

Productivity Effects of Artificial Intelligence and Other Emerging Technologies

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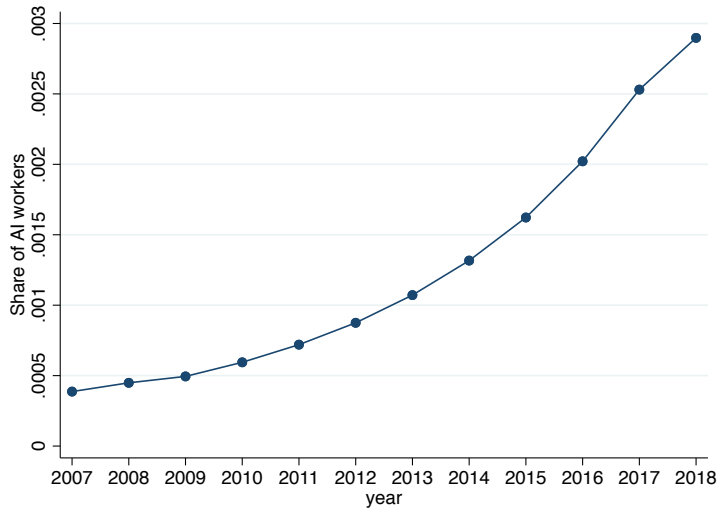
Today

- How do recent technologies like artificial intelligence (AI) affect productivity?
 - Our evidence shows a null effect on firm-level productivity
 - However, these technologies do lead to firm growth through product innovation
- Potential explanations and policy implications

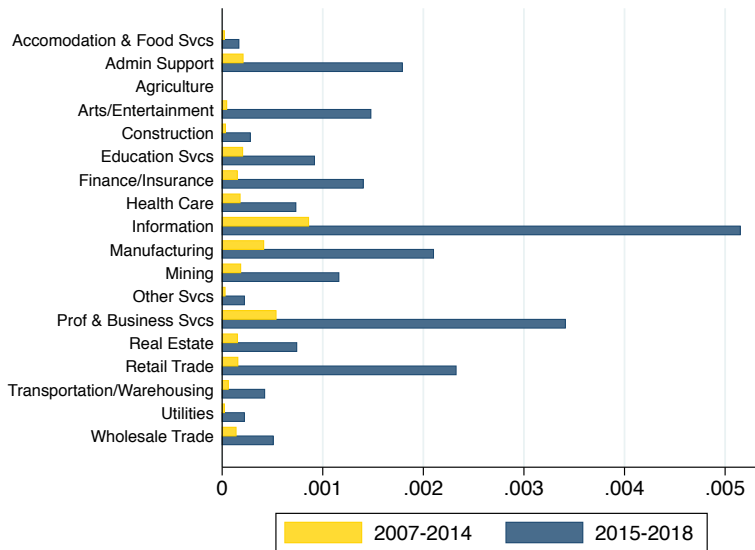
Explosion in AI Investments

- There has been an explosion in AI investments
 - From \$7.6 billion in 2010 to \$48 billion in 2018 in the US + \$24 billion targeted by EU, \$150 billion by China
 - AI system is a *“Machine-based system that can, for a given set of human-defined objectives, make predictions, recommendations or decisions”*
 - Most AI investments are in machine learning (ML), natural language processing (NLP), and computer vision (CV)
- Key inputs of AI: data, computing power, and AI-skilled labor
- In Babina, Fedyk, He, and Hodson (2021), we measure AI investments using AI-skilled labor based on worker resumes

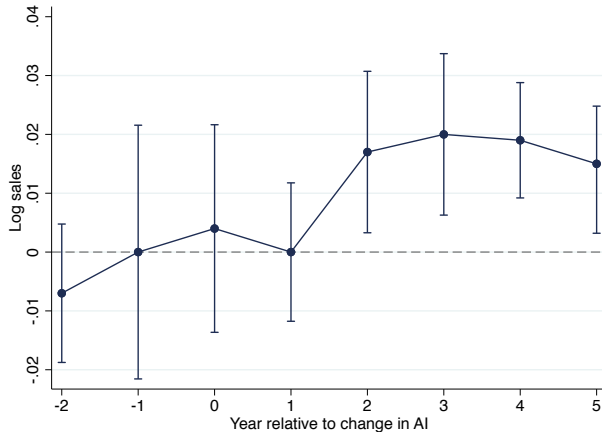
Explosion in AI Investments



AI is a General Purpose Technology



AI Investments Leads to Growth in Firm Output



A one-standard-deviation increase in AI investment \Rightarrow **20%** higher sales over 2010–2018

