A Theory of Falling Growth and Rising Rents

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[1]DISCLAIMER: Opinions and conclusions herein are those of the authors and do not necessarily represent the views of the Federal Reserve System.

Motivation

The U.S. economy over the past 30+ years is characterized by the following patterns:

1. Falling "long run" growth (after a burst of growth)
2. Falling labor share (mostly due to composition)
3. Rising concentration
4. Falling job reallocation rate

Our goal

Provide a theoretical framework that speaks to these facts.

Calibrate our model to gauge potential magnitudes.

Use our theory to discuss policy questions (*not yet done*).

Our story

Theory of endogenous growth with heterogeneous firms.

Source of the change since the 1990s: ICT improvements extending the boundary of high-productivity firms.

High-productivity firms (with high markups) expand in response; aggregate labor share falls.

Expansion of high productivity firms deters innovation and undermines long-run growth (after initial burst of growth).

Related literature

Declining growth and rising concentration:
Akcigit and Ates (2018), Liu, Mian and Sufi (2018)

Rising concentration:
Chatterjee and Eyigungor (2018)

Declining labor share:
Autor et al. (2017), Barkai (2017), De Loecker and Eeckhout (2018), Eggertsson et al. (2018), Gourio and Farhi (2018), Karabarbounis and Neiman (2018), Martinez (2018)

Our contribution: a model generating all three patterns in response to increased span of control

Why Our Story

- Falling cost of ICT and rising intangibles investment
- Micro evidence that concentration might hinder growth
- Persistent firm markup differences
- Why not pursue other stories?

Roadmap for today

Motivating facts

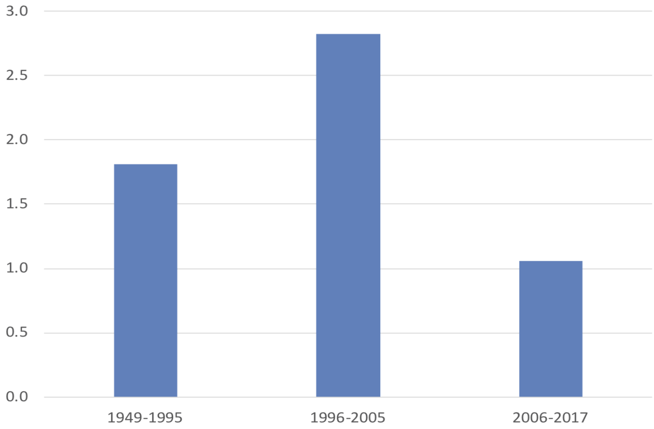
Theoretical framework

Quantification

4 Motivating Facts

1. Falling "long run" growth (after a burst of growth)
2. Falling labor share (mostly due to composition)
3. Rising concentration
4. Falling job reallocation rate

Rise and decline in TFP growth



Source: BLS multifactor productivity series + R&D and IP contribution in labor augmenting form.

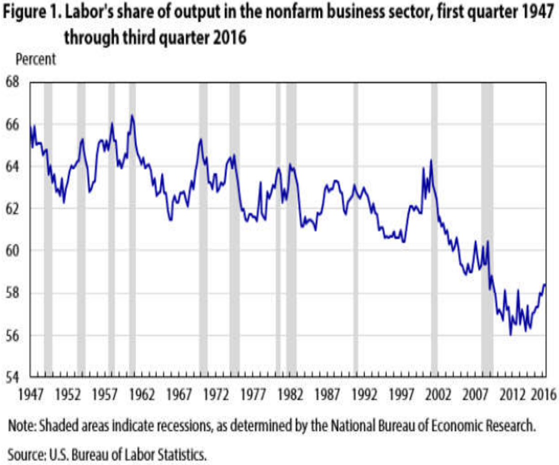
Key take-aways: TFP

Productivity slowdown since mid-2000s, preceded by a 10-year burst in productivity growth

Similar trends in other developed countries.

