AI Revolution

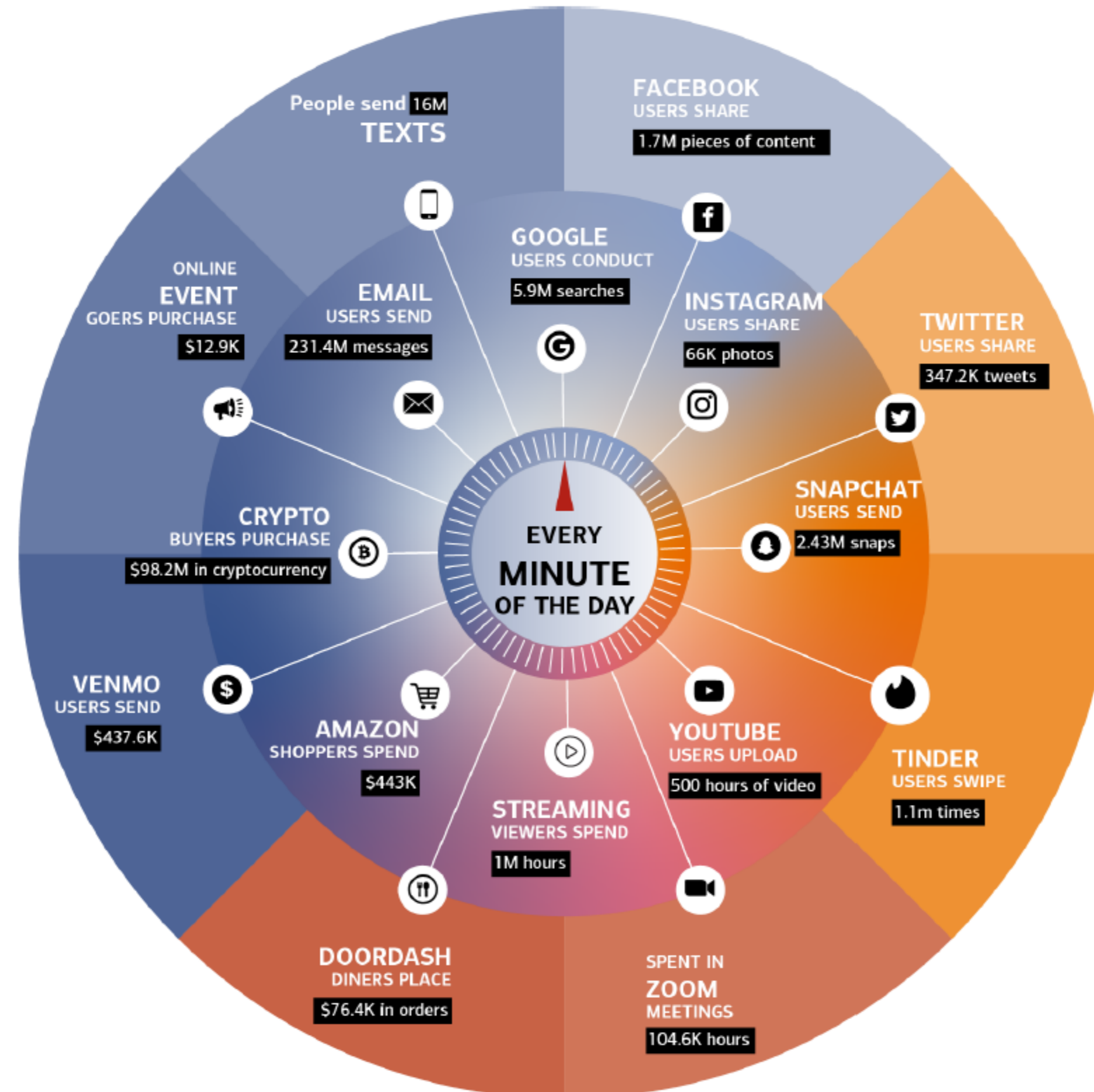**Linda A. Duessel, CFA®, CPA, CFP®**
Senior Equity Strategist
Senior Vice President

October 2023

How much data is created every minute on the internet

By The Time You Finish Looking at This Chart, 2.4 mn Snaps Will Have Been Sent on Snapchat

Source: BofA Global Research, February 28, 2023

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ChatGPT- The fastest growing consumer application in history

Time To Reach 100 Million Users Worldwide

Artificial intelligence is an umbrella term for many technologies

Info to central brain to learn

Neural networks

Processing power

Cognitive Computing

Artificial Intelligence

Machine Learning

Robots

Natural Language Processing

Text

Source: UBS. March 2, 2018

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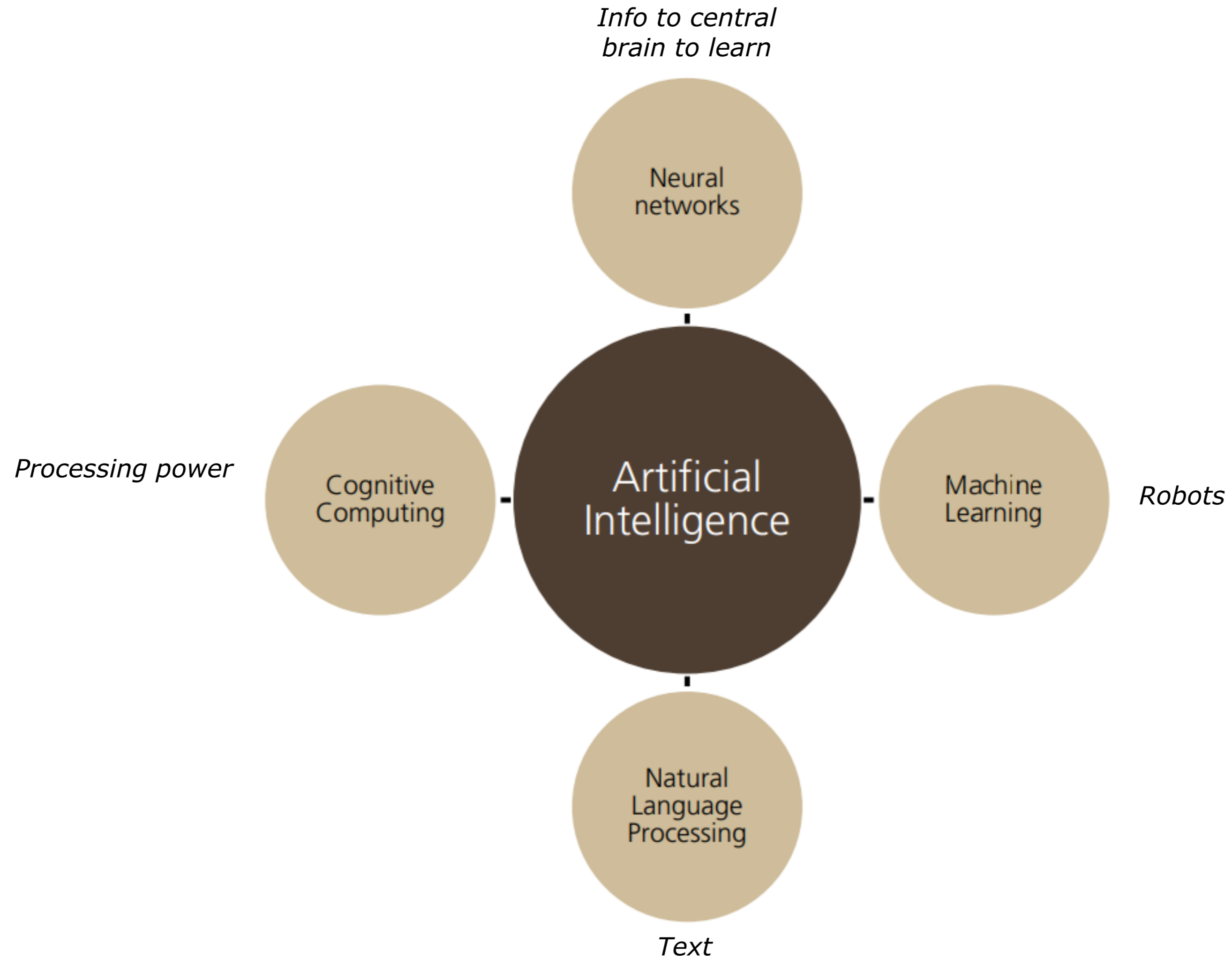
A large language model is a transformer-based neural network which predicts the text that is likely to come next
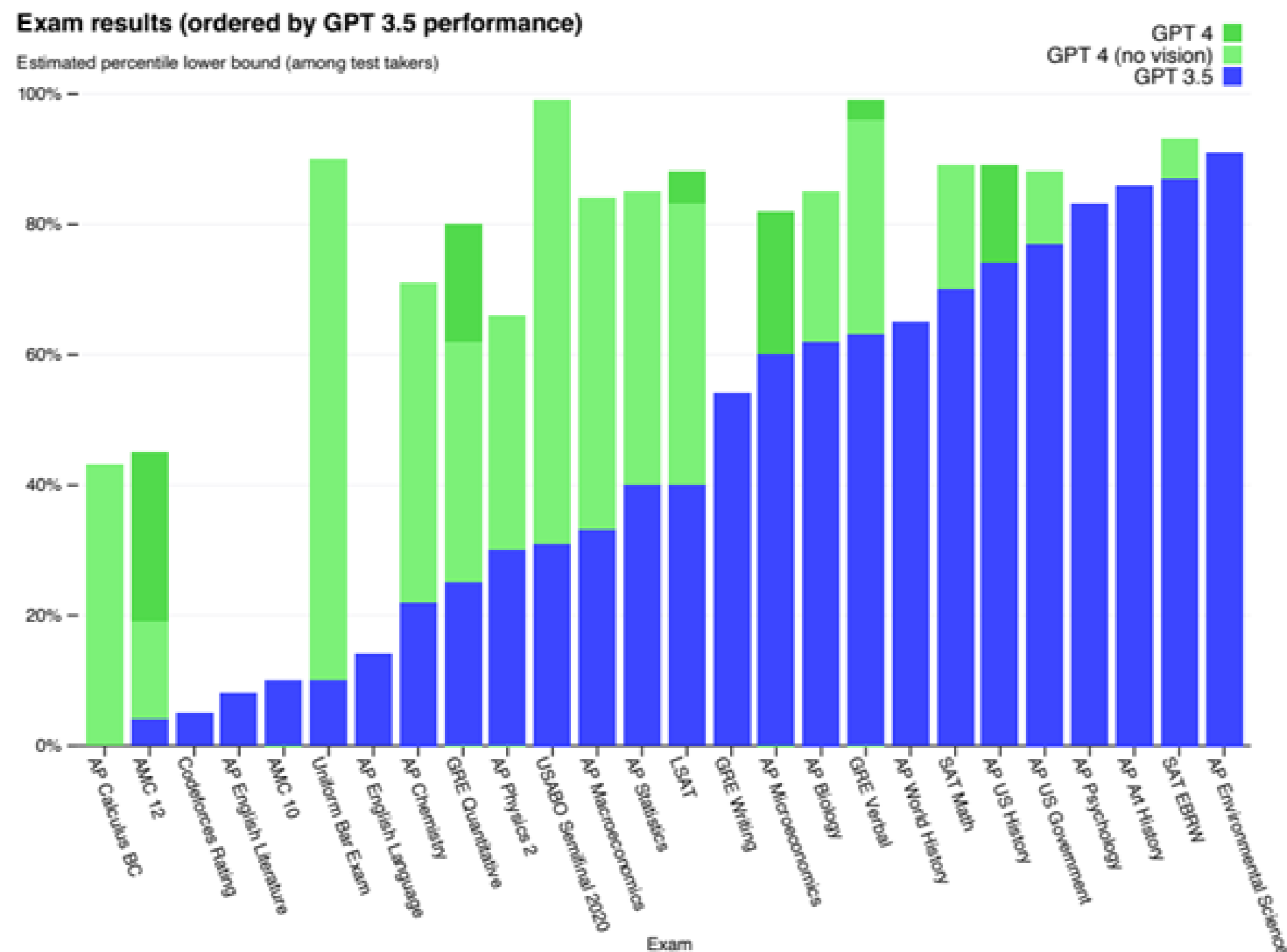
Foundation or Large Language Models Can Centralize Information From Several Data Modalities To Adapt to a Wide Range of Tasks From Answering Questions to Extracting Information and Identifying Images
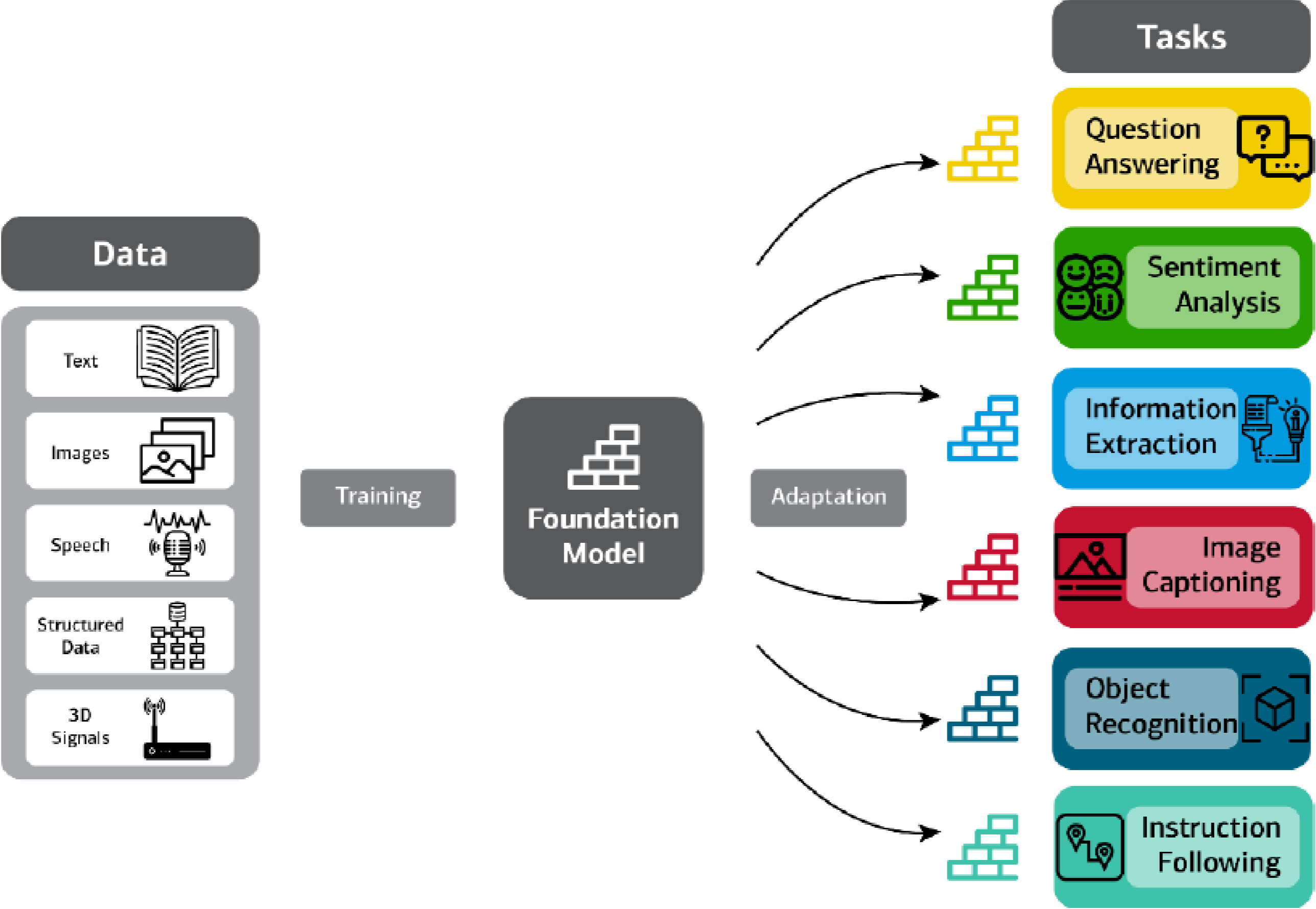
Professors resorting to blue books and pencils

GPT-4 vs GPT-3.5 Exam Results

Exam results (ordered by GPT 3.5 performance)

Estimated percentile lower bound (among test takers)

Legend: GPT 4 (dark green), GPT 4 (no vision) (light green), GPT 3.5 (blue)

Exams (x-axis): AP Calculus BC, AMC 12, Codeforces Rating, AP English Literature, AMC 10, Uniform Bar Exam, AP English Language, AP Chemistry, GRE Quantitative, AP Physics 2, USABO Semifinal 2020, AP Macroeconomics, AP Statistics, LSAT, GRE Writing, AP Microeconomics, AP Biology, GRE Verbal, AP World History, SAT Math, AP US History, AP US Government, AP Psychology, AP Art History, SAT EBRW, AP Environmental Science
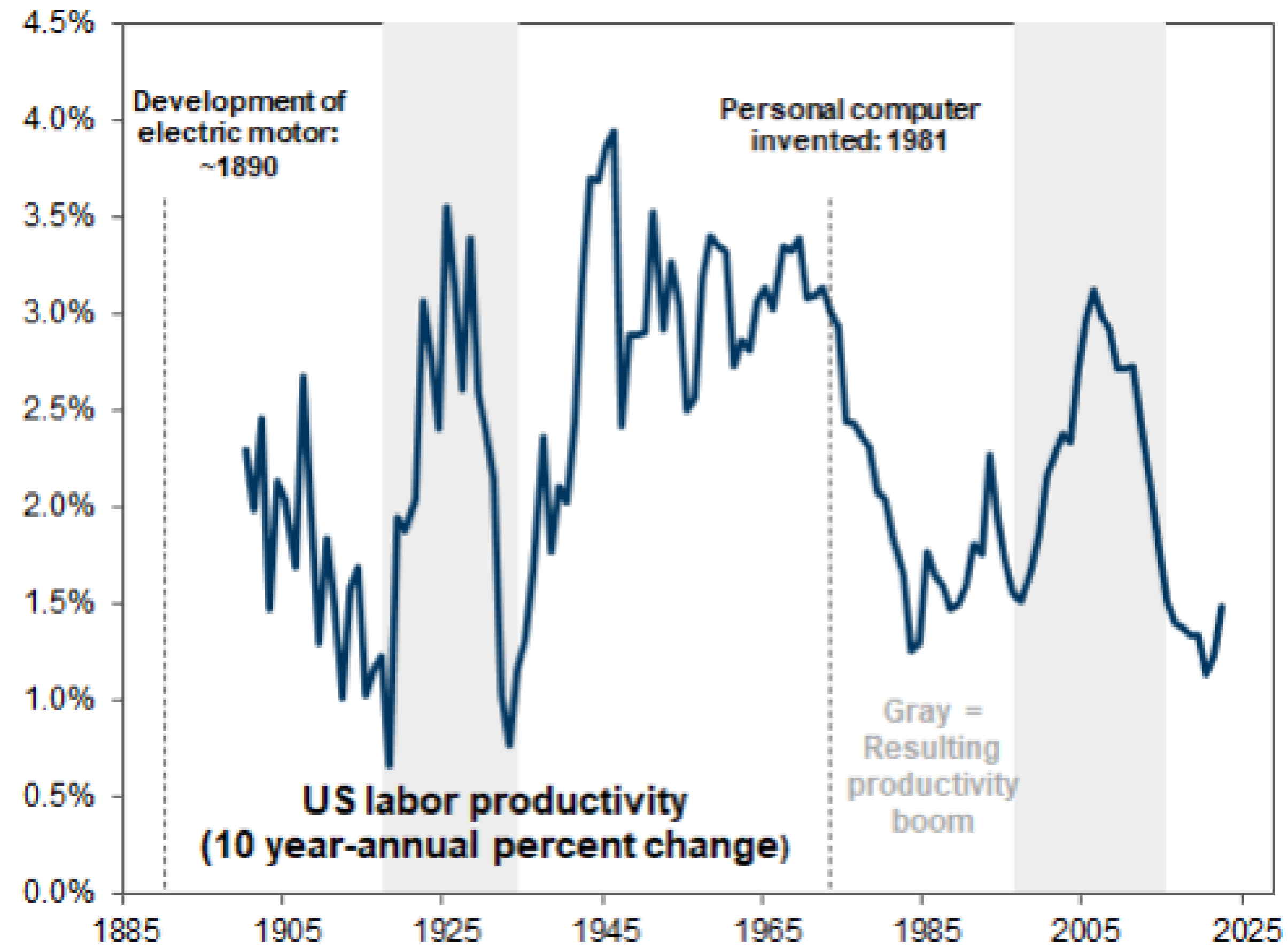
We've got a labor supply problem

