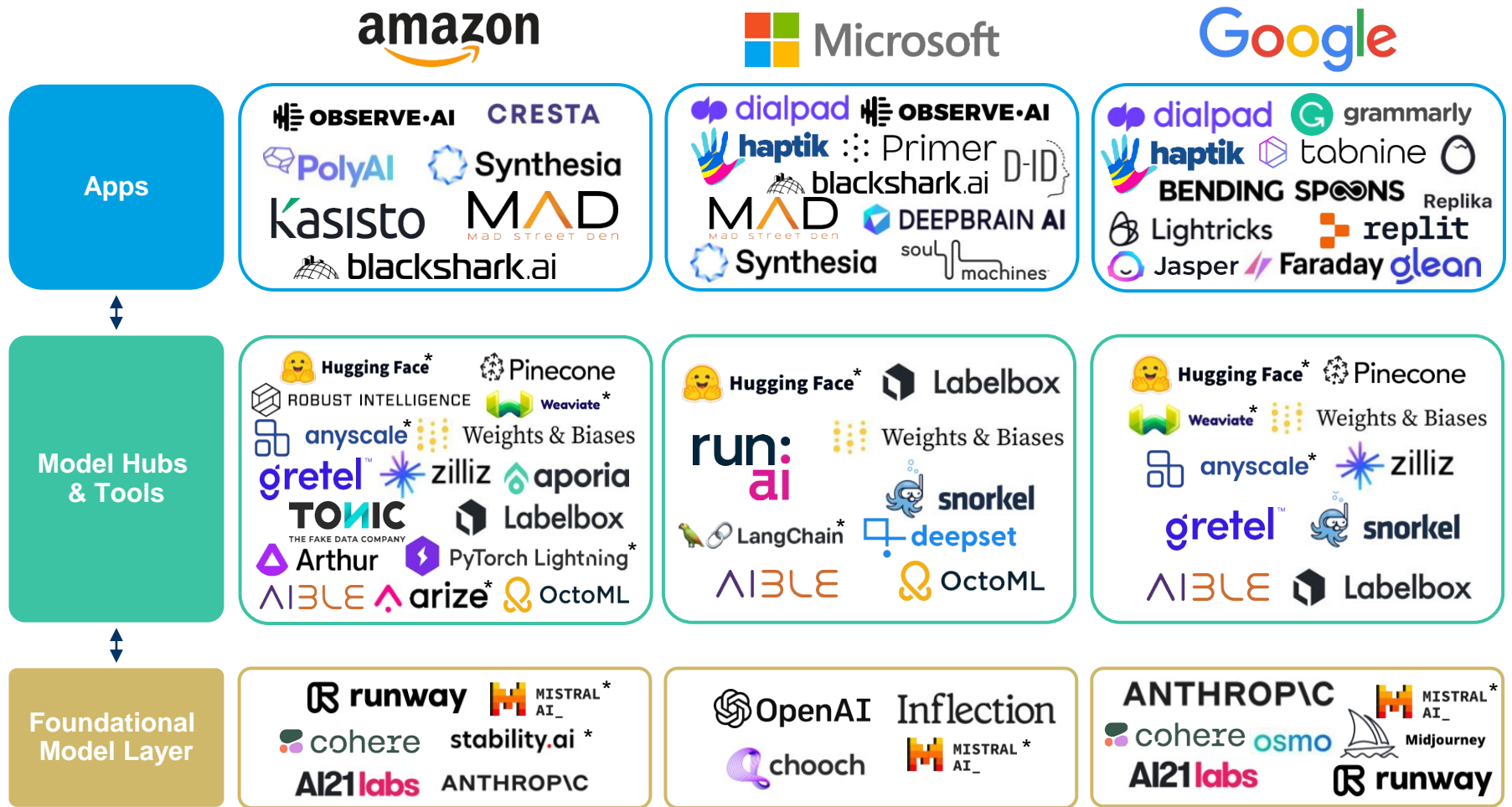
Source: Pitchbook, Morgan Stanley Research.

...Resulting in Majority or Minority Control of Several Key AI Assets



Source: Pitchbook, Morgan Stanley Research.

Privates are Also Becoming Entwined With Publics Via Partnerships

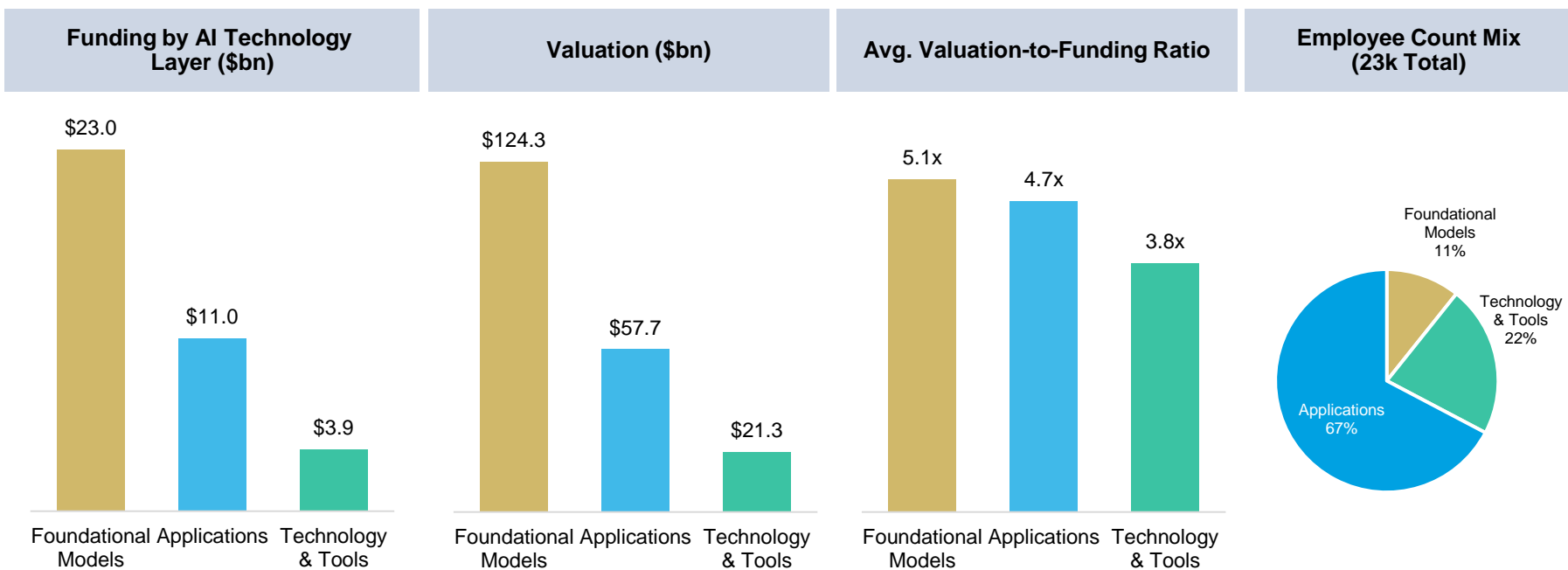


Source: Company data, Morgan Stanley Research. * Denotes open-source offering. Note: This chart reflects publicly announced partnerships. Not all encompassing.

Value Creation is Concentrated Within Foundational Models, For Now

~150 Leading GenAI Start Ups

- **Foundational Model Vendors are leading in funding and valuation.** FM companies have raised ~\$23bn to-date at an aggregate valuation of \$124bn*. Interestingly though, the total number of employees working at private FM companies only represents 11% of the total employee base from ~150 leading GenAI start ups.
- **Expect More Value Created at Applicational Layer Long Term.** Interestingly, we found that the employee count at the Application layer represents 67% of GenAI Private employees. While GenAI app funding to-date is roughly half of the FM layer, there is a significant amount of talent that resides here which bodes well for future innovation and value creation.



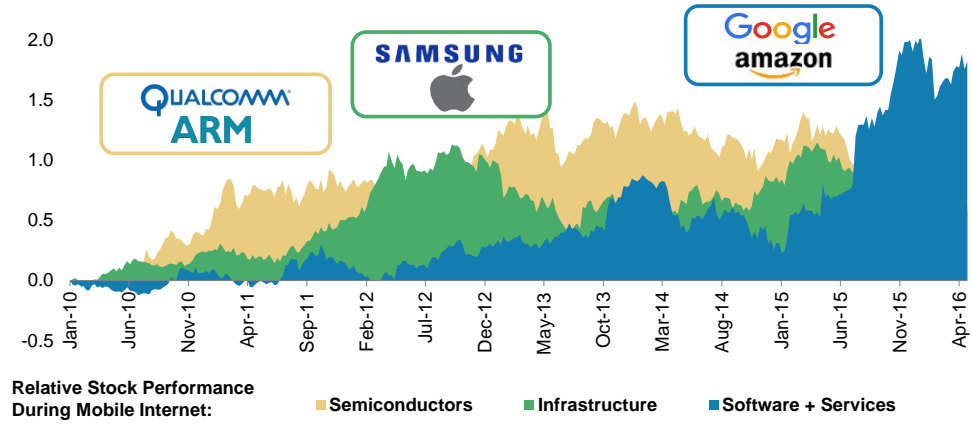
Source: Company Data, Morgan Stanley Research. *Note: Accounts for OpenAI's expected \$80-90bn valuation.

GenAI Monetization Roadmap: Expect Largest Value Creation in App Layer Long Term

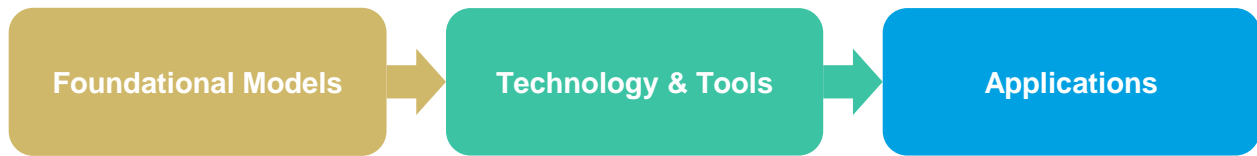
Compute Cycle Monetization

- **GenAI Monetization:** Similar to prior computing cycles and within the microcosm of GenAI software, expect value to accrue first to the enabling technologies (foundational models), then the tooling layer (i.e. ML Ops, Data Services), and finally the application layer (as AI apps are sold into a growing installed base of AI infrastructure/devices).
- **We expect most value to be created at the application layer in the long term and expect funding amounts and valuations to similarly reflect this dynamic in time.** It remains early and difficult to determine the applications winners though.

