Innovation, Productivity Growth and Productivity Dispersion[1]

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CRIW, March 2017

[1]Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure that no confidential information is disclosed.

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

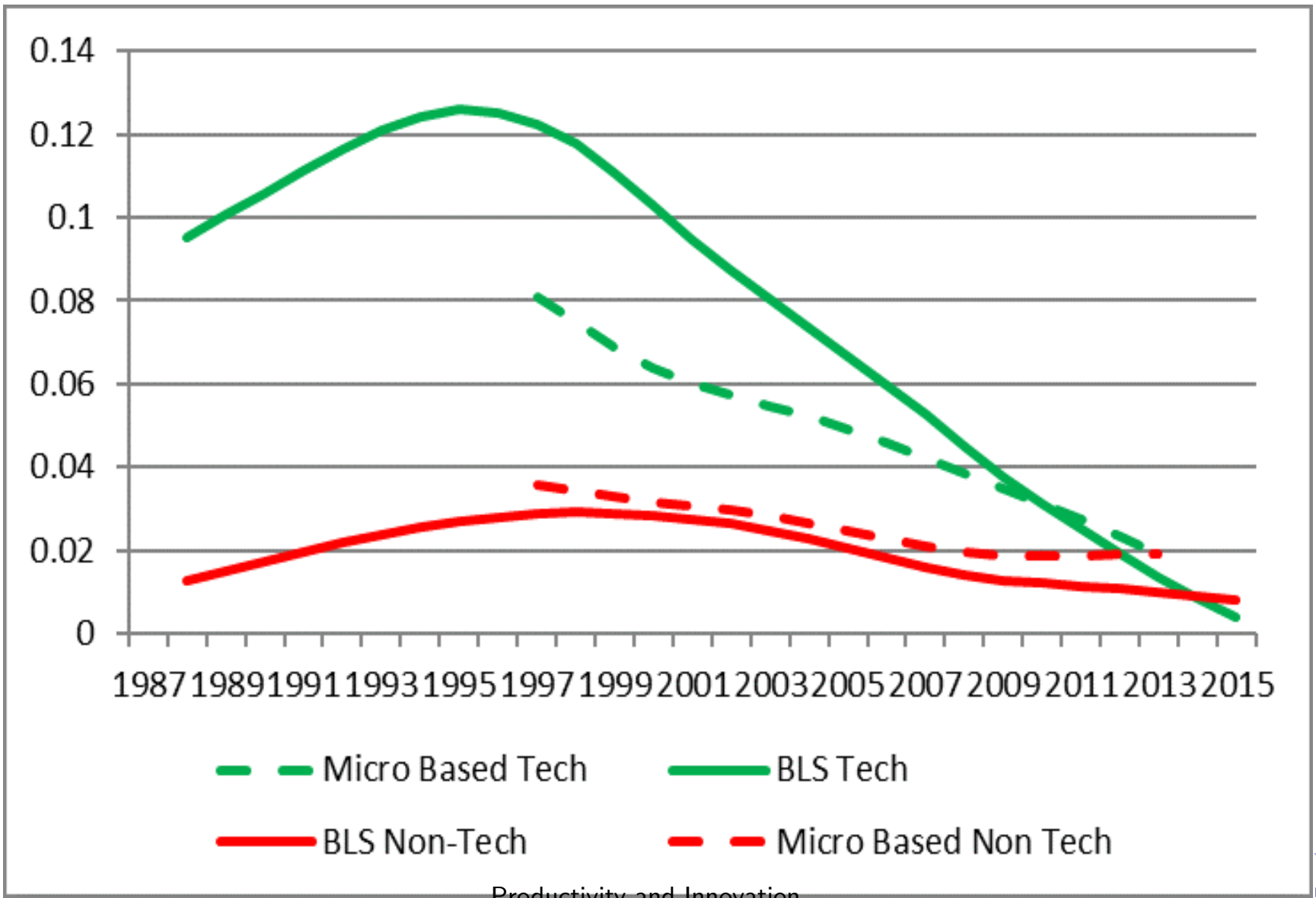
- Related hypotheses from Jovanovic (1982) and Gort and Klepper (GK) (1982) provide guidance about the relationship between innovation, entry, productivity dispersion, reallocation and productivity growth:
  1. Periods of rapid innovation $\rightarrow$ surge in entry since expected profitability $\uparrow$
  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.
  - LBD available from 1976 to 2013. Revenue data available 1996 to 2013.

