Firms and Growth

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Kuznets Lecture

Yale University

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for his empirically founded interpretation of economic growth, which has led to new and deepened insight into the economic and social structure and process of development

– citation for the 1971 Nobel Memorial Prize in Economics

Modern revival of growth research

1980's Endogenous growth models (CRS)

- Romer (1986), Lucas (1988)

1990's Endogenous growth models (IRS)

- Romer (1990), Aghion-Howitt (1991), Kortum (1997)

1990's Cross-country empirics

- Barro (1990), Mankiw-Romer-Weil (1992), Hall-Jones (1998)

Problem: Little interaction with micro data

More recent growth research

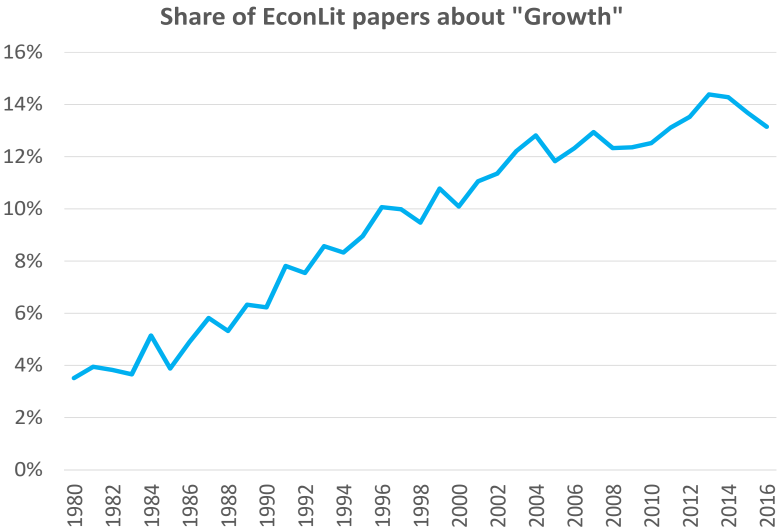
2000’s Institutions, Directed Technological Change, Trade

- Acemoglu (various), Eaton and Kortum (2002), Melitz (2003)

2010’s Firm Dynamics, Inequality, Trade

- Acemoglu, Aghion, Akcigit, **Arkolakis**, Atkeson, Atkin, Bernard, Bloom, Buera, Burstein, **Caliendo**, **Chevalier**, Costinot, David, Davis, De Loecker, Donaldson, Gabaix, **Goldberg**, Haltiwanger, Holmes, Hopenhayn, Hsieh, Jarmin, Jensen, Jones, Jovanovic, **Karlan**, **Kortum**, Lagakos, Lucas, Luttmer, Melitz, Midrigan, Miranda, **Mobarak**, Moll, Muendler, Oberfield, Perla, **Peters**, Redding, Restuccia, Rodriguez-Clare, Rogerson, Rossi-Hansberg, Schmitz, **Schott**, Syverson, Tonetti, Van Reenen, **Udry**, Venky, Waugh, Wright, Xu ...

Fuel: Healthy interaction with micro data


Share of EconLit papers about "Growth"
16%
14%
12%
10%
8%
6%
4%
2%
0%
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

Outline on Firms & Growth

1. Why firms and growth?
2. Which firms and how?
   - entrants vs. incumbents
   - own innovation vs. creative destruction vs. new varieties
3. Which contributions show up in official statistics?

BLS growth accounting

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

	$g_{Y/L}$	g_A
1948–2016	2.36%	1.98%
1948–1973	3.28	3.20
1974–1995	1.55	0.84
1996–2005	3.10	2.69
2006–2016	1.19	0.80

Possible drivers of residual TFP

Human capital?

