

Innovative Growth Accounting

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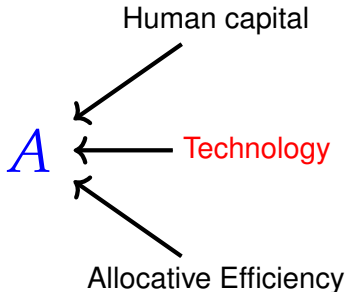
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Macro growth accounting

$$\frac{Y}{L} = A^{\frac{1}{1-\alpha}} \times \left(\frac{K}{Y} \right)^{\frac{\alpha}{1-\alpha}}$$



- A accounts for almost all of growth of Y/L
- Technology accounts for bulk of growth in A

Innovative growth accounting

We decompose the **technology** term into contribution from

- innovation types:
 - creative destruction (CD)
 - new varieties (NV)
 - own-innovation (OI)
- firm types:
 - young vs old
 - small vs large

Motivation

The U.S. economy over the past 30 years:

- ① Falling growth (interrupted by a 10-year burst of growth)
- ② Falling rates of firm entry, exit and job reallocation
- ③ Rising firm concentration within industries

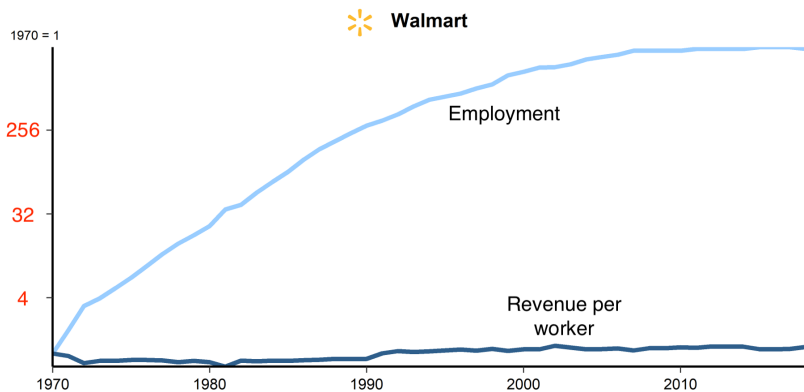
Intuition for our method

Model based accounting:
silent on determinants of innovation

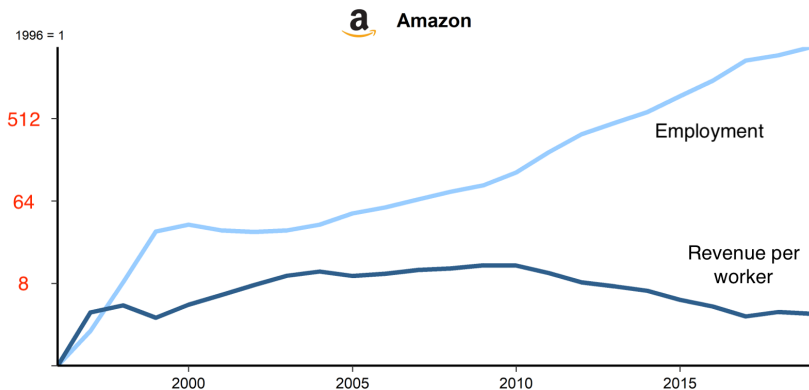
Feenstra (1994):
changes in market share reflect changes in relative productivity

Garcia, Hsieh and Klenow (2020):
CD generates more job reallocation than innovation

Why not revenue productivity?



Why not revenue productivity?



Method: Environment

Aggregate output:

$$Y = \left[\int_0^N [q(j) y(j)]^{1-1/\sigma} dj \right]^{\frac{\sigma}{\sigma-1}}$$

Product-level output:

$$y(j) = l(j)$$

Aggregate productivity:

$$Q \equiv \frac{Y}{L} = \left[\int_0^N q(j)^{\sigma-1} dj \right]^{\frac{1}{\sigma-1}}$$

Arrival rates and step sizes of innovation

	Creative destruction	New varieties	Incumbents on own products
Arrival rate	δ	ν	o
Step size $\frac{q_{t+1}(j)}{q_t(j)}$	Δ	V	O

Timing: obsolescence \rightarrow CD and NV \rightarrow OI

A firm's contribution to growth

$$g_f := \nu_f V_f^{\sigma-1} + \delta_f (\Delta_f^{\sigma-1} - 1) \quad \text{NV, CD}$$

$$+ o_f (O_f^{\sigma-1} - 1) \frac{\mathbb{E}_{G_{f,t-1}}(q^{\sigma-1})}{\mathbb{E}_{G_{t-1}}(q^{\sigma-1})} \quad \text{OI}$$

$$+ \left(\int_j \nu_j V_j^{\sigma-1} + \delta_j (\Delta_j^{\sigma-1} - 1) dj \right) \left(\left(\frac{\widehat{Q}}{Q} \right)^{\sigma-1} - 1 \right) \frac{G_{f,t-1}(\kappa_t) N_{f,t-1}}{G_{t-1}(\kappa_t) N_{t-1}}$$

$$+ o_f (O_f^{\sigma-1} - 1) \left(\frac{\mathbb{E}_{G_{f,t-1}}(q^{\sigma-1} | q \geq \kappa_t)}{\mathbb{E}_{G_{t-1}}(q^{\sigma-1})} - 1 \right) \quad \text{Selection}$$

$$- \mathbb{E}_{G_{f,t-1}}[s_{t-1} | q < \kappa_t] G_{f,t-1}(\kappa_t) N_{f,t-1}, \quad \text{Variety loss}$$

