Innovative Growth Accounting

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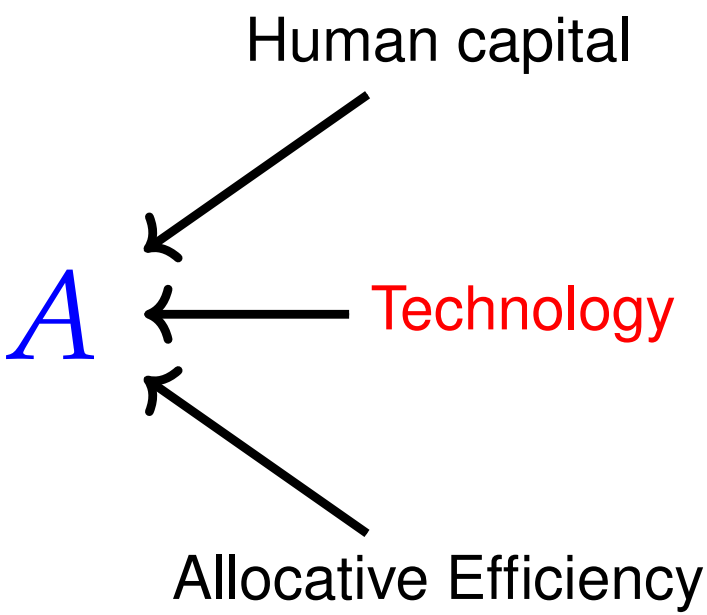
Macro growth accounting

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



- 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

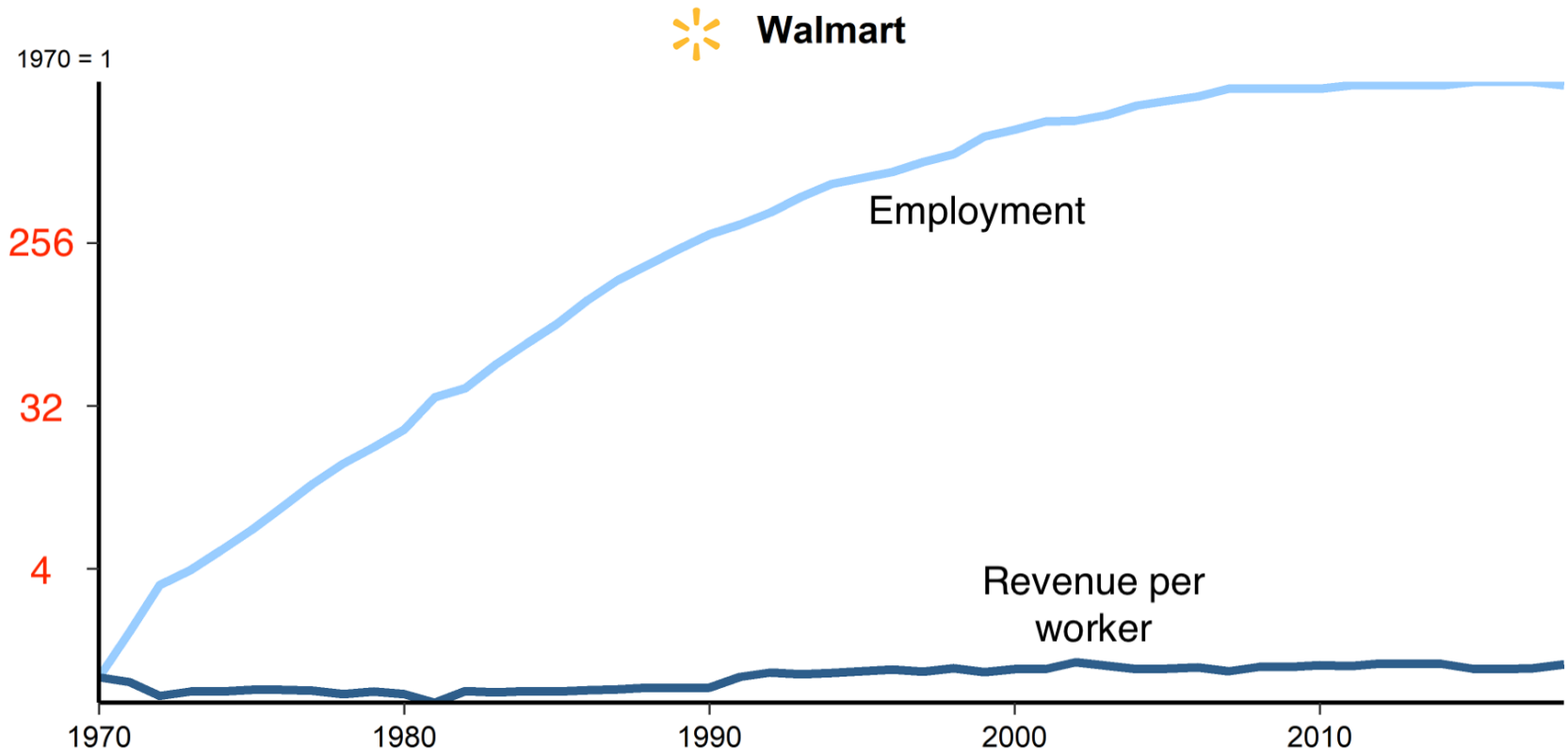
Feenstra (1994):

