



# Artificial Intelligence (AI) – Macro Implications

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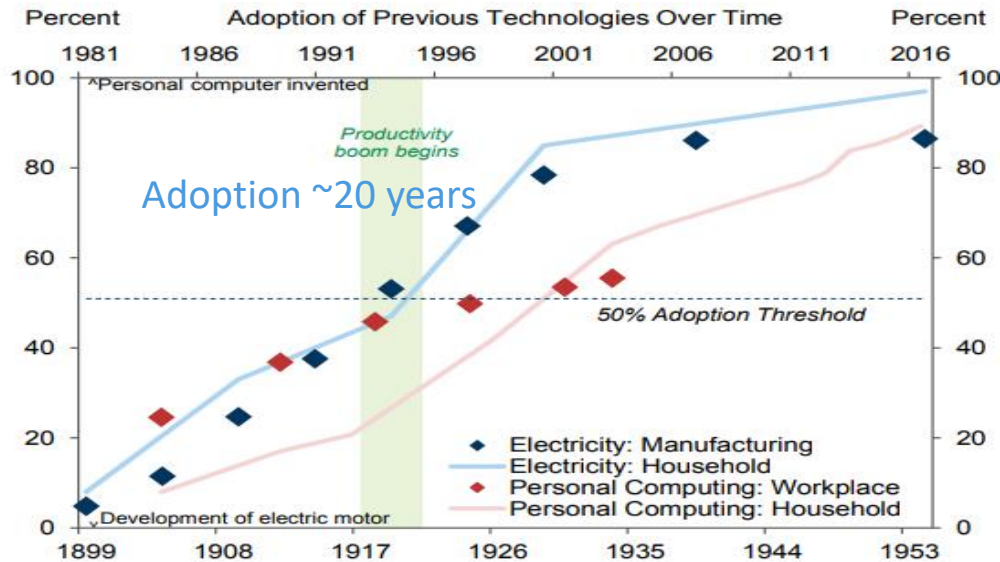
# Generative AI: Potentially Transformative Development<sup>1</sup>

- **AI (traces roots to 1950s) Simulates Human Intelligence With Machine / Traditional AI...**
  - Build discriminative statistical models that are predicative and...
    - Primarily focus on recognizing patterns in existing data
- **Generative AI (introduced in 2017) Has Creative Capabilities to Generate...**
  - Original ideas in form of text, image, audio, video, code
  - Ability to create original content touted as future of AI
  - My principal focus is on possible macroeconomic implications of generative AI
    - Implementation, productivity, employment, growth
- **Open AI's ChatGPT Spiking Interest in Generative AI**
  - Recently introduced GPT-4 can accept input in both form of...
    - Text and images to generate outputs...
    - In a particular tone and writing style and are multilingual
  - Major tech firms gearing up to participate
    - Microsoft, Alphabet, Amazon, Meta, etc.
  - Possible risks generating concerns: misinformation, copyright infringement etc
    - Elon Musk et al signed letter calling for six-month time out

1. Two recent (March 2023) GS Reports: Technological Group: "Generative AI-Part I Laying Out the Investment Framework" and Economists: "The Potentially Large Effects on Economic Growth" principal sources for AI discussion