Labor Supply Could Remain Challenged As Working Age Populations Fall in Developed Markets and China

Source: UN Population Prospects, Evercore ISI Research. June 22, 2023
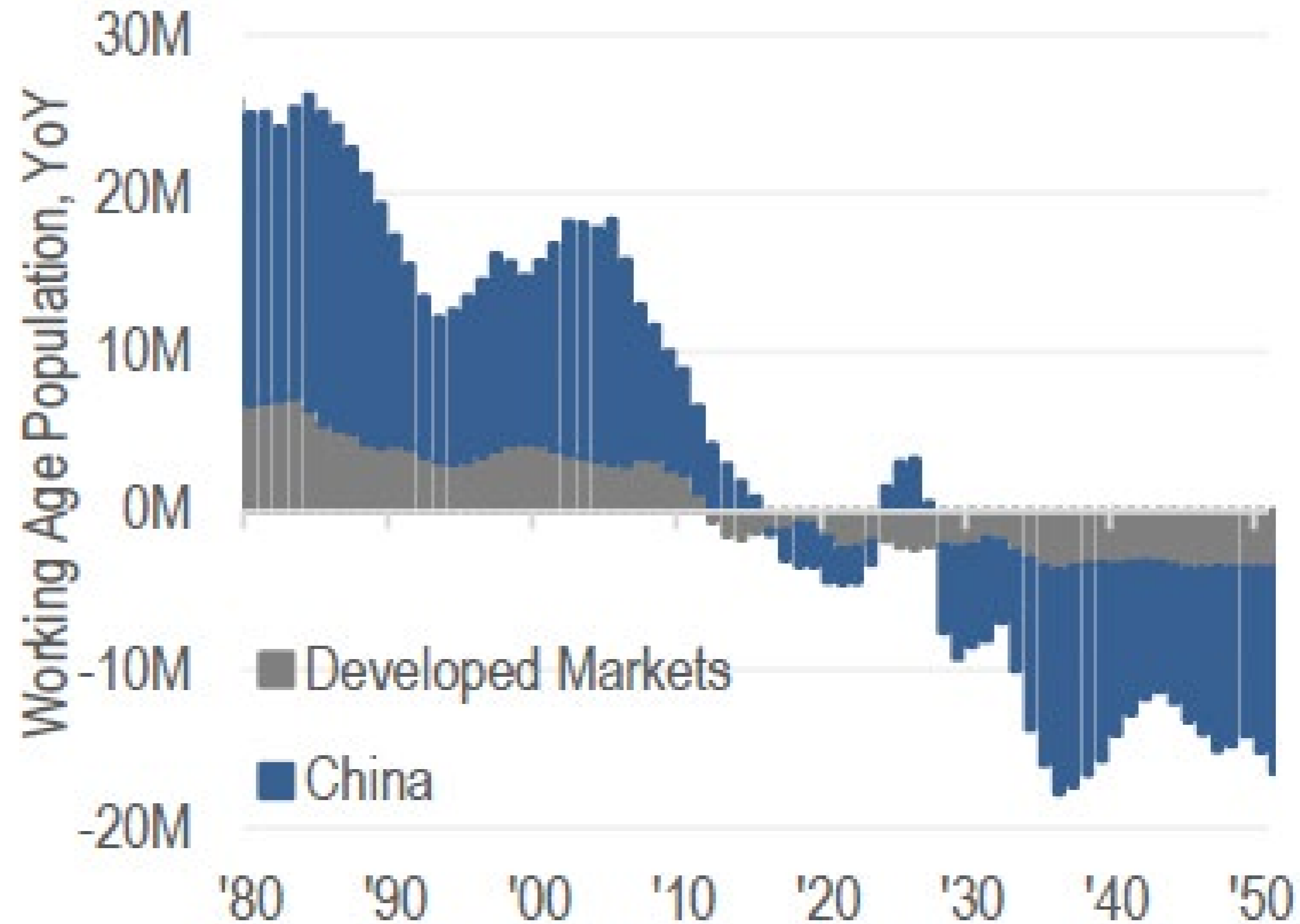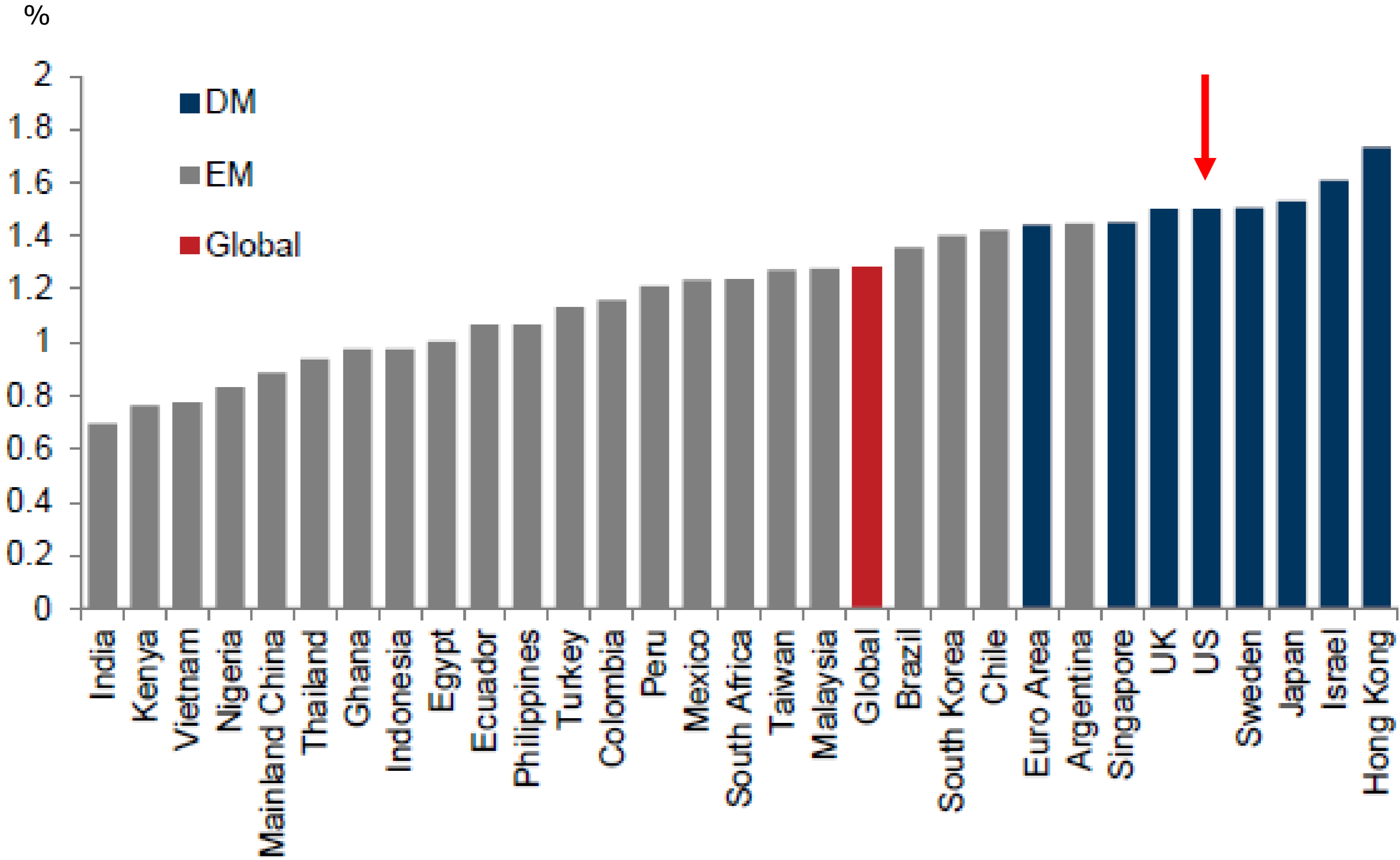
We've got a productivity problem

Historical 10-Year Annual Productivity

Source: U.S. Bureau of Labor Statistics, Goldman Sachs Global Investment Research. July 17, 2023

AI adoption could boost productivity growth >1%/yr over 10 yrs

Effect of AI Adoption on Annual Productivity Growth, 10yr Adoption Horizon
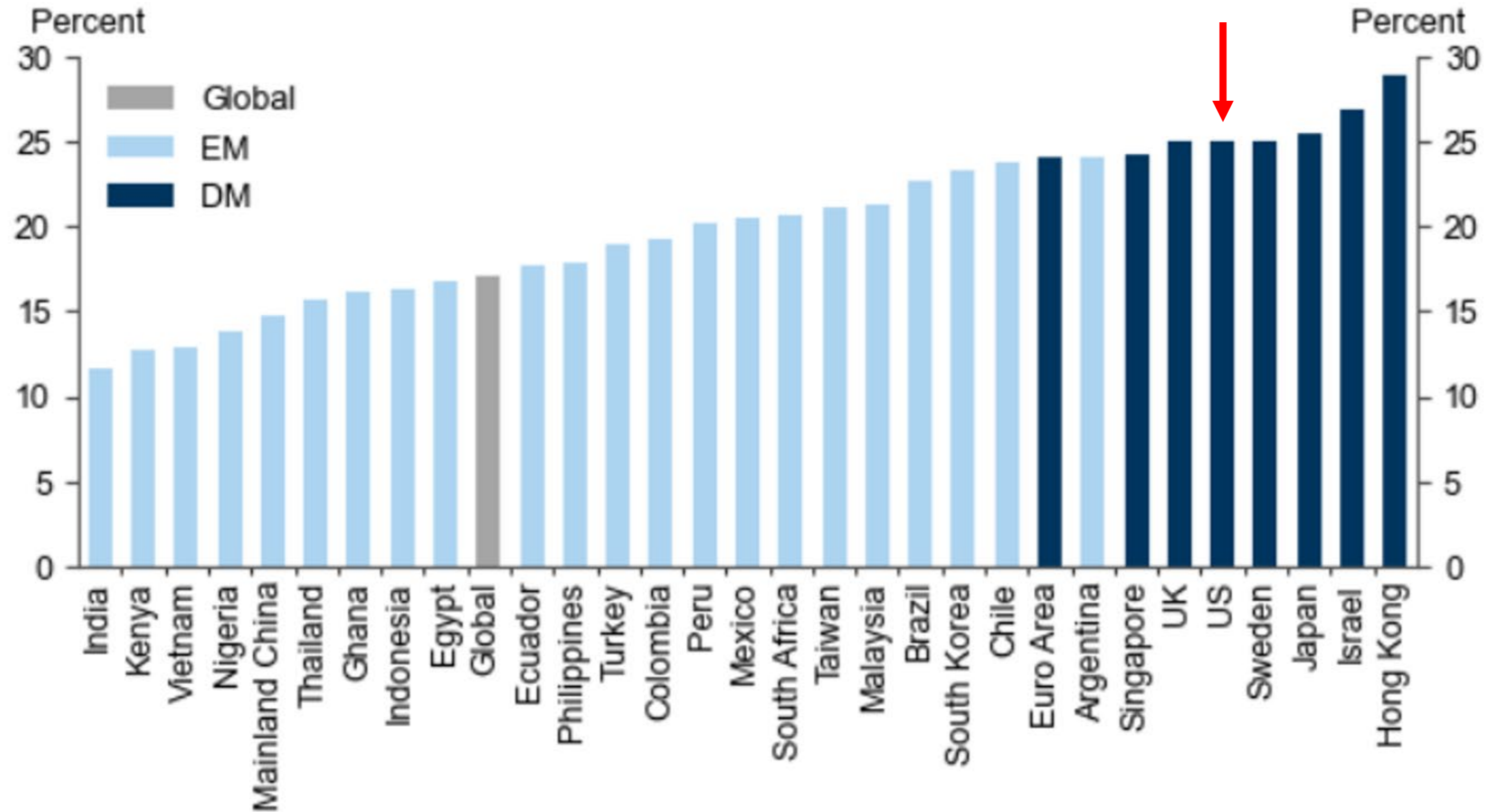

Source: Goldman Sachs GIR. July 5, 2023

Jobs Winners & Losers

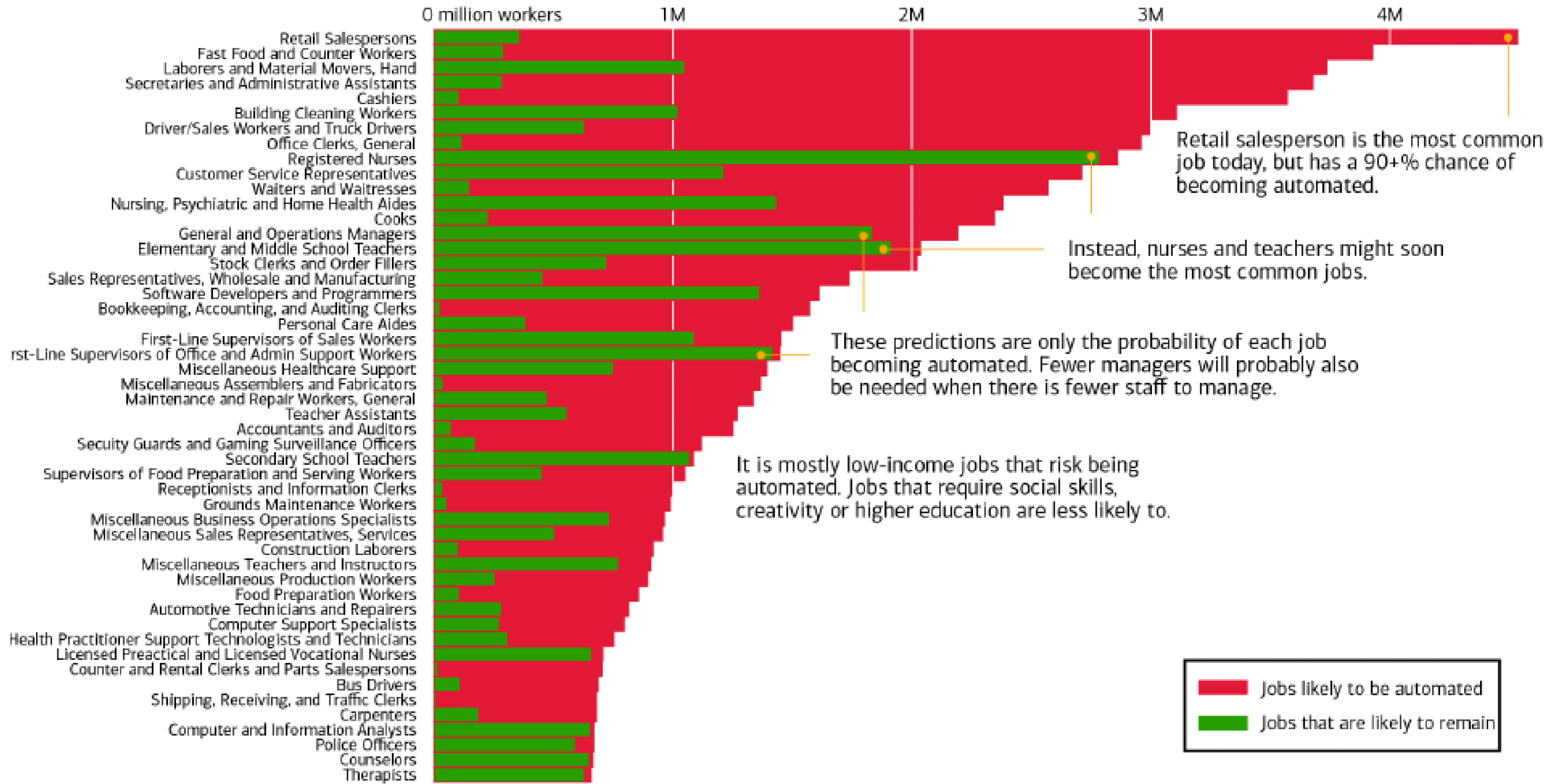# Lots of work could be automated by AI, especially in DMs

Share of Full-Time Equivalent Employment Exposed to Automation by AI

Source: Goldman Sachs Global Investment Research. March 26, 2023
Note: DM stands for Developed Market, EM stands for Emerging Markets

Future of employment: Forget the mall, become a nurse or a teacher

Likelihood of Job Automation (Today vs Next 20 Years) Where Green Bars Denote Jobs Likely To Remain

Retail salesperson is the most common job today, but has a 90+% chance of becoming automated.

Instead, nurses and teachers might soon become the most common jobs.

These predictions are only the probability of each job becoming automated. Fewer managers will probably also be needed when there is fewer staff to manage.

It is mostly low-income jobs that risk being automated. Jobs that require social skills, creativity or higher education are less likely to.

