Firms and Growth

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10th Sir Richard Stone Lecture

University of Cambridge

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Sir Richard Stone

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

Outline

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

Garcia-Macia, Hsieh and Klenow (2019)

How Destructive is Innovation?

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

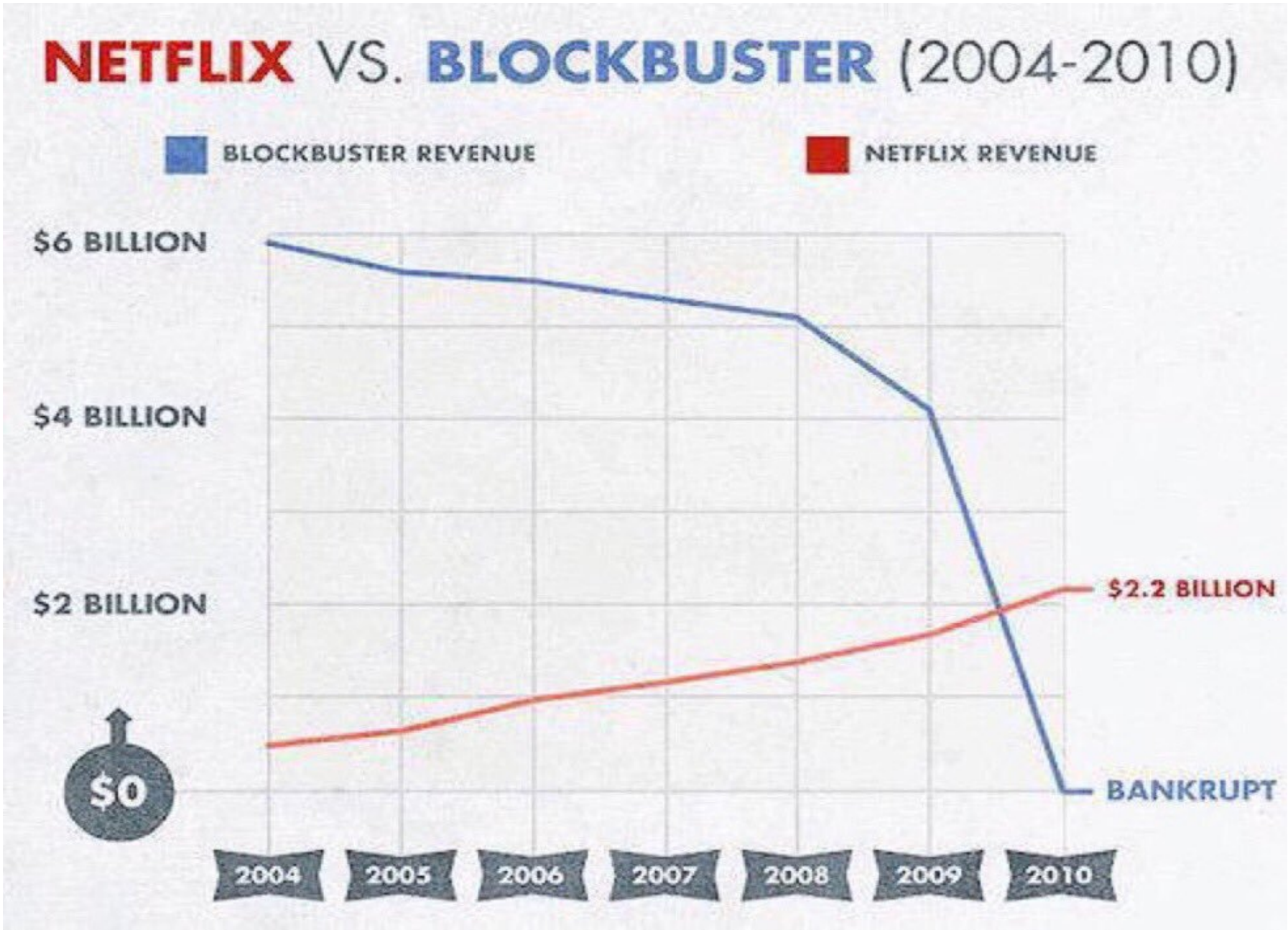
Missing Growth from Creative Destruction

Hsieh and Klenow (2017)

The Reallocation Myth

Examples of creative destruction

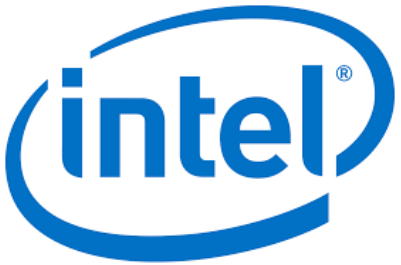
- Mini-mills vs. integrated steel mills
- Wal-Mart vs. K-Mart, Sears
- Apple/Samsung vs. Blackberry/Nokia
- Amazon vs. Borders, Circuit City
- Uber vs. taxi companies
- Google vs. newspapers


NETFLIX VS. BLOCKBUSTER (2004-2010)
BLOCKBUSTER REVENUE
NETFLIX REVENUE
$6 BILLION
$4 BILLION
$2 BILLION
$0
$2.2 BILLION
BANKRUPT
2004
2005
2006
2007
2008
2009
2010

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

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

- Y = GDP
- K = physical capital
- H = human capital
- L = worker hours
- α = elasticity of output wrt K
- Y/L = labor productivity
- A = Total Factor Productivity (TFP)

U.S. growth accounting

	Y/L	A
1948–2017	**2.34%**	**1.95%**
1948–1973	3.28	3.21
1974–1995	1.55	0.81
1996–2005	3.08	2.58
2006–2017	1.21	0.90

Source: U.S. Bureau of Labor Statistics (BLS)

Possible drivers of U.S. TFP growth

Human capital?

