TECHnological Factor Productivity

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Discussion by

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Summary

- What is behind a **firm's productivity**?
  - Establishments perform various business functions (BFs), e.g. "assembly" in automotive sector.
  - Within business functions, there are various tasks, e.g. placing window panes, doors, wheels...
  - For these tasks, firms use different technologies, e.g. operator-controlled machines, lasers, robots...
- This paper opens ~~"black box"~~ **"Pandora's box"**:
  - Survey data on general (GBF) and sector-specific (SSBF) business functions and their technologies.
  - Large coverage: 12 broad sectors, 10 countries, over 12k establishments.
  - Experts answer questions on which technologies are used, which are the most sophisticated, etc.

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- **Goals:**
  1. Understand how technologies are used within the firm.
     - e.g., is the most sophisticated technology the one that's used most intensively?
  2. Quantify dispersion in used technologies within and across establishments.
  3. Measure how technology correlates with a firm's measured productivity.
  4. Develop an index that summarizes the technology choices of an establishment (**"TechFP"**).

- **Key insights:**
  1. Most used technologies are *not* the most sophisticated ones (establishments are far from the frontier).
  2. Variation in technology sophistication is larger within establishments than across.
  3. As an establishment's technology becomes more sophisticated (TechFP ↑)...
     - ... technology sophistication increases more for some business functions than others.
     - ... that is, technology curves exhibit different (upward) slopes.

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Praise

- **Main contributions:**
  1. Introduce new and rich (survey) data on technology practices.
  2. Dissect technology within the firm.

- **Great paper:**
  - Ambitious and important work.
  - Clear aim to understand every aspect of heterogeneity (within and across firms) in technology.
    - Very nice feature $\rightarrow$ Map out technology frontier as the gap between usage and sophistication.
  - Pedagogical $\rightarrow$ Goes back to first principles, informs choices for macro modeling, ...

My Comments

1. Conceptualizing technology.
2. Extensive margins.
3. Mapping TechFP to TFP.
4. Other comments.

Comment 1: Conceptualizing Technology (1/2)

1. **Not all productivity-enhancing technologies are business function-specific:**
   - Some technologies permeate, and interact across, different business functions (e.g. IT).
     - Some of these business functions might not be GBFs, but a group of SSBFs.
     - Even within a business function, a given technology might affect different BF-specific tasks differently.
   - What's more, some technologies are not BF-specific but firm-specific.
     - A firm may find a breakthrough innovation which does not immediately diffuse to competitors.
       → *Example:* first computers to use silicon micro-chips; first companies to use AI.
     - As a sole possessor of this knowledge, the firm might apply it to all of its BFs (firm-level efficiency gains).

→ **Suggestion:** Consider non-BF-specific technologies (e.g. relevant for a group of SSBFs) in the survey.

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Comment 1: Conceptualizing Technology (2/2)

2 **Knowledge spillovers:**

- Technologies may have knowledge spillovers, both within and across establishments.
- The knowledge (human?) capital required to implement a technology might be transferable across BFs.

→ **Suggestion:** Use proxies for knowledge spillovers, e.g. firm's patents and citations, employee mobility...

3 **Embodied vs disembodied technology:**

- Some knowledge is diffused through technology that is embodied in inputs themselves.
- This matters if firms buy inputs from other firms (I-O structure) who have adopted "on their behalf".

→ **Suggestion:** Ask experts about *physical input*'s sophistication, and about input sourcing (I-O matrix).

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Comment 2: Extensive Margins (1/2)

1. **Adoption:**
   - Authors discuss intensity of existing technologies. What about the extensive margin?
   - In reality, overall sophistication ↑ of establishment (TechFP ↑) might be due to (a combination of):
     1. Same intensity of existing technologies, but more process innovation now makes them more sophisticated.
     2. More intensity in use of more sophisticated technologies, at given level of process innovation.
     3. Same intensity and same process innovation, but entry of new technologies (product innovation/adoption).
   - What drives these intensive- vs extensive-margin choices?
   - Model in Section 4:
     - Tries to conceptualize some of this using a simple trade-off between sophistication benefits vs adoption costs.
     - But adoption costs are over implementation of existing technologies, not adoption of new technologies.

→ **Suggestion:** Ask experts about *age* and *origin* of their existing technologies [Q: Is this in Module D?].

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2 **Productivity growth:**

- In dynamic macro models, we not only care about productivity level, but also productivity growth.
  - How do establishments accumulate knowledge capital? (Process vs product innovation)
  - How do they move up on the "sophistication ladder" as they grow older? (margins previous slide)
- Similarly: entry and exit of BFs as firms become more complex organizations over time?

→ **Suggestion:** In subsequent waves, keep track of firms and their portfolios of BFs and technologies.

Comment 3: From TechFP to TFP

- What's the mapping from "technology" (TechFP) to "measured productivity" (TFP)?
- Section 6 finds correlations between TechFP with measured TFP... But this is the tip of the iceberg!
  - Businesses differ in their (i) intensity of usage and (ii) sophistication of existing technologies.
  - Relevant questions for mapping to productivity:
    - Why don't establishment use their most sophisticated technologies more intensively?
    - What explains the gap between a firm's technology mix and the frontier?
    - Why do establishments upgrade some business functions more than others?
  - Answers should come from a model of frictions vs strategic behavior:
    - Frictions may impede knowledge flow from top to bottom firms (sorting b/w top firms and top inventors?).
    - But some businesses may optimally choose to keep technology gap with competitors (market power story?).

→ **Suggestion:** Explore a richer dynamic model with R&D/adoption margins and strategic behavior.

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1. **Other interesting indicators:**
   - Distribution of least used ("LEAST") and of least sophisticated ("MIN") technology?
   - Distribution of technology gaps ("MAX-MIN" and "MOST-LEAST") within and across firms.
   - Could be used to explain productivity differences across sectors and countries.

   → **Suggestion:** Compute and explore these.

2. **Firms or establishments?**
   - Paper uses the terms "firm" and "establishment" interchangeably at times.
   - In standard macro models, we usually think of productivity at the firm level.
   - For multi-establishment firms, firm productivity is the aggregate of each establishment's productivity.
     - Firm might choose to allocate technologies and BFs across establishments in some optimal way.
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Conclusion

- This paper opens up the establishment and looks into use and sophistication of its technologies.
- Exciting and important agenda, lots of work ahead with new waves (if any) of the survey.
- **My comments:**
  1. Explore technology more broadly (non-BF-specific, knowledge spillovers, embodied technologies, ...).
  2. Explore adoption of new technologies and productivity growth.
  3. Explore richer and dynamic model of innovation/R&D/competition.
  4. Explore determinants of firm-level productivity and technology gaps across firms.

Thank you!