We Find No Effect on Firm-level Productivity

	Δ Log Sales/Worker		Δ Revenue TFP	
Δ Share AI Workers	-0.028 (0.038)	-0.006 (0.035)	-0.015 (0.033)	0.004 (0.035)
Ind FE	Y	Y	Y	Y
Controls	N	Y	N	Y

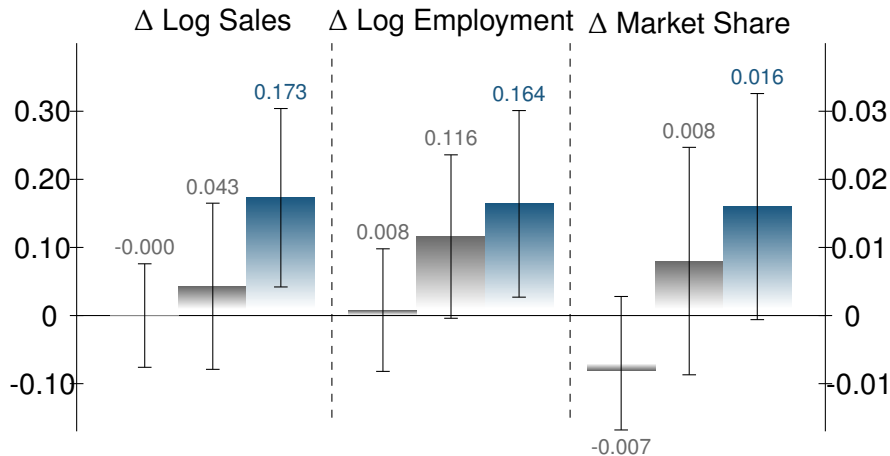
- **Sales/Worker** measures labor productivity
- **(Revenue) TFP** is a standard measure of productivity based on Cobb-Douglas production function

But There Is A Strong Positive Effect on Product Innovation

	Δ Trademarks		Δ Product Patents		Δ Product Fluidity	
	(1)	(2)	(3)	(4)	(5)	(6)
Δ Share AI Workers	0.144** (0.065)	0.152** (0.077)	0.221*** (0.035)	0.227*** (0.039)	0.148*** (0.036)	0.114*** (0.035)
Industry FE	Y	Y	Y	Y	Y	Y
Controls	N	Y	N	Y	N	Y

- **Trademarks** are registered whenever new products/services are commercialized
- **Product patents** measures product innovation (as opposed to process innovation)
- **Product fluidity** reflects updates to firms' product portfolios

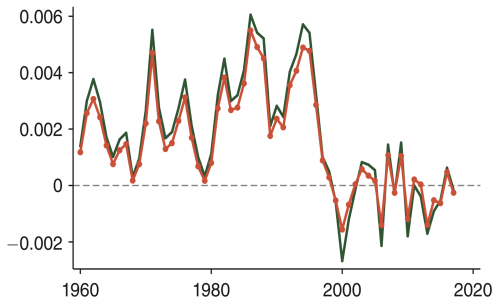
Growth is Concentrated in the Largest and Most Productive Firms



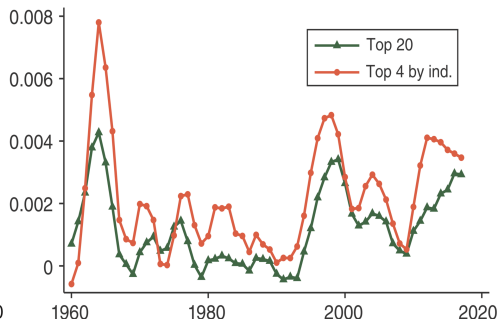
Implications for Aggregate Productivity

- We find:
no productivity growth at the **firm** level and
reallocation to more productive firms at the **aggregate** level
- Consistent with “fading stars” in Gutiérrez and Philippon (2019)