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?



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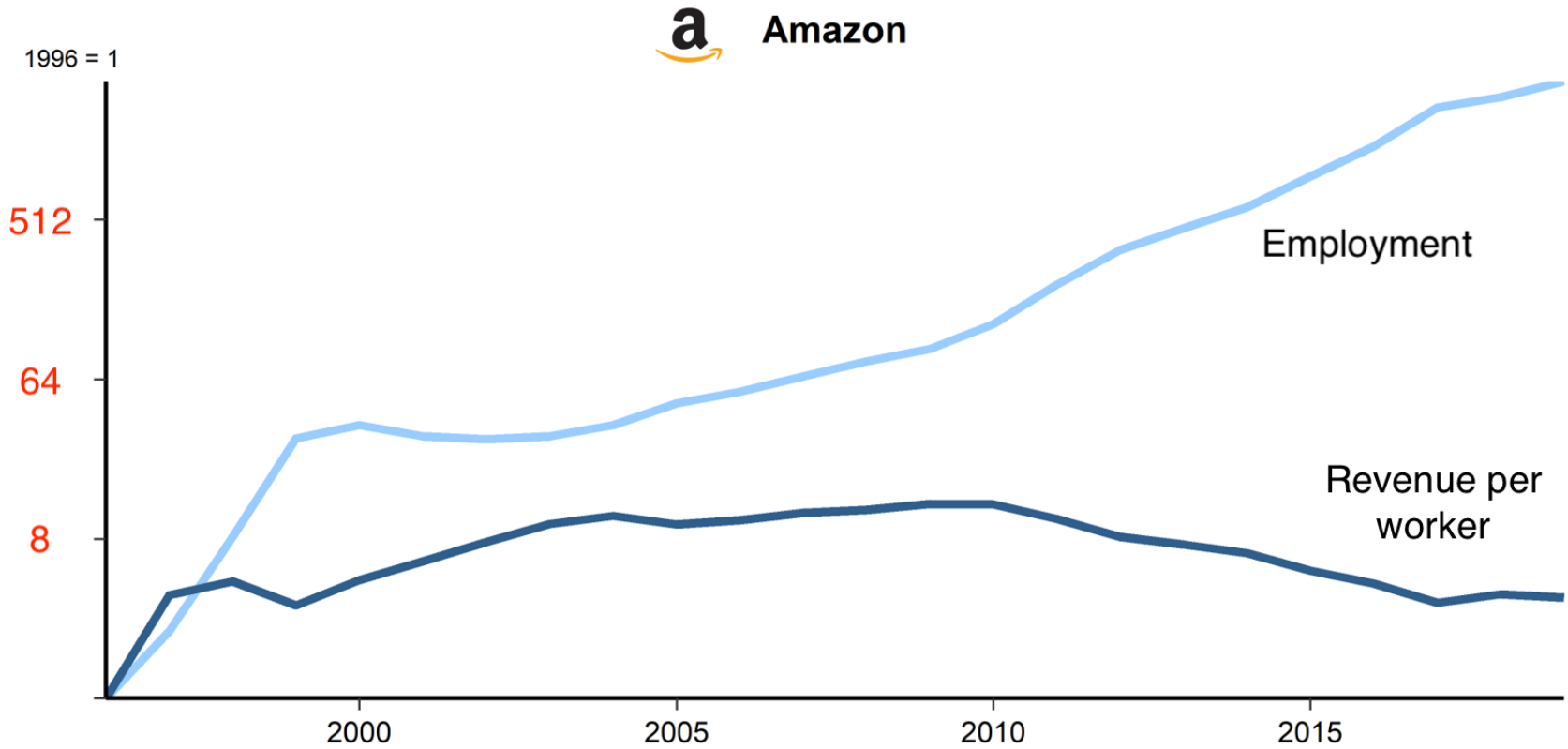