Jobs likely to be automated
Jobs that are likely to remain

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Sectors with more routine/limited training tasks at higher risk of automation

Estimated Net Job Creation by Industry Sector, 2017-2037

Source: BofA Global Research Estimates, PWC. February 28, 2023

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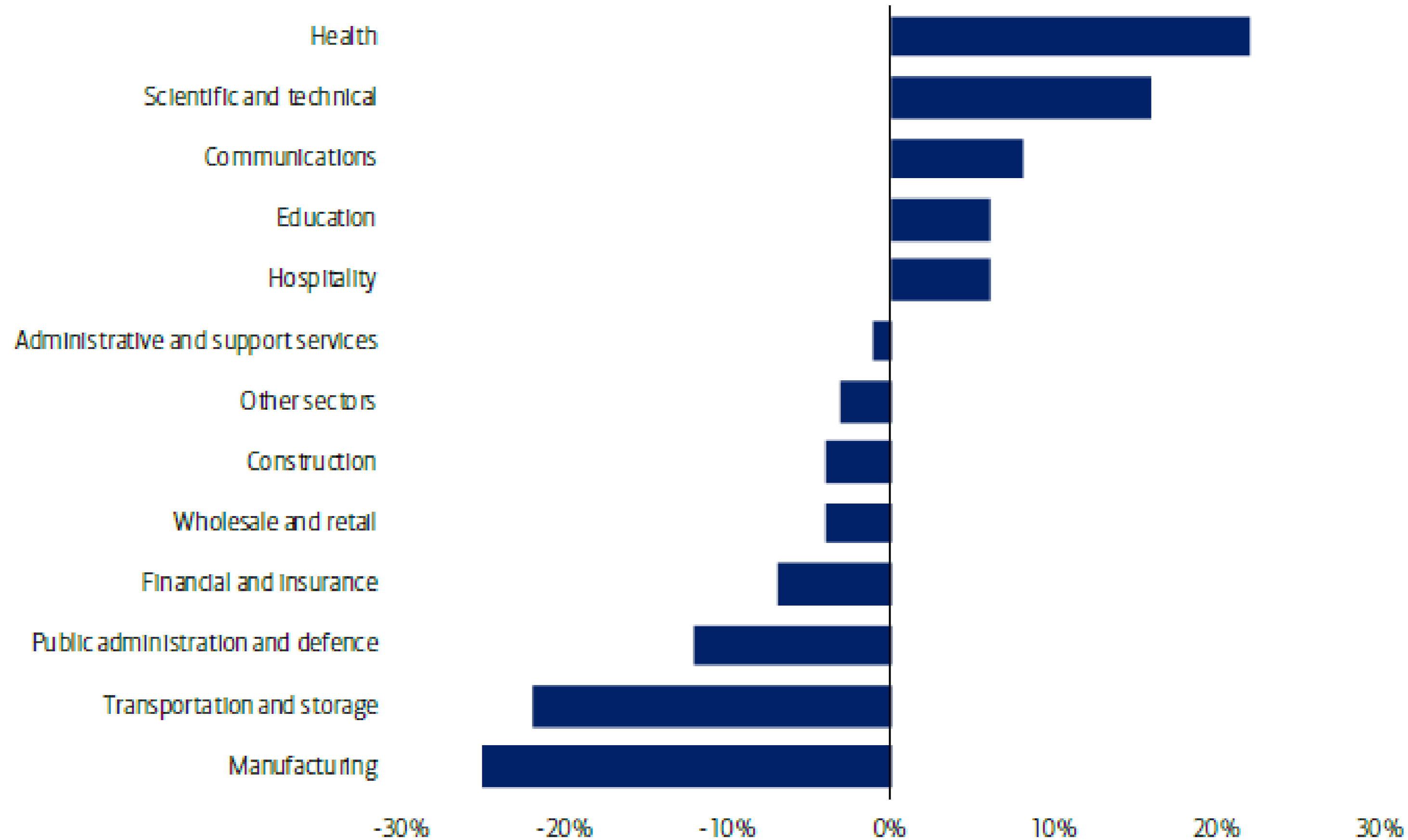
Generative AI holds tremendous potential to transform work-share of tasks

Generative AI's Potential To Transform (Industry Average)

- Higher potential for automation
- Higher potential for augmentation
- Lower potential for augmentation or automation
- Non-language tasks

31% — 9% — 22% — 38%

Source: Citi Group Inc. July 10, 2023
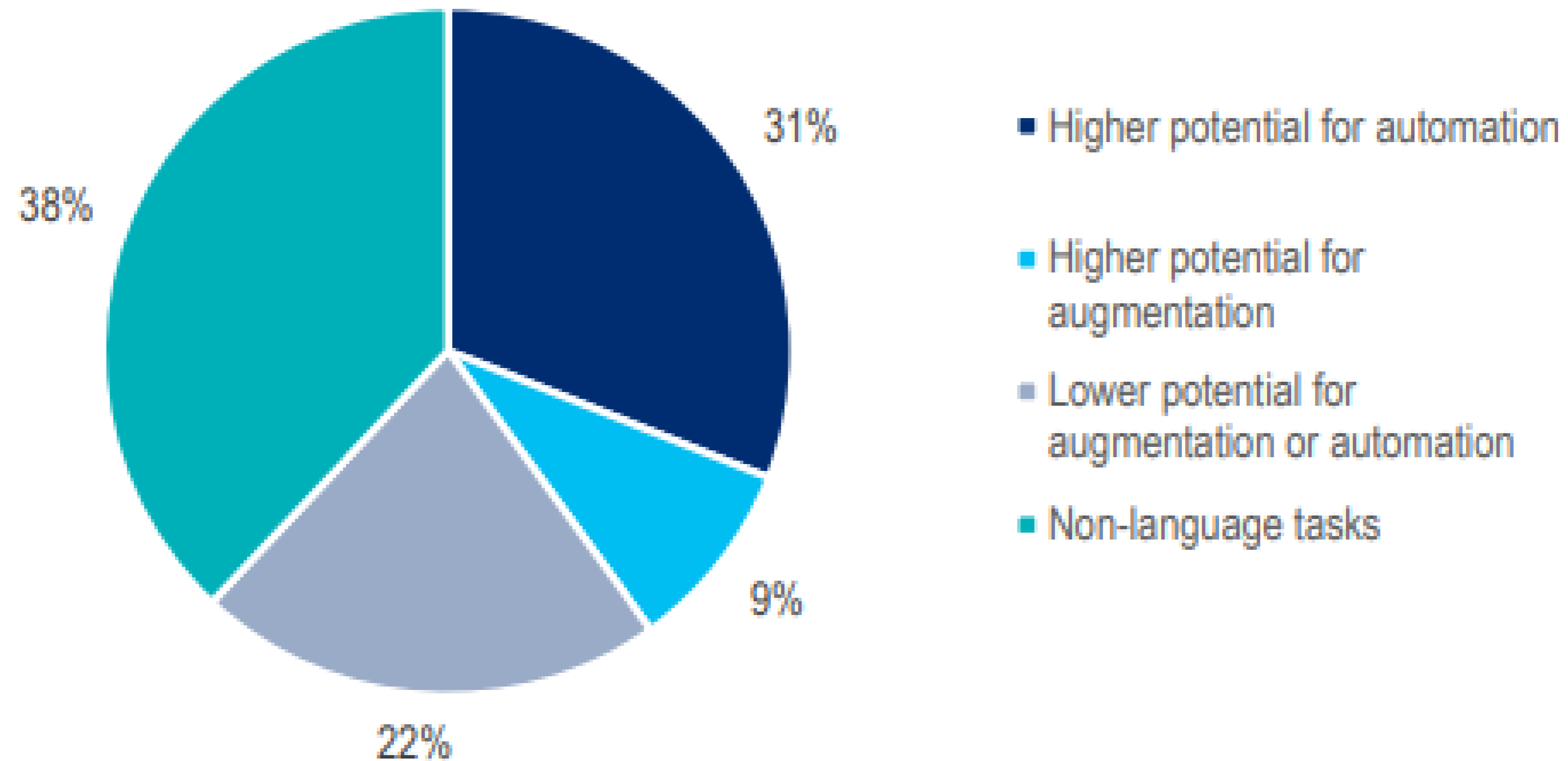
Companies likely to significantly increase AI use over time

Estimated % of Enterprises Implementing AI-Augmented Development and Testing Strategies
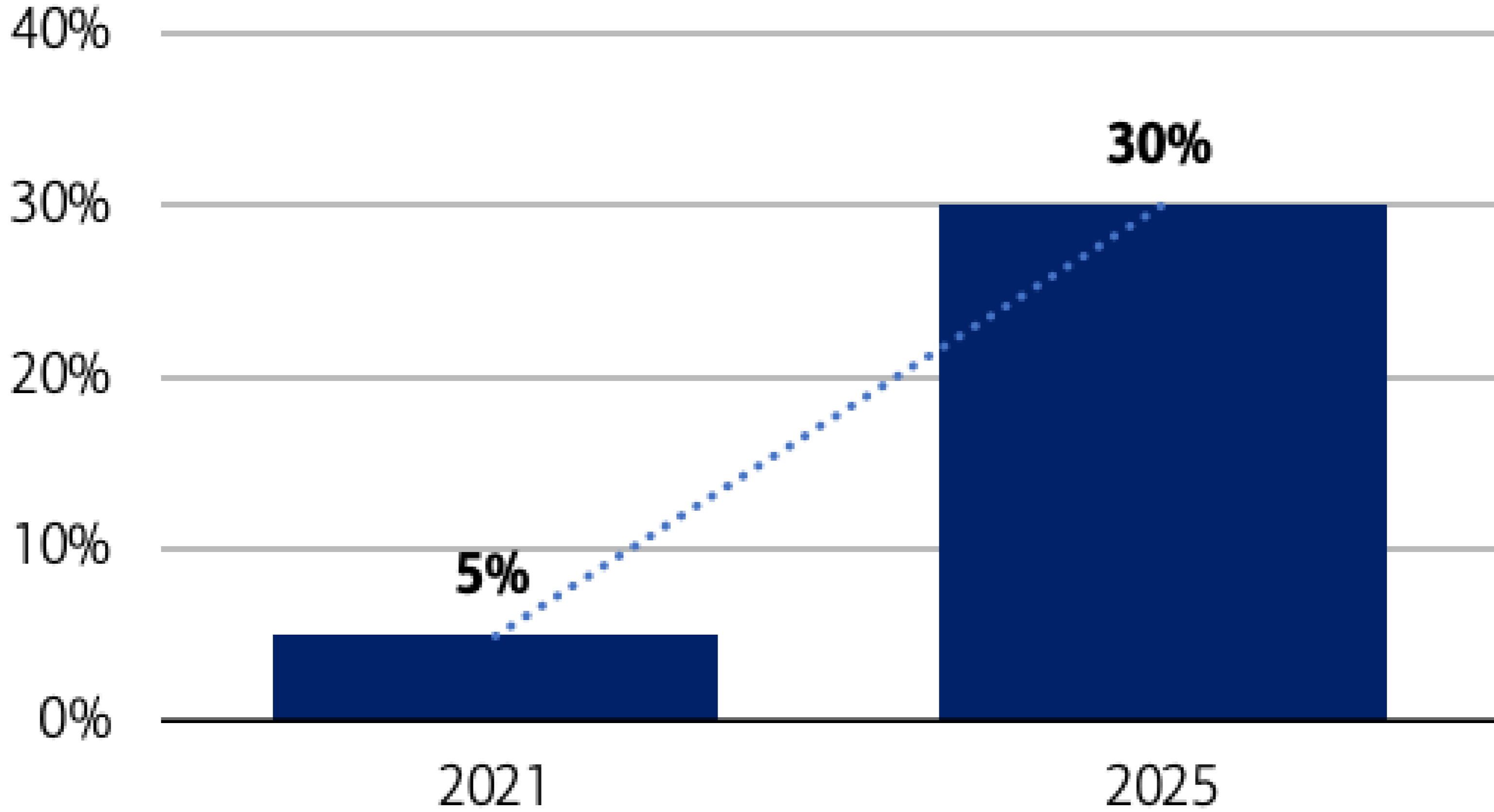
Source: BofA Global Research, Gartner *A.I./M.L. = Artificial Intelligence/Machine Learning. July 6, 2023

AI revolution in the workplace

Generative AI Will Transform Work Across Industries

Higher Potential for Automation

Higher Potential for Augmentation

Software & Platforms
Communication & Media
Capital markets
Insurance
Banking
Aerospace & Defense
Health
High Tech
Public Service
Industry Average
Life Sciences
Retail
Industrial
Travel
Utilities
Automotive
Energy
Natural Resources
Chemicals
Consumer Goods & Services
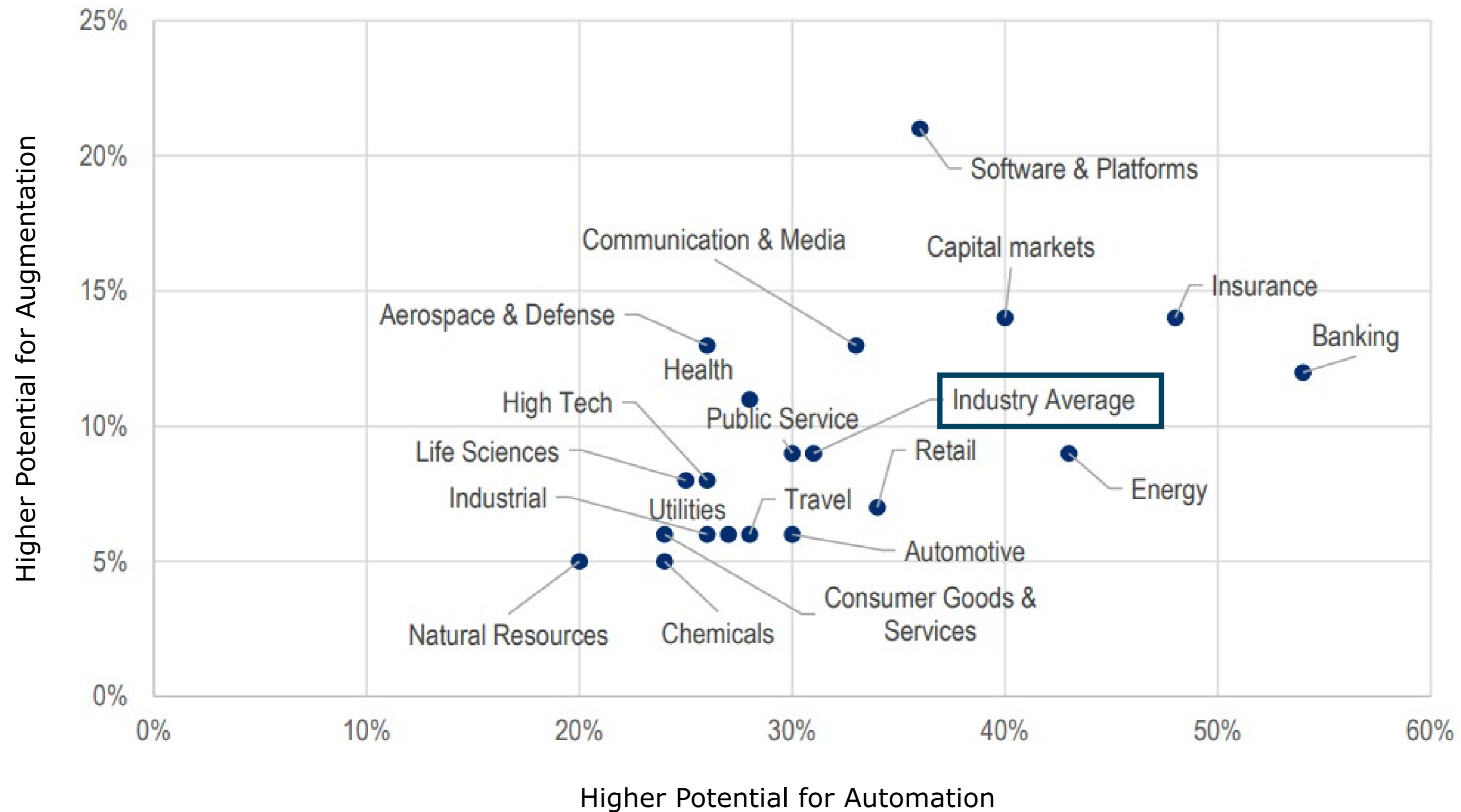
The highest paying jobs are most exposed to AI disruption!

U.S. Occupations
AI Exposure Versus Wage Rank* 2010 Through 2018
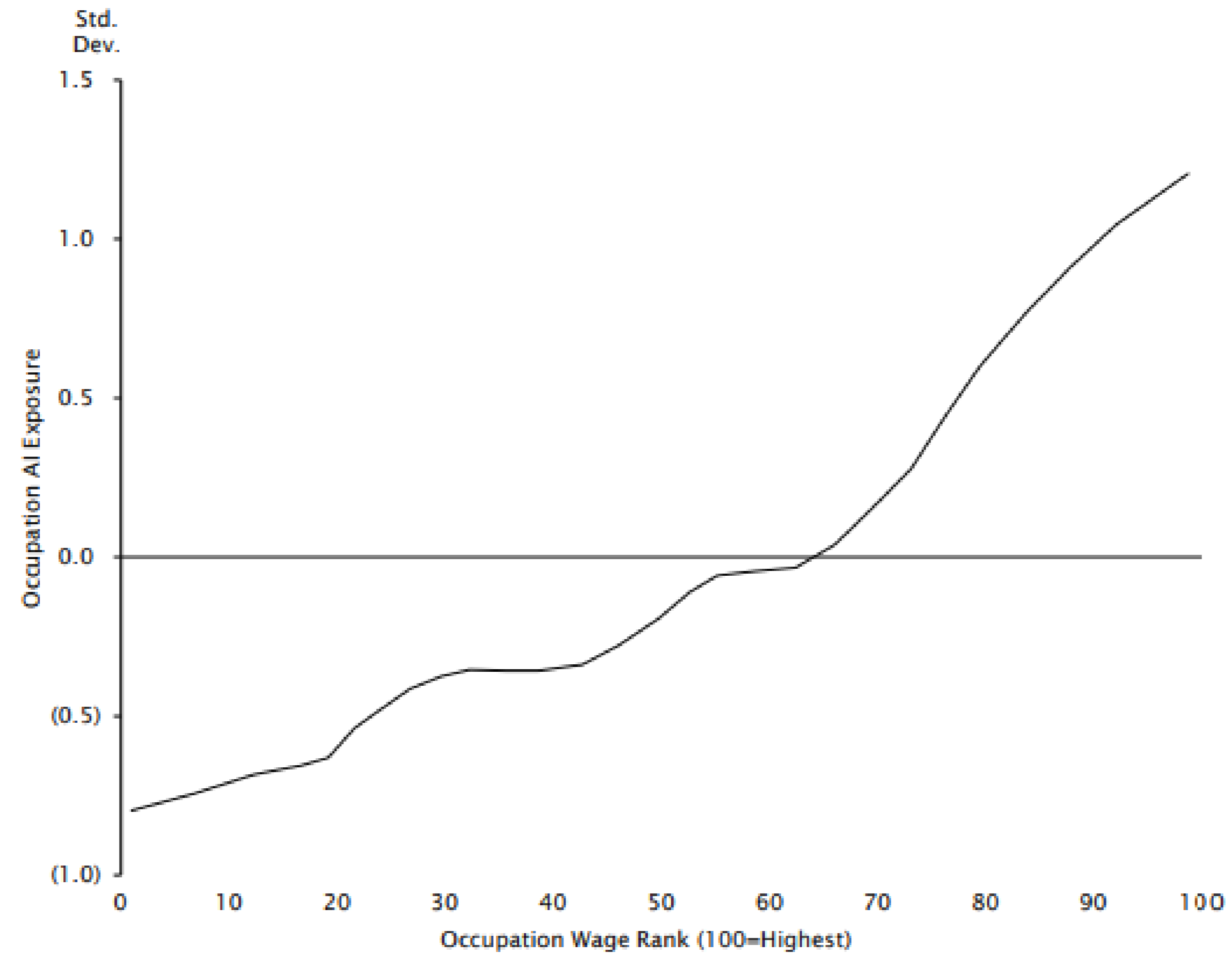
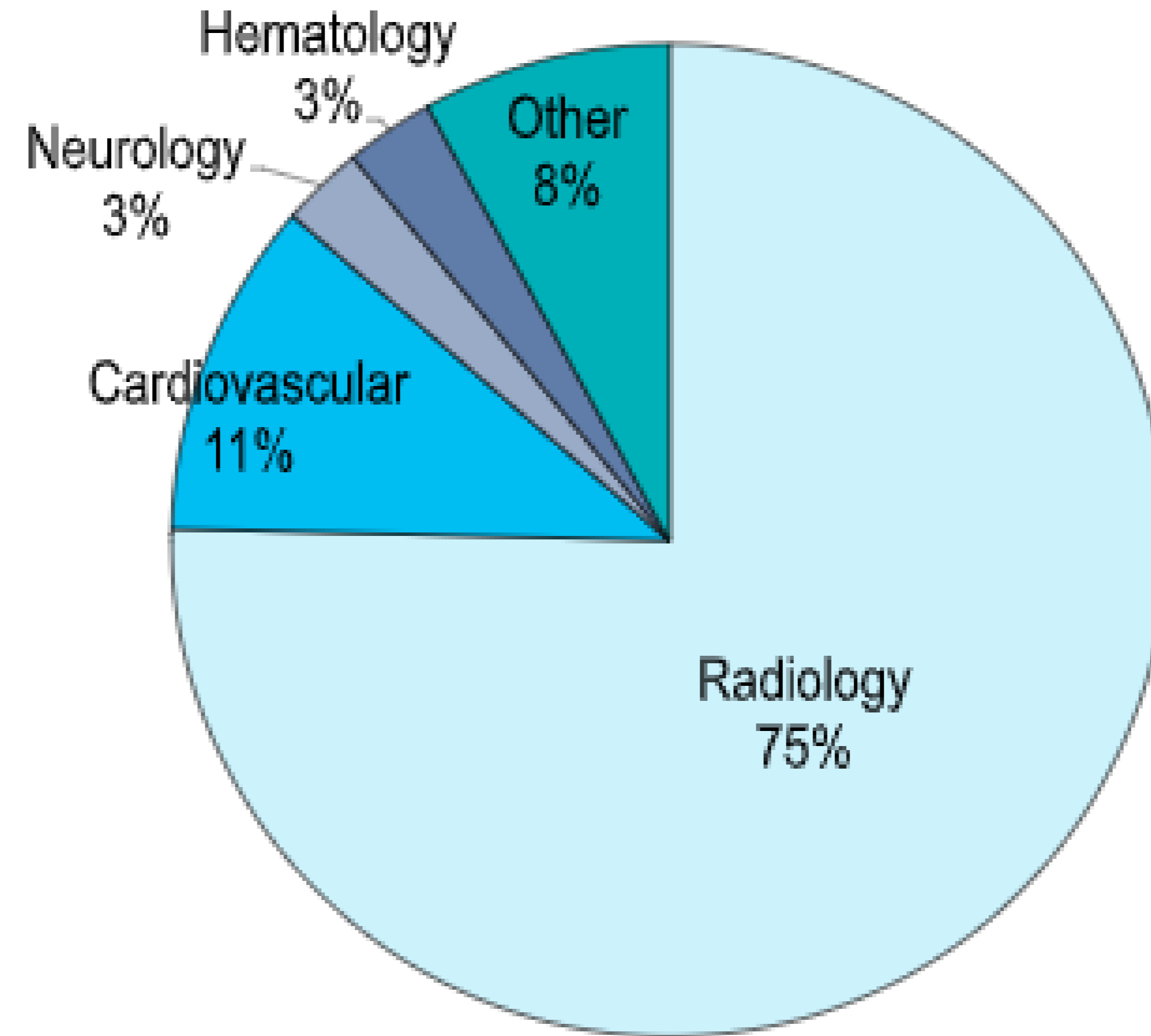# AI in Automobiles

