Firms and Growth

Pete Klenow

Stanford University

10th Sir Richard Stone Lecture

University of Cambridge

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1984 Nobel citation

for having made fundamental contributions to the development of systems of national accounts and hence greatly improved the basis for empirical economic analysis
1. Why *firms* and growth?

2. Types of firm innovation?
   - creative destruction vs. new varieties vs. own innovation

3. Which firms?
   - entrants vs. incumbents
   - fast-growing incumbents vs. slow-growing incumbents

4. What shows up in official statistics?
Key References


How Destructive is Innovation?

Aghion, Bergeaud, Boppart, Klenow and Li (2019)

Missing Growth from Creative Destruction

Hsieh and Klenow (2017)

The Reallocation Myth
Examples of creative destruction

- Mini-mills vs. integrated steel mills
- Wal-Mart vs. K-Mart, Sears
- Apple/Samsung vs. Blackberry/Nokia
- Amazon vs. Borders, Circuit City
- Uber vs. taxi companies
- Google vs. newspapers
NETFLIX vs. BLOCKBUSTER (2004-2010)

BLOCKBUSTER REVENUE

NETFLIX REVENUE

$6 BILLION

$4 BILLION

$2 BILLION

BANKRUPT

$2.2 BILLION

2004 2005 2006 2007 2008 2009 2010

$0
Examples of own innovation by incumbents

- New car model years
- Generations of Intel microprocessors
- Successive versions of Apple iPhones
- Hospitals reducing mortality by introducing checklists
- Big Pharma?
Gazelles and Rockets
Why do we care which firms drive growth?

- spillovers may be bigger from entrants
- entrants may face financial constraints
- business stealing from creative destruction

► see Atkeson and Burstein (2019)
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Growth accounting

\[ Y = K^\alpha (A \cdot H)^{1-\alpha} \Rightarrow \frac{Y}{L} = \left( \frac{K}{Y} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{H}{L} \right) \cdot A \]

- \( Y = \text{GDP} \)
- \( K = \text{physical capital} \)
- \( H = \text{human capital} \)
- \( L = \text{worker hours} \)
- \( \alpha = \text{elasticity of output wrt } K \)
- \( Y/L = \text{labor productivity} \)
- \( A = \text{Total Factor Productivity (TFP)} \)
# U.S. growth accounting

<table>
<thead>
<tr>
<th>Period</th>
<th>$Y/L$</th>
<th>$A$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948–2017</td>
<td>2.34%</td>
<td>1.95%</td>
</tr>
<tr>
<td>1948–1973</td>
<td>3.28</td>
<td>3.21</td>
</tr>
<tr>
<td>1974–1995</td>
<td>1.55</td>
<td>0.81</td>
</tr>
<tr>
<td>1996–2005</td>
<td>3.08</td>
<td>2.58</td>
</tr>
<tr>
<td>2006–2017</td>
<td>1.21</td>
<td>0.90</td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of Labor Statistics (BLS)
Possible drivers of U.S. TFP growth

Human capital?

BLS already netted it out, albeit imperfectly

Allocative efficiency?

Evidence is limited to manufacturing and Compustat firms

Firm-led innovation

This is promising and will be my focus
Allocative efficiency in U.S. manufacturing

Source: Bils, Klenow and Ruane (2018)
Segue on allocative efficiency and development

Allocative efficiency *does* appear to be important for:

- levels of development
  - China, India, Mexico vs. the U.S.
- transitional growth
  - China, Spain, Eastern Europe

References
Bartelsman, Haltiwanger and Scarpetta (2013)
Gopinath, Kalemli-Ozcan, Karabarbounis, Villegas-Sanchez (2017)
U.S. vs. Indian allocative efficiency

Source: Bils, Klenow and Ruane (2018)
Evidence on firm-level innovation

- Patents and R&D?
- TFP growth decompositions?
- My approach: market shares
Manufacturing share of:

- Patents: 90%
- R&D: 69%
- GDP: 12%
- TFP growth: 11%

Sources: USPTO, NSF, BEA, BLS

Shares are in 2012 except for TFP growth (1987–2014)
TFP growth decompositions

- TFP of entering vs. exiting firms
- Reallocation of inputs from low to high TFP surviving firms
- TFP growth within surviving firms

Atheoretical (which is both good and bad!)

Need output and input data so limited to manufacturing in the U.S.

Lack of firm-level deflators (unit prices do not reflect quality, variety)
My approach: market shares

Use employment as a proxy for sales (market share).