- BLS tries to net it out, but imperfectly

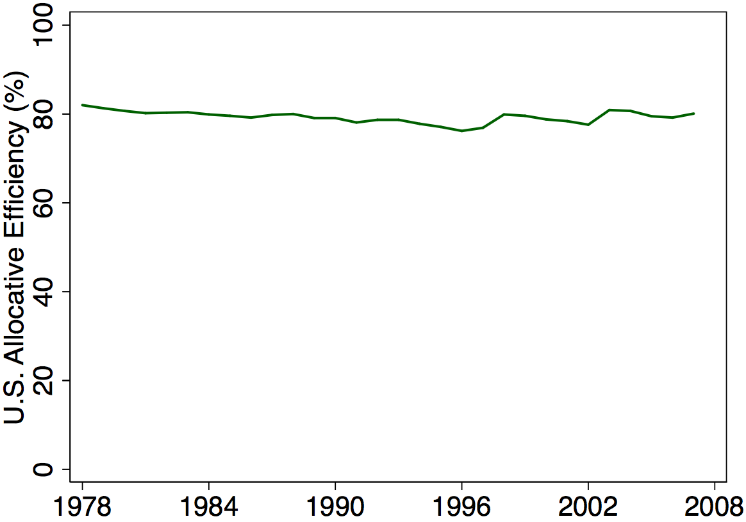
Allocative efficiency?

- Evidence is limited to manufacturing (see next slide)

Firm-led innovation

- This is promising and will be my focus

U.S. allocative efficiency



Source: Bils, Klenow and Ruane (2017)

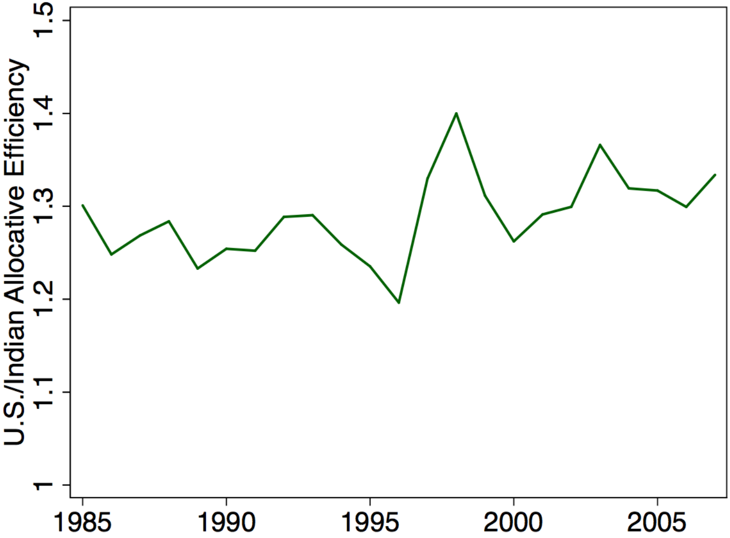
Segue on allocative efficiency and development

Allocative efficiency *does* appear to be important for:

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

Sources: Hsieh and Klenow (2009, 2014), Bartelsman, Haltiwanger and Scarpetta (2013), Gopinath, Kalemli-Ozcan, Karabarbounis, and Villegas-Sanchez (2016)

U.S. vs. Indian allocative efficiency



Source: Bils, Klenow and Ruane (2017)

Evidence on firm-level innovation

- Patents and R&D?
- Accounting decompositions *a la* Haltiwanger?
- Indirect inference using firm employment

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)

Accounting decompositions?

Using plant-level or firm-level data:

$$
\begin{aligned}
g_{Y/L} = \; & \text{Entrants - Exiters} \\
& + \text{Reallocation among survivors} \\
& + \text{Growth within survivors}
\end{aligned}
$$

Atheoretical (both good and bad)

Limited to manufacturing because need output data

Indirect inference with the U.S. Census LBD

Longitudinal Business Database covers $>80\%$ of employment

Employment as a proxy for market share and innovation:

- 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
Rectangular Snip
55K
50K
45K
40K
35K
30K
25K
20K
15K
10K
5K
0K
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year