Mobile Internet Era:



AI Era:



Source: Morgan Stanley Research

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Unresolved Debates and Risks

January 2024

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Unresolved Debates and Risks

- | | | | |
|---|-------------------------------|---|---------------------------------|
| 1 | Accuracy | 5 | Model Differentiation |
| 2 | Geopolitics | 6 | Privacy |
| 3 | Labor Market vs Productivity | 7 | Artificial General Intelligence |
| 4 | Content Rights and Regulation | 8 | Silicon Demand |

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Overview: the Global Regulatory Landscape is Uneven and Uncertain

- **EU: currently leading the US with AI Act**
- **US: federal agencies have issued guidelines & recommendations but Congress remains in learning mode**
- **China: guidelines reflect more intense government oversight than in the US or EU**

US

- Agencies have issued guidance & Biden has signed EOs, but Congress has not passed major legislation
- Briefings are scheduled as lawmakers continue to learn, but have also introduced bills covering different aspects of AI regulation like Sec 230 application
- Companies are being expected to adhere to guidance voluntarily and without enforcement

Europe

- EU Parliament has approved the AI Act Risk management framework, which establishes tiers of risk for AI that each require a different level of government involvement
- Seeking to apply existing laws (GDPR, DSA, DMA) to scope in AI

China

- Guidelines focus on a variety of topics, including 1) algorithmic transparency 2) non-discrimination and 3) curbing disinformation and deep fakes, but also 4) intense government oversight as measures seek to require makers of AI products to submit to security assessments before public release and to make sure content reflects "core socialist values" and does not encourage "subversion of state power"
- It also specifies that companies providing access to generative AI via "programmable interfaces" are responsible for all content produced

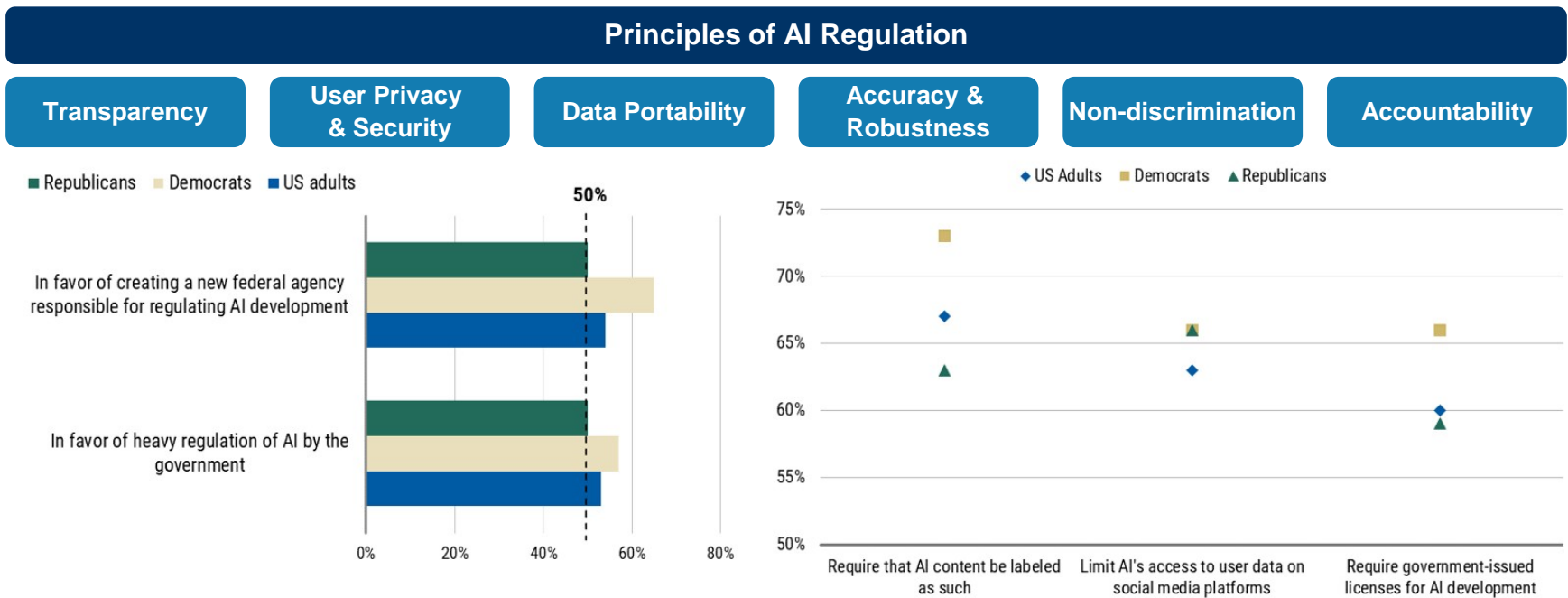
Source: Morgan Stanley Research, Congress.gov, EU Parliament, Cyberspace Administration of China

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Strong Voter Consensus for Government Regulation & Involvement in AI Development

- Voters across ideologies in the US support regulation
- Republicans are more concerned with data portability and user privacy
- Democrats are focused on non-discrimination and prefer heavier government involvement
- Both sides support measures on transparency and data privacy



Source: Morning Consult, Morgan Stanley Research

Morgan Stanley

Current US Efforts and Proposals: Summary

	Entity	Description
Regulation	FTC	<ul style="list-style-type: none"> • FTC stated it had developed AI expertise in enforcing a variety of statutes, such as the Fair Credit Reporting Act, Equal Credit Opportunity Act, and FTC Act • FTC issued an advance notice of proposed rulemaking aimed at addressing “commercial surveillance” and data security – but which also contained a full section exploring rulemaking for “automated decision-making systems.” The FTC specifically invited public comment on “whether it should implement new trade regulation rules” governing AI-powered technologies that make decisions impacting consumers
	NIST	<ul style="list-style-type: none"> • Developed AI Risk Management Framework, a voluntary framework that seeks to ensure AI is: 1) valid and reliable, 2) safe, 3) fair and non-biased, 4) explainable and interpretable, and 5) transparent and accountable • The second part of the AI RMF is a framework designed to help companies identify concrete steps to manage AI risk and make AI trustworthy. It is built around a “Map – Measure – Manage” structure, where each concept covers a different phase in the AI planning, development, and deployment cycle
	White House	<ul style="list-style-type: none"> • WH released an AI Bill of Rights detailing AI harms to economic & civil rights and five principles for mitigating harms • Principles: 1) Safe & Effective Systems, 2) Alg. Discrimination Protections, 3) Data Privacy, 4) Notice & Explanation, and 5) Human Alternatives • Pres. Biden released an EO in late 2023 calling for more transparency, reporting and standard-setting from agencies (see here for our takeaways)
Legislation	Congress	<ul style="list-style-type: none"> • Global Technology Leadership Act: establishes an office to analyze competitiveness in technologies like AI relative to countries like China • AI Framework: Balance need for security, accountability and transparency with facilitating innovation via four guardrails: 1) identification of who trained the algorithm, 2) disclosure of data source, 3) explanation for how it arrives at responses, and 4) transparent and strong ethical boundaries • Hawley-Blumenthal Bill: clarify that Sec. 230 does not apply to AI • Lieu-Eshoo-Buck Bill: creates National AI Commission to explore regulation, in particular 1) how regulation responsibility is distributed across agencies, 2) capacity of agencies to address challenges related to regulation, and 3) alignment among agencies in enforcement practices • Algorithmic Accountability Act: empowers FTC to require companies to conduct evaluations of their AI systems on a wide range of factors, including bias and effectiveness • Bennett Bill: establishes a Federal Digital Platform Commission: expands on the definition of an algorithmic process, clarifying that the proposed commission would have jurisdiction over the use of personal data to generate content or to make a decision. For the most significant platforms — “systemically important” — it would create requirements for algorithmic audits and public risk assessments of the harms their tools could cause

Source: Morgan Stanley Research, FTC, NIST, WH, Congress.gov. Note: Shaded-grey indicates that proposals are in effect, shaded-blue have been introduced but not passed in Congress.

January 2024

Key AI Primers

Global Technology: How is AI Set to Change the Tech Landscape...and What's NEXT? (2 Mar 2023)

- Our AI primer deck analyzes the AI tech layers and players, from silicon to software. Our NEXT framework shows how AI could accelerate tech diffusion across the economy, with unique, scaled data and investment critical in the AI age ahead. We also discuss 8 key unresolved debates to watch from here that could impact how and at what pace the AI ecosystem develops.

Global Technology: AI Index – Mapping the \$4 Trillion Enterprise Impact (1 Oct 2023)

- Generative AI enables an expanding set of work to be automated by Enterprise Software which could drive an additional \$150 billion in software spend within 3 years based on our proprietary analysis. However, investors must be cognizant of the longer time frames for Enterprise technology adoption.

Internet & Software: GenAI Privates: Where Are We Now and 12 Debates From Here (20 Dec 2023)

- Our analysis of ~150 GenAI privates finds \$38bn/\$203bn of aggregate funding/valuation to-date, with corporates a prominent force in fund-raising. We detail 30 GenAI privates and 12 key debates across the 3 GenAI layers that will shape each layer and the GenAI tech stack from here.

Thematics: Mapping AI's Diffusion (2 Jan 2024)

- AI has established itself as a critical theme, but we are in the early innings of its diffusion. In a bid to help investors, we have made an initial attempt to analyse AI's impact across the market. 2024 will be the year of the Adopters.

Economics & Sustainability: How GenAI May Reshape Labor and the Economy (12 Oct 2023)

- Building on our tech team's work mapping the impact of generative AI on labor, we explore the implications for the US economy. Disruptive technologies from the tractor to the spreadsheet offer a road map. We assess resources that can mitigate risks to labor, and chart the future of work.

Economics, Technology & Public Policy: The Great Productivity Race (25 Apr 2023)

- After an extended period of sluggish growth, we think productivity is poised to rebound. Tight labor markets and supply chain disruption in the multipolar world make higher productivity an imperative. Our economists and industrials teams show how technology diffusion can drive change.

Sustainability: AI & ESG: Our Thoughts on Benefits, Risks, Investing, and Regulation (3 Apr 2023); Sustainability: The Status of US AI Regulation in 2024 (5 Jan 2024)

- We analyze the range of ESG implications from the coming AI evolution, including the many ESG-related benefits and risks/negative implications. We then layout our approach on how to invest in AI-driven ESG opportunities, and end with a deep dive on regulation, frameworks, and guidance globally.
- Following our conversation with experts from Stanford University on AI regulation, we share key reflections/takeaways from our session. We continue to believe that the development and implementation of AI regulation in the US will not be imminent and discuss multiple hurdles to clear.