The key idea:

- Entrant employment share reflects entrant innovation
- If survivors innovate, they add workers
- If creative destruction, thick tails for firm job growth
- If own innovation, modest employment gains
U.S. Census micro data on firms and plants

All firms with paid employees (excludes sole proprietors)

All sectors other than agriculture, government

Covers > 80% of all employment

1983–2013 and decades within
Job creation and destruction in the U.S. LBD
Exit rate by firm size

Source: U.S. Census of Manufacturing
Environment and static equilibrium

\[ Y = \left[ \sum_{j=1}^{M} (q_j y_j)^{\frac{1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \]

\[ y_j = l_j = \left( \frac{\sigma - 1}{\sigma} \right)^{\sigma-1} L W^{1-\sigma} q_j^{\sigma-1} \]

\[ L_f \equiv \sum_{j \in M_f} l_j = \left( \frac{\sigma - 1}{\sigma} \right)^{\sigma-1} L W^{1-\sigma} \sum_{j \in M_f} q_j^{\sigma-1} \]

\[ W \propto Y/L = M^{\frac{1}{\sigma-1}} \left[ \sum_{j=1}^{M} \frac{q_j^{\sigma-1}}{M} \right]^{\frac{1}{\sigma-1}} \]

25 / 56
Arrival rates of innovation

Own-variety improvements by incumbents $\lambda_i$
Creative destruction by entrants $\delta_e$
Creative destruction by incumbents $\delta_i$
New varieties from entrants $\kappa_e$
New varieties from incumbents $\kappa_i$

The average step size for quality improvements for own innovation $s_\lambda$ and creative destruction $s_\delta$ are both $s_q = \left(\frac{\theta}{\theta - (\sigma-1)}\right)^{1/(\sigma-1)} \geq 1$. New varieties are drawn from the quality distribution of existing products times $s_\kappa$. 
quality level

$q$

firm $j$ (3 initial varieties) $M_t$
own improvements

firm \( j \) (3 initial varieties)

quality level

\( q \)

\( S_\lambda \)

\( M_t \)
quality level

$q$

own improvements

creative destruction

new varieties

firm $j$ (3 initial varieties)

$M_t + 1$
own improvements

creative destruction

new varieties

entrant firms
Firm-led innovation and growth

Two ways of decomposing the gross growth rate \((1 + g)^{\sigma - 1}\):
Model JC/JD with *only* Creative Destruction
Model JC/JD with *only* Own Innovation
1 Why firms and growth?

2 Types of firm innovation?
   ▶ creative destruction vs. new varieties vs. own innovation

3 Which firms?
   ▶ entrants vs. incumbents
   ▶ fast-growing incumbents vs. slow-growing incumbents

4 What shows up in official statistics?
<table>
<thead>
<tr>
<th>Sources</th>
<th>Basis Points per Year</th>
<th>% of Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own Innovation</td>
<td>115</td>
<td>65%</td>
</tr>
<tr>
<td>Creative Destruction</td>
<td>46</td>
<td>26%</td>
</tr>
<tr>
<td>New Varieties</td>
<td>16</td>
<td>9%</td>
</tr>
<tr>
<td>All sources</td>
<td>176</td>
<td>100%</td>
</tr>
</tbody>
</table>

Sources of the U.S. speedup and slowdown

Basis points per year

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Creative Destruction</td>
<td>44</td>
<td>64</td>
<td>29</td>
</tr>
<tr>
<td>New Varieties</td>
<td>23</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Own Innovation</td>
<td>99</td>
<td>147</td>
<td>98</td>
</tr>
</tbody>
</table>
Outline

1. Why firms and growth?

2. Types of firm innovation?
   - creative destruction vs. new varieties vs. own innovation

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## Entrants and gazelles drive job creation...

<table>
<thead>
<tr>
<th>Employment growth</th>
<th>% of gross job creation</th>
<th>% of net job creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>50%</td>
<td>800%</td>
</tr>
<tr>
<td>Incumbents &gt; 20%</td>
<td>13%</td>
<td>208%</td>
</tr>
</tbody>
</table>

... but not TFP growth

<table>
<thead>
<tr>
<th>Employment growth</th>
<th>% of gross job creation</th>
<th>% of TFP growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>50%</td>
<td>13%</td>
</tr>
<tr>
<td>Incumbents &gt; 20%</td>
<td>13%</td>
<td>4%</td>
</tr>
<tr>
<td>Incumbents 0 to 20%</td>
<td>37%</td>
<td>65%</td>
</tr>
<tr>
<td>Incumbents &lt; 0%</td>
<td>0%</td>
<td>18%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>% of Job Creation</th>
<th>% of TFP Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 1</td>
<td>31%</td>
<td>9%</td>
</tr>
<tr>
<td>Age 1–5</td>
<td>13%</td>
<td>14%</td>
</tr>
<tr>
<td>Age 5–10</td>
<td>11%</td>
<td>14%</td>
</tr>
<tr>
<td>Age 10–15</td>
<td>9%</td>
<td>12%</td>
</tr>
<tr>
<td>Age &gt; 15</td>
<td>36%</td>
<td>51%</td>
</tr>
</tbody>
</table>

Source: Garcia-Macia, Hsieh and Klenow (2019)
1 Why *firms* and growth?