Productivity slowdown of ~ 0.7 ppt. compared to pre-1995

Falling labor income share



Source: BLS.

Declining labor share (mostly due to composition)

Cumulative change over specified period (ppt)

	1982–2012				92–12	92–07
	MFG	RET	WHO	SRV	FIN	UTL
$\Delta\frac{\text{Payroll}}{\text{Sales}}$	-7.01	-0.79	0.19	-0.19	3.25	-1.89
within	-1.19	3.74	4.01	2.43	6.29	0.58
between	-4.97	-4.03	-4.38	-0.44	-3.62	-2.39

Source: Autor et al. 2018 Table 5. A Melitz-Polanec decomposition of the change in the labor share.

Key take-aways: Labor share

Aggregate labor income share decreased by about 5 ppt. since the mid-1990s.

This was driven by composition effects, not falling labor share within firms.

See Autor et al. (2017).

Why the falling labor share?

Arguing <u>against</u> a rising capital elasticity:

- Weak I/Y
  - Barkai (2017), Gutierrez and Philippon (2018)
- Falling (user cost of capital)*K/Y
  - Barkai (2017), Baqaee and Farhi (2018)
- Translog estimates of the capital elasticity
  - De Loecker and Eeckhout (2018)

These studies instead blame rising price-cost markups

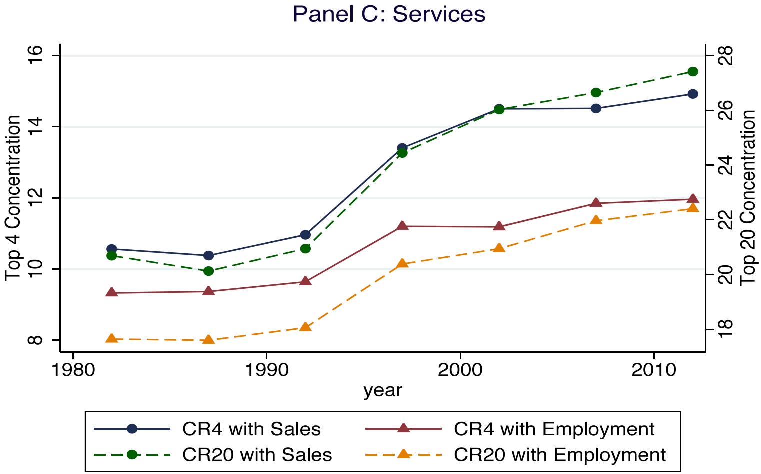
Rising national concentration

Average 5-year change (ppt)

	1982–2012				92–12	92–07
	MFG	RET	WHO	SRV	FIN	UTL
Δ Top 4 firms sales share	0.7	2.5	0.4	0.7	2.1	1.9
Δ Top 20 firms sales share	0.8	2.7	1.0	1.0	3.6	1.2

Source: Autor et al. 2017 Table 1. Averages across 4-digit industries weighted by industry sales.

Rising concentration in Services

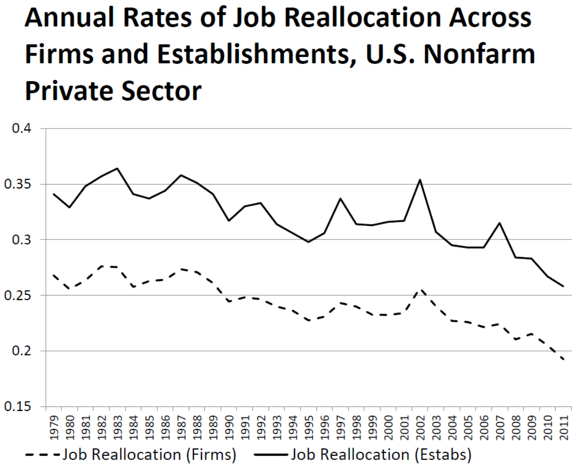


Source: Autor et al. 2017.

Key take-aways: Concentration

Rising industry concentration due to expansion of big firms.