# Generative AI Adoption: Will It Follow Historical Precedent?

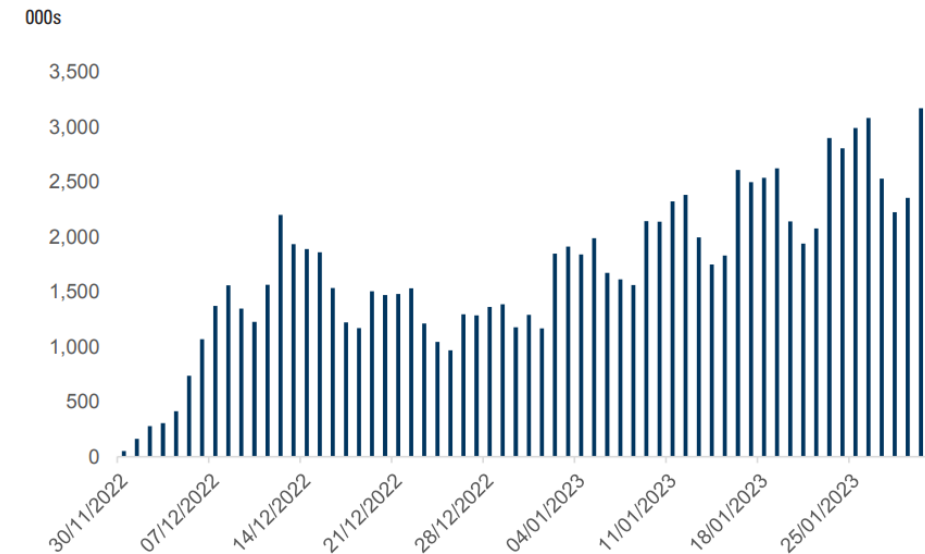
## Adoption of Milestone Technologies



Source: BLS, World in Data, Haver

- For prior milestone technologies — electricity and personal computers -- ~20-year interval between breakthrough and...
- Point when roughly half of US businesses adopted the technology

## No. of ChatGPT Visits Since Launch

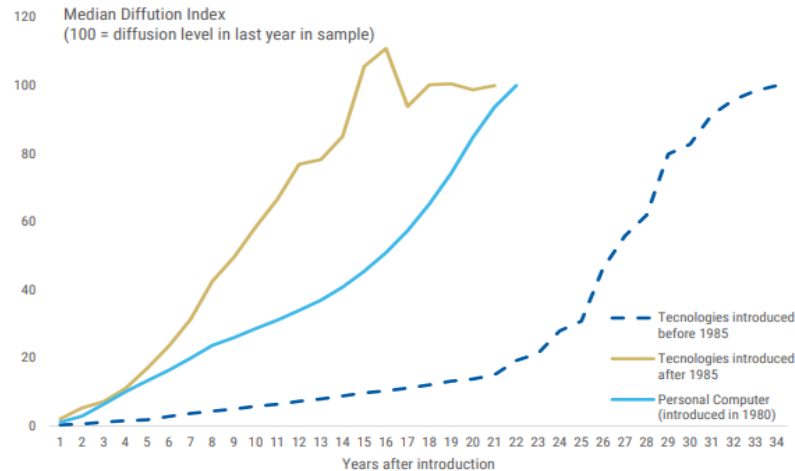


Source: Similar Web, GS

- Growing interest in ChatGPT which is publicly available, easy to use, and accepts inputs in form of text and images to generate text outputs...
- Generative AI might be adopted faster than prior milestones

# Technology Adoption Evolving / Forward Investment Indicators Strong

## Pace for Adoption Accelerating Over Time

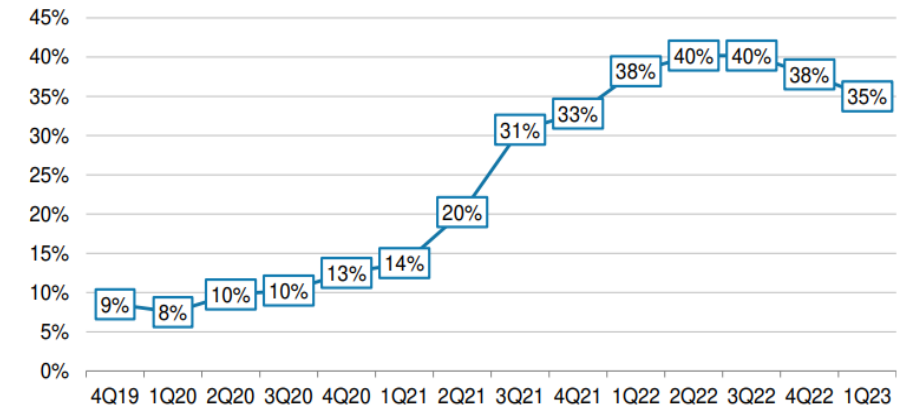


Source: Cornin & Habijn 2020, MS

- In fact, there is considerable evidence that time for adoption is accelerating
- Median adoption time for post 1985 advances (gold line). Pre-1985 technological advances (dashed blue line)