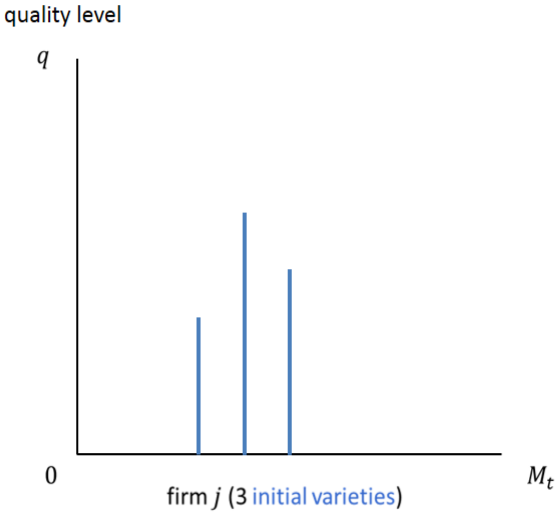
Next borrow heavily from two papers

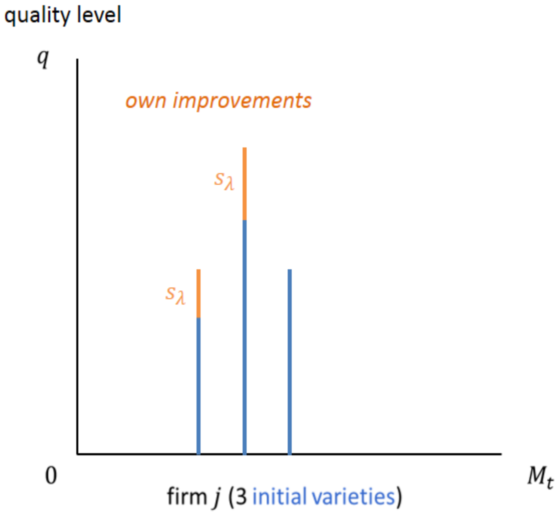
Klette and Kortum (2004)

Innovating Firms and Aggregate Innovation

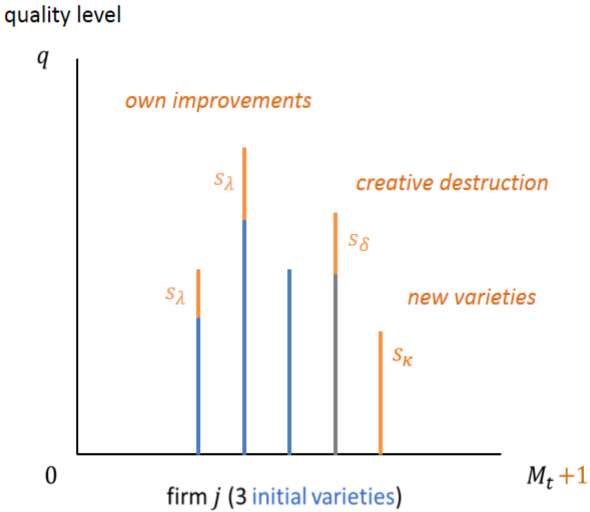
Garcia-Macia, Hsieh and Klenow (2016)

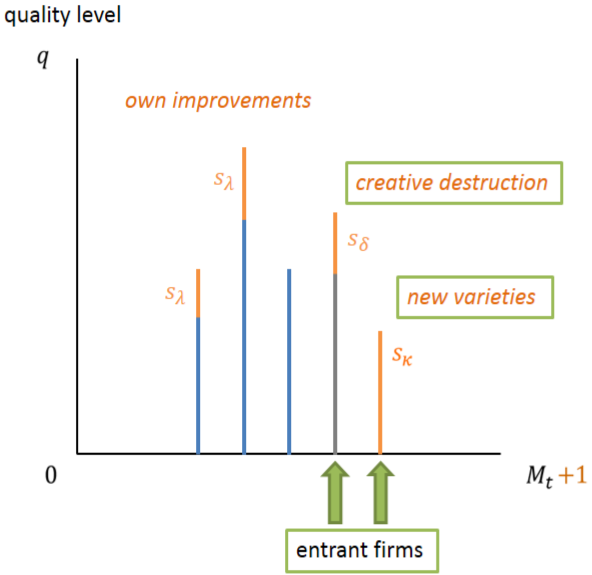
How Destructive is Innovation?