Thematics: Tech Diffusion: 10 Lessons from 100 Years (1 Jun 2023)

- The breadth, depth and speed of change posed by AI are leaving many investors looking to history for a guide on stocks, even if an imperfect one. History tends to rhyme for businesses' valuations and consensus earnings both to the upside and downside.

Sustainability: AI & ESG: Our Latest Thinking on AI Risk Management (17 Jul 2023)

- In our latest piece on AI & ESG, we offer an update on our thinking on AI risk following a recent event we hosted with an expert from the Federation of American Scientists.

Internet: Sizing the \$6 Trillion AI Internet Opportunity and Who Will Capture It (2 Mar 2023)

- We detail our views on accelerating AI trends driving new consumer use cases and changes in behavior. We outline potential new/improved search tools, AI assistants, stronger social/e-commerce recommendation engines, next generation content creation tools, more optimized shared economy marketplaces, and more.
- Analyzing our NEXT framework, scale and investment, we also detail 11 companies best positioned to drive/benefit from AI (including GOOGL/AMZN/META/SSTK/TTD/U), 14 likely to face challenges, and 10 with unresolved debates.

Internet: Building JARVIS: Will GOOGL, AMZN, AAPL or META Win the AI Assistant Race? (10 May 2023)

- We dive into AI-based assistants, which seem on the way. Our analysis of hardware, data and AI tech speaks to GOOGL's leading opportunity here, the behavior changes needed for AMZN/META to lead, and the AI uncertainty around AAPL. We also lay out potential financial upside and catalysts from here for each player.

Microsoft: The Next \$1 Trillion - Frameworks for Monetizing AI (6 Jul 2023); Microsoft: Feedback on our 'Frameworks for Monetizing AI' (17 Jul 2023)

- Generative AI looks to significantly expand the scope of business processes able to be automated by software, and Microsoft stands best positioned in software to monetize that expansion, which accompanied with a still reasonable valuation makes MSFT our Top Pick in Large Cap Software. PT to \$415.
- Questions on capex requirements related to the build out of GenAI capabilities and

potential gross margin impacts were the most often heard feedback to our 'AI Monetization' note, followed by level of price uplift, pace of installed base penetration, and timing of the revenues.

Software: What's New in the 'New Stack'? The Rise of the Vector Database (22 Jun 2023)

- Vector databases play a key role in making proprietary data accessible to foundational LLMs while also addressing many of their limitations. We see pure plays capturing much of the early market enthusiasm but see an opportunity for MSFT, SNOW, MDB and ORCL to address vector use cases over time.

Asia Primer: AI: The Internet Opportunity and Tech Diffusion (19 Jun 2023)

- China's AI evolution is at the inflection point, catching up with the US despite hurdles in regulation and semi restriction. We identify potential beneficiaries, debated and challenged names amid the US\$7.4tn AI opportunity in China.

Global Technology: AI – Golden Age of Technology (6 Jul 2023)

- The pace of technological change in AI is breathtaking. For investors, this is one of the most important themes of the next decade, still at an early stage but tricky to navigate. In the semis and hardware value chain, we highlight 37 leaders and 8 least preferred stocks in this transition.

Global Technology: Data Center Technology and Supply Chain: What's Built Into Price for AI? (10 Jul 2023)

- Data center technology and supply chain companies with AI exposure are up 44% YTD as investors look for winners beyond NVDA, 1200bps greater than the NASDAQ. In conjunction with our GVAT team, we look at three questions to help investors with where opportunities and risks still exist.

Morgan Stanley AI Research

** Denotes Inclusion In Key AI Primers Section*

Additional Primers and Thematic Reports:

US Tech: 4Q23 CIO Survey – AI Rises to the Top of the CIO's Priority List (11 Jan 2024)

- The expectation for stronger IT spending growth in 2024 sustained in our Q4 CIO survey, and forward indicators see incremental improvement. Matching the investor fervor, CIOs have brought AI/ML to the top of the Priority List, with 68% indicating impacts to their current IT budgets.

Sustainability: AI & ESG: Biden Executive Order on AI Safety Establishes an Important Framework (31 Oct 2023)

- The White House published its highly anticipated executive order on AI safety following voluntary commitments made with leading AI developers earlier this summer. We share five key takeaways. Later this week, we expect to hear additional news at the Global AI Safety Summit in the UK.

Thematics: Multi-Earning in a GPT Era (18 Sep 2023)

- Contrary to the belief that gig working and employee bargaining power would diminish post-Covid, multi-earning has evolved into a secular growth theme, with Generative AI the differentiator. Our AlphaWise survey shows gig-earners' income boosted 21% by using Generative AI tools versus those not.

Global Technology: A Pivotal Moment for AI (21 Aug 2023)

- With a backdrop of a shift in spending towards AI, and an exceptional supply demand imbalance that should persist for the next several quarters, investors need to be cognizant of tactical upside risk for AI stocks. Fundamentals remain intact – earnings revisions are higher and valuations lower.

Thematics: Diffusion Alpha (27 Sep 2023)

- The 1 year de-rating of perceived "AI challenged" sectors has been double that which was priced in disruption events of the past. Tactical opportunities are emerging. Education, Music and Ad Agencies look more favourable. Call Centres are cheap but lack upgrades to warrant a re-rating in our view.

Thematics: Global Trendspotting: Quantifying AI (14 Aug 2023)

- As expected, 1H results saw an inflection in companies discussing AI. ~15% of companies quantified a revenue or cost benefit from the application of machine learning across a broad spectrum of applications. Stocks quantifying customer service savings outperformed. Diffusion is accelerating.

Sustainability: AI & ESG: Assessing US Voluntary Commitments, and What We Are

Watching for Post White House Announcement (23 Jul 2023)

- We react to the White House's press release on voluntary commitments made by 7 leading AI companies to manage AI risks. We assess progress, public/private partnerships, and collaboration. We also share what we are watching for: executive order, other external involvement, accountability, and more.

Thematics: Global Trendspotting: Quantifying AI (10 Jul 2023)

- Moving through reporting season, companies are likely to ramp up their discussion of AI. Investors will need to separate the noise from the signal. We will be parsing transcripts over the coming weeks to flag quantified improvements to businesses as a result of AI's applications.

Thematic Thursday: The Race to Regulate AI (22 Jun 2023)

- Senate Majority Leader Schumer announced the start of a series of lawmaker briefings on AI, focusing on 1) the state of AI today, 2) where AI is headed, and 3) national security implications. Other governments – such as the EU and China – are also beginning to craft their own unique approach to AI regulation.

Thematic Thursday: Navigating AI with Amara's Law (8 Jun 2023)

- Amara's Law states that we tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run. In this context and according to EPFR data, last week saw the largest inflow into public tech equities in history (c\$9bn), over 40% more than the next largest weekly inflow in 2021. This is in spite of the fact that history shows many eventual AI industry-specific equity winners are likely still private and thus uninvestible to most at this point.

Thematics: Venture Vision: The Downside of AI (9 May 2023)

- While AI is diffusing at a faster pace than any technology in history since its "iPhone moment", uncertainty is high and the venture world demonstrates this acutely.

Thematic Alpha: Data Era Spend - Generating Alpha and Productivity (22 Jul 2021)

- COVID catalyzed a repricing of the value of tech inside non-tech firms, and new evidence suggests greater urgency to invest in tech post-pandemic. We see alpha in selecting IT investment leaders and key enablers, and argue that tech diffusion can support productivity gains and economic growth.

Global Technology: The Data Era Becomes Investable (12 Apr 2018)

- The dawning data-centered computing cycle can double incremental enterprise tech investment over the next 10 years and speed broader productivity growth for the first time in 20 years. Our "Data Era 15" features near-term Semi and Infrastructure and long-term Software and Services data plays.

Internet:

***Internet: Sizing the \$6 Trillion AI Internet Opportunity and Who Will Capture It (2 Mar 2023)**

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Amazon.com Inc: AWS re:Invent: Right on Q (1 Dec 2023)

- AWS showed its early but broad AI offerings, with its NVDA partnership, Guardrails, Q and vector search notable. The week also re-enforced how early it is in Gen AI adoption/hurdles to clear. We also detail a product-level breakdown of AWS/Azure/GCP Gen AI tools to track platform differentiation.

Internet: Top 10 AI Debates for 2024 (20 Nov 2023)

- We highlight 10 key AI questions for 2024: 1) Personal AI Assistants, 2) The Future of Search, 3) AI Creator Tools, 4) SMID AI Winners, 5) AI ASIC Adoption, 6) Regulation, 7) The Future of Foundational Models, 8) Robotics, 9) Healthcare, and 10) Autonomous Vehicles

Internet: How Large is the GPU IaaS Opportunity for GOOGL and AMZN? (23 Oct 2023)

- GPU IaaS represents a meaningful potential driver of AWS/GCP long-term rev and profit. We size the '26 rev opportunity at \$30bn/\$20bn for AWS/GCP and see 5% potential upside to '26 AMZN/GOOGL company-wide gross profit. It could also help GOOGL's multiple given the material potential GCP upside.

Internet: How Is AI Adoption, Social Engagement and Top of Funnel Consumer Behavior Changing? (16 Oct 2023)

- Recent AlphaWise data speak to 1) incremental AI tool adoption and rising commercial intent, 2) rising META Reels engagement which is bullish for '24, 3) GOOGL's leadership at the top of the e-commerce/travel funnels, and 4) why PINS/SNAP engagement has monetization potential, with execution the key

Online Travel: Could New AI-Based Tools Disrupt Online Travel Behavior...and Who is Best Positioned to Drive Change? (20 Jul 2023)

- We see AI improving online travel over time (more personalized/conversational) and analyze each players' position to drive behavior change. We already see GOOG tools improving while the OTAs' travel expertise/data and AI disruption risk highlight the need to invest in AI tools sooner than later.

Meta Platforms Inc: Letting the Llama Out (18 Jul 2023)

- META expanded its AI partnership with MSFT and distribution through AWS & HuggingFace, which should drive more developer adoption, improve META's innovation feedback loop, and ultimately accelerate META's AI-based innovation on its core applications.