## Expected IT Spending Increasing

CIO Long Term IT Spending Intentions: Net % of CIOs Expecting an Increase in IT Spend as a % of Revenue Over the Next 3 Years - Trailing 4 Quarter Average

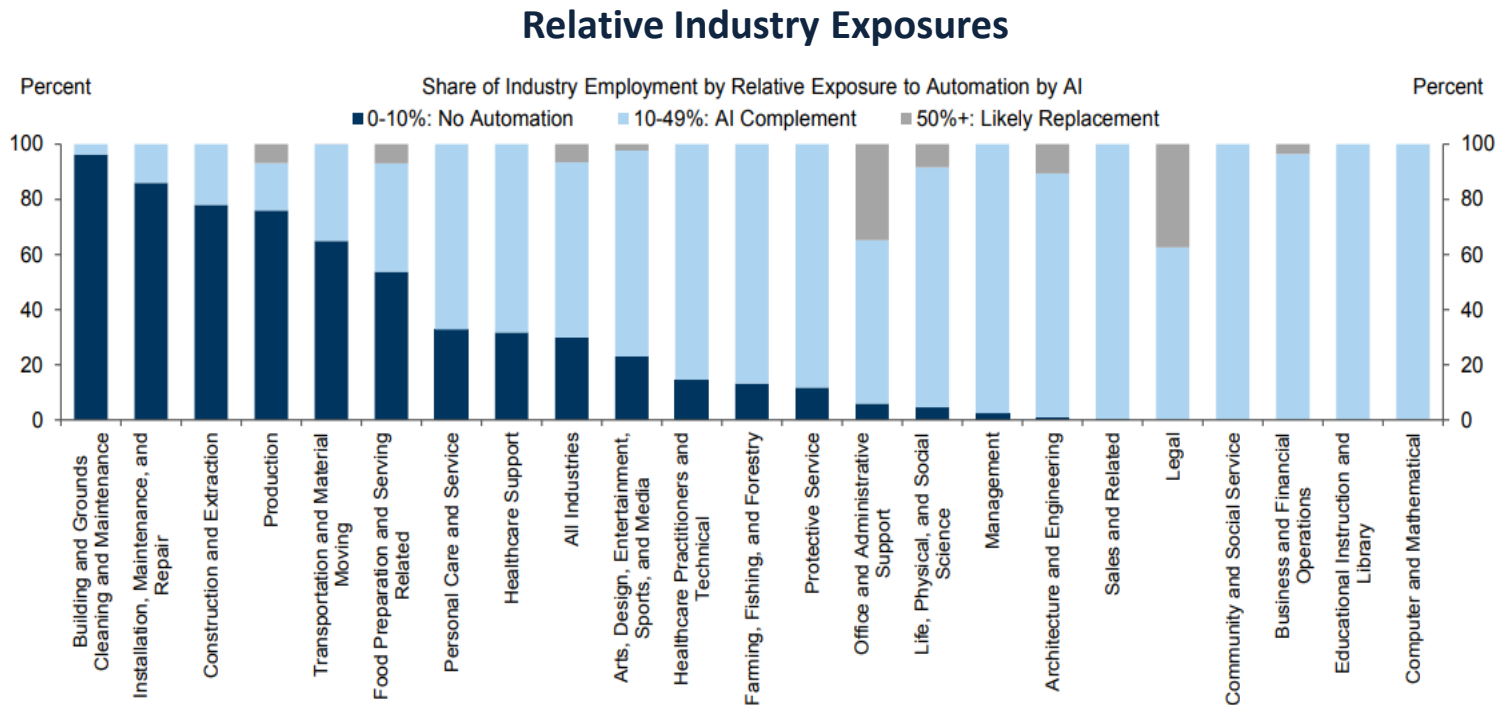


Source: AlphaWise CIO Summary, MS

- Recent CIO surveys: IT spending for next three years expected to be ~2.5 times pre-covid pace<sup>1</sup>

1. As of 2021 US and global private investment in A1 totaled \$53 bn and \$94 bn, respectively, up five -fold over prior 5 years. GS predicts US A1 investment could approach 1% of GDP by 2030.