Growth from each type of firm

Aggregate growth

$$g = \frac{1}{\sigma - 1} \ln \left[1 + \int_f g_f df \right] \approx \frac{1}{\sigma - 1} \int_f g_f df$$

Contribution of a firm group

$$\frac{\int_{f \in \mathcal{F}} g_f df}{\int_{f'} g_{f'} df'}$$

Growth from each type of innovation

Creative destruction:

$$\frac{\int_f \delta_f (\Delta_f^{\sigma-1} - 1) df}{\int_f g_f df}$$

New variety:

$$\frac{\int_f \nu_f V_f^{\sigma-1} df}{\int_f g_f df}$$

Own innovation:

$$\frac{\int_f o_f (O_f^{\sigma-1} - 1) \frac{\mathbb{E}_{G_{f,t-1}}(q^{\sigma-1})}{\mathbb{E}_{G_{t-1}}(q^{\sigma-1})} df}{\int_f g_f df}$$

U.S. Census Data

- Longitudinal Business Database (LBD)
- all nonfarm private sector plants
- employment, wage bill, firm, industry
- results for 1982–2013
 - subperiods 1982–1995, 1996–2005, 2006–2013

Mapping to Moments

Assume existing plants carry out OI but not CD or NV

⇒ plant entry and exit reflects arrival of NV, CD, and obsolescence

CES implies a plant's market share is isoelastic wrt to its quality

⇒ change in market share reflects relative quality growth

Data Target Moments

For each firm group \mathcal{F}

$\mathcal{E}_{\mathcal{F}t}/N_{t-1}$	# of new plants
$\mathcal{X}_{\mathcal{F},t-1}/N_{t-1}$	# of exiting plants
$S_{\mathcal{E}_{\mathcal{F}t}}$	employment share of new plants
$S_{\mathcal{X}_{\mathcal{F},t-1}}$	employment share of exiting plants
$S_{C_{\mathcal{F}t}}/S_{C_{\mathcal{F}t-1}}$	growth in employment share of continuing plants
$S_{\mathcal{E}_{\mathcal{F}t}}^{\{2\}}$	2nd moment of employment share of new plants
$S_{\mathcal{E}_{\mathcal{F}t}}^{\{3\}}$	3rd moment of employment share of new plants

Aggregate moments

$S_{\mathcal{N}_{t-1}}^{\{k\}}$	k th moment of employment share of all plants, $k = 1, 2, 3$
g	TFP growth rate

Notes: $S_{\mathcal{P}t}^{\{k\}} := \int_{\mathcal{P}} s_t^k(i) di$, where s denotes employment share.

Growth by innovation type, 1982–2013

g	CD	NV	OI
1.64	0.21	0.38	1.06
Baseline (Entrants age 0)	13.0%	27.2%	59.8%
Alternative (Entrants age 0–5)	17.1%	40.2%	42.7%

Growth speedup and slowdown by innovation type

Own innovation drove the speedup and slowdown

Period	Δg	CD	NV	OI
1982–1995 vs 1996–2005	1.67	9.8%	-0.5%	90.8%
1996–2005 vs 2006–2013	-1.79	11.0%	7.1%	81.9%

Growth by age group, 1982–2013

New firms' contribution to growth exceeded their employment share

	Age 0	Age 1–5	Age 6–10	Age 11+
% of growth	30.3%	18.9%	9.7%	41.1%
% of employment	3.3%	13.4%	11.2%	72.1%
% of firms	10.7%	31.1%	18.5%	39.6%

Growth speedup and slowdown by age group

Older firms were most important for the speedup and slowdown

Period	Δg	Age 0	Age 1–5	Age 6–10	Age 11+
1982–1995 vs 1996–2005	1.67	4.4%	13.4%	12.6%	69.6%
1996–2005 vs 2006–2013	-1.79	11.8%	17.0%	12.3%	58.9%

Growth by size group, 1982–2013

Small firms' contribution to growth exceeded their employment share

	Small (0–19)	Medium (20–249)	Large (250–4999)	Mega (5000+)
% of growth	62.2%	15.0%	12.2%	10.7%
% of employment	21.4%	26.3%	26.9%	25.4%
% of firms	88.0%	11.2%	0.8%	0.03%

Growth speedup and slowdown by size group

All size groups were important for the speedup and slowdown

Period	Δg	Small (0–19)	Medium (20– 249)	Large (250– 4999)	Mega (5000+)
1982–1995 vs 1996–2005	1.67	27.0%	24.7%	25.5%	22.7%
1996–2005 vs 2006–2013	-1.79	37.5%	22.2%	20.2%	20.1%

Contribution of superstar firms not so super?

- U.S. Census Bureau forbids us from disclosing identity of firms
- Apply our method to NETS data to estimate the contribution of Walmart and Amazon to fast growth from 1996–2005

	Walmart	Amazon
% of growth	0.80%	0.0041%
% of employment	0.41%	0.0013%

Growth by age-size group, 1982–2013

New firms are particularly important

	New small	Young small	All small
% of growth	29.9	14.1	62.2
% of employment	3.3	6.1	21.4
% of firms	10.7	28.8	88.0

Conclusion and future research

We provide a method to decompose aggregate productivity growth into contributions from firms and innovation types.

Many caveats that we hope future studies can address:

- CD and NV through new plants
- Plant employment shares instead of sales shares
- Stable CES demand
- Untargeted creative destruction
- No misallocation