Method: Environment

Aggregate output:

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

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

$$
\begin{aligned}
g_f \;&:=\; \nu_f V_f^{\sigma-1} + \delta_f(\Delta_f^{\sigma-1}-1) && \text{NV, CD}\\
&+\; o_f(O_f^{\sigma-1}-1)\frac{\mathbb{E}_{G_{f,t-1}}(q^{\sigma-1})}{\mathbb{E}_{G_{t-1}}(q^{\sigma-1})} && \text{OI}\\
&+\; \left(\int_j \nu_j V_j^{\sigma-1} + \delta_j(\Delta_j^{\sigma-1}-1)\,dj\right)\left(\left(\frac{\widehat{Q}}{Q}\right)^{\sigma-1}-1\right)\frac{G_{f,t-1}(\kappa_t)N_{f,t-1}}{G_{t-1}(\kappa_t)N_{t-1}}\\
&+\; o_f(O_f^{\sigma-1}-1)\left(\frac{\mathbb{E}_{G_{f,t-1}}(q^{\sigma-1}|q\geq\kappa_t)}{\mathbb{E}_{G_{t-1}}(q^{\sigma-1})}-1\right) && \text{Selection}\\
&-\; \mathbb{E}_{G_{f,t-1}}[s_{t-1}\,|\,q<\kappa_t]G_{f,t-1}(\kappa_t)N_{f,t-1}, && \text{Variety loss}
\end{aligned}
$$

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

$\Rightarrow$ plant entry and exit reflects arrival of NV, CD, and obsolescence

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

$\Rightarrow$ 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
$S^{\{2\}}_{\mathcal{E}_{\mathcal{F}t}}$	2nd moment of employment share of new plants
$S^{\{3\}}_{\mathcal{E}_{\mathcal{F}t}}$	3rd moment of employment share of new plants

Aggregate moments

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

Notes: $S^{\{k\}}_{\mathcal{P}t} := \int_{\mathcal{P}} s^k_t(i)di$, 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	**1.67**	9.8%	-0.5%	90.8%
vs 1996–2005				
1996–2005	**-1.79**	11.0%	7.1%	81.9%
vs 2006–2013				

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

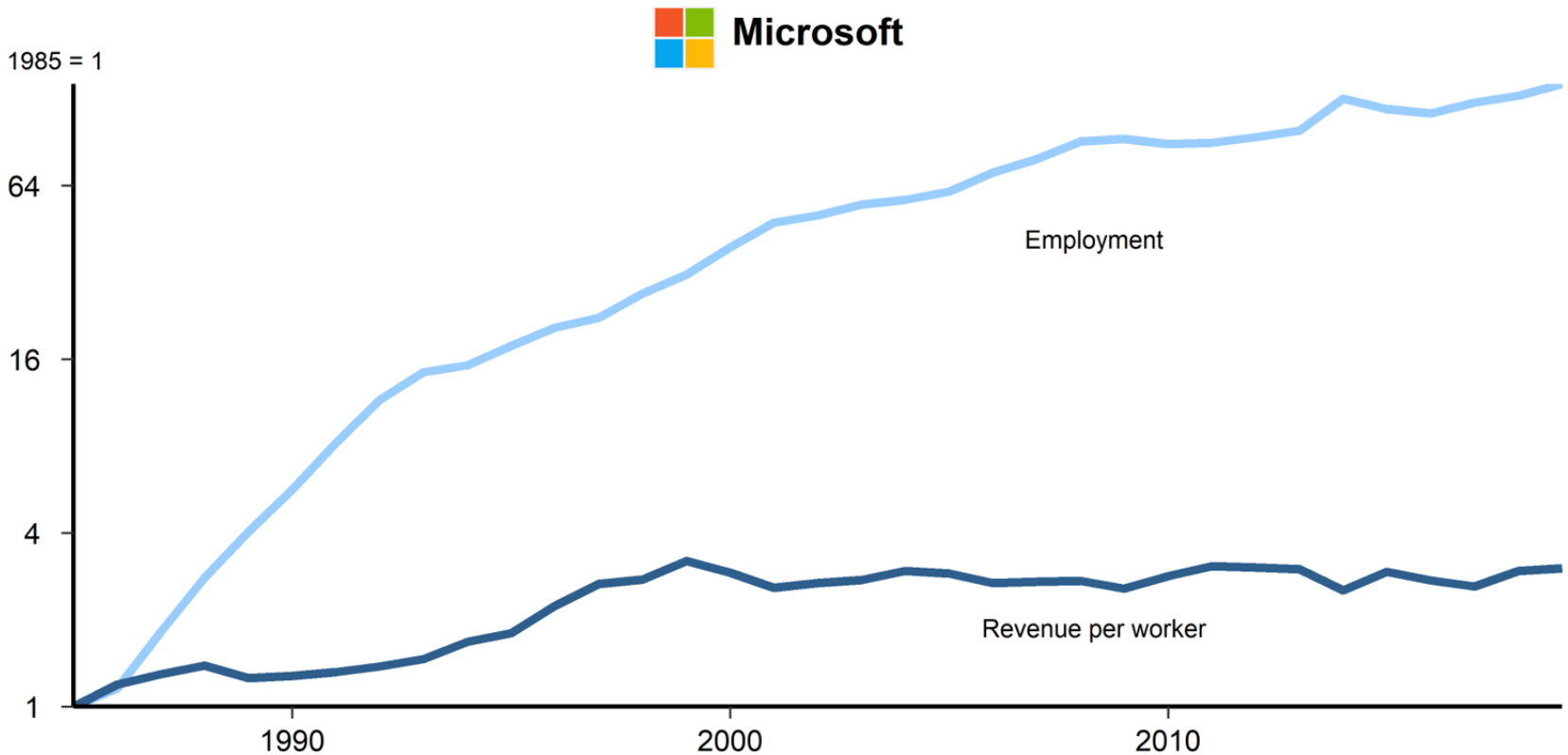
We provide a method to decompose aggregate productivity growth into contributions from firms and innovation types.