Internet: GOOGL and META: AI vs Fundamental 2H Debates (13 Jul 2023)

- We analyze how AI could change Search, why GOOGL is best positioned to disrupt itself, META's incremental AI drivers, capex/FCF in '23/'24, and catalysts ahead. Near-term fundamentals leave us bullish GOOGL and META into 2H, and we note that GOOGL now trades at a ~40% FCF discount to META.

Amazon.com Inc: Why AWS is (Still) Well Positioned To Drive Public Cloud Adoption Through the AI Age (21 Jun 2023)

- We see AWS' full AI tech stack, open source integration, and (importantly) 10+ year focus on industry-specific innovation positioning it well to drive forward AI-based public cloud adoption. 2H AI customer and product announcements (watch re:Invent in Nov) key catalysts from here.

Amazon.com Inc: How is AWS Continuing to Improve its AI Offerings? (27 Jul 2023)

- We highlight 4 AI takeaways from the AWS Summit in NYC including 1) The addition of new LLMs to Bedrock, 2) Enhancements to LLM functionality with agency capabilities, 3) Domain specific innovation and 4) General availability of NVDA H100 GPUs.

Meta Platforms Inc: Further Laying the AI Foundation; Adoption Key Now (28 Sep 2023)

- Meta Connect showcased impressive tech advancements leveraging AI to create new use cases/monetization opportunities. Now, assessing differentiation vs. other products (i.e. SGE, ChatGPT, Bard) and monitoring user/developer adoption will be key in gauging potential monetization opportunity.

Alphabet Inc.: What's Next in AI? (30 Aug 2023)

- We detail 4 key takeaways from Day 1 of Google's Cloud Next showcase including 1) General availability of H100 GPUs and further NVDA integration 2) Addition of 20+ new open source models 3) Updates to GOOGL's own LLMs and GCP Duet AI integration and 4) General availability of Duet AI for Workspace.

Internet: What's Next in AI? Our 2H:23 AI Internet Catalyst Calendar (24 Aug 2023)

- We detail 10+ potential AI catalysts across large cap Internet between now and year end. These catalysts are important to monitor as they may help the market better understand/size/analyze each companies' AI opportunities and risks ahead. Up first, Google Cloud Next, next week.

Meta Platforms Inc: AI Glory Days; Raise PT to \$375 (27 Jul 2023)

- META's AI investments continue to drive higher engagement, advertiser return, platform monetization and EPS. And the product pipeline is flush with a September AI event catalyst. Raise '24 EPS by 8%, PT to \$375, remain OW.

Alphabet Inc.: Across-the-Board Beat, AI Leadership and Opex Discipline Still at 17x '24 EPS; Remain OW (26 Jul 2023)

- 2Q rev was stronger across the board, which led to better EBIT/FCF even as GOOGL's broad-based AI leadership (across consumer, advertisers, developers, and enterprises) continues to bud. '24 EPS/FCF increase by 5%/5% (even with \$37bn of '24 capex), and we remain OW with a \$155 PT.

Europe Internet: Framing the AI Opportunities and Risks (20 Jun 2023)

- We think the opportunity to reduce costs from new AI tools could be meaningful for European Internet companies yet is overlooked. However, ~70% of companies in our coverage are reliant on network effects, meaning disintermediation risk from AI assistants is high and a threat to monitor.

Baidu Inc: The Best AI Play in China (19 Jun 2023)

- We believe China's AI evolution is at an inflection point, and BIDU is the best play to capture the US\$7.4tn AI internet opportunity. We see 12% upside to our 2025 core revenues in our AI-enabled scenario. Near-term regulatory approval could be a catalyst. Upgrade to OW, second pick after BABA.

Internet: How Are AI, Social, and E-commerce Behaviors Changing...And What Trends Mean For META/GOOGL (6 Jun 2023)

- Latest AlphaWise data highlight 1) Increasing Reels adoption, a positive for META revenue durability, 2) How early it is in ChatGPT/Bard adoption but 3) Multiple emerging commercial AI use cases and 4) GOOGL's resilient/leading top of funnel e-commerce/travel position to capitalize on next-gen AI tools.

Alphabet Inc.: (Even) More AI Powered Advertising To Come (23 May 2023)

- Google Marketing Live showcased GOOGL's leading AI-driven ad product suite, as

GOOGL remains focused on connection, creative and confidence (performance). We see these tools reducing advertiser friction, improving creative, driving conversion higher and leading to durable multi-year ad growth.

Alphabet Inc.: Google, Supercharged by AI (11 May 2023)

- Updates from Google I/O, which showcased GOOGL's strong long term AI competitive position across search, the developer community and productivity apps. AI is reshaping all of GOOGL's products faster than expected, as today should build investor confidence in business durability and AI upside to come.

Internet: Structural AI-Driven Efficiency Ahead? (24 Apr 2023)

- We detail how next gen AI tools are set to lead to internal productivity gains (within engineering, sales and G&A), why we look for big tech leaders (META/GOOGL/AMZN) to lead in these areas through slower hiring and higher budgeting discipline going forward and potential EBIT upside from increased efficiency focus.

Meta Platforms Inc: How Can AI Drive Upside to Estimates and Key Catalysts Ahead (23 Apr 2023)

- We see META benefitting from AI-driven enhancements across core Facebook and Instagram, leading to more durable multi-year revenue growth as generative AI tools should drive engagement, ad unit conversion and platform utility. We also see call options like paid verification supporting growth and outline key META AI-based catalysts from here.

Alphabet Inc.: How Can AI Drive Upside to Estimates and Key Catalysts Ahead (16 Apr 2023)

- We detail expected AI-driven behavior change that we see leading to more durable multi-year e-commerce and online ad growth, and why we believe GOOGL is positioned to drive and benefit from these changes. We also lay out key catalysts ahead and why we remain bullish.

Internet: A Slice of AI: Key Takeaways from AMZN, GOOGL and Open AI's Pi Day Announcements (15 Mar 2023)

- We recap key product announcements from Pi day as we continue to monitor innovation and expanding AI-based offerings from big tech. AMZN outlined its full suite of AI products, GOOGL announced new Workspace and GCP AI tools and expanded its AI ecosystem through partnerships, while Open AI unveiled its widely anticipated GPT-4 language model.

Alphabet Inc.: How Large are the Incremental AI Costs...and 4 Factors to Watch Next (9 Feb 2023)

- We believe GOOGL has the AI tech and scale to maintain/grow its leading user base. But a deeper than expected AI integration speaks to higher incremental cost risk, as we see every 10% of searches moving to language models adding ~ \$1.2bn of opex. We also detail 4 GOOGL trends to monitor from here

Alphabet Inc.: Are GOOGL's Margins at Risk from ChatGPT and OpenAI? (10 Jan 2023)

- While we don't see ChatGPT as a threat to GOOGL Search's position as the starting point for online behavior, ChatGPT's ~7X higher cost per query than paid search (due to AI/natural language/compute intensity) speaks to GOOGL's margin risk of higher natural language tool adoption.

Internet: ChatGPT: What is it? Why it Matters? Is it a Google Threat...and Broader Industry Implications (12 Dec 2022)

- Investor questions about OpenAI and ChatGPT have picked up after its viral launch. We detail what ChatGPT is, why we believe Google Search is still well positioned (and set to improve with its own AI/ML offerings), broader industry and stock implications, and what to watch for next.

Software:***Global Technology: AI Index – Mapping the \$4 Trillion Enterprise Impact (1 Oct 2023)**

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- Vector databases play a key role in making proprietary data accessible to foundational LLMs while also addressing many of their limitations. We see pure plays capturing much of the early market enthusiasm but see an opportunity for MSFT, SNOW, MDB and ORCL to address vector use cases over time.

Software: 2024 Outlook – In GenAI We Trust (21 Dec 2023)

- While multiples significantly rebounded in 2023, with the industry on the precipice of the largest innovation cycle in decades, Software's secular dominance remains firmly intact. Add in improving IT budgets and room for margins, and the sector

should continue to be best positioned in '24.

Software: What's New in the 'New Stack'? The Battle for the AI Stack Starts to Heat Up (27 Nov 2023); Software: What's New in the 'New Stack'? AWS Throws Its Hat Into the Ring (15 Dec 2023)

- Recent announcements from OpenAI and Microsoft signal that competition to own more of the emerging AI stack is heating up. MDB and SNOW remain well positioned given multiple vectors for growth, but RAG use cases are likely to see more competition.
- Building on recent announcements from OpenAI & Microsoft, AWS detailed its vision of the AI stack – we highlight Q, Guardrails, and vector search. While a number of approaches to building Gen AI apps are being introduced, it will take some time before the market settles on a common architecture.

Microsoft: Solving for the 'AND' Gate (21 Nov 2023)

- While the leadership tumult at OpenAI may create an opportunity for competitors to close the gap to the market-leading GPT model, near-term financial impacts appear limited and Microsoft looks to be taking swift action to mitigate the risks. That said, the situation continues to be fluid.

Technology: What Can We Learn from the GPU Math? (23 Oct 2023); Software: Feedback on our 'GPU IaaS Math' (1 Nov 2023)

- Graphics processing units (GPUs) deliver the foundation for AI training and inference in cloud data centers today. By introducing the MS GPU Monetization Framework and initial NVDA data center unit/pricing estimates, we size up potential revenue and margin impacts for MSFT, AMZN, GOOGL, and ORCL.
- Our recent note 'What Can We Learn from the GPU Math?' sparked likely debate from investors, primarily around three topics: 1) What will GPU allocations actually look like?, 2) What happens to average GPU pricing longer term?, and 3) Is there enough Gen AI demand to justify this GPU IaaS spend?

Cybersecurity: Help Wanted: Why AI Could Unlock a >\$30 Billion Opportunity (28 Jun 2023)

- With rising threats and a significant labor shortage, AI-driven automation unlocks tangible benefits for speed and efficiency needed for today's security organizations. We size >\$30B potential opportunity from productivity gains, with value accruing to platforms like PANW, MSFT, CRWD.

Salesforce.com: Dreamforce 2023 Partner Call Recap – Generative AI in Focus, But Opportunity Still Early (26 Sep 2023)

- Our recent Dreamforce Partner call highlighted Salesforce's continued focus on Industries, as well as the criticality of Data Cloud in realizing the gen AI opportunity. While much is still to be learned on pricing for gen AI, a focus on trust-based AI appears to be a key point of differentiation.