- BLS already netted it out, albeit imperfectly

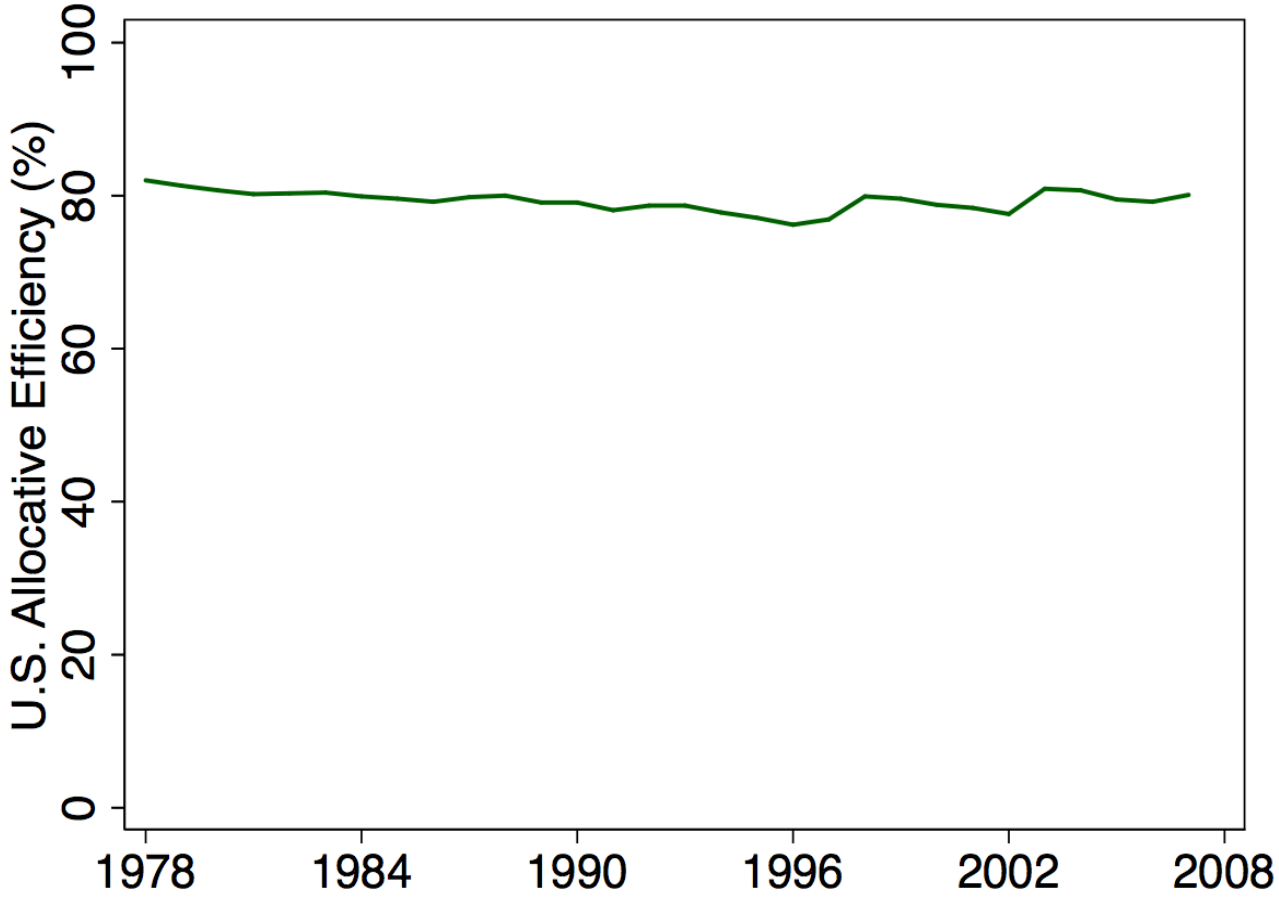
Allocative efficiency?

- 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

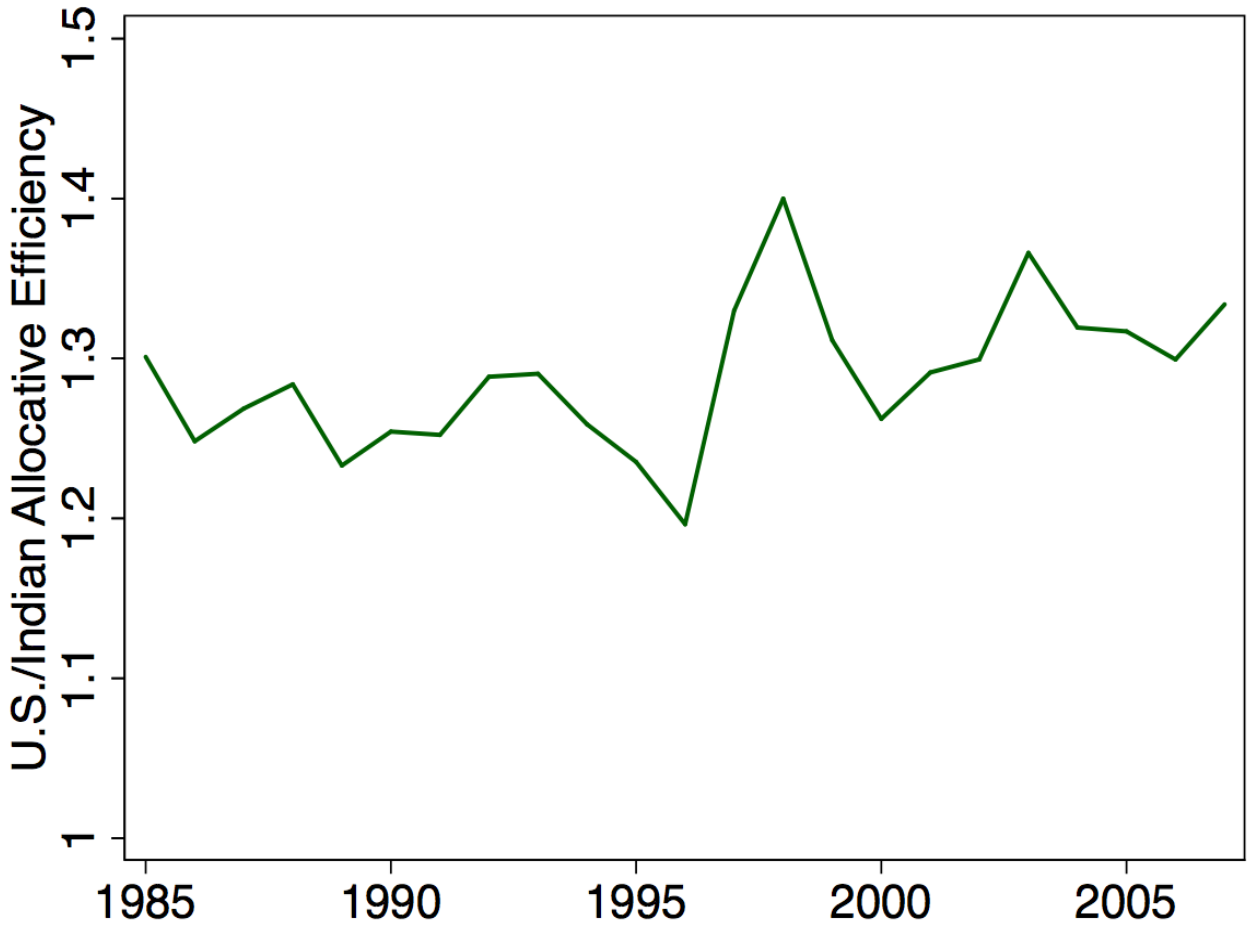
References

Hsieh and Klenow (2009, 2014)

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

Patents and R&D

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.