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
firm j (3 initial varieties)
M_t +1


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
s_λ
creative destruction
s_δ
new varieties
s_κ
0
$M_t + 1$
entrant firms

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 and creative destruction, weighted by employment, is $s_q = \left(\frac{\theta}{\theta-(\sigma-1)}\right)^{1/(\sigma-1)} \geq 1$. New varieties are drawn from the quality distribution of existing products times s_κ.

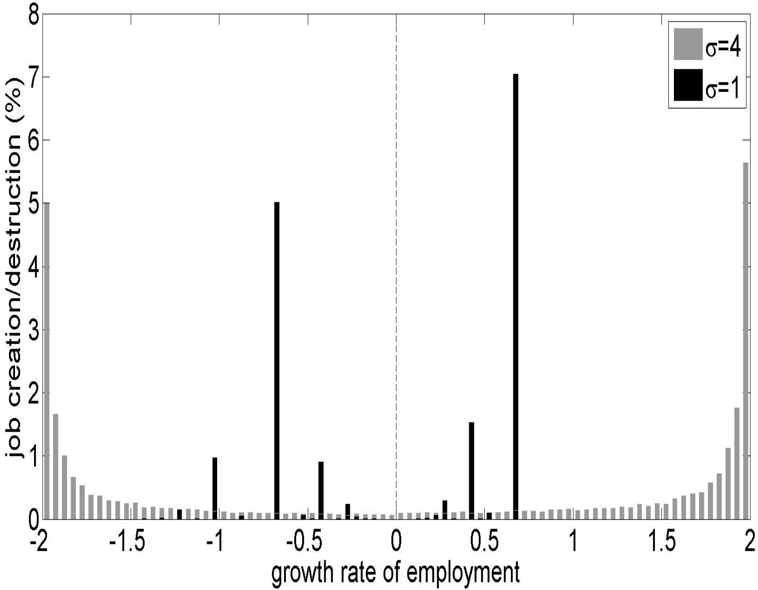
Firm-led innovation and growth

Two ways of decomposing the gross growth rate $(1+g)$:

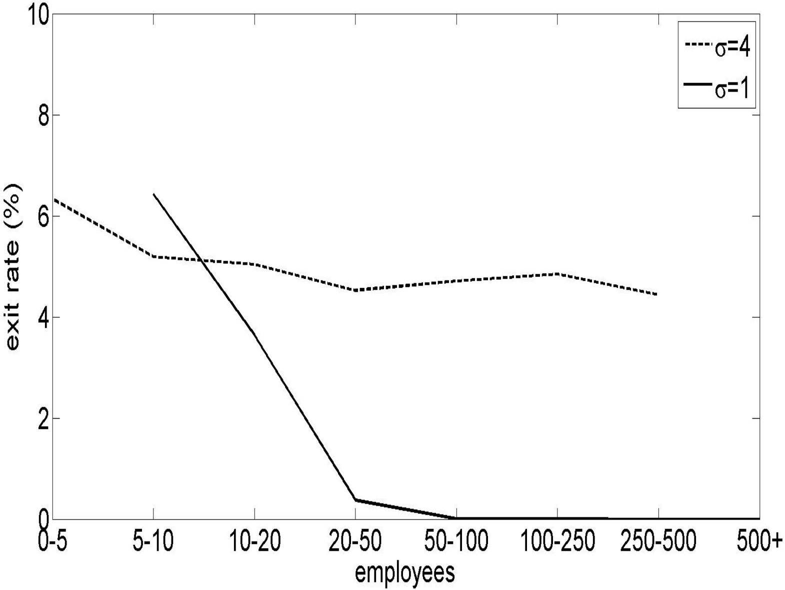
$$\left(1+\underbrace{s_\kappa\left(\kappa_e+\kappa_i\right)}_{\text{new varieties}}+\underbrace{\left({s_q}^{\sigma-1}-1\right)\lambda_i}_{\text{own innovation}}+\underbrace{\left({s_q}^{\sigma-1}-1\right)\left(\tilde{\delta}_e+\tilde{\delta}_i\right)}_{\text{creative destruction}}-\delta_o\psi\right)^{\frac{1}{\sigma-1}}$$