CrowdStrike Holdings Inc: Framework for Monetization – How Charlotte AI Could Drive Upside to Numbers (18 Sep 2023)

- Given a strategic position within the enterprise security stack, we think CRWD is well positioned to monetize its new Charlotte AI offering. We expect a 30% ASP uplift and potential for an incremental \$100M+ ARR (+2% upside) by CY25. This could drive the stock towards our \$200 bull case.

Varonis Systems, Inc.: Improving Topline + Underappreciated AI Tailwinds, Upgrade to Overweight (16 Oct 2023)

- Stabilizing demand and signs of a faster than expected SaaS transition underpin our upgrade to Overweight, while our bull case could see the stock double from here as Varonis' data security platform becomes a key enabler of Generative AI adoption within the enterprise. Top SMID cap security idea.

ServiceNow Inc: Minding the P's & Q's as NOW Embraces GenAI (17 May 2023)

- Generative AI is set to permeate through the platform via partnerships with tech vendors and domain-specific models trained on NOW's data, adding significant value to customers and likely proving accretive to the operating model. Current valuation still undervalues durable FCF growth, remain OW.

Cybersecurity: Can Microsoft Co-Pilot the Way to Security Automation? (29 Mar 2023)

- Advancements in AI have potential to automate and disrupt an >\$100B market for security services. While Microsoft's new Security Copilot (a new AI assistant to help security professionals quickly summarize and make sense of threat intelligence, investigate incidents and help with reporting) aims to improve productivity for security users/teams, we think the features showcased are more evolutionary vs. revolutionary so far.

Microsoft: Co-Piloting the Way to Productivity Gains (17 Mar 2023)

- The demo of Microsoft 365 Copilot, powered by an OpenAI-based LLM well illustrates the large potential for productivity gains driven by Generative AI. While investors have to wait 'a few' months before pricing and GA are announced, the potential value unlock for MSFT is readily apparent today.

Software: Public Cloud 2.0: Building Towards a \$2.5 Trillion Opportunity (16 Mar 2023)

- Declining costs of compute and software development, matched with the ubiquity of data and expanding capabilities of software driven by recent AI advancements will shift the pendulum back to customers building new capabilities, propelling cloud market from \$500bn + today to \$2.5tr over the next decade, implying a 17% CAGR.

Microsoft: Opening the Curtain on OpenAI (1 Mar 2023)

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Microsoft: Ready for the Next Round of the Search Battle (8 Feb 2023)

- Four new AI-enabled updates to the portfolio in seven days show Microsoft's focus on establishing a leadership position in this ramping AI/ML tech cycle. Today's preview of the new Bing and Edge functionality were impressive, but changing consumer behavior can be difficult (and expensive).

Semiconductors:

Intel Corporation: Intel AI Everywhere event & mgmt meetings (15 Dec 2023)

- Launch of Meteor Lake, Emerald Rapids, and early color on Gaudi 3 largely as expected; management meetings around the event highlight the potential to extract value from manufacturing.

Advanced Micro Devices: AMD Advancing AI Event Highlights AI Opportunity (7 Dec 2023)

- The AMD event had an impressive breadth of endorsement of its MI300 architecture, but did not really break new ground in defining the company's role.

NVIDIA Corp.: Strong quarter sets the company up nicely for 2024 (22 Nov 2023)

- NVIDIA had a very strong quarter - without the shock-and-awe upside of the last two quarters, but with a trajectory that should alleviate sustainability concerns. Reiterate OW.

Global Technology: Another Pivotal Moment for AI (20 Nov 2023)

- It's already Thanksgiving and digestion is what investors worry about as semiconductors share prices are back to highs and the next move in tech hangs on NVIDIA's results. We expect an exceptionally strong quarter for NVIDIA but are cognizant of the bull and bear scenarios for the AI supply chain.

Greater China Semiconductors: Cloud Semis: Still upside on AI? (30 Oct 2023)

- Meta's capex guidance for 2024 is a surprise to the downside to the Street, yet overall we see more signs that non-AI cloud semis have bottomed.

Global Technology: US export controls impact (19 Oct 2023)

- We view this tightening as a slight setback for AI overall globally, and see risk for some stocks with larger China exposure, but also opportunities for others as the correction appears overdone. Downstream appears more impacted vs. upstream.

Global Semiconductors: IP and Design in an AI Era – Initiating Coverage of Arm,

Synopsys and Cadence (10 Nov 2023)

- AI-related themes are driving sales/margin growth for IP (Arm) and Design (Synopsys, Cadence). Valuations look fair for Arm and Cadence, despite some risks smouldering off screen, and we see a buying opportunity with Synopsys (Overweight).

Greater China Technology Hardware: AI Server Components – Our Stock Preference (16 Oct 2023)

- Our STEAM analytical framework shows power supply and thermal solutions to be two major types of AI server components benefiting from GPU computing power upgrade for potential offering value increase. We factor in the latest business outlook for all four related stocks. AVC is our preferred play.

Hon Hai Precision: Technology Day 2023: The Broader Scope of EV Manufacturing – AI Factory + EVs (18 Oct 2023)

- EVs were the focus this year with the introduction of the Model N cargo van. Hon Hai is also partnering with NVDA on the 'AI factory' concept, which will transform data into intelligence to create smart cities, smart manufacturing, etc.

Technology - Global SemiCap: The 'Gate-All-Around' (R)evolution (18 Sep 2023)

- The transition to 3D 'gate-all-around' architecture marks a monumental shift for leading-edge logic chip architectures. We model a cumulative >\$10bn opportunity for semicap OEMS by FY30, with ramps accelerating into 2H24. Our proprietary work points to gains for 3D enablers – and AMAT and ASM in particular.

NVIDIA Corp.: Upgrading to OW as large language model enthusiasm is transforming cloud capex (16 Mar 2023)

- Having been EW for a large move in the stock, we still see indications that LLM enthusiasm is turning into stronger spending both near term and long term; we have been too data point oriented around a positive bigger picture, but the narrative is too strong to remain on sidelines and the development of generational AI is too much of a megatrend to get distracted by tactical concerns. The stock will continue to be hard to ignore in an otherwise challenging semiconductor environment.

Advanced Micro Devices: AI opportunity looks to be multiples of our initial assessment (11 May 2023)

- We have tried to set conservative forecasts for AMD's AI, given historical false starts, but higher price points plus supply chain commentary is pointing to an opportunity that is multiples of our initial target. We continue to hear about more aggressive investment in both training and inference and AMD's share of this opportunity seems more tangible and durable.

Asia Semiconductors: Tech Diffusion – Fulfilling the surge in AI demand with custom chips (11 Jun 2023)

- We believe GP GPUs (provided by NVIDIA and AMD) demand will continue to expand in 2024e, but AI ASICs (or custom chips) may outgrow GP GPUs given lower costs reaching scale. We view TSMC, Alchip, GUC, Andes, and ASM Pacific as key enablers in Asia.

Podcast | Morgan Stanley Tech Talk: Joe Moore & Meta Marshall on AMD & ANET AI enthusiasm vs capex pushouts and switching vs InfiniBand debate | Episode 114 (9 May 2023)

- Joe Moore and Meta Marshall discuss AMD and ANET in terms of AI enthusiasm vs cloud apex pushouts and the ethernet switching vs InfiniBand (NVDA Mellanox) debate, along with latest views on the Smartphone + Networking cycles post QCOM, QRVO, JNPR, and FFIV.

NVIDIA Corp.: Developer's conference/GTC keynote highlights progress in chips, services, and software (22 Mar 2023)

- NVIDIA announced new chips as expected (CPU Grace, CPU+GPU Hopper, DPU bluefield 3), several new inference products, new software libraries, and software and cloud partnerships. In all, the event demonstrated the breadth of AI opportunities both in terms of expanding presence in existing markets (extending Hopper into the inference market, introducing the Grace CPU supplementing its GPUs), but more significantly expanding beyond chips and cards to systems, software, and cloud services. In our view the company is putting themselves in a position to capitalize on the transformative nature of AI investments.

Podcast | Morgan Stanley Tech Talk: Joe Moore on NVDA AI opportunity + nuances on Training vs Inference chips | Episode 103 (15 Feb 2023)

- Joe Moore discusses the NVDA opportunity around AI. He thinks NVDA is the best play on the theme but does temper near-term expectations given nuances around Training vs Inference (heterogeneous chips vs all NVDA A100), diminishing returns on neural net complexity, and hyper-scale drive.

NVIDIA Corp.: Context on the NVIDIA Chat GPT opportunity - and ramifications of large language model enthusiasm (10 Feb 2023)

- We have been excited for deep learning for large language models for several years - it has been the focus of our constructive view since 2018. ChatGPT can be a catalyst for expansion. We think that some estimates for near term direct revenues are too high, but the long term opportunity is significant.

Japan Semiconductors: Upgrading Our Industry View to Attractive (6 Jul 2023)

- We believe both cyclical recovery in the semiconductor market and long-term growth for AI chips are still in early innings.

Technology - Global Semiconductors: Microcontrollers for Edge AI and TinyML (11 Sep 2023)

- We see a range of new MCUs coming to market that enable greater deployment of

edge-AI. There is competition, yet the moving pieces inform a new landscape, which we see the likes of STM and IFX gearing up for. Although a growth driver for the longer term, we think investors should pay attention.

Global Technology: Correction: More aggressive AI custom chip designs from hyperscalers (12 Sep 2023)

- TSMC and Asia ASIC design services are well positioned for the US hyperscalers' acceleration of custom chip designs.

Global Technology: Correction: AI – A New Era for Advanced Packaging (20 Sep 2023)

- Why advanced packaging matters to investors: Often overlooked, advanced packaging is pushing system performance boundaries and helping to drive AI chip capabilities. To meet the challenge of increasing performance at a reasonable cost, a better model is to pull high-speed chips, such as processor cores, into the leading-edge nodes and keep the remaining chips at other nodes, which together form a 'package' that makes these constructions more powerful and quicker to produce. To evaluate the best opportunities, our Asian and European teams have taken an in-depth look across the full advanced packaging value chain to ascertain in which areas the money is being made and how this is distributed globally. This informs our global stock picks.

Global Semiconductors: MCU – The proxy to play RISC V and AIOT (13 Aug 2023)

- Besides China's ongoing semiconductor localization, our AlphaWise survey shows faster RISC-V adoption and stronger AIOT demand in China. We believe Espressif in China will be the largest beneficiary. Globally, we like Renesas, given sustained share in China and ongoing constraints in autos.