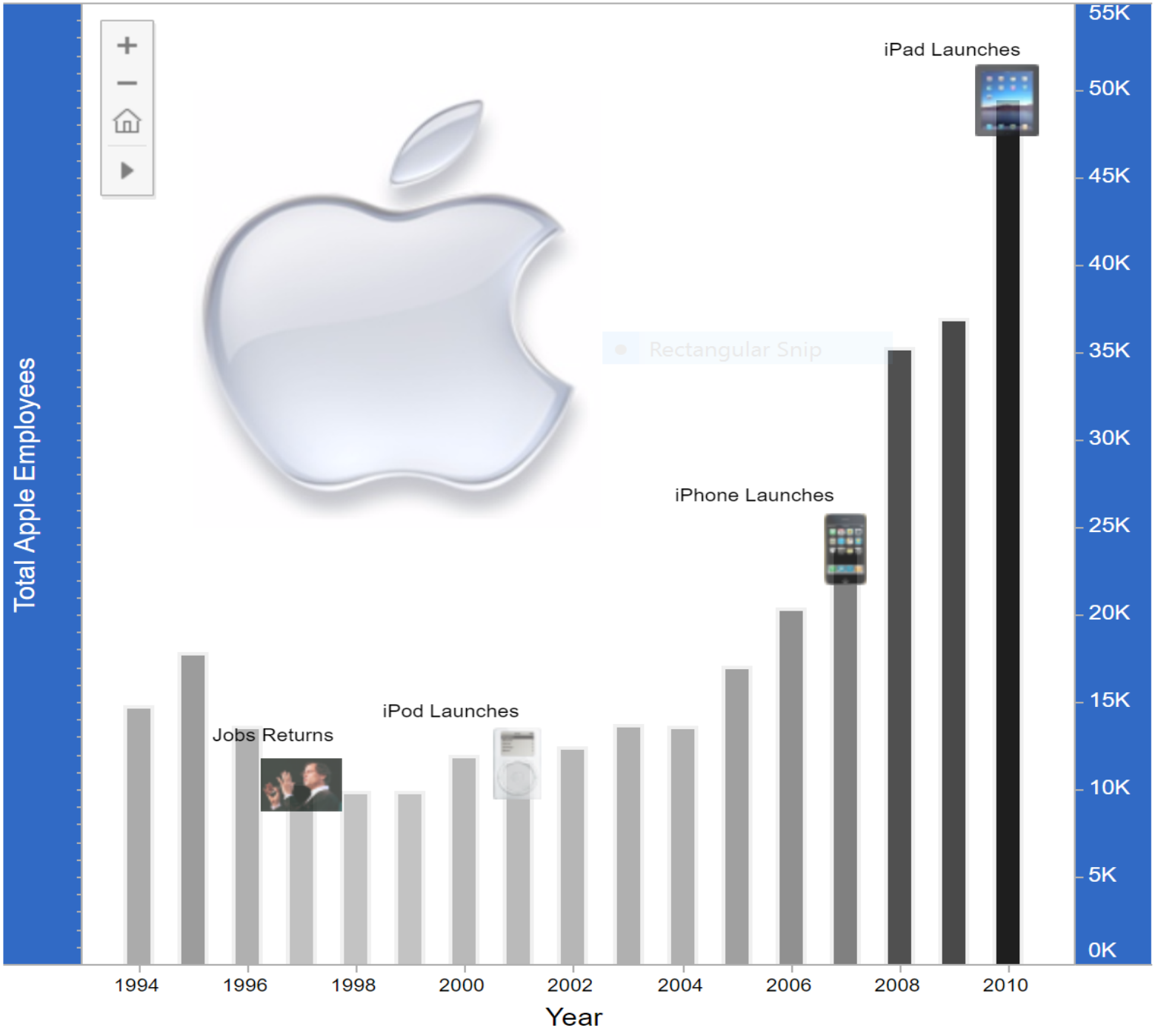
Lack of firm-level deflators (unit prices do not reflect quality, variety)

My approach: market shares

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

The key idea:

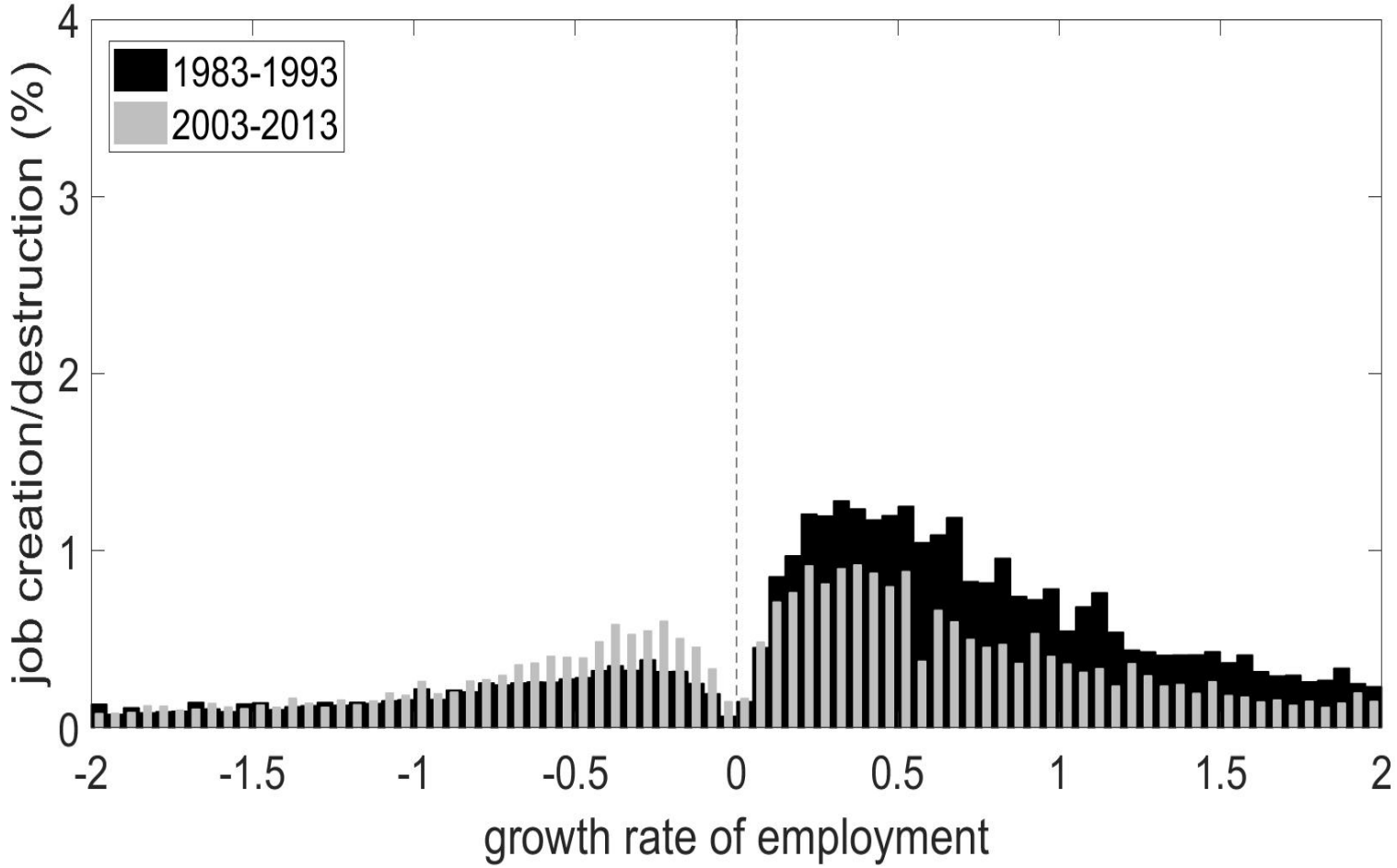
- Entrant employment share reflects entrant innovation
- If survivors innovate, they add workers
- If creative destruction, thick tails for firm job growth
- If own innovation, modest employment gains


Total Apple Employees
iPad Launches
iPhone Launches
iPod Launches
Jobs Returns
55K
50K
45K
40K
35K
30K
25K
20K
15K
10K
5K
0K
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year