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

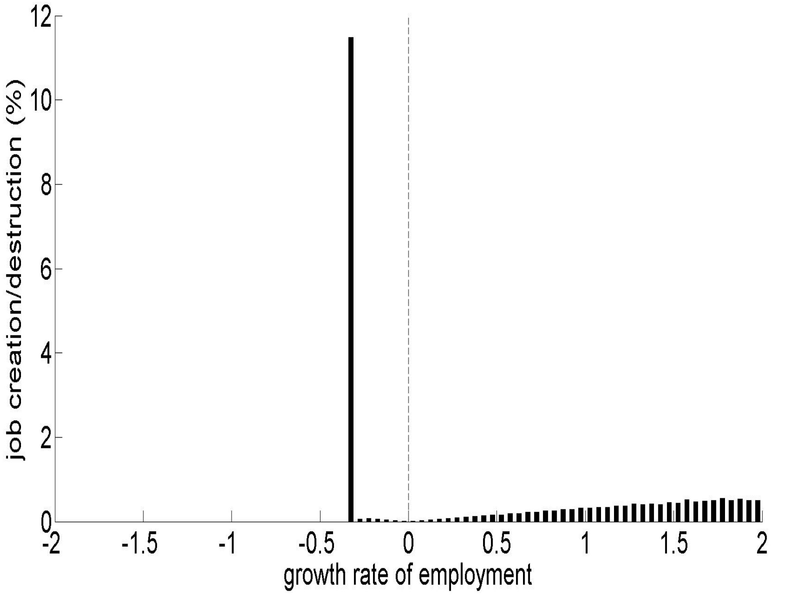
Model JC/JD with *only* Creative Destruction



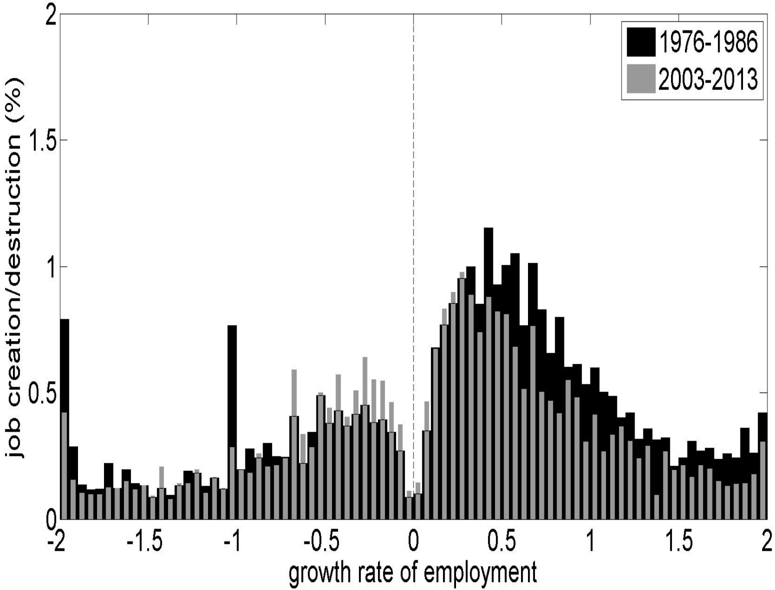
Model exit by size with *only* Creative Destruction



