Older and Slower: The Effects of the Startup Deficit on Aggregate Productivity Growth

Titan Alon \textsuperscript{a}  David Berger \textsuperscript{b}  Robert Dent \textsuperscript{c}  Benjamin Pugsley \textsuperscript{c}

\textsuperscript{a}Northwestern University
\textsuperscript{b}Northwestern University and NBER
\textsuperscript{c}New York Fed

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\textsuperscript{*}Any opinions and conclusions expressed herein are those of the author(s) and do not necessarily represent the views of the U.S. Census Bureau, Federal Reserve Bank of New York or the Federal Reserve System. All results have been reviewed to ensure that no confidential information is disclosed.
The Startup Deficit and Aging of American Businesses

- Startup firm share (left axis)
- Startup employment share (right axis)

- Mature firm share (left axis)
- Mature employment share (right axis)
Main Question: How has the decline in entry and its effects on the age distribution ("startup deficit") impacted aggregate productivity?

Economic Theory suggests many important channels:

Growth Theory: Innovation, New Products
Trade: Opening of New Markets
Industrial Organization: Competition
Firm Dynamics: Selection, Reallocation, Learning (Demand/Process)

Though theory does not offer an unambiguous answer.
Cross-Sectional Evidence

**Dependent Variable:** Local labor productivity growth

**Demographic IV:** 20-year lagged fertility rates †

**Collateral IV:** Speculative housing price rises‡

<table>
<thead>
<tr>
<th></th>
<th>Baseline (1)</th>
<th>Demographics Channel (2)</th>
<th>(3)</th>
<th>Collateral Channel (4)</th>
<th>(5)</th>
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</thead>
<tbody>
<tr>
<td><strong>Startup Rate</strong></td>
<td>0.796***</td>
<td>1.46**</td>
<td>1.796***</td>
<td>1.618***</td>
<td>3.767***</td>
</tr>
<tr>
<td></td>
<td>(0.210)</td>
<td>(0.620)</td>
<td>(0.910)</td>
<td>(0.388)</td>
<td>(1.134)</td>
</tr>
<tr>
<td><strong>Year FE</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
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<td>IV</td>
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<td>All Ind</td>
<td>Ex-Con,NT</td>
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</tbody>
</table>

† See Karahan, Pugsley, Sahin (2016) for more details
‡ See Charles, Hurst, Notowidigdo (2016) for details on IV construction
Our Approach and Preview of Results

Our Aim: Isolate age-composition channel

Our Approach:
- Estimate *age-productivity* profile
- Develop explicit aggregation technique
- Adapt DOP to provide economic interpretation
- Illustrative model based on Hopenhayn (1992)

Main Findings:
- Robust link between firm age and productivity
- Selection and Reallocation are primary channels
- Between 1980-2014, aggregate productivity reduced by 3-4%
- Additional declines in allocative-efficiency of oldest firms
Data and Methodology
Main Data Set: Census Administrative Data on Firm-Level Labor (Revenue) Productivity for Non-Farm Business Sector, 1996-2012.

- *Longitudinal Business Database* (LBD) - geography, industry, firm age, employment, organizational structure
- *Business Register* (SSEL) - firm tax receipts
- *Bureau of Labor Statistics* (BLS) - 4-digit NAICS price indices

Create *Revenue-Enhanced LBD* following Haltiwanger et. al. (2016).

- Panel Data for Entire Non-Farm Business Sector
- Propensity Score Sampling Weights for Match Bias
- Filters for Outliers, Coding Errors, M&A activity, etc.
Let $\Phi_{iat}$ be the employment weighted log labor productivity of a cohort of firms age $a$ in industry $i$ at period $t$. We estimate:

$$\Delta_{at} \Phi_{ait} = \nu_i + \mu_t + \sum_{a}^{A} 1_{at} \delta_a + \varepsilon_{ait}$$

where the $\delta_a$ non-parametrically identify firm lifecycle productivity growth.

For new entrants, we run auxiliary regression

$$\Delta_{t} \Phi_{E,it} = \eta + \nu_i + \epsilon_{E,it}$$

where we interpret $\eta$ as common trend in new entrants.
Aggregating Firm Level Findings