Falling job reallocation



Source: Decker et al. (2014)

Falling entry and exit rate

Source: BDS

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Household side

Representative household maximizing

$$U_0 = \sum_{t=0}^{\infty} \beta^t \log(C_t)$$

subject to $a_{t+1} = (1 + r_t)a_t + w_t L - C_t$ and a nPg-condition.

Resulting in the standard Euler equation

$$\frac{C_{t+1}}{C_t} = \beta(1 + r_{t+1})$$

Production side

Final output is competitively produced according

$$Y = \exp\left(\int_0^1 \log\left[q(i)y(i)\right]di\right),$$

where intermediates differ in quality $q(i)$ and price $p(i)$.

Resulting demand:

$$y(i) = \frac{YP}{p(i)},$$

where P is the price index.

Firm heterogeneity

There are J firms.

Exogenous, permanent differences in the level of process efficiency across firms.

Endogenous, evolving differences in the level of product line specific quality across firms.

Process efficiency

Process efficiency across firms: share ϕ with high productivity φ^H, share $1-\phi$ with low productivity φ^L.

Production of product i by firm j is linear in labor

$$y(i,j) = \varphi(j) \cdot l(i,j).$$

Productivity differential $\Delta = \frac{\varphi^H}{\varphi^L} > 1$.

Product quality

Firm j owns patent to produce $i \in [0, 1]$ at quality $q(i, j)$.

Quality distribution evolves endogenously.

Spending $\psi_c \cdot Y$ units of final output on R&D increases the frontier quality of a randomly drawn line by factor $\gamma > 1$.

Market structure

Bertrand competition within each product line $i \in [0, 1]$.

In each line i the leading firm $j(i)$ sets

$$p(i, j(i), j'(i)) = \frac{q(i, j(i))}{q(i, j'(i))\varphi(j'(i))} w,$$

where $j'(i)$ indexes the next highest quality firm.

We assume $\gamma > \Delta$ so the highest quality producer is active.

Price is constrained by the second-best quality.

Markup

Markup is endogenously determined by the relative quality and process efficiency of the best and second-best firms.

The markup factor $\mu(i) = \frac{p(i,j(i),j'(i))}{w/\varphi^{j(i)}}$ is given by

$$\mu(i, j(i), j'(i)) = \begin{cases} \gamma, & \text{if type of } j = \text{type of } j' \\ \gamma\Delta, & \text{if } j = H\text{-type}, j' = L\text{-type} \\ \gamma/\Delta, & \text{if } j = L\text{-type}, j' = H\text{-type} \end{cases}$$

Labor income share

Aggregate labor income share is the inverse of the average cost-weighted markup factor

$$1 - \alpha_t = \frac{1}{\int_0^1 \mu_t(i) \frac{l_t(i)}{L} di} = \int_0^1 \frac{1}{\mu_t(i)} di.$$

Thus, it depends on the distribution of markups, and in turn the joint distribution of leader and follower.

Remark on firm heterogeneity

We explicitly distinguish between *process efficiency* and *product innovation*.

Product quality can be imitated whereas process efficiency cannot be.

As a consequence, high productivity firms charge persistently higher markups.

In line with the highly persistent TFPR differences across firms documented by David and Venkateswaran (2018).

Boundary of the firm

Per-period overhead cost for firm j with $n(j)$ products

$$\psi_o \cdot \frac{1}{2} n(j)^2 \cdot Y$$

Convexity yields a well-defined boundary of the firm.

High productivity firms operate more lines but not all lines.