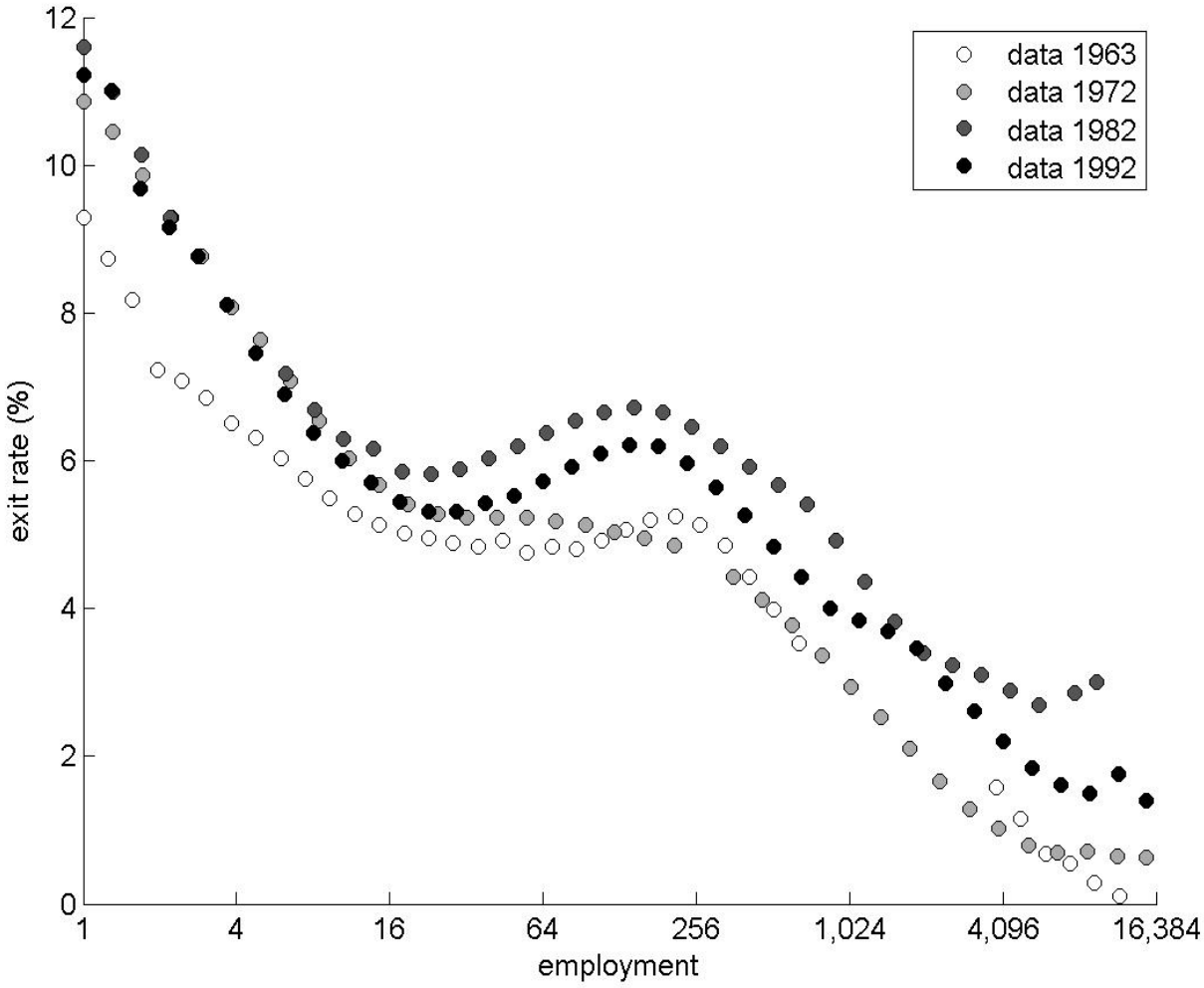
Longitudinal Business Database (LBD)

- 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

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

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

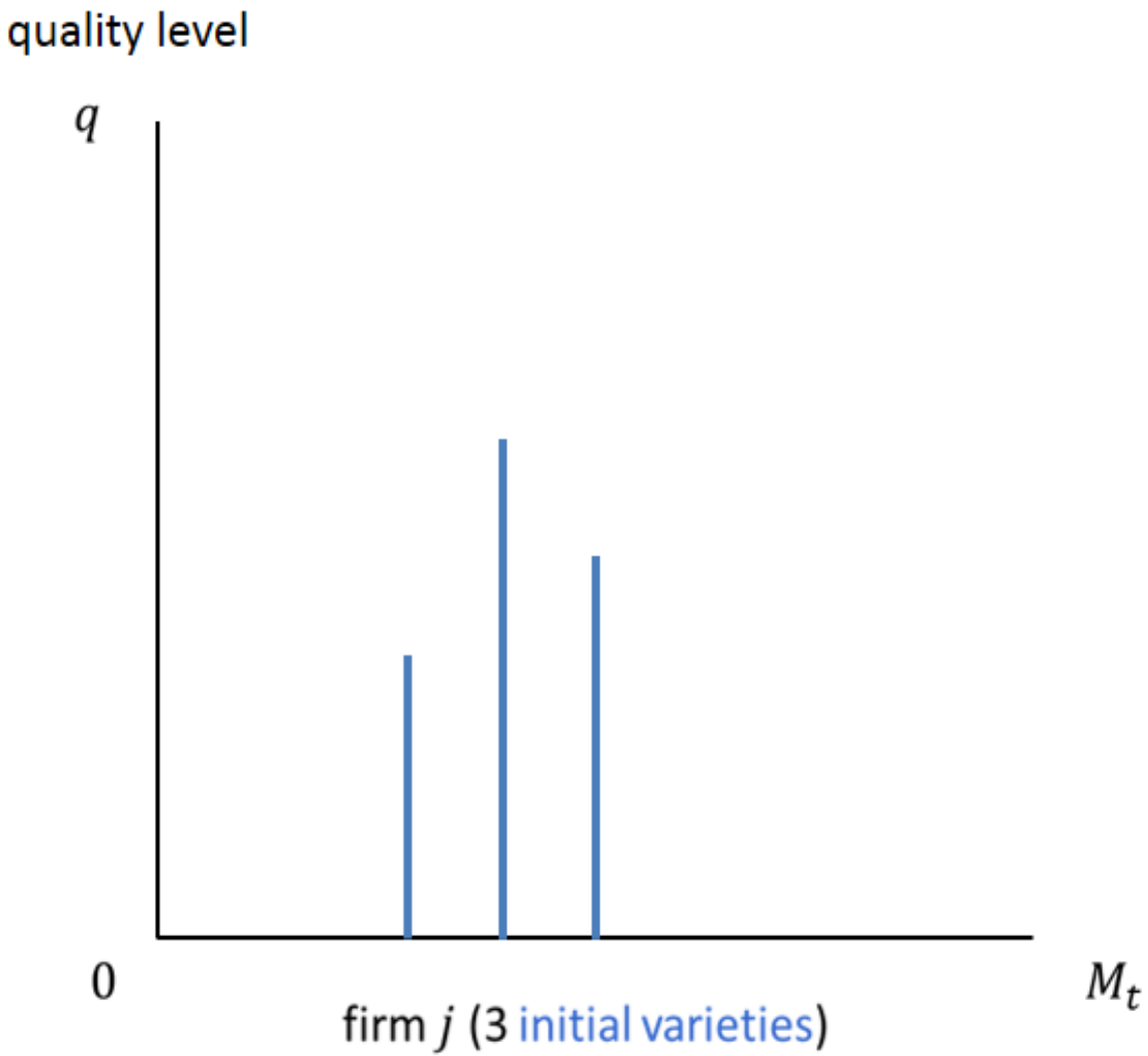
$$L_f \equiv \sum_{j \in M_f} l_j = \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma-1} L W^{1-\sigma} \sum_{j \in M_f} q_j^{\sigma-1}$$