To isolate effects of aging, we observe that the empirical design implies

\[ \mathbb{E} [\Delta \Phi_{a,t} \mid \mu = 0, \nu = 0] = \delta_a \]
\[ \mathbb{E} [\Delta \Phi_{E,t} \mid \mu = 0, \nu = 0] = \eta \]

so that for surviving incumbents (dropping \( \mathbb{E} \) notation)

\[ \Phi_{a,t} = \sum_{j=1}^{a} \delta_j + \Phi_{E,t-a} \]

and for new entrants

\[ \Phi_{E,t} - \Phi_{E,t-1} = \eta \]

which also allows us to write:

\[ \Phi_{E,t-a} = -\eta a + \Phi_{E,t} \]
Aggregating Firm Level Findings

Rewriting aggregate productivity growth conditional on a historical time path for employment shares:

\[
\mathbb{E}[\Delta \Phi | s_{a,t}] = \sum_a s_{a,t} \Phi_{a,t} - \sum_a s_{a,t-1} \Phi_{a,t-1}
\]

we can plug in our results above to calculate the net effect on aggregate productivity had shares followed a counter-factual trajectory \(s^{cf}_t\)

\[
\mathbb{E}[\Delta \Phi | s^{cf}_{a,t}] - \mathbb{E}[\Delta \Phi | s_{a,t}] = \sum_a \left( \Delta s^{cf}_{a,t} - \Delta s_{a,t} \right) \sum_{j=1}^a \delta_j - \eta \sum_a \left( \Delta s^{cf}_{a,t} - \Delta s_{a,t} \right)
\]

- Lifecycle
- Cohort
Decomposing Labor Productivity Growth

To interpret results, we adapt the Dynamic Olley-Pakes decomposition.

For a cohort, year $t - 1$ productivity is composed of survivors and exiters

$$
\Phi_{a,t-1} = s_{sa,t-1}\Phi_{sa,t-1} + s_{xa,t-1}\Phi_{xa,t-1} \\
= \Phi_{sa,t-1} + s_{xa,t-1}(\Phi_{xa,t-1} - \Phi_{sa,t-1})
$$

Expressing the cohort’s period $t$ productivity in terms of survivors yields

$$
\Delta at\Phi at = \Delta \Phi_{sa,t} - s_{xa,t-1}(\Phi_{xa,t-1} - \Phi_{sa,t-1})
$$

Applying the Olley-Pakes Decomposition to first component

$$
\Delta at\Phi at = \underbrace{\Delta \bar{\phi}_{sa,t}}_{\text{Within Firm}} + \underbrace{\Delta \hat{Cov}_a(s_{ist}, \rho_{ist})}_{\text{Allocative Efficiency}} - s_{xa,t-1}(\Phi_{xa,t-1} - \Phi_{sa,t-1})
$$

Selection
Results and Robustness
The Age-Productivity Profile

![Graph showing net labor productivity growth across different age groups.](image-url)
The Firm Dynamics Decomposition

**Total**

**Selection**

**Within**

**Allocation**

Net Labor Productivity Growth

Contribution to Net LP Growth

Age Group
Robustness

- **Price Effects:** Real versus Nominal
- **Organizational:** Multi-Unit versus Single-Unit Firms
- **Industrial:** Industry Compositions
- **Geography:** Geographic Variations
- **Age Censoring:** Triangular Panel Approach
- **Weight Aggregation:** Cross-Sectional Weighting
- **Time Stability:** High Growth (1994-04) and Low Growth (2005-12)
### Mature Firms

<table>
<thead>
<tr>
<th></th>
<th>Change in Average Mature (Age 16+) Firm Industry Productivity Growth $\Delta \Phi_{16+jt}$</th>
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<tbody>
<tr>
<td></td>
<td>Total</td>
</tr>
<tr>
<td>Late Period (2005-2012)</td>
<td>-0.023</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
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</table>

**Time Stability**  **Age Censoring**
Conclusions and Takeaways
Conclusions and Takeaways

Takeaways

- In last three decades, there has been a **substantial reallocation of activity away from entrants and young firms to older incumbents**...
- ...which is worrisome because **labor productivity varies significantly across cohorts and with firm age**
- ...due mainly to the **forces of selection and reallocation** on the young
- ...accounting for a **cumulative reduction in aggregate productivity of 3.00-4.15% from 1980-2014**.

Other content in the full paper...

- Illustrative simulations from modified Hopenhayn (1992)
- Many more cross-sectional regressions
- A battery of robustness checks
Linked Appendix
Related literature

- **Business dynamism**: Davis, Haltiwanger, Jarmin and Miranda (2006); Reedy and Litan (2011); Decker, Haltiwanger, Jarmin and Miranda (2014); Davis and Haltiwanger (2014);

- **Importance of firm age**: Dunne, Roberts and Samuelson (1996); Haltiwanger, Jarmin and Miranda (2013); Adelino, Ma and Robinson (2014); Pugsley and Şahin (2014)


- **Entrepreneurship, innovation and growth**: Schumpeter (1942), Aghion and Howitt (1994); Caballero and Hammour (1994); Klette and Kortum (2004); Ackigit and Kerr (2010), Acemoglu, Ackigit, Bloom and Kerr (2013)
# Robustness: Price Effects