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Creative destruction is a key source of growth

- See the survey by Aghion, Akcigit and Howitt (2014)
- 26% of growth in Garcia-Macia, Hsieh and Klenow (2019)

Does it show up in *measured* growth?

- standard measurement assumes new producers have the *same* quality-adjusted price as producers they replace
- but creative destruction ⇒ new producers have a *lower* quality-adjusted price
Numerical example

- 80% of items: 4% inflation (no innovation)

- 10% of items: −6% inflation (innovation w/o CD)

- 10% of items: −6% inflation (CD)

- True inflation = 2%, True growth = 2%

- Imputed inflation due to CD = $\frac{8}{9} \cdot 4\% + \frac{1}{9} \cdot (-6\%) = 2.9\%$

- Measured growth = 1.1%, Missing Growth = 0.9%
Our questions

1. How much is U.S. growth understated, on average, because of creative destruction?

2. Has such “missing growth” increased in recent years?
1. How much is U.S. growth understated, on average, because of imputation for creative destruction?

\[ \sim 0.5 \text{ ppt per year} \text{ between 1983–2013} \]

2. Has “missing growth” increased a lot in recent years?

No
Missing growth with Cobb-Douglas aggregation

Sources of bias from Creative Destruction:

\[(\delta_e + \delta_i) \left\{ \left(1 - \hat{\lambda}_i\right) \log \hat{s}_\lambda + \log s_\delta - \log \hat{s}_\lambda \right\} \]

- not all incumbents innovate
- different stepsize for CD
Relative prices ⇔ market shares

CES demand ⇒ market share isoelastic with respect to price

\[
\text{Missing Growth} = \left( \frac{S_{I_t,t+1}}{S_{I_t,t}} \right)^{\frac{1}{1-\sigma}}
\]

- \(S_{I_t,t}\) = market share in \(t\) of all goods sold in both \(t\) and \(t + 1\)
- \(S_{I_t,t+1}\) = market share in \(t + 1\) of all goods sold in \(t\) & \(t + 1\)

Shrinking share of non-CD goods ⇒ missing growth
If existing plants carry out OI but not CD or NV:

\[
\text{Missing Growth} = \left( \frac{S_{I_{t,t+1}}}{S_{I_{t,t}}} \right)^{\frac{1}{1-\sigma}}
\]

\[S_{I_{t,t}} = t \text{ share of all establishments operating in } t \text{ and } t + 1\]

\[S_{I_{t,t+1}} = t + 1 \text{ share of all establishments operating in } t \text{ and } t + 1\]
Missing growth implied by survivor employment shares

<table>
<thead>
<tr>
<th>Period</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983–1995</td>
<td>52</td>
</tr>
<tr>
<td>1996–2005</td>
<td>48</td>
</tr>
<tr>
<td>2006–2013</td>
<td>65</td>
</tr>
</tbody>
</table>

basis points per year
Adding in the Missing Growth

basis points per year

<table>
<thead>
<tr>
<th>Period</th>
<th>Measured</th>
<th>“True”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983–2013</td>
<td>187</td>
<td>241</td>
</tr>
<tr>
<td>1996–2005</td>
<td>268</td>
<td>316</td>
</tr>
<tr>
<td>2006–2013</td>
<td>98</td>
<td>163</td>
</tr>
</tbody>
</table>
Sectors contributing to Missing Growth

Hotels & Restaurants  34%
Retail Trade        29%
Professional services  9%
Manufacturing       2%
Why do we care if some growth is missed?

- business stealing
- relating growth to policy
- whether ideas are getting harder to find (Gordon, Jones)
- how many people are better off than their parents (Chetty)
- setting the Fed’s inflation target
- indexing Social Security and tax brackets
Focused on U.S. growth today

But issues are just as relevant for other countries:

- Firms everywhere are innovating and growing (or not)
  - See India and Mexico vs. the U.S.
- Same issues arise with growth statistics outside the U.S.
Age shall wither them

Index of employee numbers at average company
Employment at company’s birth = 1

- United States
- Mexico
- India

Source: World Bank
Open questions

- How big are externalities?
  - entrants vs. incumbents
  - domestic vs. international

- Sources of firm-level innovation outside the U.S.?

- Missing growth outside the U.S.?

- Reasons for declining dynamism and growth?

- Creative destruction, trade, and inequality?