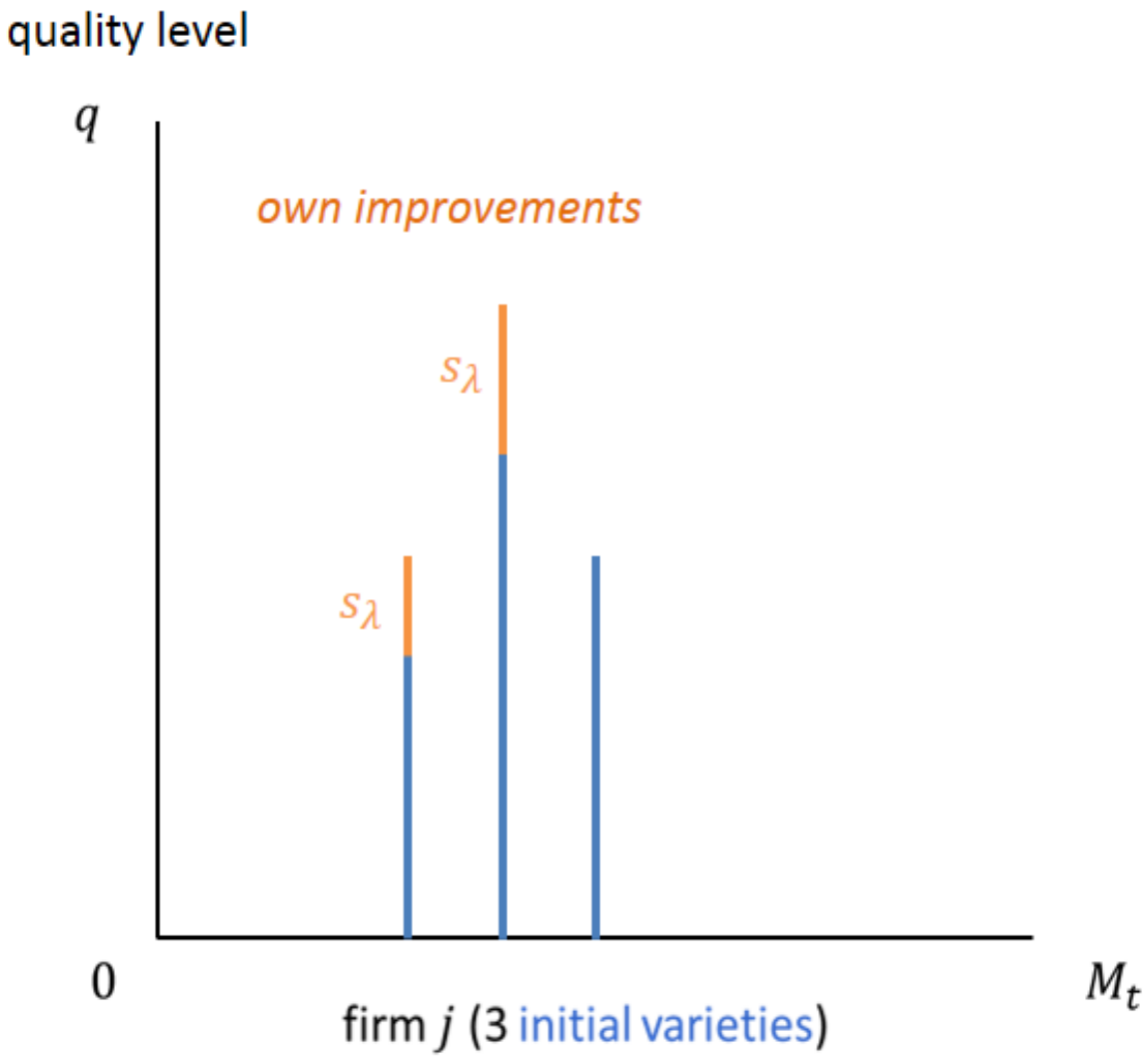
$$W \propto Y/L = M^{\frac{1}{\sigma-1}} \left[\sum_{j=1}^{M} \frac{q_j^{\sigma-1}}{M} \right]^{\frac{1}{\sigma-1}}$$