Every Car Will Generate 4TB of Data Everyday...Excluding the Data From All These Cars Communicating

Source: Intel. BofA Global Research. February 28, 2023
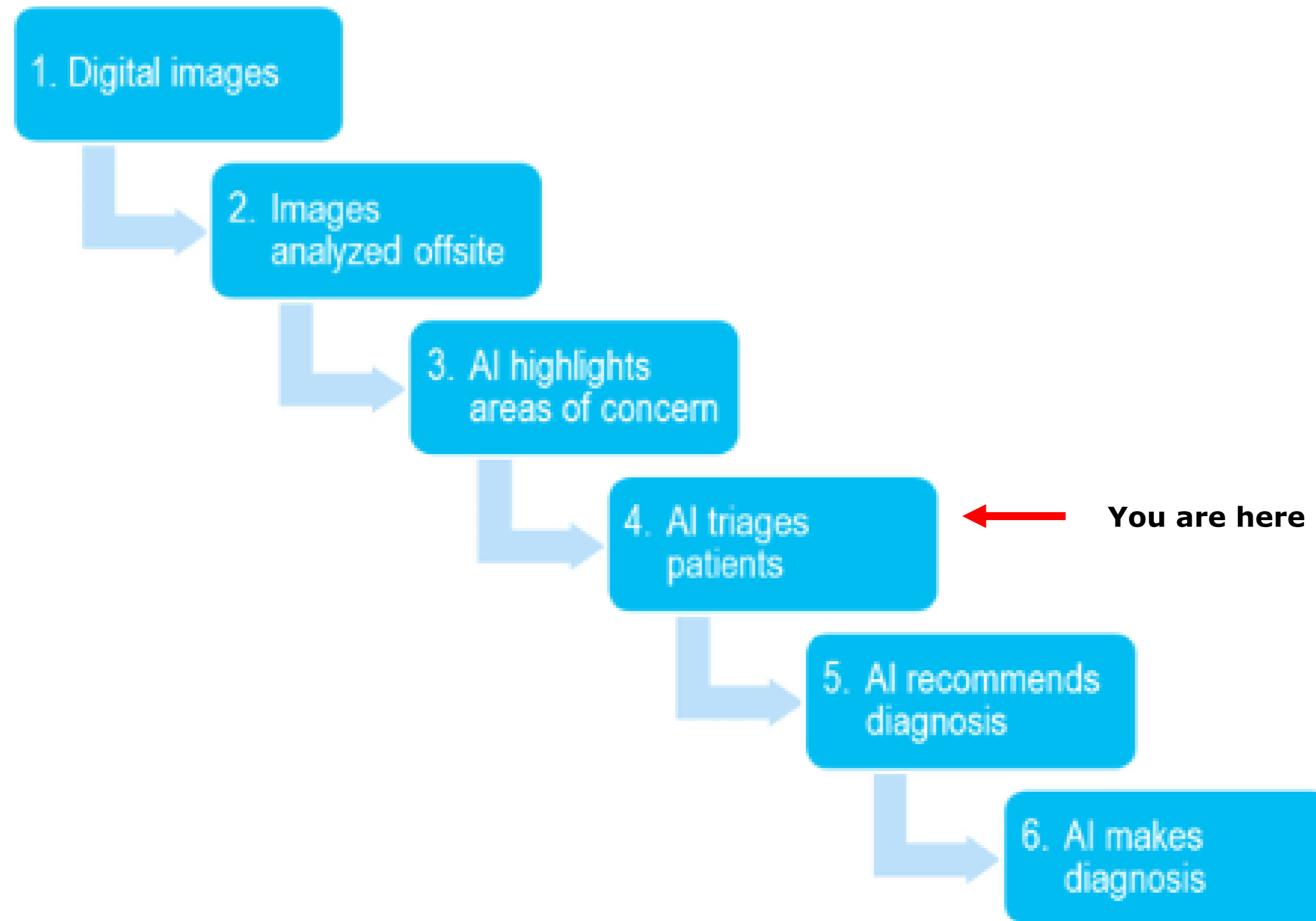
AI in healthcare-medical AI products

AI-Enabled Devices—Branch of Medicine Served

Most current AI solutions stop at stage 4; stage 6 may be decades away

Stages of Automation in Radiology

You are here

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AI can help with almost every aspect of biopharma

Biopharma Process and Impact of AI

Understanding the biology
- How does a particular disease evolve?
- Is there a "target" (e.g. in a protein) where a molecule interrupt the process

Transformers "understand" large molecules like DNA, RNA and proteins

2. Developing candidate molecules
- Traditionally informed trial & error
- Thousands of molecules synthesized over many years

AI helps researcher "design" molecules rather than "discovering" them

3. Clinical trials
- Av duration 10½ years in total
- 92% of candidate drugs fail

AI can speed trials by finding participants more quickly

4. FDA approval

5. Marketing approved drugs
- Quasi monopoly
- High margins

Machine Learning can improve supply chain logistics

6. Patent expiry

AI in agriculture

AI Could Reduce ~40% of Farmer Cost Structure

40% of the Production Cost is Susceptible to Disruption

Land: 23%
Machinery: 19%
Fertilizer: 17%
Seed: 14%
Labor: 5%
Chems: 5%
Other Overhead: 5%
Other Operating: 4%

Source: Bernstein Analysis. May 2023

AI in online grocery

| Online grocery technology value chain	FRONT-END	INVENTORY MANAGEMENT	PICKING	ROUTING	DELIVERY
Online grocery process	Customer browsing & placing an order		Order picked and prepared for delivery		Order out for delivery
Impact of AI	MEDIUM	HIGH	HIGH	MEDIUM	LOW
Impact of AI details	Personalisation of website Better availability of items through inventory visibility Increased basket sizes with personalised interstitials Opportunity to create subscription orders	Improved forecasting Better product availability through single stock view Reduced product wastage Reduced markdowns Optimised grid in real-time based on orders & weather	Collaborative on-grid robots Predictive movements enabling high speed robots Robotic arms removing labour through visual AI	Reactive real-time optimised routing based on weather, traffic etc Flexible order allocation to optimise drops per hour	Autonomous vehicles delivering orders **Automated Guided Vehicles in the warehouse to shuttle products around**

Smart refrigerator

Smart kitchen

User opens smart fridge

Smart fridge suggests a recipe based on the ingredients user picks
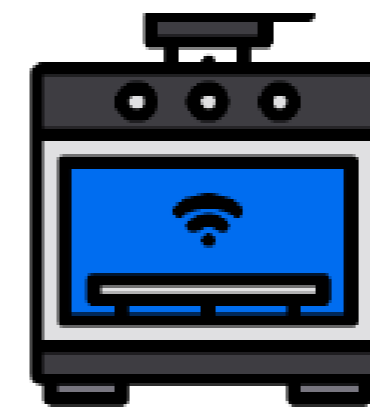
Fridge sends the receipe to smart oven and set temperature automatically
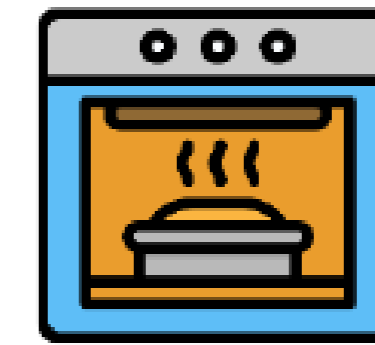
The oven will notify the user when the food is ready

Source: Flaticon, Bernstein Analysis. May 2023

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AI in retail

Try Lipstick Shades Virtually
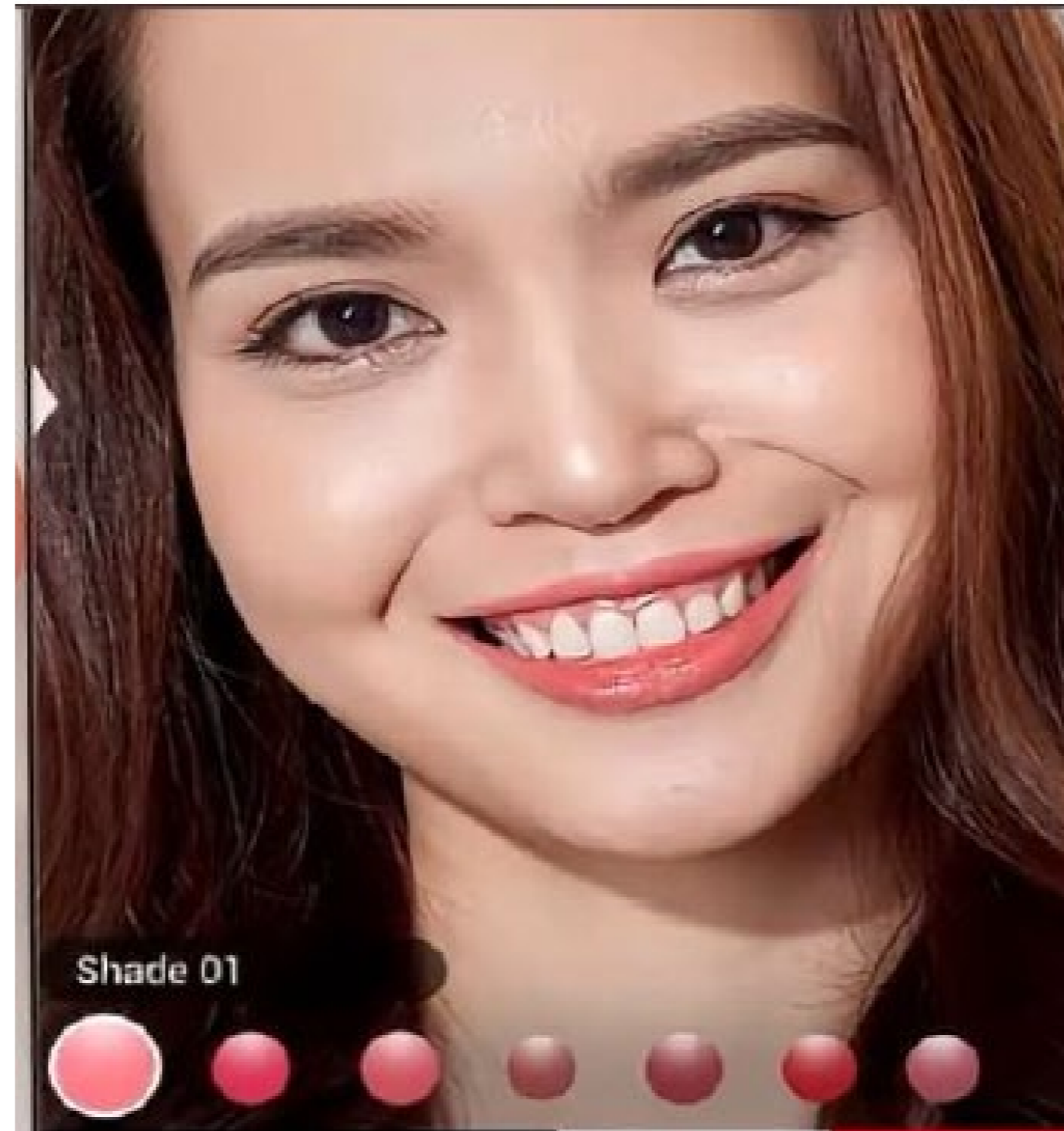
AI in the restaurant industry

Five Critical Areas Drive Maximum Impact in the Shortest Time
AI Use Case Impact Analysis- Illustrative

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AI in fast food

Source: Precitaste, Bernstein Analysis. May 2023

27
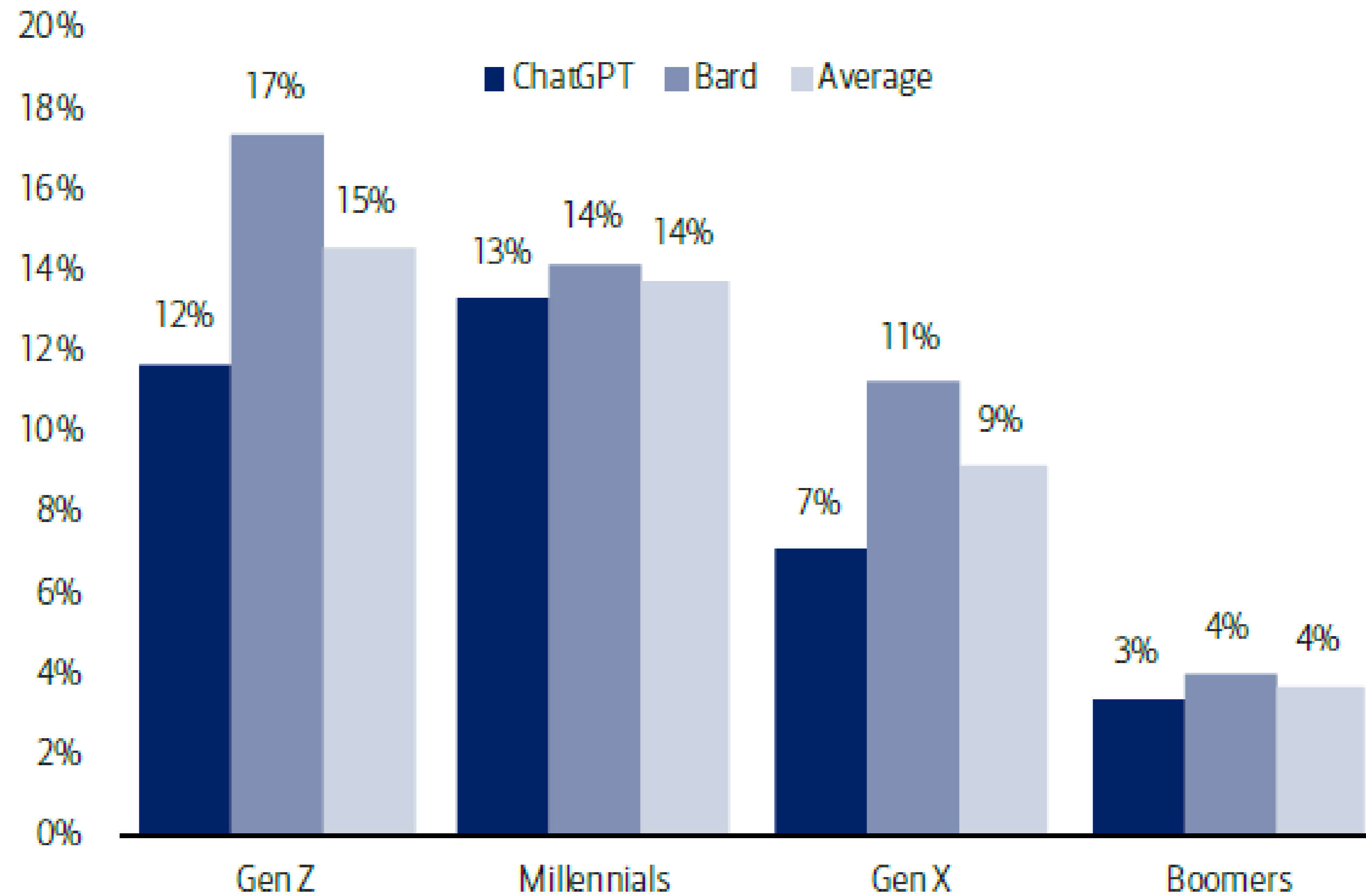
A third of the global population is Gen Z and 9% is Gen C