Hardware, Networking, and Telecom:

Greater China Technology Hardware: VR/MR Headsets: AI-enabled and Progressing into the Metaverse (5 Dec 2023)

- 3D interface, spatial computing, and edge AI have been accelerating VR/MR headset spec advances, evidenced by Apple Vision Pro, Quest 3, and HTC XR Elite. We expect innovative use cases to be available from 2024, driving VR/MR headset sales and the metaverse ecosystem build. Initiate HTC at EW.

Global Technology: Edging Into a Smartphone Upcycle (9 Nov 2023)

- Cloud AI burst into the mainstream in 2023 with chatGPT. We think Edge AI will be the next big thing to take hold, fuelling a new product cycle for smartphones. The completion of de-stocking, rush orders, and Huawei's return to the market could also trigger a cyclical recovery.

Apple, Inc.: Gaining an Edge By Enabling Gen AI at 'The Edge' (7 Nov 2023)

- We see Apple as an emerging 'Edge AI Enabler', or a beneficiary of compute being

pushed to the edge to enable new Gen AI-driven 'killer apps'. 5 different paths to monetizing Gen AI are most likely, with Apple's key competitive advantages being Data, Privacy and Vertical Integration. Reiterate OW.

Telecom & Networking Equipment: Networking Explainer / OCP Wrap-Up: Trying to Solve For the Many Challenges of AI Networks (18 Oct 2023)

- OCP highlighted that cloud networks had been fairly homogenous over the last 10 yrs, but needs are starting to splinter with AI (and w/in AI use cases), increasing the strain on, and complexity of, the network. Strong desire to solve issues with open standards, like Ethernet, a benefit to ANET.

Greater China Technology Hardware: Transceivers: A Year of High Growth in 2024; Innolight, Coherent and Marvell best positioned to benefit (5 Nov 2023)

- We believe the transceiver industry is likely to enjoy rapid earnings growth in 2024, mainly driven by AI GPU's rapid volume growth. The recent A-share market correction has introduced good investment opportunities, while Coherent and Marvell are best positioned to benefit in the US.

Arista Networks: ANET Analyst Day: Deep Dive on AI Opportunity (10 Nov 2023)

- Cloud and AI Innovators Analyst Day presented a deep dive into technology problems created by AI, and solved by Arista. As expected, financial targets laid out were largely as previewed on Q2/Q3 earnings, giving room for eventual new CFO and flexibility given customer concentration. Remain OW.

Asia Technology: AI Hardware Supply Chain – Introducing our Interactive on ODMs (25 Oct 2023)

- This is a quick follow-up on our deep dive analysis on the value proposition and growth potential across the AI hardware supply chain. In this report, we include a custom-built interactive tool to give you a quick and easy way to assess the revenue and profit impacts to ODMs from AI servers.

Asia Technology: AI Hardware Supply Chain – The Value of STEAM Power (16 Oct 2023)

- We have undertaken a deep dive analysis to examine the value proposition and growth potential across the AI hardware supply chain amid AI demand growth. We also introduce our proprietary STEAM framework to identify respective long-term beneficiaries. We see valuations enjoying a sustained re-rating.

Global Technology: Data Center Technology and Supply Chain: What's Built Into Price for AI? (10 Jul 2023)

- Data center technology and supply chain companies with AI exposure are up 44% YTD as investors look for winners beyond NVDA, 1200bps greater than the NASDAQ. In conjunction with our GVAT team, we look at three questions to help investors with where opportunities and risks still exist.

Telecom & Networking Equipment: A High Speed Connection: The AI Transceiver Market (15 Jun 2023)

- AI demand would accelerate datacomm transceiver market, with COHR better exposed vs. LITE. We believe there is better opportunity in '24, post inventory digestion across datacom / telecom, and as 200G EMLs and capacity ramps.

Global Technology: AI – Golden Age of Technology (6 Jul 2023)

- The pace of technological change in AI is breathtaking. For investors, this is one of the most important themes of the next decade, still at an early stage but tricky to navigate. In the semis and hardware value chain, we highlight 37 leaders and 8 least preferred stocks in this transition.

Intel Corporation: Intel Innovation 2023 highlights AI focus; no big surprises (20 Sep 2023)

- Intel highlighted the importance of AI throughout their client and data center roadmaps; highlights included an Intel based supercomputer with 4k Gaudi chips; cautious gross margin commentary in Q&A consistent with our model.

Dell Technologies Inc.: What We Learned From DELL About The Gen AI Opportunity (18 Jul 2023)

- Today DELL hosted an 'Ask The Experts' webinar with Co-COO Jeff Clarke, ISG President Jeff Boudreau and CTO John Roese discussing emerging technology trends, with a specific focus on AI. We share our 5 key takeaways from today's event below.

Dell Technologies Inc.: Moving to Top Pick Given Rich Catalyst Path and AI Upside Optionality (1 Sep 2023)

- DELL is now our Top IT HW Pick given several catalysts (incl Oct 5th SAM) plus better execution/cost mgmt and most importantly, DELL emerging as our 1st Gen AI winner (with more to come). Our \$70 PT is now high on the Street. We like DELL across cap structure, w/ credit trade to buy 10Y bonds too.

Dell Technologies Inc.: Is DELL's AI Server Opportunity Closer Than You Think? (8 Aug 2023)

- Our checks point to DELL rapidly ramping AI server builds in CY23/24. GPU supply is a gating factor, but at \$5B of revs and ~30c of EPS in FY25, AI servers have potential to drive 4-5% upside vs. our above-Street FY25 ests. We embed this oppty in our new \$84 bull case valuation, for now. Remain OW.

Global Technology: Cloud Optimization: Short Term Pain for Long Term Gains (12 Apr 2023)

- Morgan Stanley conducted a proprietary AlphaWise survey to look at duration and long term impacts of cloud optimization. Survey points to slightly longer digestion period than expected, but nearly 25% higher public cloud adoption longer term.

Microsoft and Google would be the biggest share gainers as cloud growth resumes given AI expertise, but there is a longer tail of beneficiaries enabling hybrid future; challenged vendors are still largely premise technology providers.

Telecom & Networking Equipment: AI Workloads: A Look at the Networking Opportunity (2 Mar 2023)

- With GPU workloads the fastest growing part of cloud data center spend, networking architectures need adaptations to accommodate increased bandwidth. We estimate cloud networking TAM could grow to \$24bn as a result, increasing Ethernet TAM ~50%. ANET is the biggest branded beneficiary.

***Tech Hardware Pulse: What Investors Are Asking: What Is the AI Opportunity For Hardware Companies? (24 Feb 2023)**

- Over a multi-year period, generative AI could drive greater demand for more powerful compute (GPU-enabled servers, AI-integrated PC CPUs) and data storage (flash & HDDs). AAPL, STX, DELL, and IBM are names we believe could benefit from this shift, but the P&L impact is still in its early days.

IT Services:

Global IT Services: AI - At your service (19 Jun 2023)

- Short term, we see IT Services vendors as likely beneficiaries from data and AI-driven spend. Longer term, we see areas such as consulting and system integration at lower risk of disruption versus BPO and application maintenance. We favour vendors who adopt AI early with scope to invest at scale.

Greater China IT Services and Software: New Era of Office Digitalization (10 Sep 2023)

- We think both technology and commercialization are propelling office digitalization into a new era. We see good gateway value in OA platforms and sizable upside from integrating Gen AI in office software. Initiate Weaver at EW.

Non-Tech Industry AI Notes:

Global Education: More than Meets the Eye: Sizing the GenAI Opportunity in Education (20 Nov 2023)

- Generative AI is a game changer in education. The market is debating whether GenAI is a threat or an opportunity, but that's the tip of the iceberg. Our work uncovers a \$200bn impact on the global education sector over the next 3 years. Favored names: Vitru, Afya, Coursera, Docebo, TAL Education.

Pearson: Sizing the GenAI opportunity in education (20 Nov 2023)

- We see Pearson as one of the better positioned companies globally in the education space, which should see it become a net beneficiary from GenAI.

Healthcare Technology: AI Deep Dive: Framing the Use Cases and Investment Opportunities (24 Oct 2023)

- Generative AI represents a catalyst for increased adoption of technology in Healthcare, a market that's bogged down by archaic business practices and inefficiencies. It's early innings, but we see the greatest fundamental impact on MODN, DH and RCM, representing optionality for the stocks.

Asset & Wealth Management: The AI Tipping Point (4 Oct 2023); Slide Deck, Video

- Gen AI will transform the way the industry operates, but it is just one part of an integrated strategic approach to drive growth and build resiliency.

Quantitative Equity Research: How LLMs Can Boost Earnings Call Signals (17 Oct 2023)

- Using a Google Large Language Model (LLM), we raised the Sharpe ratio of sentiment signals from earnings call transcripts by 80%. We lay out the process of harnessing this cost-effective new technology.

Tesla Inc: Unlocking Tesla's AI Mojo... Enter the Dojo: Upgrade to OW, PT \$400, Top Pick (10 Sep 2023)

- The autonomous car has been described as the mother of all AI projects. In its quest to solve for autonomy, Tesla has developed an advanced supercomputing architecture that pushes new boundaries in custom silicon and may put Tesla at an asymmetric advantage in a \$10trn TAM.

Hotels & Travel: AI for Hotels: Will the Hotel of the Future Fit in the Palm of Your Hand? (18 Aug 2023)

- Hotel Brands & OTAs have the potential to revolutionize the travel experience before, during, and after trips while also supporting business fundamentals using AI. Currently, tech-first OTAs and Google are key beneficiaries, but we see significant upside potential for Brands if they harness loyalty & unique customer data.

Biotechnology: Takeaways from our Second Annual Biotech AI Summit (5 Jul 2023)

- We held a conference on 6/29 in NYC focused on tech-enabled drug development, where we hosted several management teams for discussions on AI drug development use cases, company formation, capital allocation, and applications in diagnostics, among other topics.

Business & Education Services: Generative AI in Info Services (20 Jun 2023)

- We see Info Services as a beneficiary from AI and provide a four-factor framework for assessing AI in Info Services. We view SPGI as the AI leader, TRI and CLVT as less at-risk than perceived. IT has opportunities from a revenue and expense perspective.

Healthcare: What's NEXT - How AI/ML Could Shape Healthcare (19 Jun 2023)

- Through the lens of our NEXT framework we examine the impact that AI/ML is already having on the healthcare sector, but also where this could be leveraged on the forward to drive opportunities and efficiencies. Clearly we are in the early stages of adoption, but potential benefits are significant.