Panel A. Hulten contribution, top 20 no oil



Productive reallocation



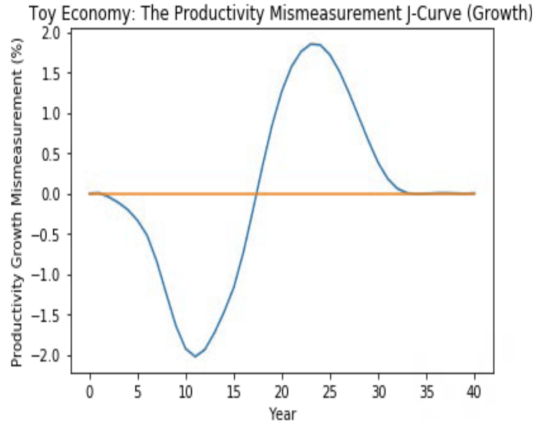
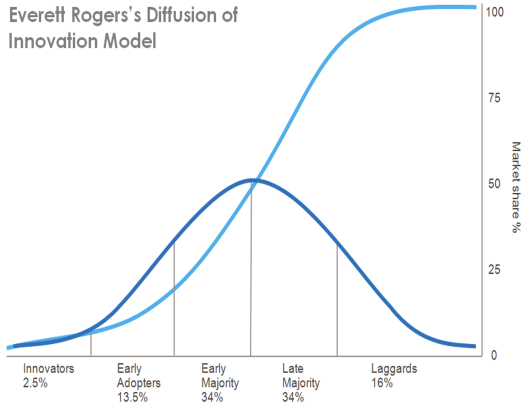
How Does AI Compare to Previous General Purpose Technologies?

- Previous general purpose technologies lead to huge productivity gains
 - Fiszbein et al. (2020): **electricity** adoption led to rapid productivity growth
 - Graetz and Michaels (2018): **robot** adoption raises labor productivity
 - These technologies also led to product innovation
[Bartel et al. \(2007\)](#); [Braguinsky et al. \(2020\)](#); [Dixon et al. \(2021\)](#)
- **IT**: Solow Paradox in 1987, but followed by productivity growth in the 1990s
- Acemoglu et al. (2022) also find no effect of AI on productivity, but find positive effects of robotics and cloud computing

Maybe Productivity Growth is Lagged...

- **Productivity J-curve:** firms accumulate intangible capital without increasing output in early years of technology adoption (Brynjolfsson et al. 2021)

Everett Rogers's Diffusion of Innovation Model



Is This Time Different?

- Unique features of AI:

1. Ability to predict facilitates product development & customization (e.g. Moderna)
2. Reliance on big data benefits large firms owning more data

Is This Time Different?

- Unique features of AI:
 1. Ability to predict facilitates product development & customization (e.g. Moderna)
 2. Reliance on big data benefits large firms owning more data
- Why do AI-investing firms grow and develop new/better products but fail to improve productivity?
 - Ideas may get harder to find (Bloom et al. 2020), esp for productive firms
 - Acemoglu (2021): AI currently focuses on automating human tasks instead of creating new tasks in the production process
 - Size gives superstar firms a natural advantage in the age of AI, and reduces competition and incentives to improve productivity
 - Aghion et al. (2019): productivity gains from reallocation may be temporary and offset by long-run decline in incentives to innovate

Conclusion and Thoughts for Policy

- We have seen
 - An explosion of AI investments
 - Growth from AI is *not* accompanied by productivity gains
 - Growth from AI is concentrated in largest and most productive firms
- The adoption of AI is still quite low: 3% of firms and 13% of workers in 2018
- Policies to fully unleash the potential productivity benefits of AI:
 - Address constraints of AI adoption: AI-skilled labor and data access
 - Targeted R&D subsidies and public-private research partnerships
 - Competition policy

The End

Thank you!

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