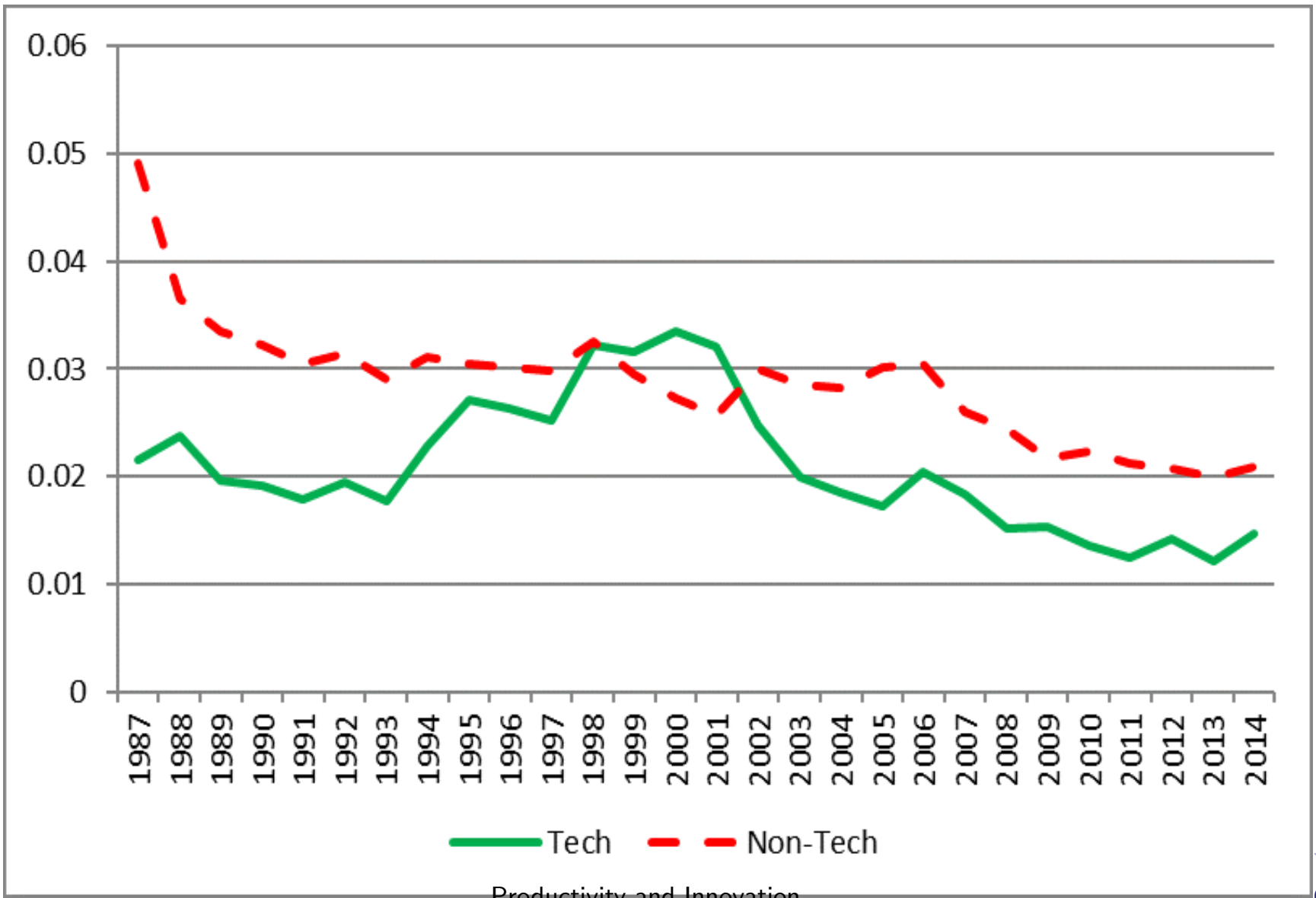
Basic facts - Labor Productivity growth (HP trends)