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

Appendix

Why not revenue productivity?



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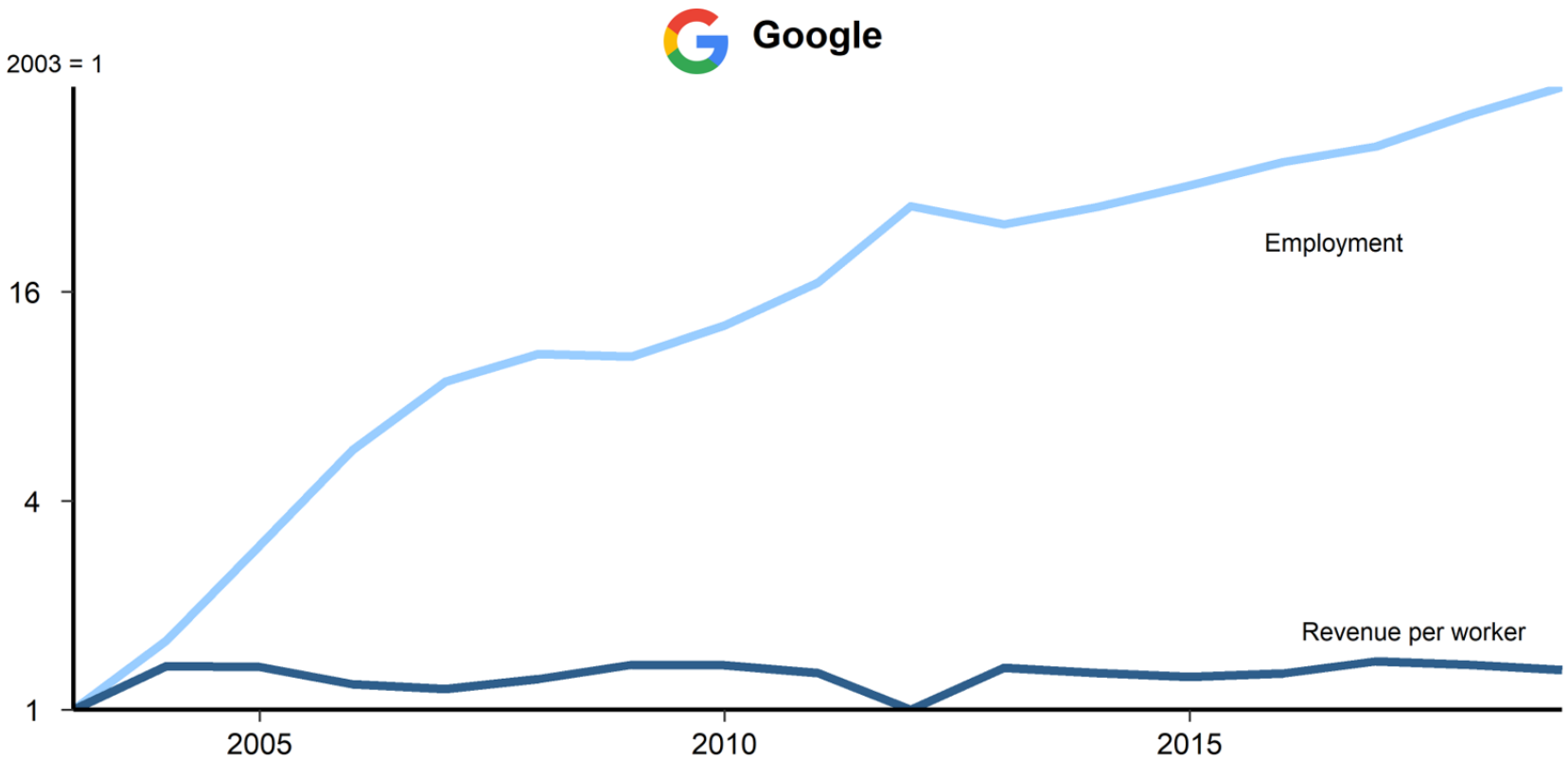