Freight Transportation: AI in Freight Transportation: The Final Piece of the Automation Puzzle? (24 May 2023)

- We have long believed the Freight Transportation space is on the cusp of a generational shift driven by disruptive technologies including Autonomous, EV, blockchain and drones. AI is the latest one of these potentially transformative technologies to emerge – and perhaps the most powerful to-date.

Theme Trades: What's Technology Worth: Introducing Data Era Stocks 2.0 (1 Oct 2020)

- We refresh our list of non-tech US companies creating value through investments in technology. We see 38 companies at the cutting edge of a Data Era driven productivity boom. The market is rewarding investments from these companies with median PE premiums of 1x vs peers and 5x vs the market.

Capital Goods: Data Era Investment and the 'Second Machine Age' (12 Sep 2018)

- The dawning Data Era Investment cycle will be focused on Manufacturing, driving a \$650bn uplift in spend by Industrial OEMs. We think productivity gains worth ~5% of global GDP are possible across all kinds of industries, as cost savings boost global corporate EBITDA by >20% on a sustainable basis.

Theme Trades: What's Technology Worth? (6 Sep 2018)

- We look across our US coverage for companies creating value through investments in technology. We see 26 companies at the cutting edge of a Data Era driven productivity boom. The market is rewarding investments from these companies with median/average PE premiums of 0.5x/7.7x relative to peers.

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(as of December 31, 2023)

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Stock Rating Category	Coverage Universe		Investment Banking Clients (IBC)			Other Material Investment Services Clients (MISC)	
	Count	% of Total	Count	% of Total IBC	% of Rating Category	Count	% of Total Other MISC
Overweight/Buy	1346	37%	266	41%	20%	605	39%
Equal-weight/Hold	1668	46%	317	49%	19%	717	46%
Not-Rated/Hold	3	0%	0	0%	0%	1	0%
Underweight/Sell	598	17%	61	9%	10%	224	14%
Total	3,615		644			1547	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

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INDUSTRY COVERAGE: Internet

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Brian Nowak, CFA		
Airbnb Inc (ABNB.O)	U (12/06/2022)	\$142.01
Alphabet Inc. (GOOGL.O)	O (08/11/2015)	\$145.99
Amazon.com Inc (AMZN.O)	O (04/24/2015)	\$154.78
Booking Holdings Inc (BKNG.O)	E (01/09/2019)	\$3,506.02
DoorDash Inc (DASH.O)	E (04/24/2022)	\$104.66
Expedia Inc. (EXPE.O)	E (01/09/2019)	\$145.66
Lyft Inc (LYFT.O)	E (10/24/2019)	\$12.76
Meta Platforms Inc (META.O)	O (03/20/2023)	\$381.78
Mondee Holdings Inc (MOND.O)	E (01/04/2024)	\$2.65
Nextdoor Holdings Inc (KIND.N)	E (02/24/2022)	\$1.65
Pinterest Inc (PINS.N)	E (03/28/2022)	\$37.16
Snap Inc. (SNAP.N)	U (07/25/2022)	\$16.61
Uber Technologies Inc (UBER.N)	O (06/04/2019)	\$64.55
Lauren Schenk		
Bumble Inc. (BMBL.O)	E (03/08/2021)	\$13.97
Chewy Inc (CHWY.N)	O (10/31/2023)	\$19.64
eBay Inc (EBAY.O)	U (06/23/2022)	\$41.06
Etsy Inc (ETSY.O)	E (08/04/2021)	\$70.82
Farfetch Ltd. (FTCHF.PK)	NR (12/18/2023)	\$0.04
FIGS, Inc. (FIGS.N)	E (06/21/2021)	\$5.99
Match Group Inc (MTCH.O)	O (06/17/2021)	\$36.22
Peloton Interactive, Inc. (PTON.O)	E (03/14/2022)	\$5.86
RealReal Inc (REAL.O)	E (11/17/2020)	\$1.90
Rent the Runway, Inc. (RENT.O)	E (11/18/2022)	\$0.60
Revolve Group Inc (RVLV.N)	E (02/24/2022)	\$14.99
Rover Group Inc (ROVR.O)	E (08/06/2021)	\$10.93
Shutterstock Inc (SSTK.N)	E (07/28/2022)	\$50.11
Stitch Fix Inc (SFIX.O)	E (12/03/2021)	\$3.42
ThredUp Inc. (TDUP.O)	E (04/20/2021)	\$2.26
WW International Inc (WW.O)	O (07/25/2023)	\$4.71
Matthew Cost		
AppLovin Corp (APP.O)	E (11/27/2022)	\$43.36
Compass, Inc. (COMP.N)	E (07/20/2022)	\$3.51
Criteo SA (CRO.O)	E (01/26/2016)	\$24.74
DoubleVerify Holdings Inc (DV.N)	O (12/12/2023)	\$40.44
Electronic Arts Inc (EA.O)	E (08/04/2021)	\$137.57
Innovid Corp (CTV.N)	E (01/17/2023)	\$1.32
Integral Ad Science Holding Corp. (IAS.O)	O (07/26/2021)	\$15.51
Opendoor Technologies Inc (OPEN.O)	E (07/24/2023)	\$3.49

Playtika Holding Corp (PLTK.O)	E (11/27/2022)	\$7.42
Roblox Corporation (RBLX.N)	E (08/10/2023)	\$40.48
Take-Two Interactive Software (TTWO.O)	O (02/01/2018)	\$164.43
Trade Desk Inc (TTD.O)	O (06/01/2023)	\$69.39
Unity Software Inc (U.N)	E (11/27/2022)	\$34.22
Yelp Inc (YELP.N)	U (01/10/2019)	\$44.52
Zillow Group Inc (Z.O)	E (04/18/2018)	\$55.53

Stock Ratings are subject to change. Please see latest research for each company.

* Historical prices are not split adjusted.

INDUSTRY COVERAGE: IT Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Erik W Woodring		
Apple, Inc. (AAPL.O)	O (05/26/2009)	\$193.89
CDW Corporation (CDW.O)	E (12/12/2023)	\$226.91
Circuit City Inc (CRCT.O)	U (08/12/2021)	\$5.71
Dell Technologies Inc. (DELL.N)	O (05/01/2023)	\$81.14
Garmin Ltd (GRMN.N)	E (01/07/2015)	\$126.71
GoPro Inc (GPRO.O)	U (12/12/2023)	\$3.25
HP Inc. (HPQ.N)	O (12/12/2023)	\$29.18
IBM (IBM.N)	E (01/18/2023)	\$172.83
Kornit Digital Ltd. (KRNT.O)	O (08/10/2023)	\$16.43
Logitech International SA (LOGI.O)	E (05/01/2023)	\$95.93
NCR Corp. (VYX.N)	E (09/19/2022)	\$15.56
Resideo Technologies Inc (REZI.N)	E (03/16/2021)	\$17.46
Seagate Technology (STX.O)	E (04/21/2023)	\$87.10
SmartRent, Inc. (SMRT.N)	E (02/14/2022)	\$3.39
Snap One Holdings Corp. (SNPO.O)	E (12/08/2021)	\$8.86
Sonos Inc. (SONO.O)	O (12/12/2023)	\$16.74
Teradata (TDC.N)	O (09/19/2021)	\$48.69
Xerox Corp (XRX.O)	U (02/03/2021)	\$16.63
Meta A Marshall		
Hewlett Packard Enterprise (HPE.N)	E (11/30/2023)	\$15.50
NetApp Inc (NTAP.O)	E (07/26/2023)	\$88.62
Nutanix Inc (NTNX.O)	E (05/28/2019)	\$56.00
Pure Storage Inc (PSTG.N)	O (10/31/2022)	\$41.18

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* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Telecom & Networking Equipment

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Meta A Marshall		
Arista Networks (ANET.N)	O (10/31/2023)	\$266.60
Axon Enterprise Inc (AXON.O)	E (08/22/2023)	\$259.66
Bandwidth Inc (BAND.O)	E (04/05/2021)	\$14.34
Ciena Corporation (CIEN.N)	E (03/29/2023)	\$51.91
Cisco Systems Inc (CSCO.O)	++	\$51.57
Coherent Corp (COHR.N)	E (12/13/2023)	\$47.00
CommScope Holding Company Inc (COMM.O)	E (08/05/2022)	\$2.30
Corning Inc (GLW.N)	O (06/09/2023)	\$30.62
F5 Inc (FFIV.O)	E (04/12/2022)	\$181.89
Infinera Corp (INFN.O)	E (11/13/2018)	\$5.09
Juniper Networks Inc (JNPR.N)	E (01/10/2024)	\$37.47

Keysight Technologies Inc (KEYS.N)	O (09/15/2023)	\$154.99
KORE Group Holdings Inc (KORE.N)	E (12/17/2021)	\$0.97
Lumentum Holdings Inc (LITE.O)	E (05/12/2021)	\$54.18
Motorola Solutions Inc (MSI.N)	E (09/14/2022)	\$324.99
Viavi Solutions Inc (VIAV.O)	E (05/20/2015)	\$10.17
Zebra Technologies Corporation (ZBRA.O)	U (09/20/2023)	\$254.57

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* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Joseph Moore		
Advanced Micro Devices (AMD.O)	O (06/22/2022)	\$168.18
Aeva Technologies Inc (AEVA.N)	E (07/19/2021)	\$0.93
Ambarella Inc (AMBA.O)	O (03/29/2016)	\$57.00
Amkor Technology Inc (AMKR.O)	E (11/08/2023)	\$33.19
Analog Devices Inc. (ADI.O)	O (11/16/2023)	\$197.31
Broadcom Inc. (AVGO.O)		\$1,220.50
GlobalFoundries Inc (GFS.O)	O (03/03/2022)	\$58.74
Intel Corporation (INTC.O)	E (02/22/2023)	\$48.22
IonQ Inc (IONQ.N)	E (04/25/2023)	\$11.72
Marvell Technology Group Ltd (MRVL.O)	E (09/14/2015)	\$70.11
Microchip Technology Inc. (MCHP.O)	O (10/19/2020)	\$90.74
Micron Technology Inc. (MU.O)	U (07/21/2022)	\$89.24
Navitas Semiconductor Corp (NVTS.O)	E (08/28/2023)	\$6.50
NVIDIA Corp. (NVDA.O)	O (03/16/2023)	\$596.54
NXP Semiconductor NV (NXPI.O)	E (04/08/2021)	\$218.84
ON Semiconductor Corp. (ON.O)	E (08/03/2021)	\$75.19
Qorvo Inc (QRVO.O)	O (12/07/2023)	\$106.70
Qualcomm Inc. (QCOM.O)	E (12/07/2023)	\$152.87
Silicon Laboratories Inc. (SLAB.O)	E (01/19/2021)	\$129.69
Skyworks Solutions Inc (SWKS.O)	E (11/28/2018)	\$108.59
Teradyne Inc (TER.O)	E (03/03/2022)	\$110.09
Texas Instruments (TXN.O)	U (04/13/2020)	\$174.83
Western Digital (WDC.O)	O (01/23/2020)	\$57.00
Wolfspeed, INC (WOLF.N)	E (12/07/2020)	\$34.67
Lee Simpson		
ARM Holdings PLC (ARM.O)	E (11/10/2023)	\$77.11
Cadence Design Systems Inc (CDNS.O)	E (11/10/2023)	\$295.73
Synopsys Inc. (SNPS.O)	O (11/10/2023)	\$541.71

