Innovation, Productivity Growth and Productivity Dispersion

Lucia Foster\textsuperscript{a} Cheryl Grim\textsuperscript{a} John Haltiwanger\textsuperscript{b} Zoltan Wolf\textsuperscript{c}

\textsuperscript{a}U.S. Census Bureau
\textsuperscript{b}University of Maryland
\textsuperscript{c}Westat

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Motivation - innovation and productivity

- What are the firm dynamics accompanying innovation and productivity growth?

- Several distinct but related literatures:
  - Observed measures of innovation activity (e.g., R&D, patents)
    - Complex relationship with productivity
    - More relevant for some sectors
  - Reallocation of resources an important determinant of aggregate (industry-level) productivity growth.
  - Innovation inherently associated with experimentation. Indicators in the micro data are entry, productivity dispersion and reallocation.

- We focus on this third perspective. We take advantage of new economywide database tracking firm-level productivity along with entry and firm dynamics.

- We relate our findings to the other two literatures and use this to discuss open conceptual and measurement gaps.
Hypotheses - innovation, productivity dispersion, and productivity growth

- Related hypotheses from Jovanovic (1982) and Gort and Klepper (GK) (1982) provide guidance about the relationship between innovation, entry, productivity dispersion, reallocation and productivity growth:
  1. Periods of rapid innovation $\rightarrow$ surge in entry since expected profitability $\uparrow$
  2. Experimentation and learning
  3. Firms that successfully innovate grow, others shrink and exit
  4. Productivity growth – within and reallocation to successful firms

- Gort and Klepper (1982) (and others) provide evidence of shakeout dynamics of firms in rapidly innovating sectors

- This motivation has often been used to help explain higher volatility of young businesses (e.g., Dunne, Roberts and Samuelson (1989), Davis and Haltiwanger (1992))
Data

- Ideally we would measure: TFPR and its components: TFPQ, Demand, Cost Shocks and Dynamics. Today, focus on LPR and Dynamics.

- Data
  - Longitudinal Business Database (Jarmin and Miranda (2002)): economy-wide establishment-level and firm-level database that is primarily derived from the Census Bureaus Business Register and is augmented with other survey and administrative data. Tracks firm growth, entry and exit. We use firm-level version of LBD.
  - LBD is enhanced with revenue data (Haltiwanger, Jarmin, Kulick, and Miranda (2017)) using information from the Business Register.
  - RE_LBD includes approximately 80% of firms in the LBD.
Basic facts - Labor Productivity growth (HP trends)

Tech are STEM intensive industries – ICT plus Bio Tech
Basic facts - Entry dynamics

Employment share of startups

![Graph showing employment share of startups over time, with one line for tech and another for non-tech startups. The graph indicates a decrease in employment share for both categories over time, with the non-tech category consistently having a higher share.]
Basic facts - Young firms (age < 5)

Employment share

Productivity and Innovation
Basic facts
Productivity dispersion: IQR Within Narrow Industries, by Firm Age Groups
The Dynamic Relationship Between Entry, Productivity Dispersion and Growth

- Panel of industries using a standard difference-in-difference approach
- The hypotheses from GK are that a surge of within industry entry will yield an increase in productivity dispersion followed by an increase in productivity growth.
- Empirical specification:

\[ Y_{is} = \lambda_s + \lambda_i + \sum_{k=1}^{2} \beta_k \text{Tech} \ast \text{Entry}_{is-k} \]
\[ + \delta_k \text{NonTech} \ast \text{Entry}_{is-k} + \epsilon_{is} \]

- Low-frequency analysis - annual averages calculated over non-overlapping 3 year periods
The Dynamic Relationship Between Entry, Productivity Dispersion and Growth

Diff-in-diff regression results - effect of a 1% change in entry on dispersion and growth
Evolution of Dynamic Allocative Efficiency – Part of the Mechanism Following Innovation


\[ \Delta P_{it} = \Delta \bar{p}_{it,C} + \Delta \text{cov}_C(\theta_{ft}, p_{ft}) \\
+ \theta_{Nt}(P_{Nt} - P_{Ct}) + \theta_{Xt-1}(P_{Ct} - P_{Xt}) \]

- Components: within-firm growth (unw), covariance, net entry
- Calculate using annual industry level data, then aggregate to High Tech level
Dynamic OP decomposition
Our findings so far

▶ At industry level, entry precedes dispersion which precedes productivity growth especially for High Tech.

▶ Late 1990s high productivity in High Tech associated with a large contribution of increase in OP Covariance.
  ▶ These patterns are consistent with learning/experimentation hypotheses of GK.

▶ Where does this fit into surge and decline in productivity at aggregate level led by High Tech?
  ▶ In 1990s, surge in productivity in High Tech associated with surge in entry, reallocation and productivity growth consistent with innovation dynamics.
  ▶ Post 2000, decline in entry and reallocation consistent with falling pace of innovation.
  ▶ However, rise in productivity dispersion does not fit (likely need other factors like rising frictions/distortions as in Decker et. al. (2017)).
Conceptual and Measurement Challenges

- What is relationship between traditional measures and firm dynamics?
  - Primary focus has been on relationship between traditional measures (e.g., R&D and patents) and productivity.
  - Our findings suggest entry and productivity dispersion are useful metrics. Some work already pushing in this direction such as Acemoglu et. al. (2013). Young firms in innovative industries are more R&D and patent intensive.
  - Are firm dynamics a *black hole* method for detecting innovative activity?

- Firm entry/Dispersion dynamics may be useful for intangible capital measurement and analysis.
  - The very process of entry itself as well as much of the activity of young firms is arguably investment in intangible capital.
  - Likely not well captured by traditional measures.
Conceptual and Measurement Challenges

- Evolution of Dispersion of Productivity due to many factors.
- Shock dispersion (many factors potentially relevant here), innovation dynamics, frictions/distortions.
- Cyclical factors may be at work as well. We find for example evidence of counter-cyclical dispersion.
- Caution in interpreting increases in productivity dispersion:
  - Increase in innovation. Good news for productivity around the corner.
  - Increase in frictions. Implies declining productivity.
  - Cyclical dynamics reflecting a variety of potential mechanisms.
Summary

▶ Exploratory analysis: We interpret as prima facie evidence that within industry relationship between entry, dispersion of productivity, reallocation, and productivity growth a useful platform to quantify and investigate presence of and nature of innovation.

▶ Put differently, insufficient to estimate first moment relationships between productivity and innovative activity at firm or industry level.

▶ Next steps suggested by our analysis are to integrate traditional measures of innovative activity into firm dynamics data infrastructure. Useful as a cross check. Such efforts are underway.

▶ Our results highlight caution in interpreting within industry increases in productivity dispersion. May reflect benign and adverse factors.