Tech are STEM intensive industries – ICT plus Bio Tech



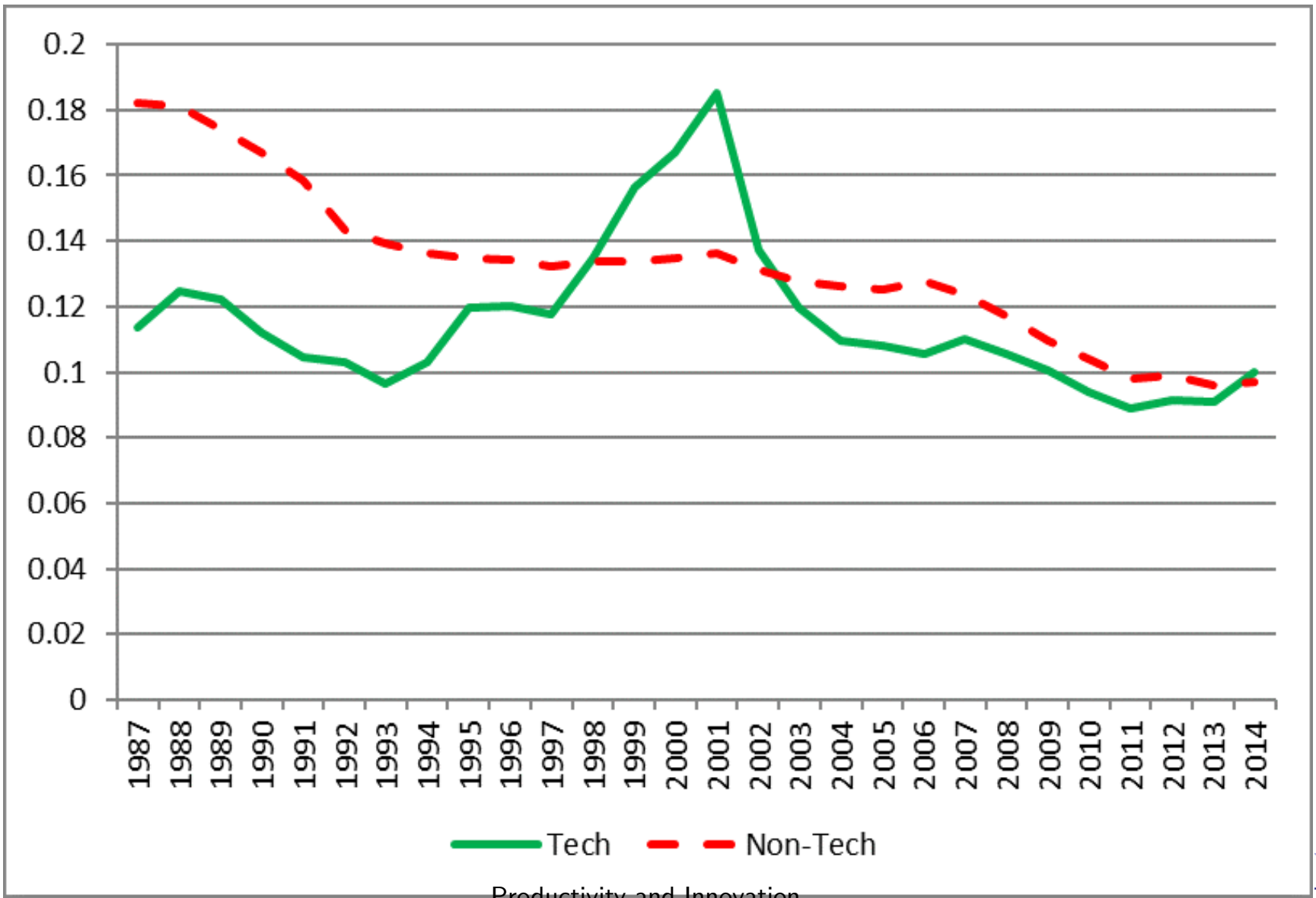
Basic facts - Entry dynamics

Employment share of startups



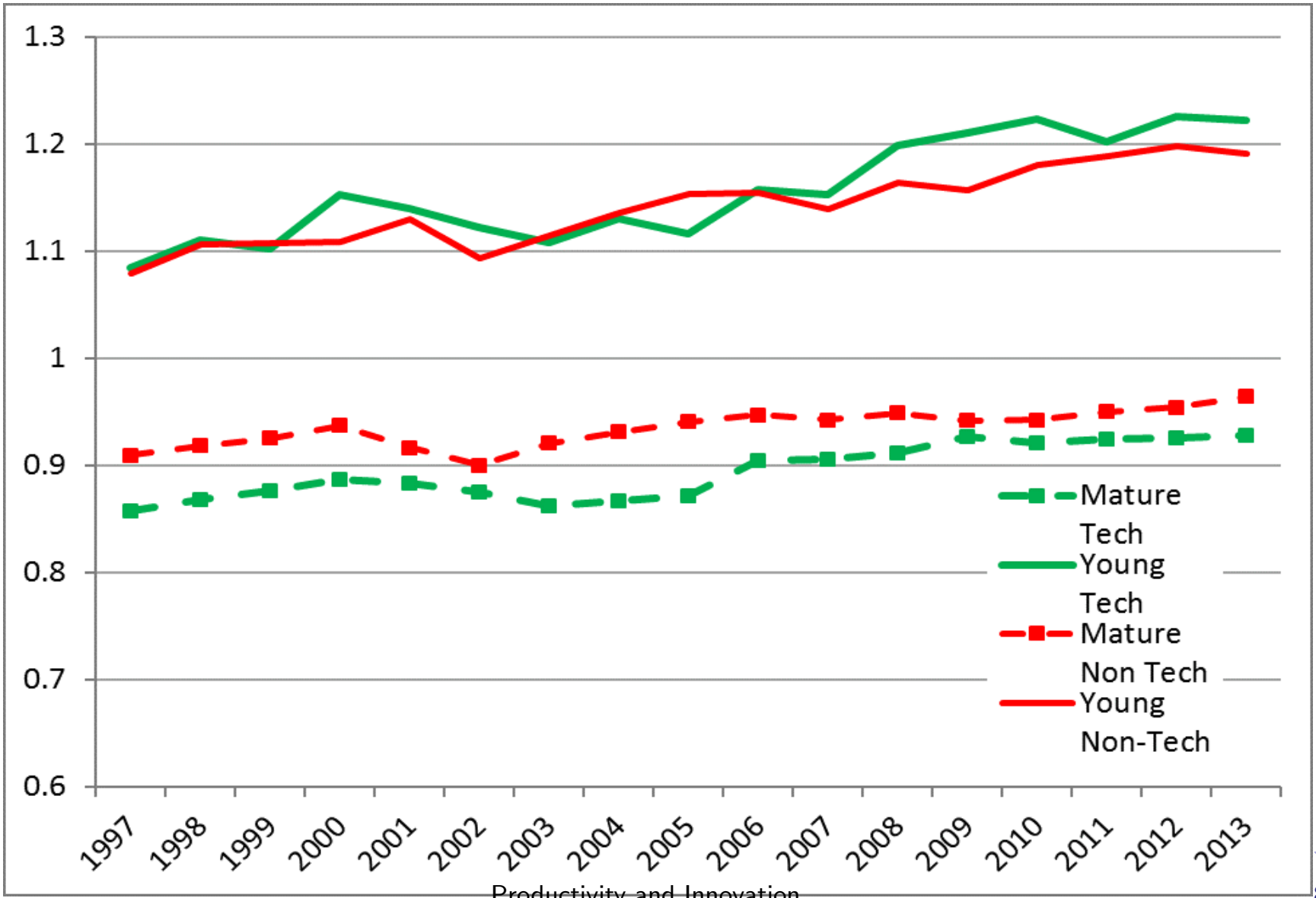
Basic facts - Young firms (age<5)

Employment share



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:

$$\begin{aligned} Y_{is} =& \lambda_s + \lambda_i + \sum_{k=1}^{2} \beta_k \text{Tech} * \text{Entry}_{is-k} \\ &+ \delta_k \text{NonTech} * \text{Entry}_{is-k} + \epsilon_{is} \end{aligned}$$