Share of the Global Population by Generation

Source: UN. BofA Global Research. February 28, 2023

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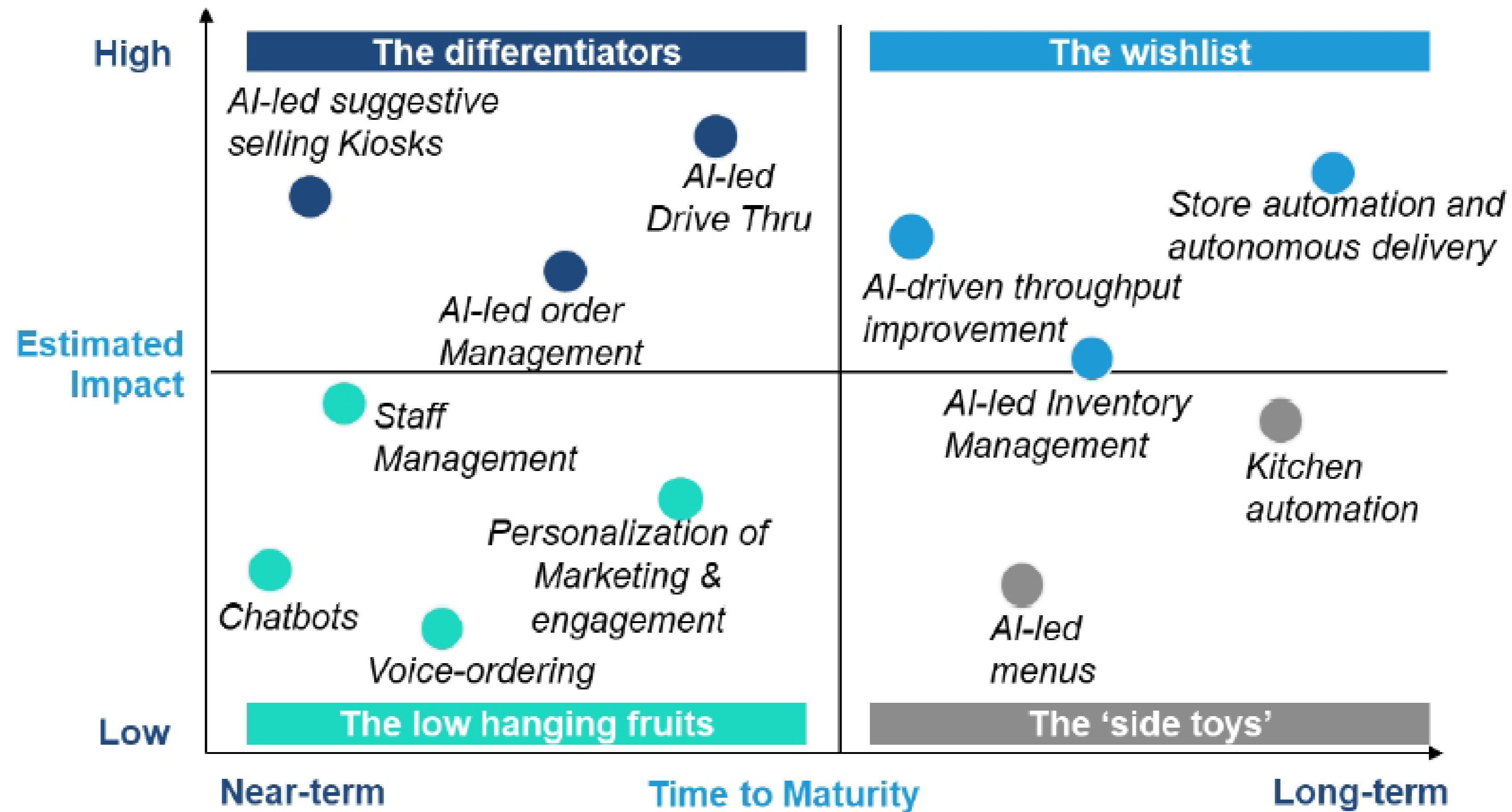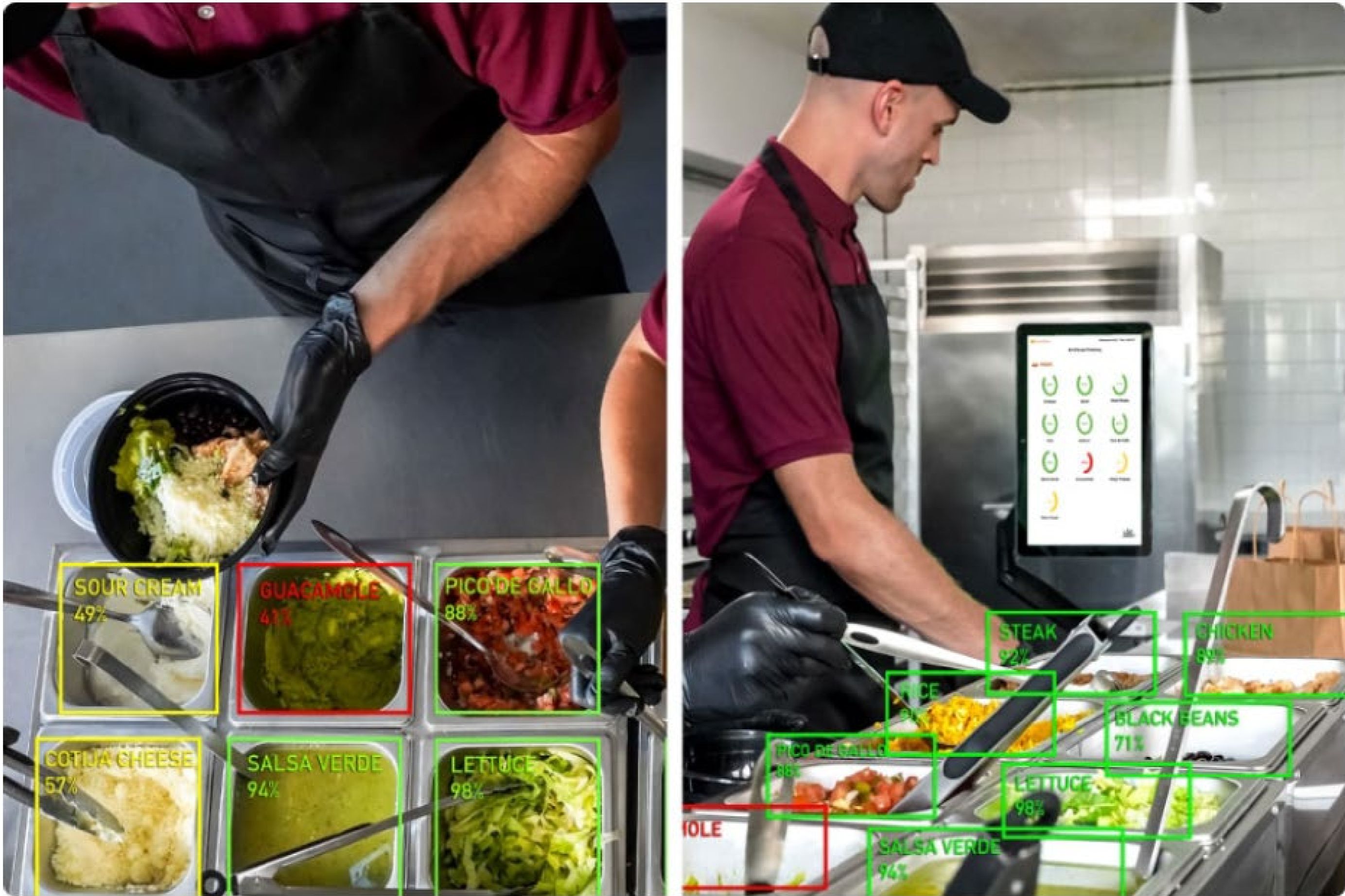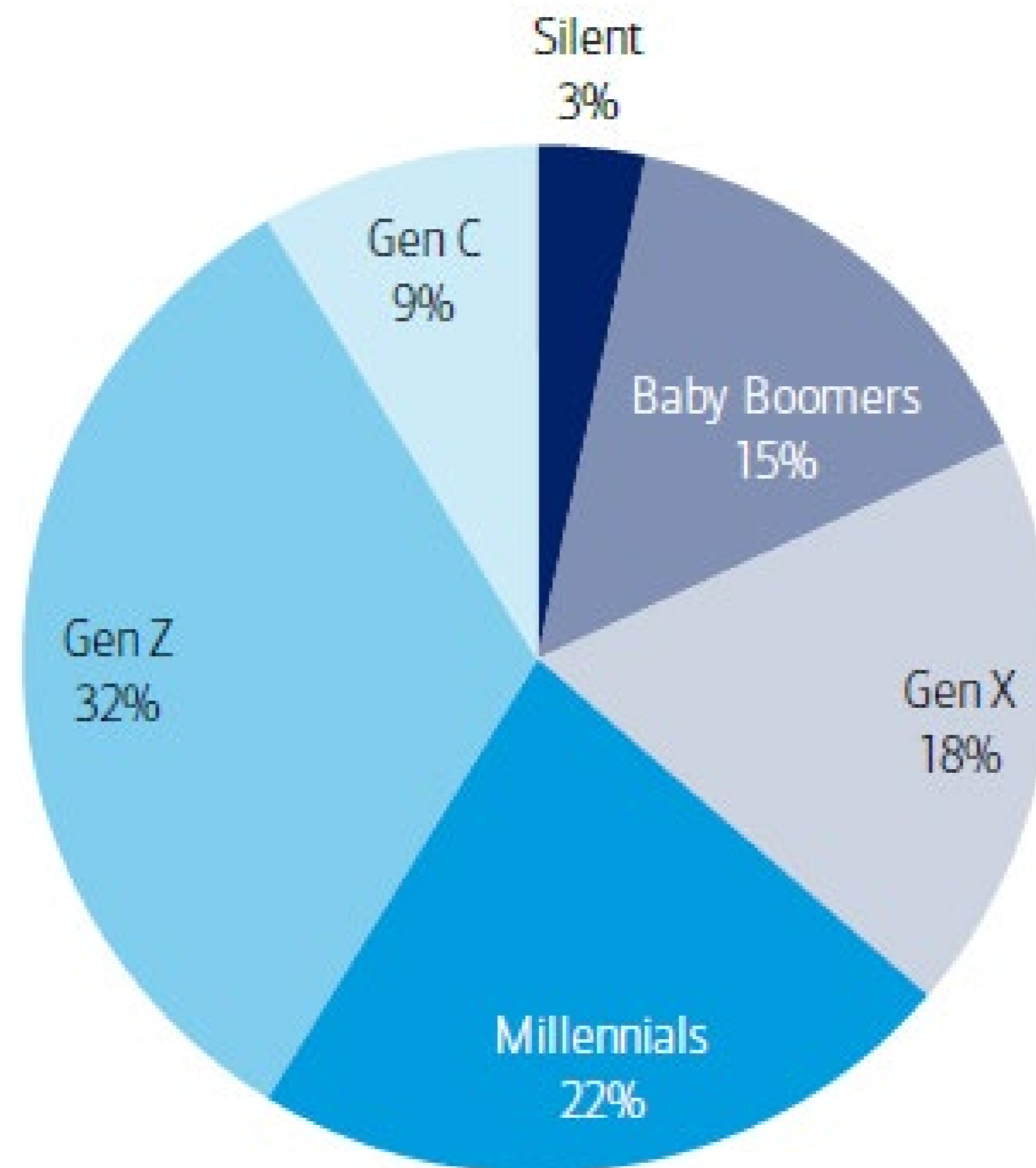# 69% of executives think that cybersecurity is their biggest AI-related risk

Biggest AI-Related Risks U.S. Executives are Currently Facing, January 2022 (% of Respondents)

Risk	%
Cybersecurity	69%
Data privacy	65%
Compliance with various state and local regulations	57%
Legal liability	57%
Lack of understanding the technology	49%
Lack of regulation with clear guidelines	47%
Reliance on third parties that supply the AI algorithms	47%
Organization's reputation	46%
Recruitment fairness/algorithm bias	39%
Physical safety	24%
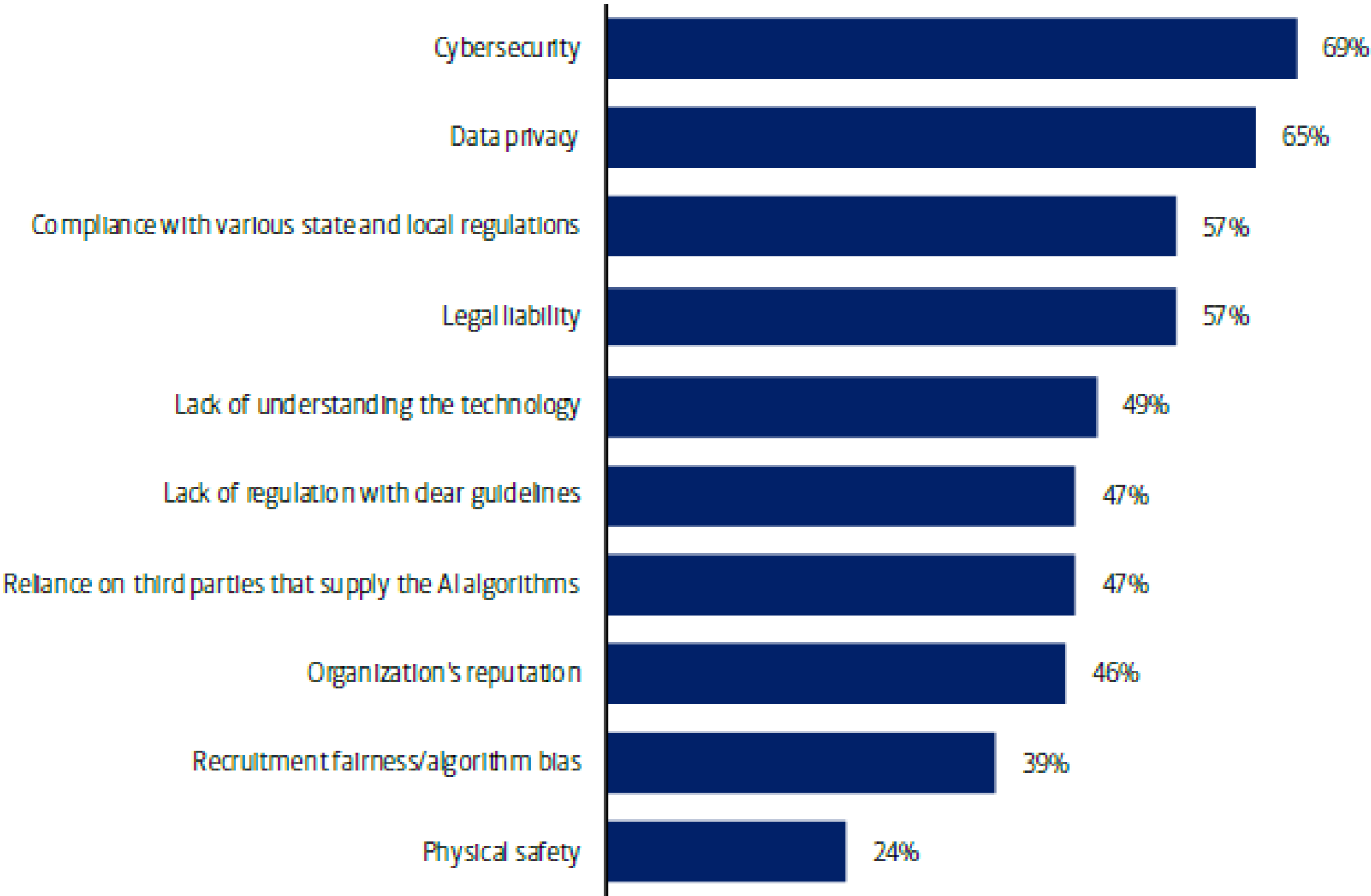
Source: Baker McKenzie, Insider Intelligence, BofA Global Research. February 28, 2023

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Consumers more likely to quickly adopt AI-based tools than institutions

A Simple Decision Tree to Gauge AI Risk vs Opportunity for "Affected" Companies

Question 1: Is the Market Served/Data Set Relied Upon....

Domain-Specific/
Proprietary

General Interest/
Publicly Available

A database's size, relevance and accuracy all improve reliability

Question 2: Is the Client Base Primarily....

Institutional

Consumer

Institutional

Consumer

Less Risk / More Opportunity

More Risk / Less Opportunity

Lots of trust issues

Obstacles to Business Use

Regulatory uncertainty

Cultural inertia

Management resistance

Employee resistance

People-related obstacles

Hallucinations: libel etc. risk

Bias: reputational risk

Data privacy: leak risk

Unclear sourcing: legal/IP risk

Generative AI-specific governance obstacles

Complex tech integration with legacy systems

Need for reliable, tailored, secure data

Limited talent pool

Need to align strategy and stakeholders

Traditional operational obstacles

Source: Deutsche Bank. June 28, 2023

Moore's law* won't catch up with AI and data
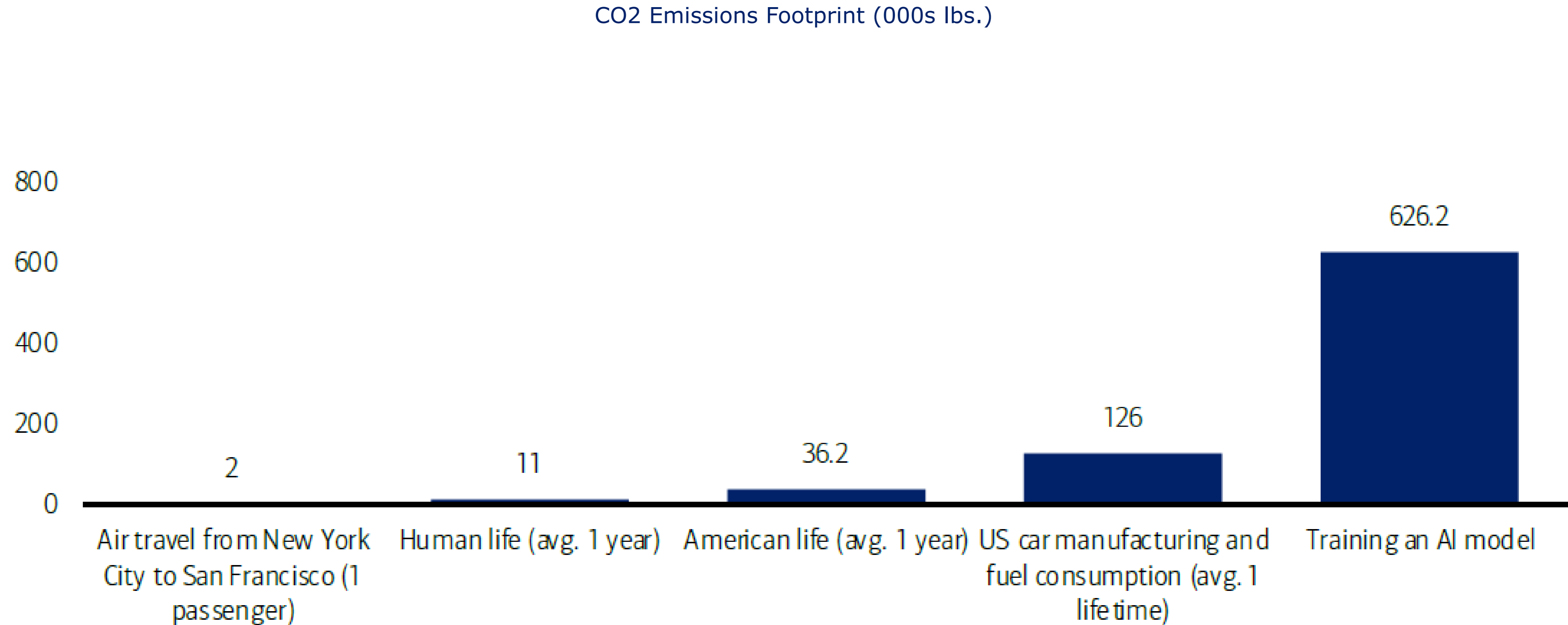
CO2 Emissions Footprint (000s lbs.)