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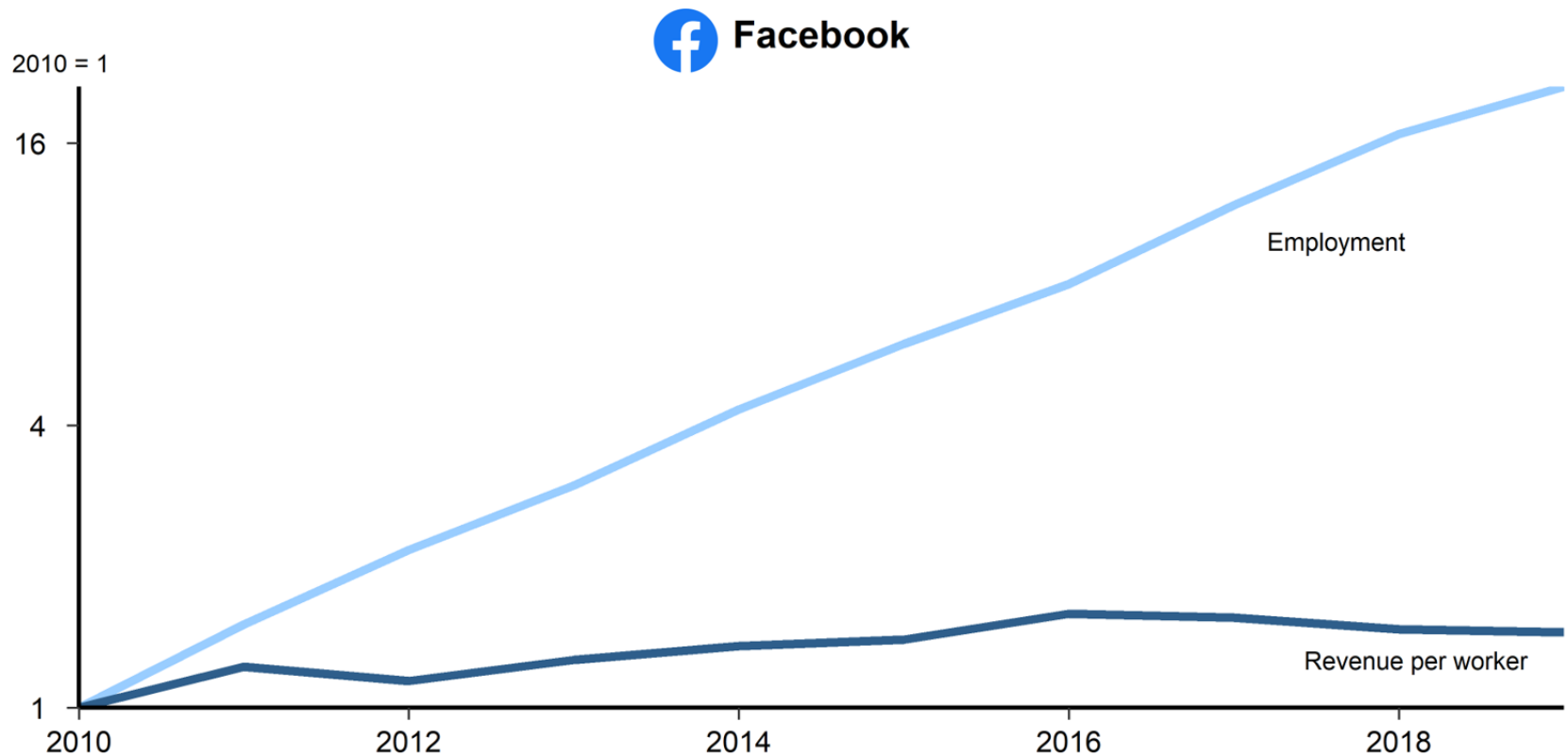