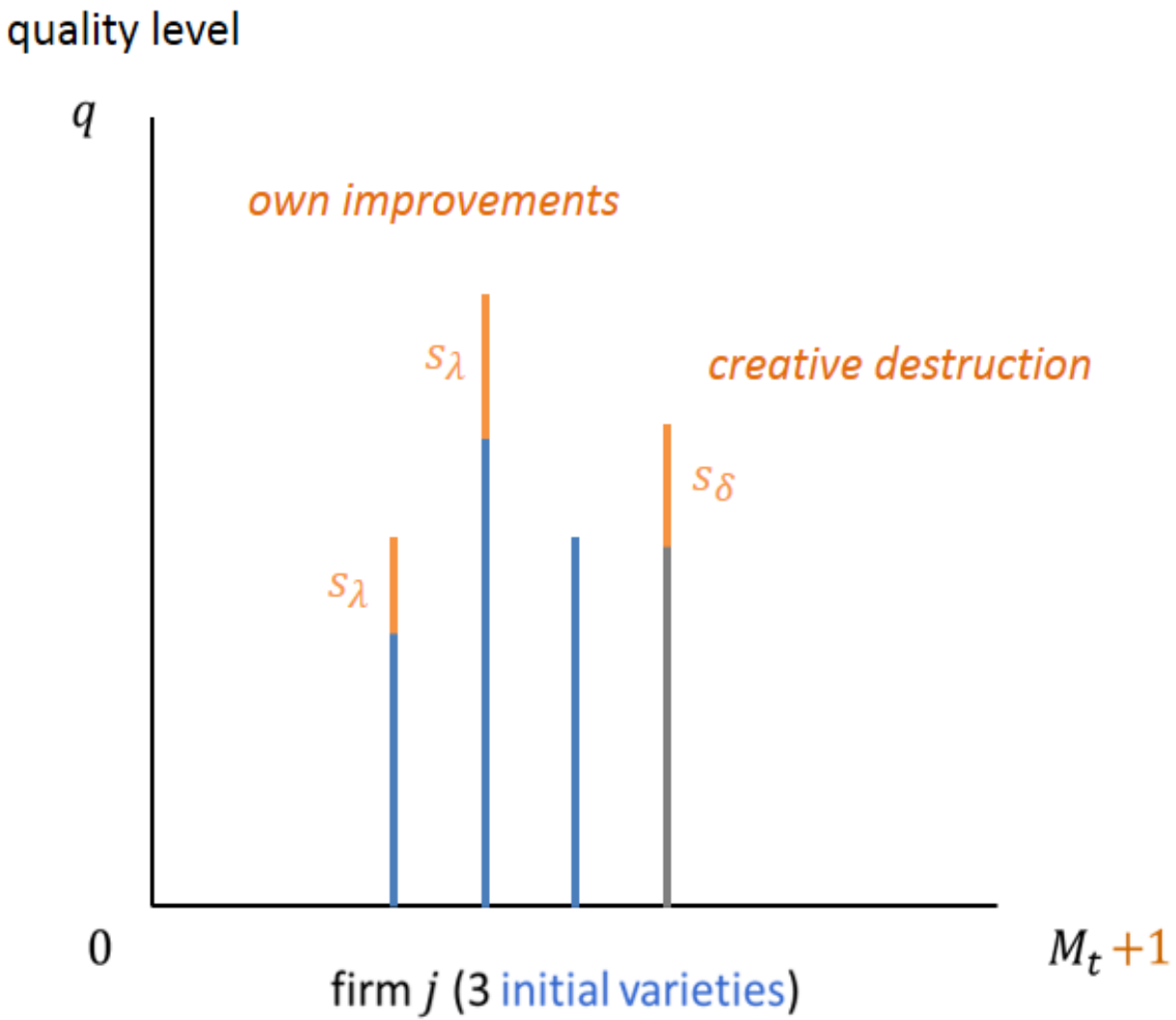
Arrival rates of innovation

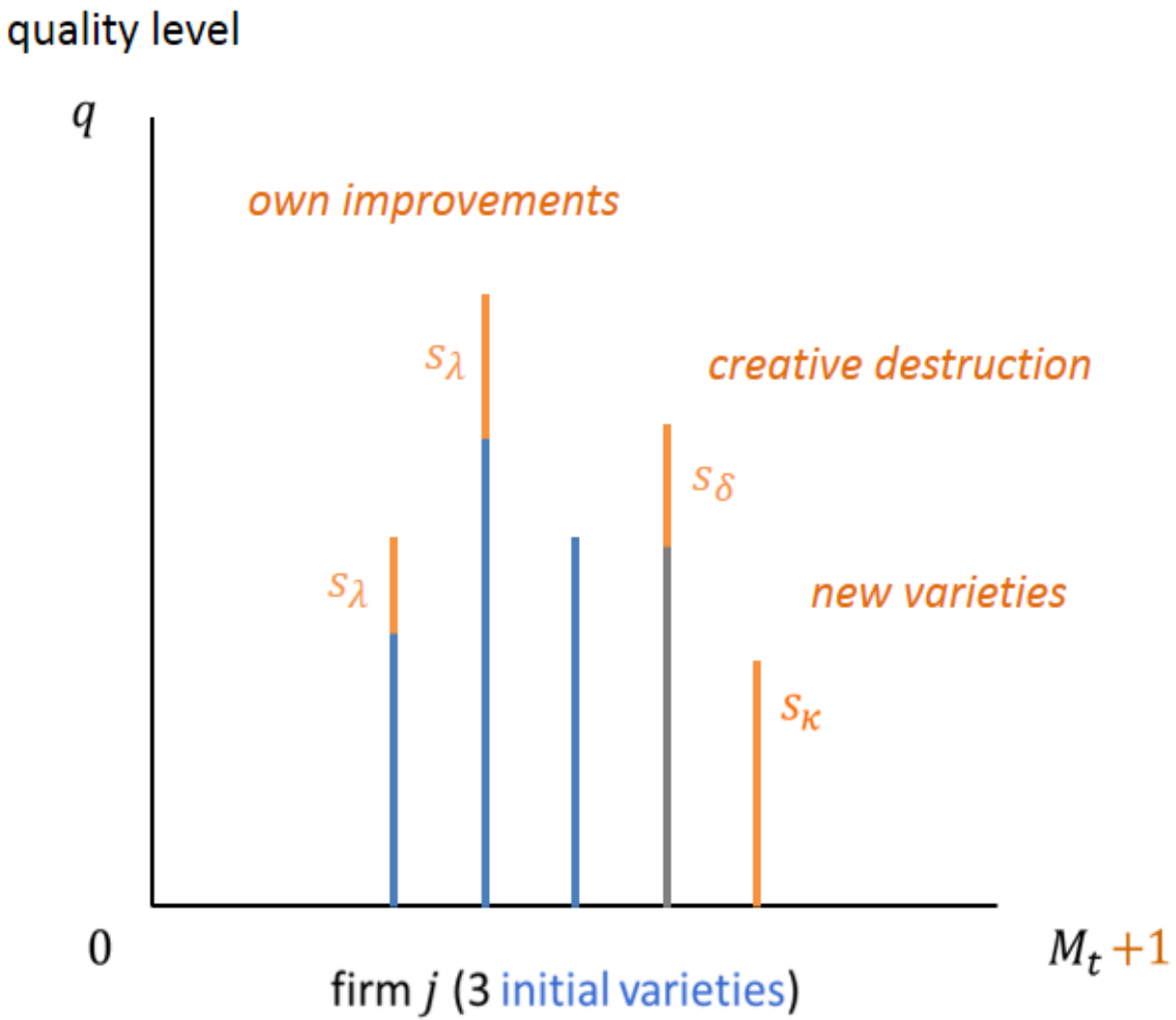
Own-variety improvements by incumbents	λ_i
Creative destruction by entrants	δ_e
Creative destruction by incumbents	δ_i
New varieties from entrants	κ_e
New varieties from incumbents	κ_i

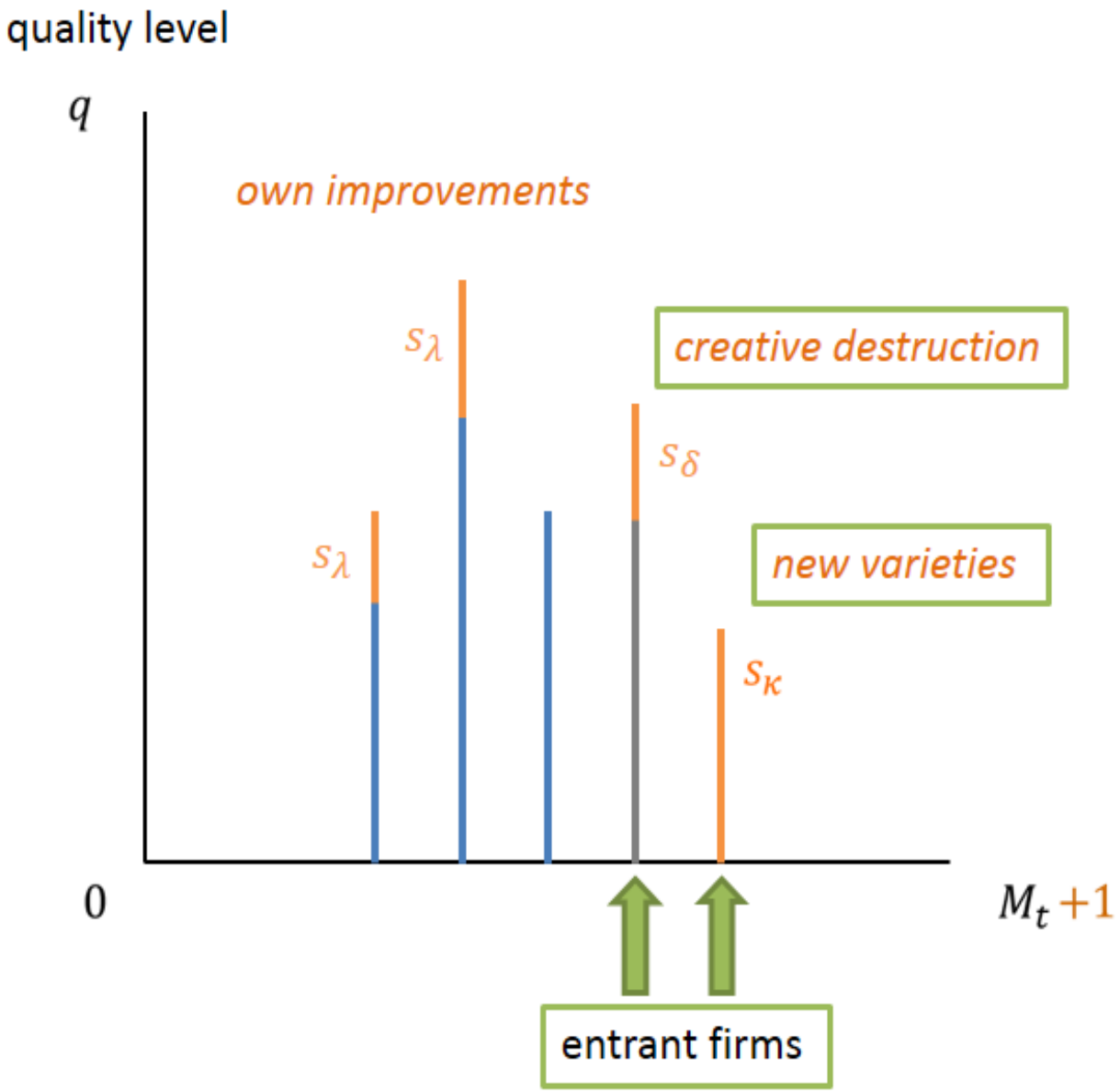
The average step size for quality improvements for own innovation s_λ and creative destruction s_δ are both $s_q = \left(\frac{\theta}{\theta-(\sigma-1)}\right)^{1/(\sigma-1)} \geq 1$. New varieties are drawn from the quality distribution of existing products times s_κ.