# Estimated Share of US Employment Exposure to Automation by AI



Source: GS

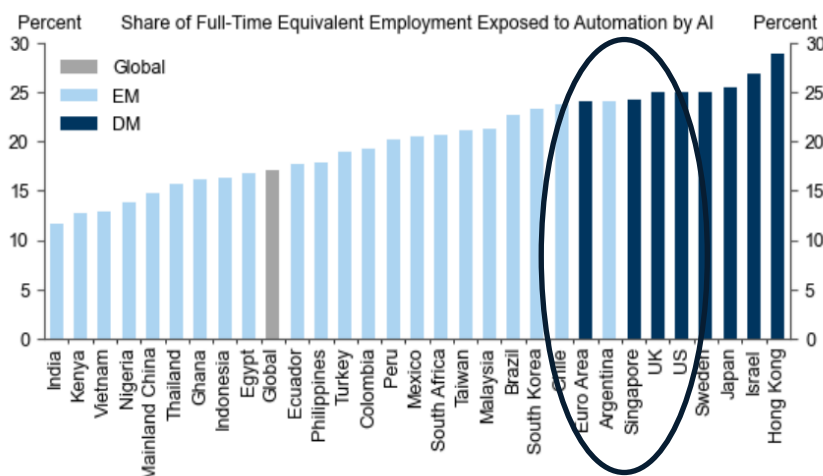
- Impact of AI on the labor market is likely to be significant...
  - But most jobs in industries that are expected to be only partially exposed to...
  - Automation and are more likely to be complemented rather than substituted
- Based on the above estimates: ~7% of US employment is likely to be substituted by AI, ~ 63% complemented by AI<sup>1</sup> and 30% unaffected

1. GS economists assume that workers employed in occupations that are partially exposed to AI automation will apply some of their freed-up capacity following adoption to productive activities that increase output



# Share of Global Work Exposed to Automation by AI / Productivity Effects

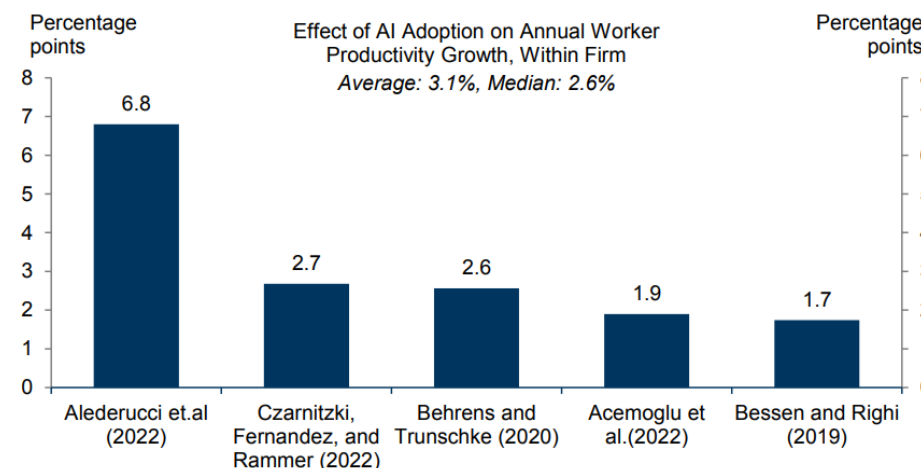
## % of Work Exposed to AI Automation



Source: GS

- Share of global work exposed to automation due to AI on full-time equivalent employment basis ~25% for major DMs and ...
- ~18% for global work in aggregate
- This significant exposure raises the prospect of meaningful savings