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INDUSTRY COVERAGE: Software

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Chris Quintero		
Blackline Inc (BL.O)	E (09/18/2023)	\$60.80
E2open Parent Holdings Inc (ETWO.N)	E (01/17/2024)	\$3.90
Vertex Inc. (VERX.O)	O (01/17/2024)	\$25.40
Elizabeth Porter, CFA		
Amplitude Inc. (AMPL.O)	E (10/25/2021)	\$12.82
Freshworks Inc (FRSH.O)	E (10/18/2021)	\$21.97
GoDaddy Inc (GDDY.N)	E (07/19/2021)	\$108.23

HubSpot, Inc. (HUBS.N)	O (03/21/2023)	\$590.25
Klaviyo, Inc (KVYO.N)	E (10/16/2023)	\$25.15
LegalZoom.com Inc (LZ.O)	U (07/28/2022)	\$10.99
Liveramp Holdings Inc (RAMP.N)	O (07/15/2019)	\$41.48
Matterport Inc (MTTR.O)	E (04/19/2022)	\$2.38
Semrush Holdings Inc -A (SEMR.N)	E (06/06/2022)	\$12.13
Sprinklr Inc (CXM.N)	E (07/19/2021)	\$12.34
Sprout Social Inc (SPT.O)	E (11/17/2020)	\$63.64
Wix.Com Ltd (WIX.O)	E (05/19/2022)	\$128.75
Zeta Global Holdings Corp (ZETA.N)	E (07/06/2021)	\$9.80
ZoomInfo Technologies Inc (ZI.O)	O (11/18/2020)	\$15.77
Hamza Fodderwala		
Check Point Software Technologies Ltd. (CHKP.O)	E (10/16/2023)	\$159.06
Cloudflare Inc (NET.N)	E (10/30/2023)	\$84.68
CrowdStrike Holdings Inc (CRWD.O)	O (01/09/2024)	\$298.66
CyberArk Software Ltd (CYBR.O)	E (01/09/2024)	\$234.29
Fortinet Inc. (FTNT.O)	O (10/07/2022)	\$62.66
Gen Digital Inc. (GEN.O)	O (11/21/2023)	\$23.56
Okta, Inc. (OKTA.O)	E (09/01/2022)	\$84.55
Palo Alto Networks Inc (PANW.O)	O (10/10/2017)	\$345.65
Qualys Inc (QLYS.O)	U (02/09/2021)	\$197.96
Rapid7 Inc (RPD.O)	E (08/11/2015)	\$54.90
Secureworks Corp (SCWX.O)	E (09/09/2020)	\$7.74
SentinelOne, Inc. (S.N)	O (06/12/2023)	\$26.29
Tenable Holdings Inc (TENB.O)	O (01/09/2024)	\$47.60
Varonis Systems, Inc. (VRNS.O)	O (10/16/2023)	\$45.45
Zscaler Inc (ZS.O)	E (01/12/2023)	\$240.85
Josh Baer, CFA		
2u Inc (TWOU.O)	E (11/24/2020)	\$0.89
Asana Inc (ASAN.N)	E (10/26/2020)	\$19.04
BigCommerce Holdings, Inc. (BIGC.O)	E (05/11/2021)	\$8.44
Box Inc (BOX.N)	O (10/03/2022)	\$26.61
CCC Intelligent Solutions Holdings Inc (CCCS.O)	E (12/12/2023)	\$11.02
Chegg Inc (CHGG.N)	U (11/20/2023)	\$10.00
Coursera, Inc. (COUR.N)	O (04/26/2021)	\$17.95
DigitalOcean Holdings Inc (DOCN.N)	E (08/11/2023)	\$34.85
Docebo Inc. (DCBO.O)	O (08/17/2023)	\$45.15
DocuSign Inc (DOCU.O)	E (01/16/2024)	\$62.01
Instructure Holdings Inc (INST.N)	O (12/09/2021)	\$25.76
Lightspeed POS Inc. (LSPD.N)	E (02/18/2021)	\$18.61
Sabre Corp (SABR.O)	E (03/16/2021)	\$4.36
Smartsheet Inc (SMAR.N)	O (05/22/2018)	\$46.25
Toast, Inc. (TOST.N)	O (12/16/2021)	\$17.21
Udemy Inc (UDMY.O)	E (11/23/2021)	\$13.85
WalkMe Ltd (WKME.O)	E (06/07/2022)	\$10.48
Keith Weiss, CFA		
Adobe Inc. (ADBE.O)	O (07/31/2023)	\$603.59
Akamai Technologies, Inc. (AKAM.O)	E (04/29/2020)	\$121.89
Atlassian Corporation PLC (TEAM.O)	O (01/13/2020)	\$245.59
Autodesk (ADSK.O)	E (08/19/2021)	\$250.79
Bill.com Holdings (BILL.N)	E (06/12/2023)	\$75.12
Intuit (INTU.O)	O (10/05/2020)	\$630.61
Microsoft (MSFT.O)	O (01/13/2016)	\$396.51
Oracle Corporation (ORCL.N)	E (01/15/2019)	\$110.10
Palantir Technologies Inc. (PLTR.N)	U (08/31/2023)	\$17.60

Salesforce.com (CRM.N)	O (12/21/2023)	\$280.30
Samsara Inc (IOT.N)	E (03/23/2023)	\$33.30
ServiceNow Inc (NOW.N)	O (11/12/2020)	\$752.45
Shopify Inc (SHOP.N)	E (06/24/2022)	\$80.26
Snowflake Inc. (SNOW.N)	O (02/07/2022)	\$199.08
Splunk Inc (SPLK.O)	++	\$153.29
UiPath Inc (PATH.N)	E (09/07/2022)	\$23.49
Workday Inc (WDAY.O)	O (04/14/2020)	\$289.88
Meta A Marshall		
8x8 Inc (EGHT.O)	E (01/13/2020)	\$3.55
Five9 Inc (FIVN.O)	E (10/10/2022)	\$79.79
NICE Ltd. (NICE.O)	O (10/16/2023)	\$213.58
RingCentral Inc (RNG.N)	E (08/08/2023)	\$35.34
Twilio Inc (TWLO.N)	O (09/19/2019)	\$73.92
Zoom Video Communications Inc (ZM.O)	E (10/11/2022)	\$69.59
Roy D Campbell		
Karooooo Ltd (KARO.O)	O (04/27/2021)	\$25.00
Sanjit K Singh		
Alteryx Inc (AYX.N)	++	\$47.44
Appian Corp (APPN.O)	E (12/03/2021)	\$33.78
C3.ai (AI.N)	U (01/04/2021)	\$26.44
Confluent, Inc. (CFLT.O)	O (04/12/2023)	\$22.40
Couchbase, Inc. (BASE.O)	E (08/16/2021)	\$24.80
Datadog, Inc. (DDOG.O)	O (05/21/2021)	\$132.98
Domo Inc (DOMO.O)	E (01/20/2023)	\$9.89
Fastly Inc. (FSLY.N)	E (04/20/2023)	\$20.32
HashiCorp (HCP.O)	E (01/03/2022)	\$21.66
JFrog Ltd. (FROG.O)	O (12/21/2023)	\$34.24
MongoDB Inc (MDB.O)	O (04/12/2023)	\$413.42
PagerDuty, Inc. (PD.N)	O (01/20/2023)	\$25.91
Solarwinds Corp (SWI.N)	E (11/13/2018)	\$12.19

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* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Freight Transportation

COMPANY (TICKER)	RATING (AS OF)	PRICE* (01/22/2024)
Ravi Shanker		
ArcBest Corp (ARCB.O)	O (12/10/2020)	\$123.36
C.H. Robinson Worldwide Inc. (CHRW.O)	U (06/09/2013)	\$87.13
Canadian National Railway Co. (CNR.TO)	O (05/04/2023)	C\$168.20
Canadian Pacific Kansas City Ltd (CP.TO)	E (09/05/2023)	C\$105.40
CSX Corporation (CSX.O)	E (04/04/2023)	\$34.75
Expeditors International of Washington I (EXPD.N)	U (12/02/2021)	\$128.67
FedEx Corporation (FDX.N)	E (06/20/2013)	\$250.69
GXO Logistics, Inc (GXO.N)	O (01/09/2023)	\$56.66
Heartland Express Inc. (HTLD.O)	E (03/15/2022)	\$13.60
Hub Group Inc (HUBG.O)	E (02/13/2018)	\$93.49
J.B. Hunt Transport Services Inc. (JBHT.O)	E (05/06/2011)	\$207.58
Knight-Swift Transportation Holdings Inc (KNX.N)	O (12/13/2017)	\$57.05
Landstar System Inc (LSTR.O)	E (01/09/2023)	\$198.60
Norfolk Southern Corp. (NSC.N)	E (04/04/2023)	\$240.14
Old Dominion Freight Line Inc (ODFL.O)	E (11/09/2021)	\$401.71
RXO Inc (RXO.N)	E (12/09/2022)	\$22.92
Saia, Inc. (SAIA.O)	U (02/13/2023)	\$468.91

Schneider National Inc. (SNDR.N)	O (05/01/2017)	\$25.28
TFI International Inc (TFII.N)	O (06/10/2020)	\$134.30
Union Pacific Corp. (UNPN)	E (03/23/2020)	\$243.11
United Parcel Service (UPS.N)	U (02/23/2016)	\$158.60
Werner Enterprises (WERN.O)	O (02/23/2016)	\$41.68
XPO Logistics, Inc. (XPO.N)	E (02/13/2023)	\$86.05

Stock Ratings are subject to change. Please see latest research for each company.

* Historical prices are not split adjusted.

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