quality level
q
0
M_t
firm j (3 initial varieties)


quality level
q
own improvements
s_λ
s_λ
0
M_t
firm j (3 initial varieties)


quality level
q
own improvements
s_λ
creative destruction
s_δ
s_λ
0
M_t+1
firm j (3 initial varieties)


quality level
q
own improvements
s_λ
creative destruction
s_δ
s_λ
new varieties
s_κ
0
$M_t + 1$
firm j (3 initial varieties)


quality level
q
own improvements
s_λ
creative destruction
s_δ
s_λ
new varieties
s_κ
0
M_t+1
entrant firms

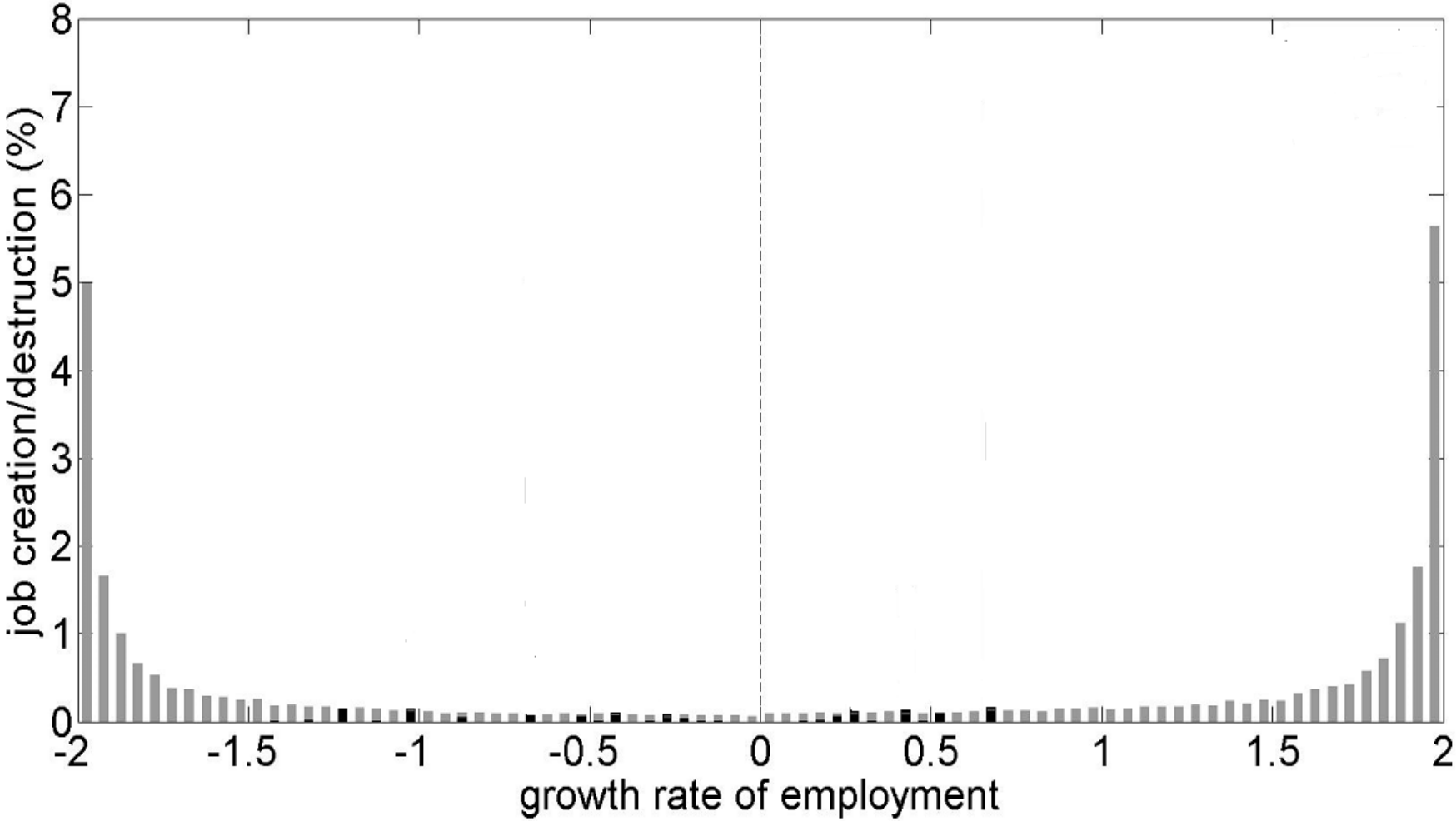
Firm-led innovation and growth

Two ways of decomposing the gross growth rate $(1+g)^{\sigma-1}$:

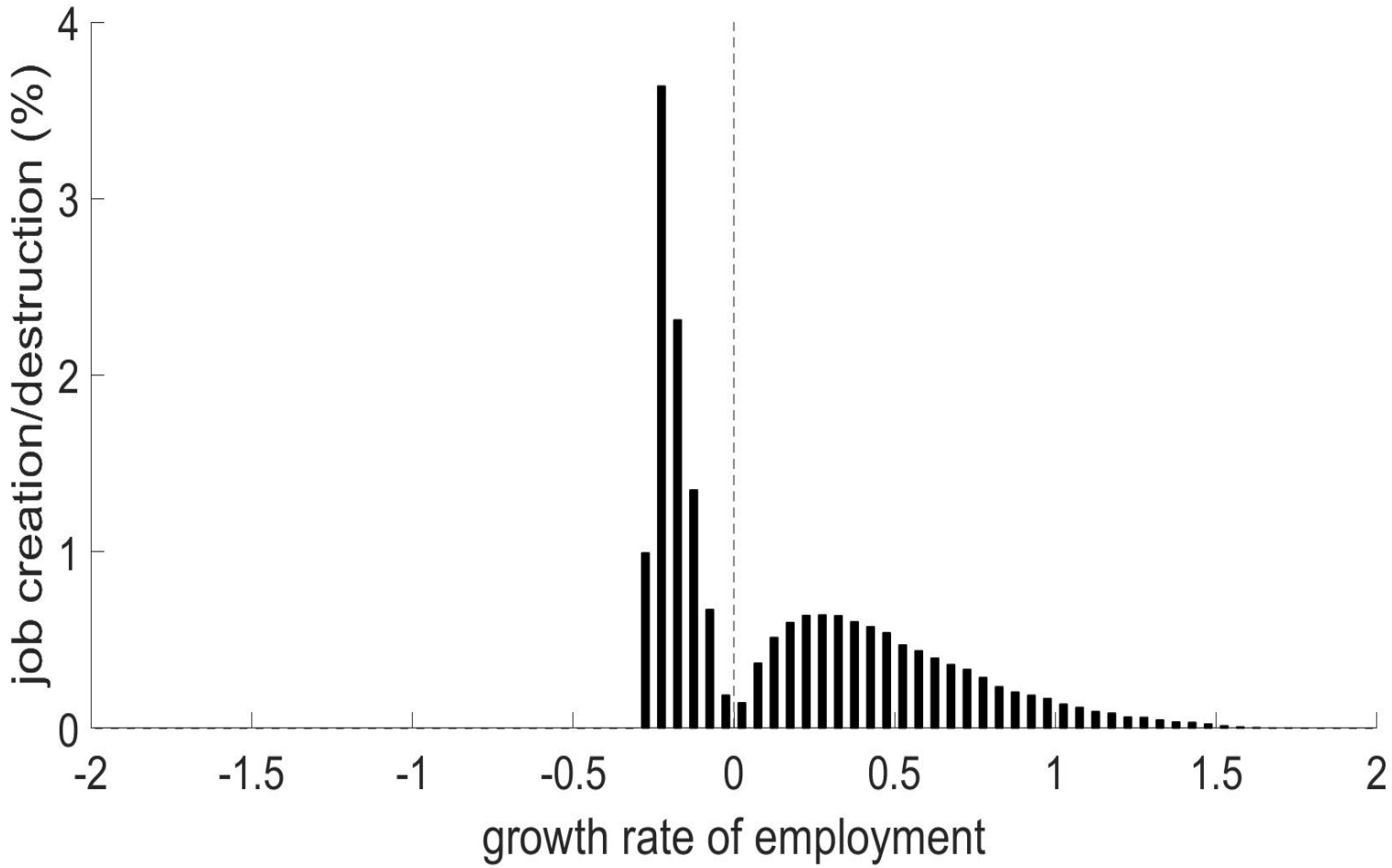
$$1+\underbrace{s_\kappa\left(\kappa_e+\kappa_i\right)}_{\text{new varieties}}+\underbrace{\left(s_q{}^{\sigma-1}-1\right)\lambda_i}_{\text{own innovation}}+\underbrace{\left(s_q{}^{\sigma-1}-1\right)\left(\tilde{\delta}_e+\tilde{\delta}_i\right)}_{\text{creative destruction}}$$