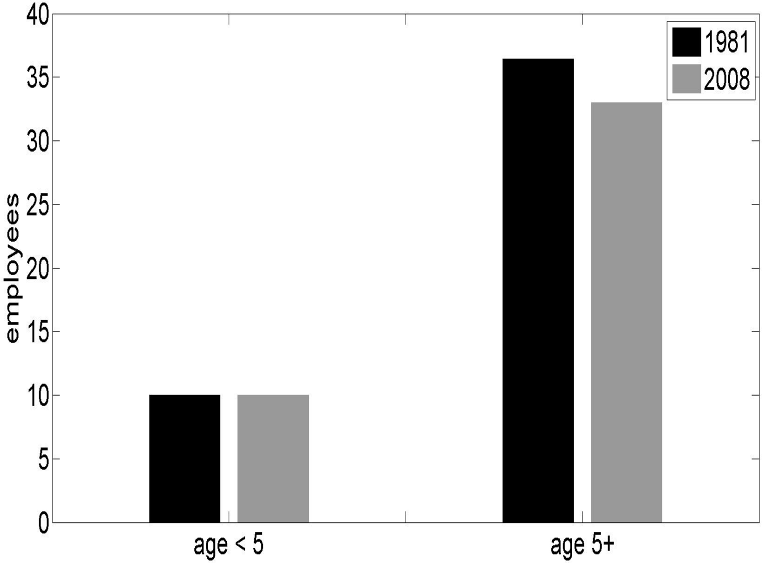
Model JC/JD with *only* Own Innovation



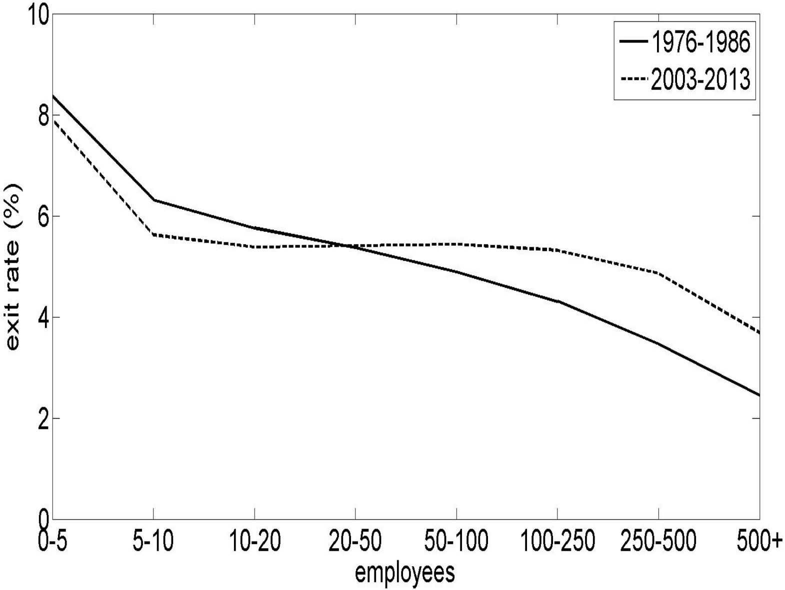
Data JC/JD in the U.S. LBD



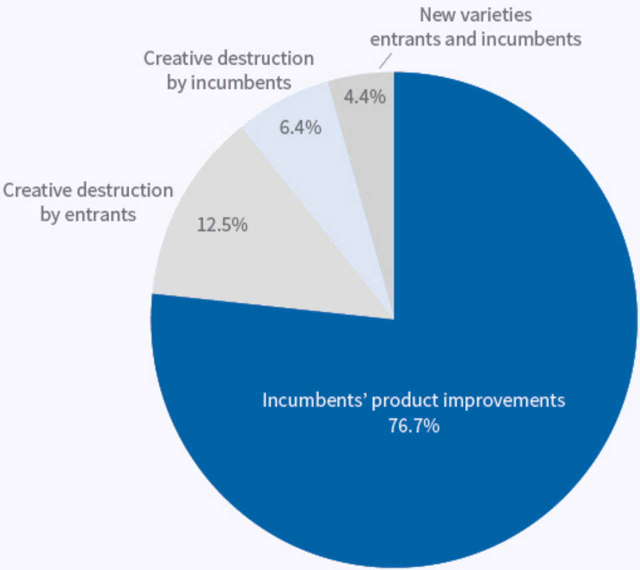
Employment per firm, young vs. old – in the U.S. LBD



Exit rate, small vs. large firms – in the U.S. LBD



Sources of Product Innovation, 2003–2013



Sources of growth

1976–1986	Entrants	Incumbents	Total
Creative destruction	19.1%	8.2%	27.3%
New varieties	0.0%	7.6%	7.6%
Own-variety improvements	-	65.1%	65.1%
Total	19.1%	80.9%	100%

2003–2013	Entrants	Incumbents	Total
Creative destruction	12.5%	6.4%	18.9%
New varieties	0.3%	4.1%	4.4%
Own-variety improvements	-	76.7%	76.7%
Total	12.8%	87.2%	100%

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 (2016)

Rest of presentation builds on three papers

Broda and Weinstein (2010)

Product Creation and Destruction

Erickson and Pakes (2011)

An Experimental Component Index for the CPI

Aghion, Bergeaud, Boppart, Klenow and Li (2017)

Missing Growth from Creative Destruction

Creative Destruction (CD)

CD is a key source of growth in many models

- See the survey by Aghion, Akcigit and Howitt (2014)
- Yet GHK find a modest role for CD

Does CD 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?