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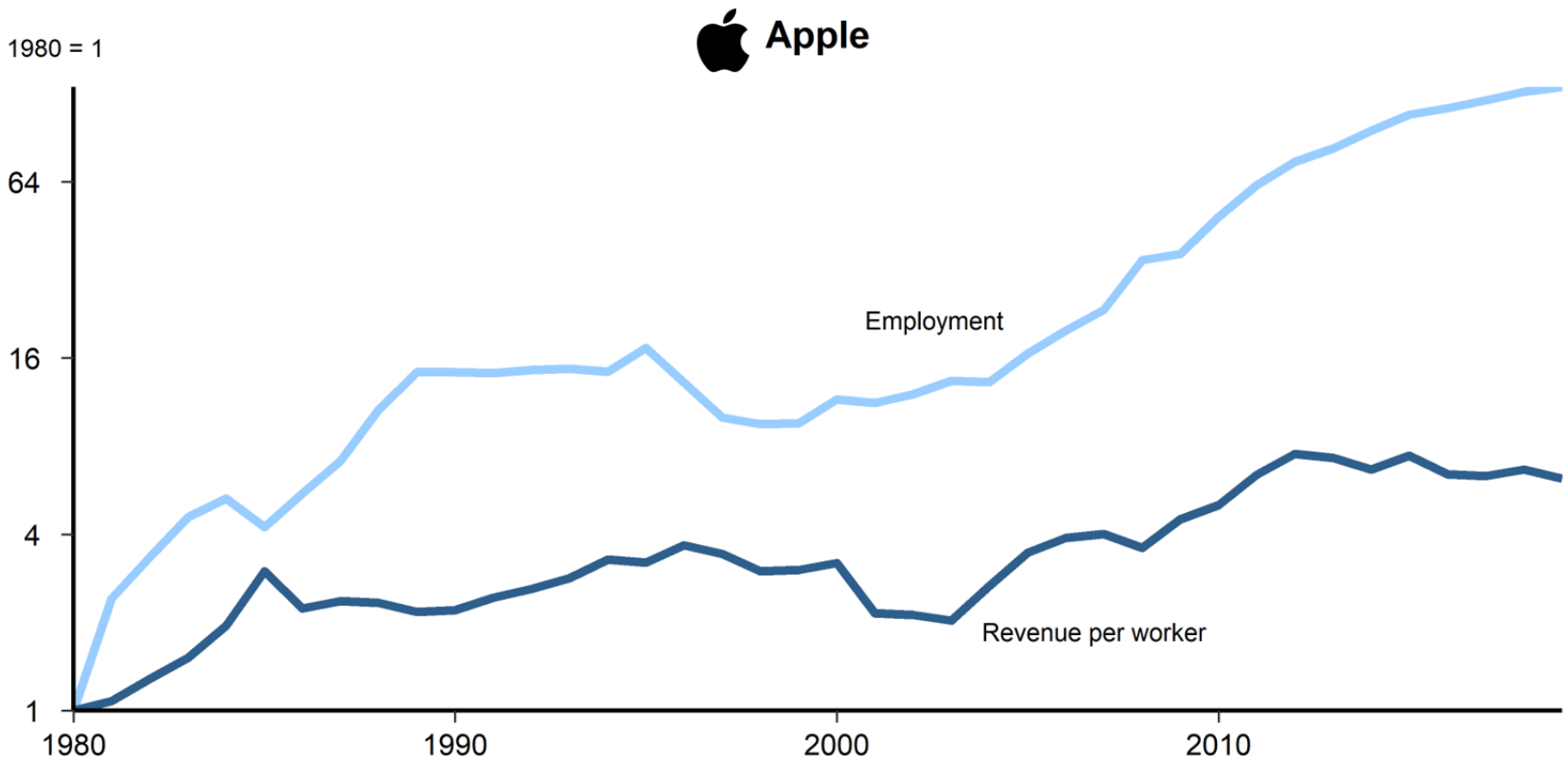

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