Productivity Effects of Artificial Intelligence and Other Emerging Technologies

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- 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
A one-standard-deviation increase in AI investment $\Rightarrow$ \textbf{20}\% higher sales over 2010–2018
We Find No Effect on Firm-level Productivity

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<tr>
<th>Δ Share AI Workers</th>
<th>Δ Log Sales/Worker</th>
<th>Δ Revenue TFP</th>
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<tbody>
<tr>
<td></td>
<td>-0.028</td>
<td>-0.006</td>
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<td></td>
<td>(0.038)</td>
<td>(0.035)</td>
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<td>Ind FE</td>
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<td>Controls</td>
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- **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

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<tr>
<th></th>
<th>$\Delta$ Trademarks</th>
<th></th>
<th>$\Delta$ Product Patents</th>
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<th>$\Delta$ Product Fluidity</th>
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<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
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<tr>
<td>$\Delta$ Share AI Workers</td>
<td>0.144** (0.065)</td>
<td>0.152** (0.077)</td>
<td>0.221*** (0.035)</td>
<td>0.227*** (0.039)</td>
<td>0.148*** (0.036)</td>
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<td>Industry FE</td>
<td>Y</td>
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- **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

<table>
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<tr>
<th></th>
<th>Δ Log Sales</th>
<th>Δ Log Employment</th>
<th>Δ Market Share</th>
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<tbody>
<tr>
<td>-0.000</td>
<td>0.043</td>
<td>0.008</td>
<td>-0.007</td>
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<td>0.173</td>
<td>0.116</td>
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<td>0.164</td>
<td>0.016</td>
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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)
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)
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
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- 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!
References

References