$$1+\underbrace{s_\kappa\kappa_e+\left(s_q^{\sigma-1}-1\right)\tilde{\delta}_e}_{\text{entrants}}+\underbrace{s_\kappa\kappa_i+\left(s_q^{\sigma-1}-1\right)\left(\lambda_i+\tilde{\delta}_i\right)}_{\text{incumbents}}$$

Model JC/JD with *only* Creative Destruction



Model JC/JD with *only* Own Innovation



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Sources of U.S. TFP growth, 1983–2013

	basis points per year	% of growth
Own Innovation	115	65%
Creative Destruction	46	26%
New Varieties	16	9%
All sources	176	100%

Estimates from Garcia-Macia, Hsieh and Klenow (2019)

Sources of the U.S. speedup and slowdown

Basis points per year

	1983–1993	1993–2003	2003–2013
Creative Destruction	44	64	29
New Varieties	23	19	6
Own Innovation	99	147	98

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Entrants and gazelles drive job creation ...

Employment growth	% of gross job creation	% of net job creation
Entrants	50%	800%
Incumbents $>$ 20%	13%	208%

Source: Hsieh and Klenow (2017) from LBD 2003–2013

... but not TFP growth

Employment growth	% of gross job creation	% of TFP growth
Entrants	50%	13%
Incumbents $>$ 20%	13%	4%
Incumbents 0 to 20%	37%	65%
Incumbents $<$ 0%	0%	18%

Source: Hsieh and Klenow (2017) from LBD 2003–2013

Young firms vs. Old firms

	% of Job Creation	% of TFP Growth
Age < 1	31%	9%
Age 1–5	13%	14%
Age 5–10	11%	14%
Age 10–15	9%	12%
Age > 15	36%	51%

Source: Garcia-Macia, Hsieh and Klenow (2019)

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Official growth statistics

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 $\Rightarrow$ 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?

Our answers

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

   $\sim$ **0.5 ppt per year** 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:

$$(\delta_e + \delta_i) \Bigg\{ \underbrace{\left(1 - \widehat{\lambda}_i\right) \log \widehat{s}_\lambda}_{\text{not all incumbents innovate}} + \underbrace{\log s_\delta - \log \widehat{s}_\lambda}_{\text{different stepsize for CD}} \Bigg\}$$

Relative prices $\Leftrightarrow$ market shares

CES demand $\Rightarrow$ 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 $\Rightarrow$ missing growth

Going from model to data

If existing plants carry out OI but not CD or NV:

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

$S_{I_t,t} = t$ share of all establishments operating in t and $t+1$

$S_{I_t,t+1} = t+1$ share of all establishments operating in t and $t+1$

Missing growth implied by survivor employment shares

basis points per year

1983–2013	**54**
1983–1995	52
1996–2005	48
2006–2013	65

Adding in the Missing Growth

basis points per year

	Measured	**"True"**
1983–2013	187	241
1983–1995	180	232
1996–2005	268	316
2006–2013	98	163

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

U.S. vs. the rest of the world

Focused on U.S. growth today

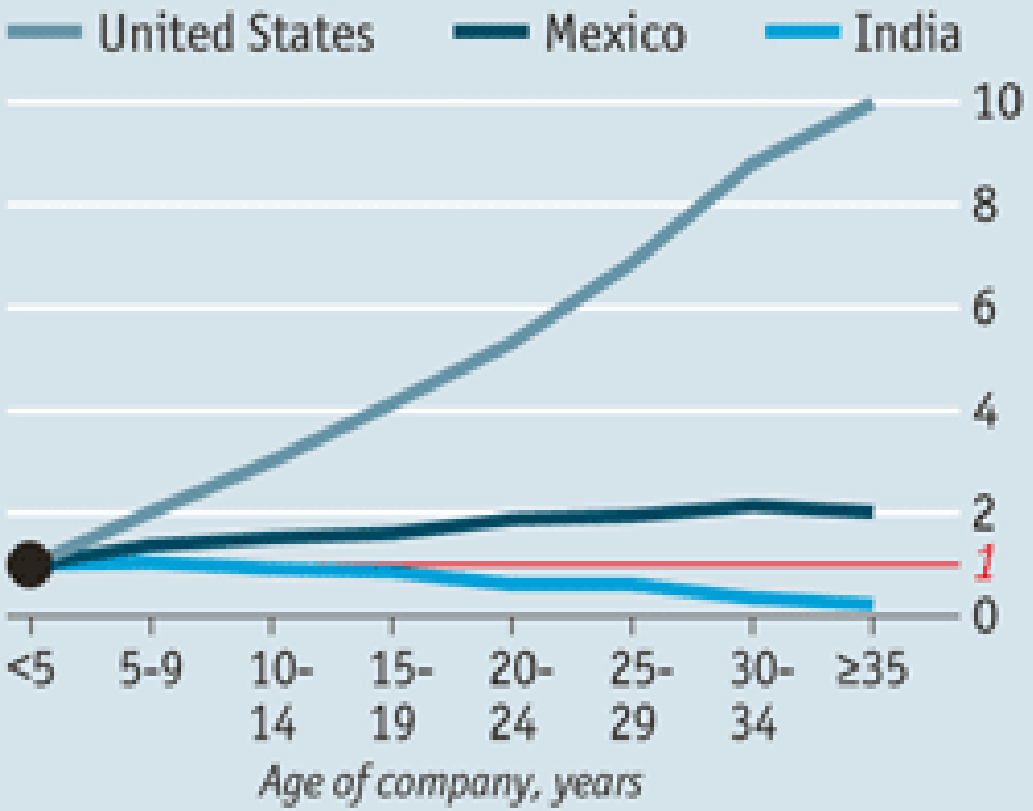
But issues are just as relevant for other countries:

- 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



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?