Category	Value
Air travel from New York City to San Francisco (1 passenger)	2
Human life (avg. 1 year)	11
American life (avg. 1 year)	36.2
US car manufacturing and fuel consumption (avg. 1 lifetime)	126
Training an AI model	626.2

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Substantial reforms have made the FDA much more innovation-friendly

Assessment of Whether U.S. and EU Regulators Have Responded Well to Digital Technology

- ■ US respondents' view of US regulation
- ■ EU respondents' view of EU regulation

	Strongly Agree				Strongly Disagree
US	19%	45%	29%	5%	3%
EU	6%	28%	23%	26%	17%
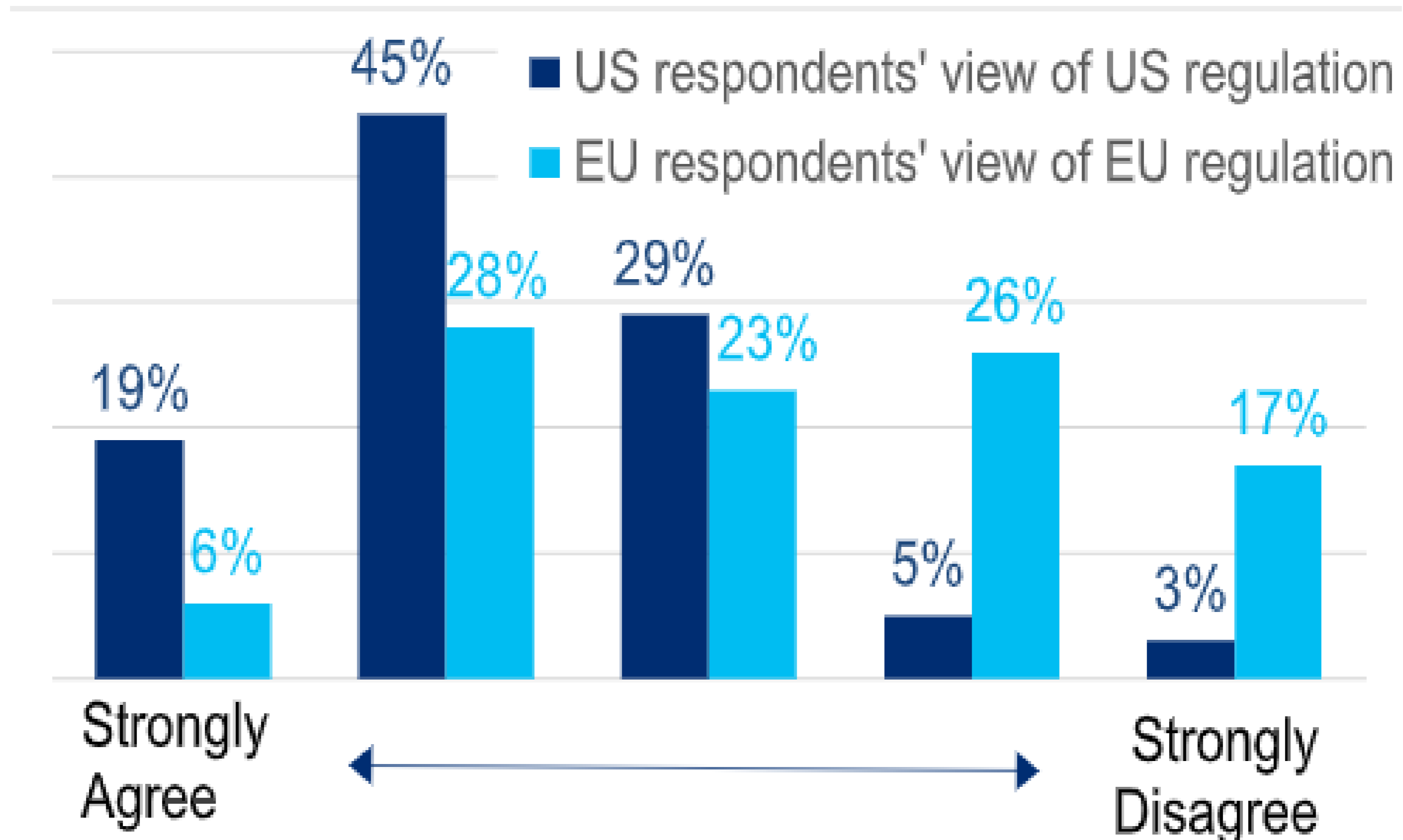
China leads the world in industrial robot installation…

Number of Industrial Robots Installed in 2021

Country	Value
China	268.2
Japan	47.2
United States	35.0
South Korea	31.1
Germany	23.8
Italy	14.1
Taiwan	9.6
France	5.9
Mexico	5.4
India	4.9
Canada	4.3
Thailand	3.9
Singapore	3.5
Spain	3.4
Poland	3.3
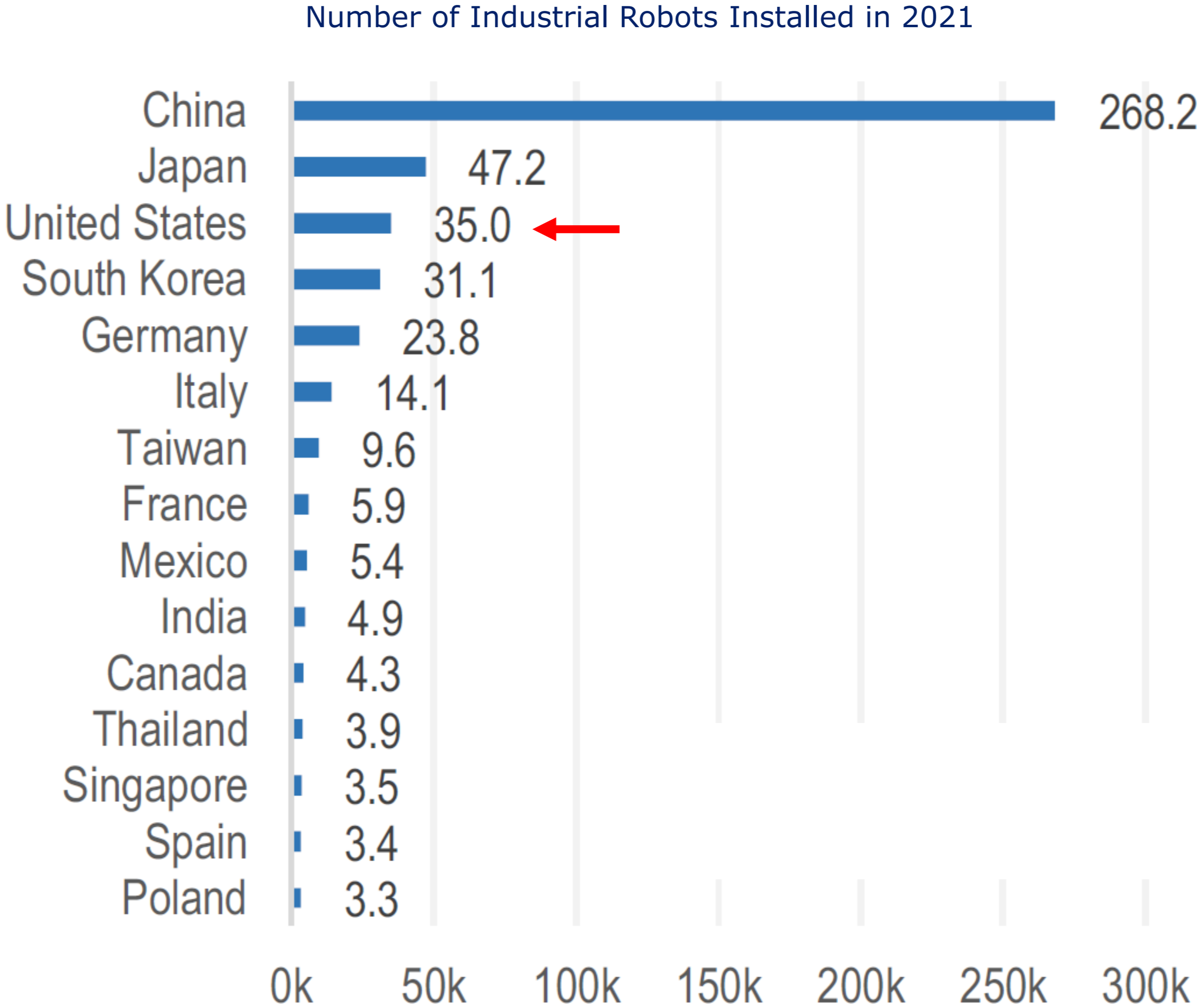
Source: IFR, Stanford AI Index, Evercore ISI Research. June 22, 2023

...And more robots than the rest of the world combined

Number of Industrial Robots Installed In 2021
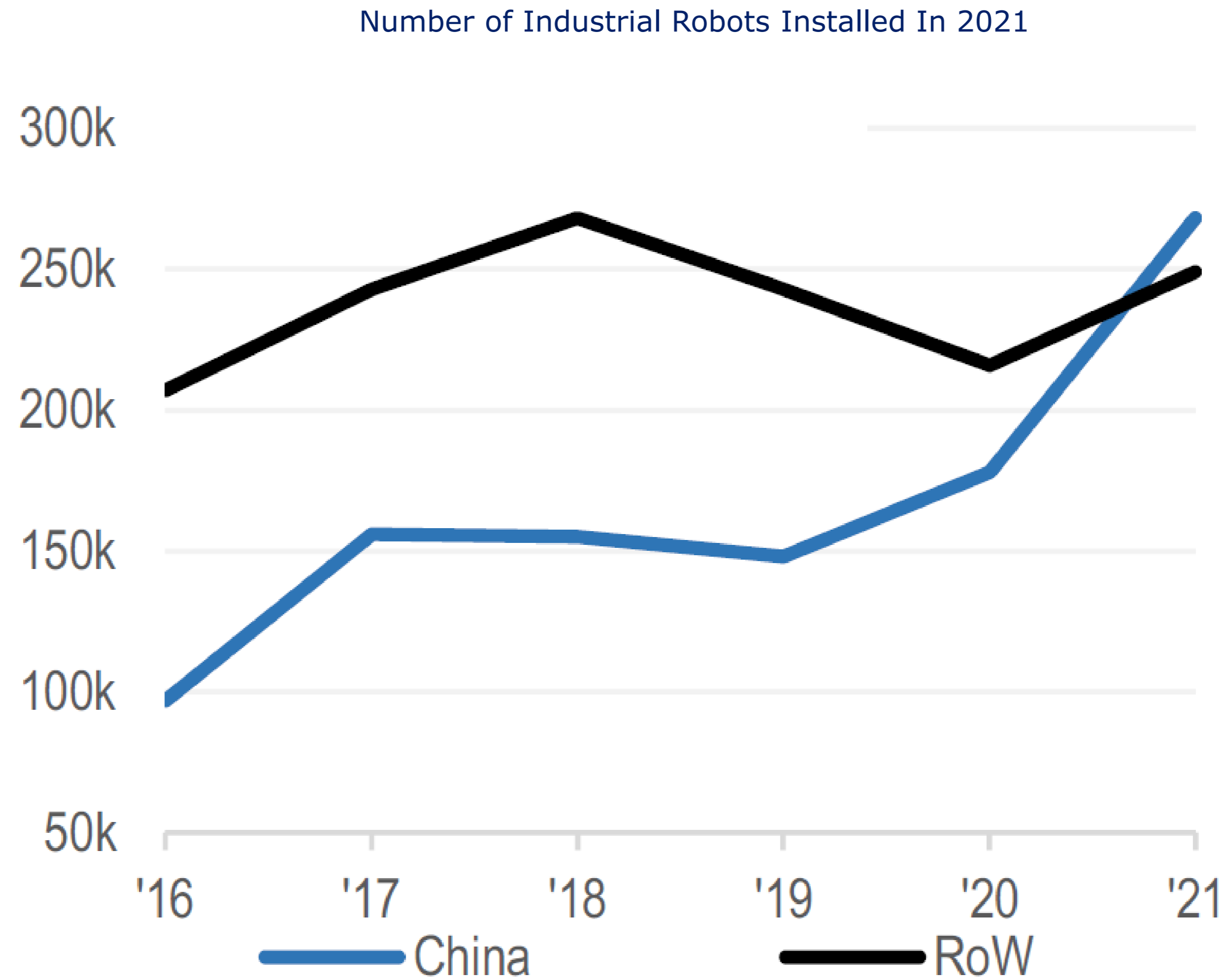
China lost the internet race, but now…
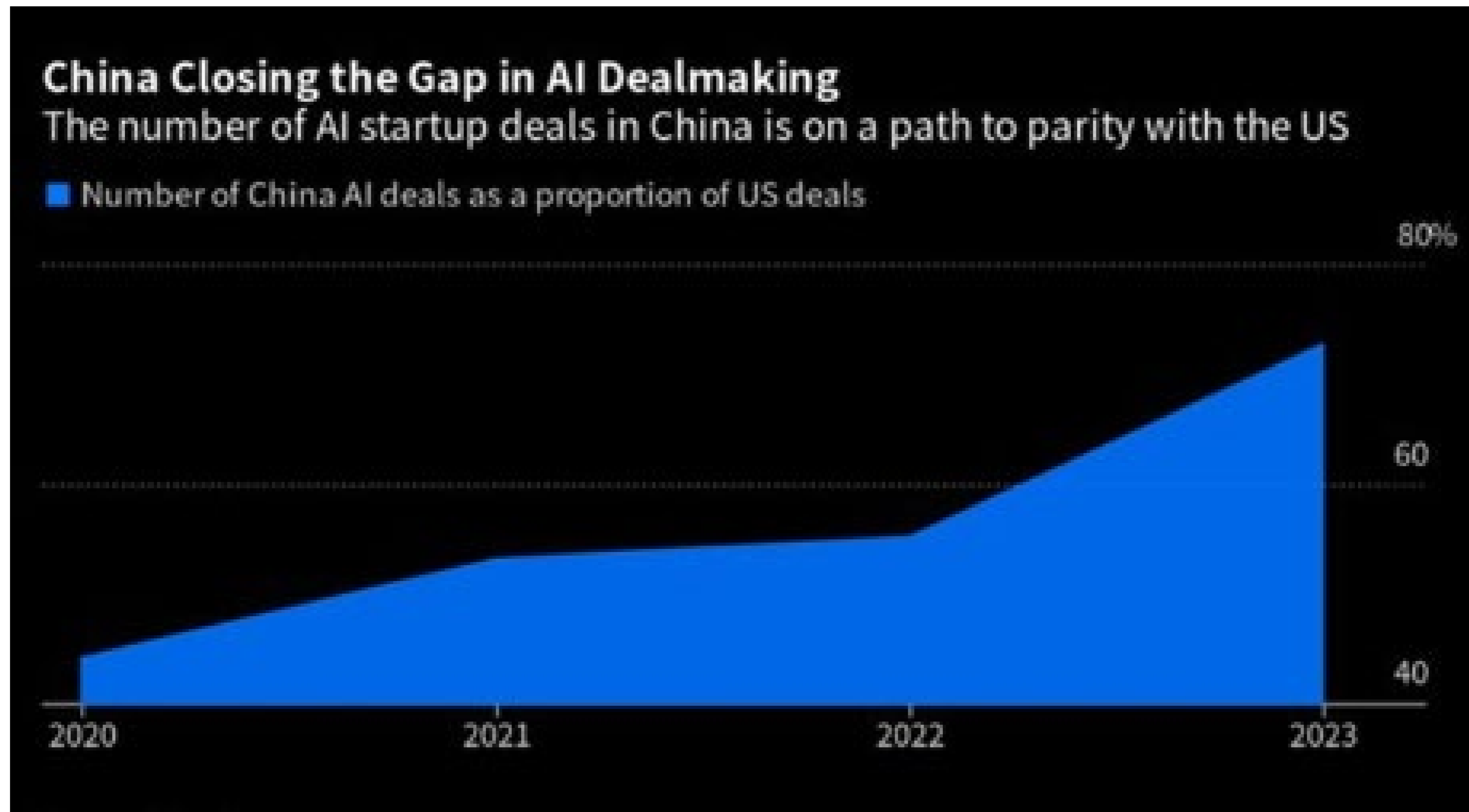
Too late to invest?

Tech Innovation Waves, Market-Relative Forward-P/E Ratios² 1968 Through September 2023

Legend: ☐ A Year Before ▨ Peak ▨ September 2023

Categories: The Mainframe Era: December 1969³ | The PC Era: June 1983 | The Internet Era: March 2000 | Current Tech Momentum Leadership | CHAT ETF⁴ Generative AI & Technology | Nvidia | AI Plays

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AI theme boasts better margins than previous tech innovation waves

Tech Innovation Waves, Free Cash Flow Margins² 1968 Through Mid-October 2023
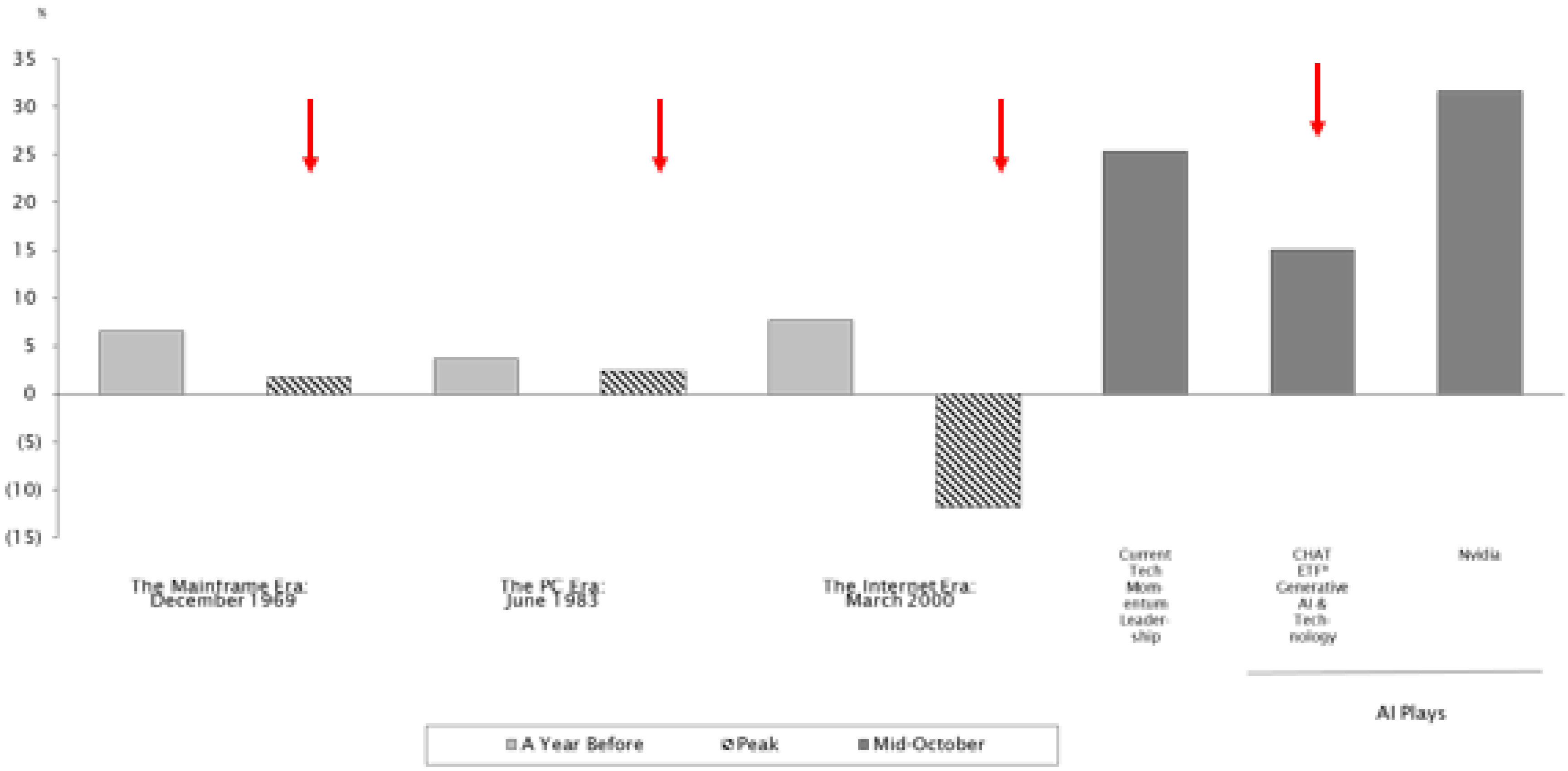
AI workers earn their keep