- 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

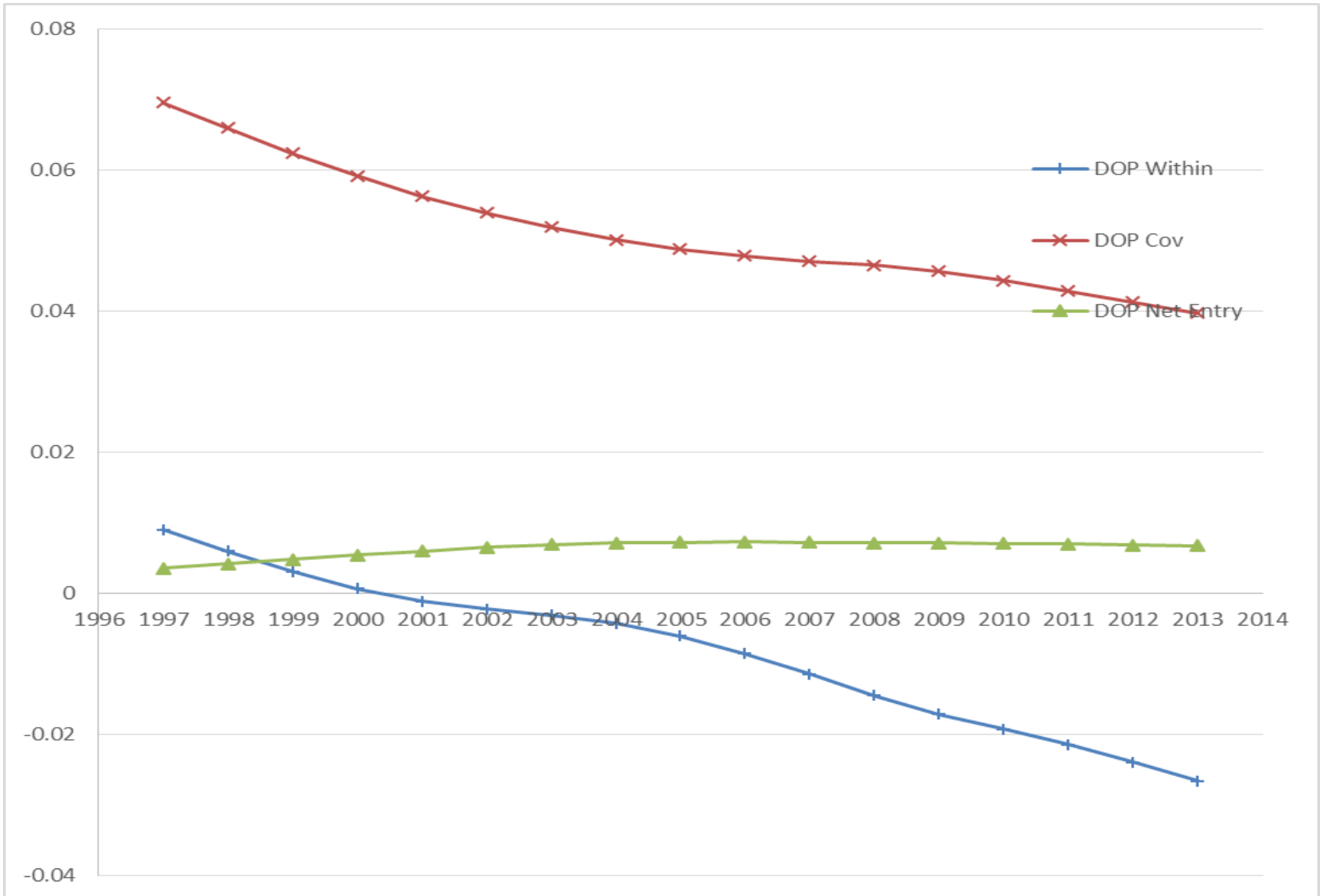
Evolution of Dynamic Allocative Efficiency – Part of the Mechanism Following Innovation

- Extension of Olley-Pakes (1996) à la Melitz and Polanec (2015)

$$\begin{aligned}\triangle P_{it} =& \triangle \overline{p}_{it,C} + \triangle \mathrm{cov}_C(\theta_{ft}, p_{ft}) \\ &+ \theta_{Nt}(P_{Nt} - P_{Ct}) + \theta_{Xt-1}(P_{Ct} - P_{Xt})\end{aligned}$$

- 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.
  - Caution: Hurst and Pugsley (2011, 2017) perspective on entrepreneurship for non-pecuniary reasons.

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.