## Effect of AI Adoption on Productivity

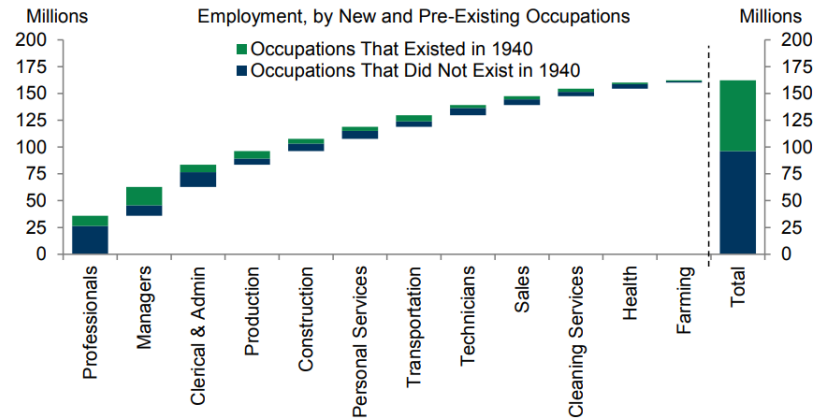


Source: Academic Studies, GS

- Academic studies confirm that workers following AI adoption experience higher productivity growth
- Estimates generally imply 2-3%-pt. per year boost. Subsequent studies that include generative AI may even show larger increases

# Effects of Technological Innovation on Employment / Two Views

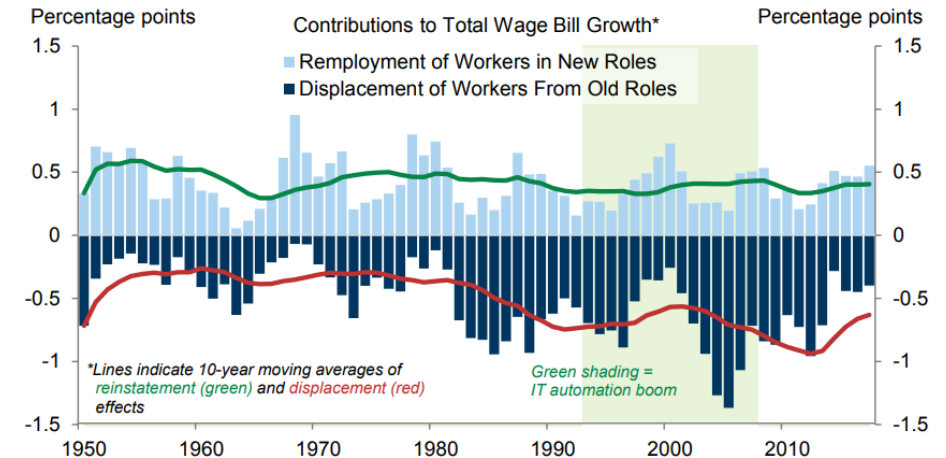
## Sanguine View



Source: Autor et al (2022), GS

- David Autor: although technological innovation initially displaces workers, it raises employment over the long term