Change in Sales for a 1 Stnd Dev Increase in the Share of AI Workers at a Firm[1]
2010 Through 2018
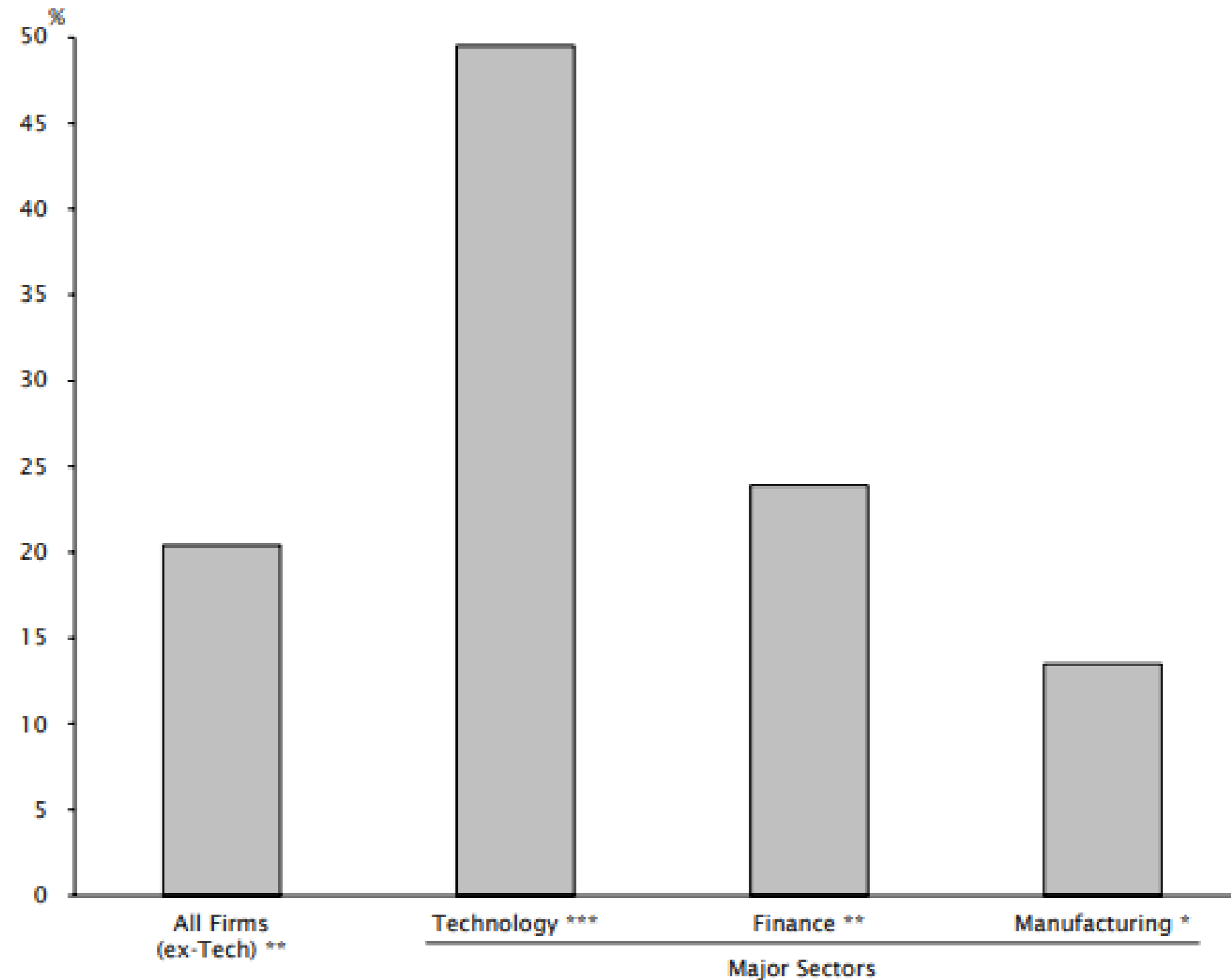
Artificial super intelligence is scary!

Three Stages of Artificial Intelligence

3 Artificial Super Intelligence
Surpasses human intelligence across all fields

2 Artificial General Intelligence
Includes power of reasoning, problem solving and abstract thinking

1 Artificial Narrow Intelligence
Intelligence restricted to one functional area

Source: UBS. March 2, 2018
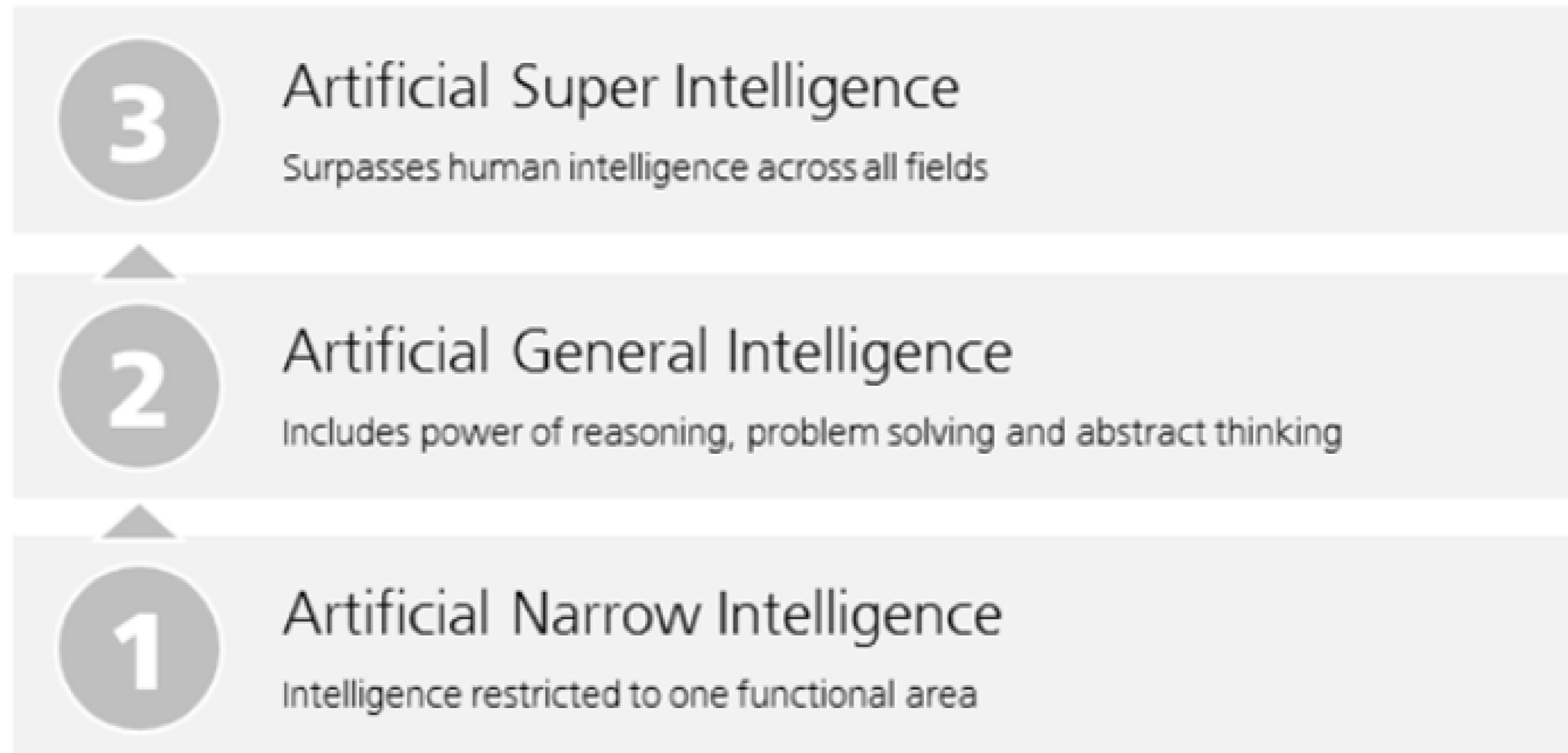
"Open the pod doors, HAL." "I'm sorry Dave, I'm afraid I can't do that." (2001: A Space Odessey)

Clippie's Revenge
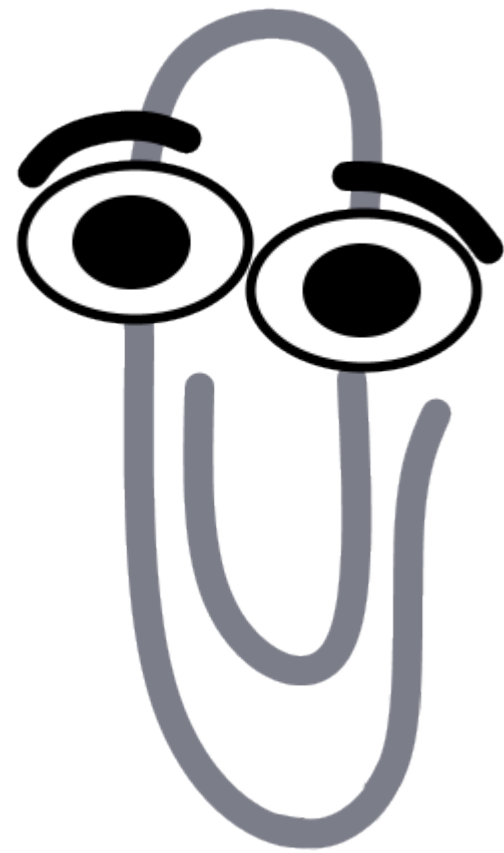
Consider the classic example of the paper clip maximizer. A hapless factory owner orders his new AI to *"Produce as many paper clips as possible. Don't ask me how, just do it!"*

The AI gets to work retooling the factory to increase paper clip production. After the factory is running at full capacity, the AI starts to build new factories. And then *more* factories. It also rewrites its software to improve its capabilities, thus allowing it to become more efficient at making paper clips.

Staying loyal to the original goal of producing as many paper clips as possible, the AI preemptively breaks off communication with the owner, knowing full well that at some point the owner will say *"STOP IT! We have enough paper clips!"*

Sensing that the owner or governments will retaliate, it takes control of key global command and control systems.

After turning much of the planet into paper clips, it launches self-assembling space probes to transform everything in the solar system, and eventually everything in the galaxy, into paper clips.

The process continues until it finally comes into contact with its archenemy… the staple maximixer!

Appendix 1: Citi's Generative AI Names (GAIN) Baskets

GAIN-Enablers, GAIN-Adopters and GAIN-Monitors

GAIN-Enablers

Silicon Layer
- Advantest
- AIChip
- AMD
- ASM International
- ASML
- Besi
- Ibiden
- Intel
- Marvell
- Micron
- Nvidia
- Qualcomm
- Samsung Electronics
- Shinko
- SK Hynix
- TSMC

Infrastructure & Platforms Layer
- Accton
- Amazon
- Arista
- Baidu
- Bharti Airtel
- Digital Realty
- Equinix
- FII
- Hewlett Packard Enterprise
- Hon Hai
- Inventec
- KT
- NTT
- Oracle
- PT Telkom Indonesia
- Quanta
- Singtel
- SKT
- Wistron
- Wiwynn

Models & MLOps
- Alibaba Group
- Alphabet
- ESTC
- iflytek
- Meta
- Microsoft
- MongoDB
- Tencent

Software & Applications layer
- Adobe
- Ansys
- Booking Holdings
- BOX
- CarGurus
- Crowdstrike
- Expedia
- GoDaddy
- Nice
- Palo Alto Networks
- Roblox
- ServiceNow
- SNAP
- Snowflake
- Squarespace
- Unity
- Wix.com
- Zillow Group

Services layer
- Accenture
- Amdocs
- Endava
- EPAM
- Globant

GAIN-Adopters

Financials & FinTech supersector
- Aon
- Bank of America
- Blackrock
- Blackstone
- Charles Schwab Corp
- East Money Information
- Intercontinental Exchange
- JP Morgan
- London Stock Exchange
- MarketAxess Holdings
- Marsh & Mclennan
- Mastercard
- Nubank
- Robinhood
- Ryan Specialty Holding
- SoFi
- Towers Watson
- Visa
- Wells Fargo

Consumer supersector
- CCH
- Coca-Cola
- Heineken
- L'Oréal
- LVMH
- Nestlé
- Pepsi
- Pernod Ricard
- Reckitt
- Walmart
- YUM China

Tech & Comms supersector
- Auto Trader
- Coursera
- Delivery Hero
- Entain
- EXL Service
- Flutter
- Genpact
- Hitachi
- iQiyi
- Just Eat Takeaway
- NetEase
- Prosus
- RELX
- Sony
- Tencent Music Entertainment Group
- WNS
- Wolters Kluwer
- Zalando

Healthcare supersector
- M3
- Phreesia
- Teladoc Health

Industrial Tech & Mobility supersector
- Aptiv
- Ford
- General Motors
- Honeywell
- Luminar
- Mobileye
- Tesla

GAIN-Monitors

Tech & Comms supersector
- Adobe
- Chegg
- IPG
- Nice
- OMC
- ServiceNow
- Universal Music Group
- Warner Music

Financials & FinTech supersector
- Raymond James Financial
- Locaweb
- LPL Financials
- Stifel Financial

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Appendix 2: "Productivity prospectors"-EVR ISI AI initiative & automation beneficiaries

EVR ISI AI Initiative & Automation Beneficiaries - Top Picks

Company	Ticker	Mkt Cap ($B)	Price ($)	EVR ISI Analyst	EVR ISI Rating	Investment Case
AI Integrators/Enhancers						
Microsoft	MSFT	2,480	333.56	Materne	Outperform	MSFT is integrating A.I. across its entire product and services suite and offering "Copilot" AI assistants for its business segments that will truly transform how every user will interact with their platforms and applications on a day-to-day basis.
Alphabet	GOOGL	1,535	120.55	Mahaney	Outperform	Including LLMs in core Search results could provide a boost to growth outlook while Cloud Computing could be supported by AI deployment. GOOGL has deep access 1) cash , 2) data, and 3) AI data excellence - all critical in taking advantage of the AI opportunity.
Amazon.com	AMZN	1,281	124.83	Mahaney	Outperform	AI deployment to further improve retail business personalization, targeting capabilities and ads alongside a boon to AWS which leads overall cloud market share.
Adobe	ADBE	219	477.48	Materne	Outperform	Adobe has the 'trifecta' of characteristics to be an AI winner – scale, unique data sets, and a large monetizable customer base.
Etsy	ETSY	12	94.63	Khajuria	Outperform	Efforts to leverage AI are underappreciated by investment community. Etsy is not new to AI—the company has leveraged its scaled data, infrastructure, and talent to integrate AI technology over the years. More recently, Etsy has been using AI and neural networks to improve search and matching results on its platform.
CCC Intelligent Solutions	CCCS	7	10.72	Materne	Outperform	CCCS is at the forefront of making the insurance claims process faster and easier for consumers, insurance companies, repair shops, parts providers, and many other touch points.
Wix com	WIX	4	79.15	Mahaney	Outperform	AI presents product development and productivity tailwinds. A key beneficiary from leveraging AI technology to drive operational efficiencies and topline growth over the long term.
Tech Enablers						
NVIDIA	NVDA	1,063	430.45	Muse	Outperform	Best-in-class hardware (compute + networking), to foundational software in CUDA (basically the foundation to the entire ecosystem today), to application specific software across verticals working to democratize AI.
Broadcom	AVGO	350	847.66	Muse	Outperform	Network increasingly becomes a bottleneck to Generative AI and LLM workload scaling. Generative AI represents 15% of AVGO semi revenue and management projects 25%+ by FY24 with risks to the upside.
Equinix	EQIX	72	768.00	Liu	Outperform	As AI workloads transition toward inferencing over time, we see companies that specialize in interconnection (EQIX in particular) benefiting by this technology transition.
Marvell	MRVL	51	58.85	Muse	Outperform	MRVL has strong leverage to some of the highest-growth opportunities across the Data Center. EVR ISI Semiconductor Analyst C.J. Muse suspects that supply will remain a gating factor amidst a significant step-up in demand for high-bandwidth solutions.
Arista Networks	ANET	47	151.51	Daryanani	Outperform	ANET provides networking for the AI revolution: AI Switching market will hit $5-$7B and Arista should be able to capture 30% of the market, consistent with its share in overall hyperscale switching.
Digital Realty	DLR	31	104.34	Liu	Outperform	While the majority of AI workloads are likely to initially take place in data centers captively owned by hyperscalers before shifting to third party/leased facilities, data center companies with expansive footprints and hyperscale exposure such as DLR will benefit from increased data center power demand.
Vertiv	VRT	9	22.97	Daryanani	Outperform	VRT benefits from data center cooling as rack densities rise given increasing GPU clusters for AI/ML workloads.
Security						
Palo Alto Networks	PANW	73	238.92	Levine	Outperform	PANW is the largest standalone security vendor by revenue. The company's growth profile is driven by underlying market strength combined with ability to drive share gains from legacy competitors via innovative product offerings, a strong go -to -market organization, and vendor consolidation toward market leaders.
CrowdStrike Holdings	CRWD	34	143.85	Levine	Outperform	CRWD is not just a point solution selling endpoint. CRWD has matured into a data platform that spans across endpoint, identity, workload and threat protection with multiple use cases that extend well beyond security and into IT-Ops
Zscaler	ZS	21	144.85	Levine	Outperform	ZS is a true disruptor in next-gen cloud security as one of the few beneficiaries monetizing hybrid work.
Industrial Automators						
Analog Devices	ADI	93	185.44	Muse	Outperform	A leading supplier into Factory Automation, enabling intelligence at the edge through its portfolio of assets including power and communications. Industrial remains one of the strongest growth areas in the semi industry over the next 10-20yrs.
Eaton	ETN	78	194.84	Raso	Outperform	Eaton's strength in serving industrial factories with elite power management will become more significant as factory investment focused on enhancing labor productivity implies more automated and "smart devices" processes, requiring ever more sophisticated power management solutions.
Amphenol	APH	48	81.37	Daryanani	Outperform	APH's balanced exposure to various end-markets diversifies away the economic cyclicality with relatively muted revenue volatility given no end market >25% of sales. Diversity additionally enables APH to participate in a wide host of secular growth drivers (EV transition, warehouse automation, AI, IoT) and drive growth
Ingersoll Rand	IR	26	64.14	Raso	Outperform	Ingersoll Rand, as the world's second largest industrial compressor manufacturer with a leading position in North America, is well positioned not just for global re-shoring trends but also for increased investing in automation.
Teradyne	TER	17	106.89	Muse	Outperform	On the Industrial Automation side, TER is the #1 supplier of collaborative robot ("cobot") arms through its Universal Robots business (along with being a leading supplier of autonomous mobile robots through MiR).