Imputaton in the CPI, 1988–2004

- 3.9% monthly exit rates of products
- 48% of the product substitutions “noncomparable”
- So 22.5% average annual “true” exit
- Noncomparable item substitutions:
  - 31% direct quality adjustments (mostly same producer products)
  - 69% linking or class-mean forms of imputation

Imputation in the PPI

2.3% monthly exit rate (Nakamura & Steisson 2008)

Missing prices

If no price report from a participating company has been received in a particular month, the change in the price of the associated item will, in general, be estimated by averaging the price changes for the other items within the same cell (i.e., for the same kind of products) for which price reports have been received.

– BLS Handbook of Methods (2015, ch. 14, p. 10)

Missing growth with Cobb-Douglas aggregation

Sources of bias from CD:

$$\underbrace{\lambda_d \left(1-\widehat{\lambda}_i\right) \log \widehat{\gamma}_i}_{\text{not all incumbents innovate}} \quad + \quad \underbrace{\lambda_d \left(\log \gamma_d - \log \widehat{\gamma}_i\right)}_{\text{different stepsize for CD}}$$

How we deviate from Garcia-Macia, Hsieh and Klenow

- GHK assume measured growth = true growth
- We argue that CD and NV are missed
- Our indirect inference differs as a result
- We infer more true growth, higher step sizes

Missing growth

Percentage points per year

1976–1986	0.52%
from CD	0.41%
2003–2013	0.42%
from CD	0.33%

Measured vs. True growth

	Measured	"True"
1976–1986	1.03%	1.55%
2003–2013	1.44%	1.86%

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 et al.'s Fading American Dream)
- setting the Fed's inflation target
- indexing Social Security and tax brackets

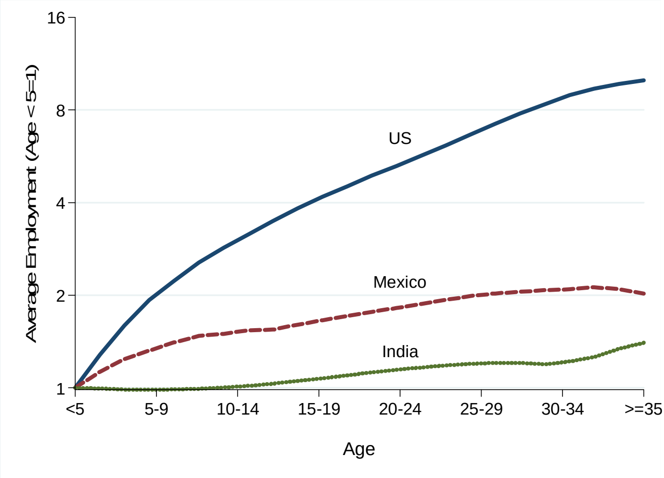
U.S. vs. the rest of the world

Focused on U.S. growth today

But issues are just as relevant for other countries:

- Firms everywhere are innovating / imitating / adopting
  - See India and Mexico vs. the U.S.
- Same issues arise with growth statistics in OECD and beyond

Growth in Average Plant Employment over the Life Cycle



Sources: Employment growth imputed from 1992 and 1997 US Manufacturing Census, 1998 and 2003 Mexican Economic Census, and 1994-1995 to 2010-2011 ASI-NSS (India).

Open questions

- How big are externalities?
  - entrants vs. incumbents
  - domestic vs. international
- Sources of firm-level innovation outside the U.S.?
- Reasons for declining dynamism and growth?
- Creative destruction, trade, and inequality?
- Missing growth outside the U.S.?