## Less Sanguine View



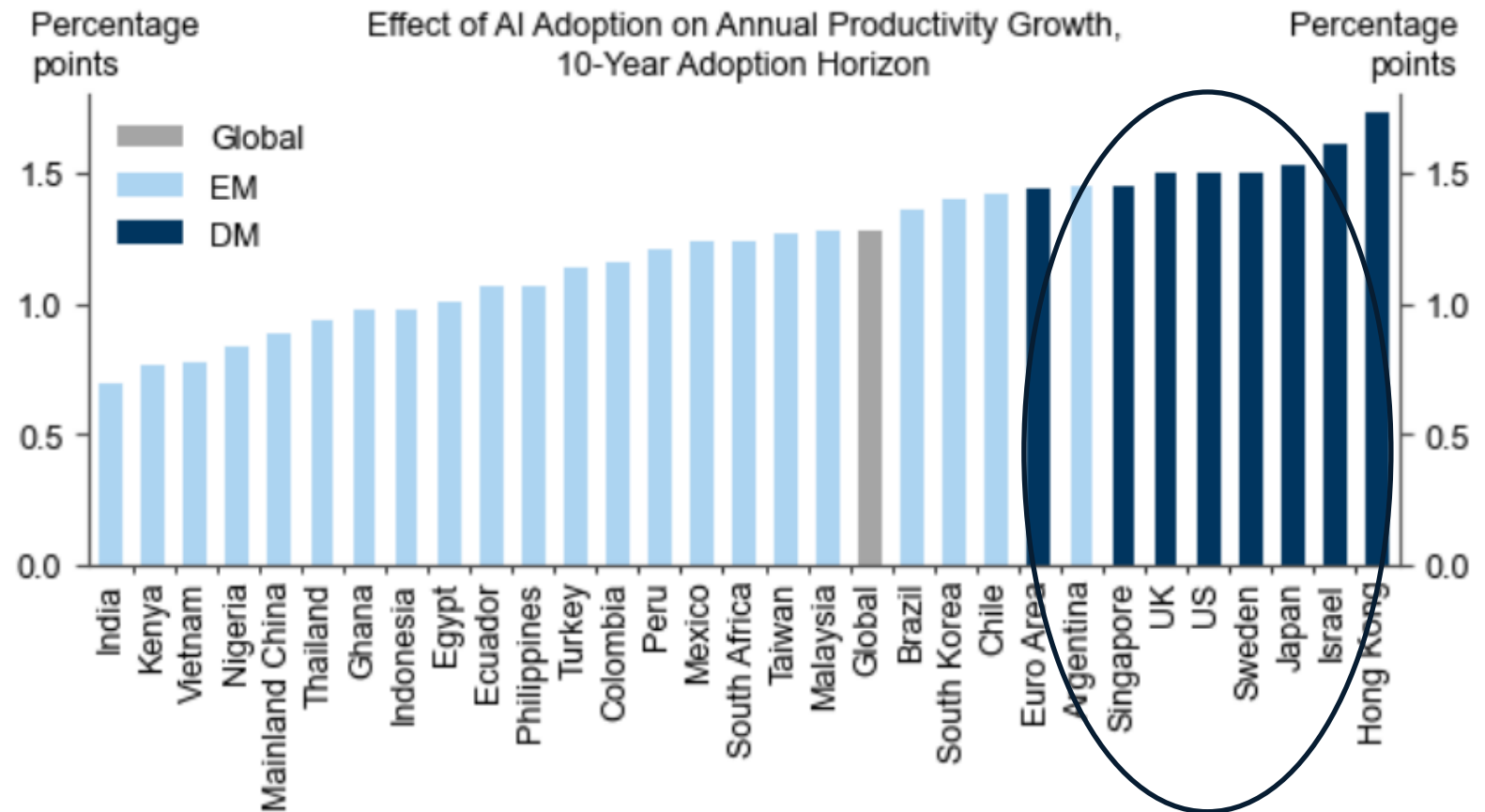
Source: Acemoglu et al (2019), GS

- Daren Acemoglu less sanguine: drivers of labor demand change over time
- Worker displacement has created a net drag in labor demand over past 10 years– Light blue bars – re-employment in new roles. Dark blue bars displacement from old roles.

# Estimated Effect on Global Productivity Growth

## AI Adoption Could Lift Global GDP Growth 1.4%

- Goldman Sachs estimates in baseline scenario imply that AI adoption could boost global annual productivity by 1.4%<sup>1</sup> and...
- Eventually drive a 7% or almost \$17 tn. increase in global GDP over a 10-year period



Source: GS

1. Key assumptions in baseline forecast: ~7% of workers displaced. Most of displaced find new positions that are less productive. Partially exposed workers (~63%) experience boost to productivity ~3%. 10-year period starts when roughly half of businesses have adopted generative AI. GS economists adjust for differences in industry composition to extrapolate US experience to other countries.



# Some Caveats Re Generative AI in Finance<sup>1</sup>

- **Generative Finance: Hints of Possible Contributions to Finance**
  - Richmond Fed paper's interesting finding<sup>5</sup> re parsing "Fedspeak"
    - ChatGPT demonstrated strong performance in interpreting Fed speeches
    - Surpassed "sentiment analysis" tool currently used by traders but..
    - Data limited, imbalanced and misfires occur sometimes
- **Prescient Academic Paper: Acknowledges Benefits but Highlights Three Risks<sup>2</sup>**
  - *Opacity* — A1 tool mysterious to all except creators
  - *Concentration* — Generative A1 likely to be dominated by few players...
    - If a bug emerges, it could poison entire system
  - *Regulatory gaps* — understanding and monitoring AI new challenge
    - Financial regulators not well equipped to oversee AI and
    - Not clear what entity or entities should regulate it

1. Gillian Tett, "The Dangers of letting AI Loose on Finance", FT, 28 April 2023  
2. G. Genseler and Lily Bailey, "Deep Learning and Financial Stability", MIT, November 1, 2020

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