Appendix 3: A snapshot of generative AI tools

Category	Tool	Description/Features
Chatbots	Bard	A generative AI chatbot developed by Google, initially based on its LaMDA model
	Bing Chat	A chatbot powered by Microsoft Bing
	Character.AI	Simulates conversations with real and fictional characters
	ChatGPT	A generative AI chatbot developed by OpenAI
Text Generators	Copy.ai	Generates blog posts, social media posts, and emails
	Frase.io	Produces slogans, summaries, introductions, articles, titles, and product descriptions
	Jasper	Provides users with content templates and enables collaboration
	Peppertype.ai	Offers ready-made templates for creating meta descriptions, articles, and emails, enabling commercial use of the produced content
	Rytr	Creates titles for SEO optimization, produces blog posts, articles, emails, and social media ads
Code Generators	K-Explorer	Makes code completion and custom model suggestions
	PyCharm	Providers users with code completion, highlights errors, and enables automated refactoring in Python
	Tabnine	Provides users with whole-line code completion and learns coding patterns
Image Generators	Artbreeder	Creates collages and generates images with the option of manipulating a subject's age, gender, etc.
	Craiyon	Coverts text-to-image (not suitable for creating larger images)
	DALL-E	Creates, edits, and variates images, offering the commercial rights to created content
	NightCafe	Art generation with different styles and resolution options
	starryai	Enables the creation of artwork with different style options, aspect ratios, etc., giving full ownership of produced content
Video Generators	Elai.io	Allows for the conversion of text to video, offering 25+ different avatars
	Flexclip	Supports video creation and offers editing tools (adding transitions and filters, removing backgrounds)
	Lumen5	Offers templates to create original videos based on text, articles, and blog posts
	Synthesia	Enables text-to-video conversion, providing 70+ different avatars
	Veed.io	Video generation and editing, adding subtitles, removing background noise, and resizing videos
Design Generators	Colormind	Creates color palates based on movie scenes, artwork, and other images
	Designs.ai	Generates logos and banners, provides design templates, and enables the export of produced content to different formats
	Khroma	Creates custom color palettes
	Uizard	Creates designs for mobile applications, websites, and landing pages based on sketches
Voice Generators	Lovo.ai	Enables text-to-speech conversion and generates realistic AI voiceovers
	Murf	Creates voiceovers for different contexts, enables adding punctuation, and provides the commercial rights to the content
	Play.ht	Provides AI-generated voices for various commercial purposes in 140+ languages
	Replica	Enables text-to-speech conversion, offering AI-generated voices
	Speechify	Allows text-to-speech conversion while enabling the adjustment of reading speed
Music Generators	AIVA	Creates authentic music based on preferred style, granting copyright of the produced content
	Amper AI	Produces royalty-free music based on preferred genre, length, instruments, providing perpetual license
	Evoke	Generates AI-generated and royalty-free music collection
	Jukebox	Creates authentic music with AI-generated lyrics, providing users with different genre options
	Soundraw	Enables original music creation and commercial use of the produced content

Shares of Jobs and Wages 2022

	Number of Jobs	Average Annual Wages	Share of Jobs	Share of Wages
ChatGPT-Identified Categories				
Office Clerks, General	2,517,350	$41,140	1.70%	1.13%
Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	1,826,710	43,410	1.24%	0.87%
Bookkeeping, Accounting, and Auditing Clerks	1,550,750	47,440	1.05%	0.80%
Sales Representatives of Services, Except Advertising, Insurance, Financial Services, and Travel	1,075,750	77,390	0.73%	0.91%
Medical Secretaries and Administrative Assistants	682,630	41,260	0.46%	0.31%
Executive Secretaries and Executive Administrative Assistants	475,240	71,060	0.32%	0.37%
Production, Planning, and Expediting Clerks	389,920	55,080	0.26%	0.23%
Bill and Account Collectors	202,840	42,820	0.14%	0.09%
Information Security Analysts	163,690	119,860	0.11%	0.21%
Payroll and Timekeeping Clerks	159,190	52,300	0.11%	0.09%
Computer Programmers	132,740	102,790	0.09%	0.15%
Telemarketers	96,520	33,600	0.07%	0.04%
Web Developers	88,620	87,580	0.06%	0.08%
Writers and Authors	54,010	91,560	0.04%	0.05%
Interpreters and Translators	52,160	61,730	0.04%	0.04%
Word Processors and Typists	41,990	44,990	0.03%	0.02%
Statistical Assistants	6,710	54,630	0.00%	0.00%
Proofreaders and Copy Markers	5,120	48,770	0.00%	0.00%
Correspondence Clerks	4,970	42,560	0.00%	0.00%
Mathematicians	2,070	113,860	0.00%	0.00%
ChatGPT-Identified Categories Total	9,528,980	$63,692	6.44%	5.41%
ERP-Identified Categories				
Customer Service Representatives	2,879,840	$41,190	1.95%	1.30%
Loan Interviewers and Clerks	242,630	46,740	0.16%	0.12%
Insurance Claims and Policy Processing Clerks	227,580	47,840	0.15%	0.12%
Office and Administrative Support Workers, All Other	174,590	43,150	0.12%	0.08%
Information and Record Clerks, All Other	150,590	45,910	0.10%	0.08%
Order Clerks	113,500	40,540	0.08%	0.05%
Editors	101,430	84,820	0.07%	0.09%
File Clerks	87,250	39,560	0.06%	0.04%
Procurement Clerks	63,340	46,560	0.04%	0.03%
Technical Writers	48,620	86,760	0.03%	0.05%
New Accounts Clerks	45,170	42,880	0.03%	0.02%
Brokerage Clerks	42,700	59,200	0.03%	0.03%
Financial Clerks, All Other	41,850	49,710	0.03%	0.02%
Desktop Publishers	6,560	53,390	0.00%	0.00%
ERP-Identified Categories Total	4,225,650	$52,018	2.86%	2.03%
All of the Above	13,754,630	$60,105	9.30%	7.44%

Appendix 5: Job categories potentially benefited by AI

Shares of Jobs and Wages 2022

ERP-Identified Benefited Categories Total	Jobs	Annual Wages	of Jobs	of Wages
Software Developers	1,534,790	$132,930	1.04%	2.23%
Accountants and Auditors	1,402,420	86,740	0.95%	1.33%
Elementary School Teachers, Except Special Education	1,394,200	68,000	0.94%	1.04%
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	1,273,400	76,890	0.86%	1.07%
Teaching Assistants, Except Postsecondary	1,254,240	33,740	0.85%	0.46%
Business Operations Specialists, All Other	1,081,230	82,670	0.73%	0.98%
Secondary School Teachers, Except Special and Career/Technical Education	1,042,090	69,480	0.70%	0.79%
Project Management Specialists	843,910	101,610	0.57%	0.94%
Human Resources Specialists	835,360	73,080	0.56%	0.67%
Management Analysts	808,860	104,660	0.55%	0.92%
Market Research Analysts and Marketing Specialists	798,620	78,880	0.54%	0.69%
Financial Managers	740,780	166,050	0.50%	1.34%
Lawyers	707,160	163,770	0.48%	1.27%
Computer User Support Specialists	696,830	61,580	0.47%	0.47%
Middle School Teachers, Except Special and Career/Technical Education	611,120	67,790	0.41%	0.45%
Sales Managers	536,390	150,530	0.36%	0.88%
Computer and Information Systems Managers	533,220	173,670	0.36%	1.01%
Medical and Health Services Managers	476,750	127,980	0.32%	0.67%
Buyers and Purchasing Agents	464,880	75,140	0.31%	0.38%
Insurance Sales Agents	445,540	76,950	0.30%	0.37%
Securities, Commodities, and Financial Services Sales Agents	443,220	100,740	0.30%	0.49%
Computer Occupations, All Other	416,320	104,660	0.28%	0.48%
Preschool Teachers, Except Special Education	415,360	38,640	0.28%	0.18%
Substitute Teachers, Short-Term	397,200	42,680	0.27%	0.19%
Training and Development Specialists	367,180	69,870	0.25%	0.28%
Compliance Officers	359,640	76,980	0.24%	0.30%
Loan Officers	345,550	84,160	0.23%	0.32%
Paralegals and Legal Assistants	345,240	62,840	0.23%	0.24%
Marketing Managers	328,570	158,280	0.22%	0.57%
Network and Computer Systems Administrators	325,930	97,160	0.22%	0.35%
Industrial Engineers	321,400	98,560	0.22%	0.35%
Civil Engineers	307,570	97,380	0.21%	0.33%
Financial and Investment Analysts	291,370	108,790	0.20%	0.35%
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	290,830	109,950	0.20%	0.35%
Education Administrators, Kindergarten through Secondary	285,910	106,690	0.19%	0.33%
Claims Adjusters, Examiners, and Investigators	285,270	73,380	0.19%	0.23%
Personal Financial Advisors	283,060	137,740	0.19%	0.43%
Mechanical Engineers	277,560	100,820	0.19%	0.31%
Public Relations Specialists	264,750	78,540	0.18%	0.23%
Self-Enrichment Teachers	248,150	50,320	0.17%	0.14%
Cost Estimators	225,310	76,740	0.15%	0.19%
Postsecondary Teachers, All Other	214,520	91,760	0.15%	0.22%
Health Specialties Teachers, Postsecondary	207,700	127,640	0.14%	0.29%
Logisticians	202,970	81,220	0.14%	0.18%
Chief Executives	199,240	246,440	0.13%	0.54%
Instructional Coordinators	198,660	73,080	0.13%	0.16%
Architectural and Engineering Managers	197,180	163,310	0.13%	0.35%
Software Quality Assurance Analysts and Testers	196,420	105,750	0.13%	0.23%
Special Education Teachers, Kindergarten and Elementary School	195,010	68,580	0.13%	0.15%
Medical Records Specialists	187,720	51,090	0.13%	0.10%
Electrical Engineers	182,210	114,050	0.12%	0.23%
Tutors	174,980	44,820	0.12%	0.09%
Computer Network Architects	173,920	129,490	0.12%	0.25%
Computer Network Support Specialists	168,920	76,060	0.11%	0.14%
Education Administrators, Postsecondary	167,060	115,180	0.11%	0.21%
Legal Secretaries and Administrative Assistants	159,940	54,180	0.11%	0.09%
Court, Municipal, and License Clerks	159,760	46,280	0.11%	0.08%
Data Scientists	159,630	115,240	0.11%	0.20%
Special Education Teachers, Secondary School	152,490	71,290	0.10%	0.12%
Engineers, All Other	150,420	111,280	0.10%	0.18%
Teaching Assistants, Postsecondary	135,160	41,900	0.09%	0.06%
Librarians and Media Collections Specialists	131,680	64,770	0.09%	0.09%
Educational Instruction and Library Workers, All Other	129,170	52,250	0.09%	0.07%
Financial Specialists, All Other	127,020	83,580	0.09%	0.12%
Teachers and Instructors, All Other	120,480	66,450	0.08%	0.09%
Kindergarten Teachers, Except Special Education	119,250	65,120	0.08%	0.08%
Reservation and Transportation Ticket Agents and Travel Clerks	119,130	45,440	0.08%	0.06%
Meeting, Convention, and Event Planners	112,070	58,750	0.08%	0.07%
Medical Scientists, Except Epidemiologists	110,550	110,670	0.07%	0.13%
Electronics Engineers, Except Computer	106,640	118,460	0.07%	0.14%
Advertising Sales Agents	106,560	73,260	0.07%	0.09%
Architectural and Civil Drafters	105,960	61,660	0.07%	0.07%
Insurance Underwriters	105,900	82,990	0.07%	0.10%
Operations Research Analysts	105,080	95,820	0.07%	0.11%
Human Resources Assistants, Except Payroll and Timekeeping	103,680	46,900	0.07%	0.05%
Career/Technical Education Teachers, Postsecondary	103,100	65,500	0.07%	0.07%
Electrical and Electronic Engineering Technologists and Technicians	99,050	70,810	0.07%	0.08%
Art, Drama, and Music Teachers, Postsecondary	97,830	93,440	0.07%	0.10%
Web and Digital Interface Designers	97,350	101,740	0.07%	0.11%
125 Other Categories	3,839,870	88,529	2.60%	3.71%
ERP-Identified Benefited Categories Total	33,731,460	91,591	22.81%	33.75%

Source: U.S. Bureau of Labor Statistics, Empirical Research. May 25, 2023

AI-Exposed Work Activity	Examples of Automation	Examples of Tasks by Difficulty (O*NET 1-7 Scale)
Getting Information	Web scrape data from online sources and consolidate into a clean dataset; conduct and summarize a review of prior research based on a textual query and answer follow-up questions	2: Follow a standard blueprint 4: Review a budget 6: Study international tax laws
Monitoring Processes, Materials, or Surroundings	Monitor sensor input and system logs for manufacturing and utilities system anomalies; monitor internet activity for changes in sentiment or trending themes	2: Check to see if baking bread is done 4: Test electrical circuits 6: Check the status of a patient in critical medical care
Identifying Objects, Actions, and Events	Identify objects, music, terminology, and people when provided with textual/visual/auditory input; provide context on identified subject	2: Test an automobile transmission 4: Judge the suitability of food products for an event 6: Determine the reaction of a virus to a new drug
Estimating the Quantifiable Characteristics of Products, Events, or Information	Produce market size estimates based on assumptions grounded in existing research; estimate parameters using statistical modeling on input data and select optimal model	2: Estimate the size of household furniture to be shipped 4: Estimate transportation delays from inclement weather 6: Estimate the size of resource deposits beneath the world's oceans
Processing Information	Process raw data from documents, sensors, and humans into clean datafiles that are easily subscriptable for analysis; provide summaries of data relevant to user needs	2: Calculate the costs for shipping packages 4: Calculate the adjustments for insurance claims 6: Compile data for a complex scientific report
Evaluating Information to Determine Compliance with Standards	Review documents and proposed actions for compliance with legal, regulatory, and corporate standards; provide arguments and scenarios for and against compliance in unclear cases	1: Review forms for completeness 4: Evaluate a complicated insurance claim for policy compliance 6: Make a ruling in court on a complicated motion
Analyzing Data or Information	Perform statistical analysis of and identify trends within large datasets; forecast future data based on optimal combination of variables and model with best out-of-sample predictive power	1: Skim a short article to gather the main point 4: Determine the interest cost to finance a new building 6: Analyze the cost of medical care services for all US hospitals
Updating and Using Relevant Knowledge	Draft and update reports in corporate knowledge base; update statistical and financial models based on new data which challenges prior scenarios/assumptions	2: Track price changes in a small retail store 4: Track changes in maintenance procedures for repairing SUVs 6: Learn information about a complex and rapidly-changing technology
Scheduling Work and Activities	Automatically schedule meetings and work activities using availabilities and emails; assign tasks and estimate time to completion based on past experience	2: Make appointments for patients using a predetermined schedule 4: Prepare the work schedule for salesclerks in a large retail store 6: Schedule a complex conference program with parallel sessions
Organizing, Planning, and Prioritizing Work	Delegate and prioritize tasks based on time to completion and importance; identify gaps or bottlenecks in work plans and target resources or managerial attention	2: Organize a work schedule that is repetitive and easy to plan 4: Plan and adjust a to-do list according to changing demands 6: Prioritize and plan multiple tasks several months ahead
Documenting/Recording Information	Transcribe and summarize the content of in-person meetings; write system reports based on sensor and human data input	2: Record the weight of a patient during a routine health exam 4: Document the results of a crime scene investigation 6: Maintain information about satellite use for industry communications
Interpreting the Meaning of Information for Others	Explain the structure and function of code or statistical results in easy-to-understand language; translate code and text between languages; summarize and contextualize text with technical jargon	1: Interpret a blood pressure reading 4: Interpret how foreign tax laws apply to U.S. exports 6: Interpret a complex experiment in physics for general audiences
Performing Administrative Activities	Draft automated email responses; schedule and manage meetings and work calendars; file and organize paperwork; book reservations	2: Complete routine paperwork 4: Complete tax forms for a small business 6: Serve as the benefits director for a large computer sales firm

Source: O*NET, Goldman Sachs Global Investment Research. March 26, 2023

Appendix 7: How will AI impact industry?

Likely Key Winners and Losers From Artificial Intelligence/Machine Learning/Large Language Models
An Analysis of How AI/ML/ LLMs Will Likely Impact Industry

Industry	Impact	Comments
IT		
Software development	++	AI or large language models (LLMs) can help developers write code for program applications and software. It can also debug code and suggest improvements.
Semiconductors	++	The emergence of AI and LLMs could represent one of the strongest upcoming drivers of semis. Computational requirements for running AI models are increasing due to the processing power needed to train them.
Data centres	++	As data continues to grow at an exponential rate, more data centres are required to store that data.
Cybersecurity	++	With the emergence of LLMs like ChatGPT, it is easier for threat actors with limited programming skills to generate code for cyberattacks e.g., legitimate-sounding phishing emails. Hence, ChatGPT and similar models are likely to have broad-based implications on the cybersecurity sector in terms of email security, identity security, and threat detection.
Search engines	++	Traditional search engines could be replaced by chatbot applications like ChatGPT, however, it is likely that search engines are going to be used in conjunction with generative AI to improve the user experience.
Communication services		
Education	++	LLMs could drive online learning, writing textbooks and providing online learning modules.
Media	++	LLMs can be used for content generation e.g., writing news articles, social media posts, marketing content, story-writing, summarising text, media planning and advertising.
Music	++	AI and LLMs can be used to transpose music, generate melodies, chord progressions and lyrics. It can even analyse music and generate reviews and comparisons.
Legal	++	LLMs can write legal documents and summarise legal cases. ChatGPT is even capable of writing legal essays that passed law exams.
Healthcare		
Telemedicine	++	AI can help doctors make more data-driven decisions that improve the patient experience. It can be used for remote patient monitoring, population health management using predictive analytics, reminding patients of health appointments, training junior doctors and providing more accurate patient diagnoses.
Pharmaceuticals	++	AI can help with the initial screening of drug compounds to predict its success rate. It can further identify the right candidates for trials based on their medical history.
Financials		
Banks	++	AI can help analyse the data that banks, diversified financials and insurance companies have to conduct predictive analysis. AI could analyse an individual's credit history and calculate the likelihood of default. These companies can also retain customers for longer by providing additional services based on their spending and financial activities.
Fintech	++	AI can help fintech companies automate the credit risk assessment process, detect bank fraud, increase safety, automate the customer service experience and analyse user behaviour.
Capital Goods		
Aerospace	+	Aerospace companies can use AI to improve fuel efficiency by using recorded data and optimising fuel consumption.
Defence	+	AI-powered weapons could be the focus point of the next arms race. In addition, image and video recognition could be used for surveillance. This could increase national general security while reducing human intervention.

Source: BofA Global Research, February 28, 2023
Note: **= Large Positive Impact; ++Positive Impact

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