## Total

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Nominal</th>
<th>Real</th>
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<tbody>
<tr>
<td>1-2</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td>2-3</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>3-5</td>
<td>0.05</td>
<td>0.1</td>
</tr>
<tr>
<td>5-10</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>10-15</td>
<td>0</td>
<td>0.05</td>
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## Selection

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Contribution to Net LP Growth</th>
</tr>
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<tbody>
<tr>
<td>1-2</td>
<td>1</td>
</tr>
<tr>
<td>2-3</td>
<td>2</td>
</tr>
<tr>
<td>3-5</td>
<td>3</td>
</tr>
<tr>
<td>5-10</td>
<td>4</td>
</tr>
<tr>
<td>10-15</td>
<td>5</td>
</tr>
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</table>

## Within

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Contribution to Net LP Growth</th>
</tr>
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<tbody>
<tr>
<td>1-2</td>
<td>Within</td>
</tr>
<tr>
<td>2-3</td>
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<tr>
<td>3-5</td>
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<tr>
<td>5-10</td>
<td>3</td>
</tr>
<tr>
<td>10-15</td>
<td>4</td>
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## Allocation

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Contribution to Net LP Growth</th>
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<tbody>
<tr>
<td>1-2</td>
<td>1</td>
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<tr>
<td>2-3</td>
<td>2</td>
</tr>
<tr>
<td>3-5</td>
<td>3</td>
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<tr>
<td>5-10</td>
<td>4</td>
</tr>
<tr>
<td>10-15</td>
<td>5</td>
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</table>
Robustness: Organizational

Total

Selection

Within

Allocation

Net Labor Productivity Growth

Contribution to Net LP Growth

Age Group

Baseline

Only single units

Contribution to Net LP Growth

Age Group

Baseline

Only single units

Net Labor Productivity Growth

Contribution to Net LP Growth

Age Group
Robustness: Industrial

Baseline Estimates

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Labor Productivity Growth</th>
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<tbody>
<tr>
<td>1</td>
<td>-0.05</td>
</tr>
<tr>
<td>2-3</td>
<td>0</td>
</tr>
<tr>
<td>4-5</td>
<td>0.05</td>
</tr>
<tr>
<td>6-10</td>
<td>0.1</td>
</tr>
<tr>
<td>11-15</td>
<td>0.15</td>
</tr>
<tr>
<td>12-17</td>
<td>0.2</td>
</tr>
<tr>
<td>18-24</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Back
Robustness: Weighting

![Graphs showing net labor productivity growth and contribution to net LP growth across different age groups for Total, Selection, Within, and Allocation cases with different weighting schemes.](image-url)
Robustness: Time Stability

### Total

- **Net Labor Productivity Growth**
  - **Age Group**
    - Total
      - Contribution to Net LP Growth
        - 1
        - 2-3
        - 4-5
        - 6-10
        - 11-15

### Selection

- **Contribution to Net LP Growth**
  - **Age Group**
    - Early Period
    - Change, Slow Growth Period

### Within

- **Contribution to Net LP Growth**
  - **Age Group**
    - Within

### Allocation

- **Contribution to Net LP Growth**
  - **Age Group**
    - Allocation
Robustness: Geographic Cyclicality

![Graphs showing Net Labor Productivity Growth and Contribution to Net LP Growth across different age groups and selection tertiles.](image-url)
Robustness: Age Censoring

### Total

- **Age Group:**
  - 1
  - 2-3
  - 4-5
  - 6-10
  - 11-15
  - 16-20
  - 21-25
  - 26-30
  - 31+

- **Net Labor Productivity Growth:**
  - -1.1
  - -0.5
  - 0
  - 0.5
  - 1
  - 1.5
  - 2

- **Contribution to Net LP Growth:**

### Selection

- **Age Group:**
  - 1
  - 2-3
  - 4-5
  - 6-10
  - 11-15
  - 16-20
  - 21-25
  - 26-30
  - 31+

- **Net Labor Productivity Growth:**
  - -1.1
  - -0.5
  - 0
  - 0.5
  - 1
  - 1.5
  - 2

- **Contribution to Net LP Growth:**

### Within

- **Age Group:**
  - 1
  - 2-3
  - 4-5
  - 6-10
  - 11-15
  - 16-20
  - 21-25
  - 26-30
  - 31+

- **Net Labor Productivity Growth:**
  - -1.1
  - -0.5
  - 0
  - 0.5
  - 1
  - 1.5
  - 2

- **Contribution to Net LP Growth:**

### Allocation

- **Age Group:**
  - 1
  - 2-3
  - 4-5
  - 6-10
  - 11-15
  - 16-20
  - 21-25
  - 26-30
  - 31+

- **Net Labor Productivity Growth:**
  - -1.1
  - -0.5
  - 0
  - 0.5
  - 1
  - 1.5
  - 2

- **Contribution to Net LP Growth:**

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**Mature Firms**