Profits

Period profits of an H-type firm producing in $n(j)$ lines and facing a share $s(j)$ of H-type competitors:

$$\Pi(j) = \left[n(j)s(j)\left(1 - \frac{1}{\gamma}\right) + n(j)[1 - s(j)]\left(1 - \frac{1}{\Delta\gamma}\right) - \psi_o \frac{1}{2} n(j)^2 \right] Y$$

Period profits of an L-type firm producing in $n(j)$ lines and facing a share $s(j)$ of H-type competitors:

$$\Pi(j) = \left[n(j)s(j)\left(1 - \frac{\Delta}{\gamma}\right) + n(j)[1 - s(j)]\left(1 - \frac{1}{\gamma}\right) - \psi_o \frac{1}{2} n(j)^2 \right] Y$$

Comment on firm setup

Here:

- *constant* cost of acquiring a new product line
- convex overhead cost leads to diminishing marginal value of lines

Klette-Kortum:

- *convex* cost of acquiring a product line
- *non-diminishing* value of additional lines

Additional difference: here firms own a continuum of products and as a consequence there is no firm exit

Firm problem

Each firm decides how much to invest in R&D, $x_t(j)$, to maximize the net present value of its profits.

This leads to an endogenous rate of "creative destruction" z_{t+1} and is the source of growth.

For ease of exposition, we will only formally specify the firm problem in steady state here.

Resource constraints, aggregates

$$Y_t = C_t + O_t + Z_t$$

$$a_t = \int_0^J V_t(j) dj$$

$$L = \int_0^1 l_t(j, i) di$$

$$z_{t+1} = \int_0^J x_t(j)\, dj$$

Steady state

Definition

A steady state is an equilibrium in which the fraction of lines served by high productivity firms, $S^\star \in (0, 1)$, and the interest rate $r^\star$ are both constant over time.

Steady state implies that the fraction of high productivity competitors faced is identical across firms, $s(j) = S^\star$.

In the following we analyze the steady state.

We are particularly interested in how the steady state changes as ψ_o, the scale of overhead costs, decreases.

Firm problem in steady state

For H-type and L-type firms, respectively:

$$v_H(n) = \max_{n'} \{\pi_H(n, S^\star) - [n' - n(1 - z^\star)]\,\psi_c + \beta v_H(n')\}$$

$$v_L(n) = \max_{n'} \{\pi_L(n, S^\star) - [n' - n(1 - z^\star)]\,\psi_c + \beta v_L(n')\}$$

A steady state is a combo of $(n_H^\star, n_L^\star, S^\star, z^\star)$ such that

$$\phi J n_H^\star = S^\star, \text{ and } (1-\phi) J n_L^\star = (1 - S^\star),$$

and the policy functions fulfill

$$f_H(n_H^\star) = n_H^\star, \text{ and } f_L(n_L^\star) = n_L^\star.$$

Steady state analysis

Proposition

Under parameter restrictions, there is a unique steady state in which $n_t(j) = n_H^\star$ for all H-types and $n_t(j) = n_L^\star$ for all L-types. Output and consumption grow at constant rate

$$\ln \frac{Y_{t+1}}{Y_t} = \ln \frac{C_{t+1}}{C_t} \equiv g^\star = z^\star \cdot \ln \gamma$$

where $z^\star$ is the endogenous rate of creative destruction.

Steady state characterization

$(S^\star, z^\star, n_H^\star, n_L^\star)$ can be determined analytically from

$$\psi_c = \frac{1 - S^\star/\gamma - (1 - S^\star)/(\gamma\Delta) - \psi_o n_H^\star}{1/\beta - 1 + z^\star}$$

$$\psi_c = \frac{1 - S^\star\Delta/\gamma - (1 - S^\star)/\gamma - \psi_o n_L^\star}{1/\beta - 1 + z^\star}$$

$$n_H^\star = \frac{S^\star}{\phi J}$$

$$n_L^\star = \frac{(1 - S^\star)}{(1 - \phi)J}$$

Steady state implications

Proposition

$n_H^\star > n_L^\star$.

Intuition: Higher expected profit per line for H-type $\rightarrow$ they push higher up their overhead cost schedule.

Corollary: $S^\star > \phi$. The fraction of H-type lines exceeds the fraction of H-type firms.

Furthermore, high productivity firms have a lower labor income share and a higher average markup.

Steady state comparison: ψ_o drops

Suppose ψ_o, which indexes overhead costs, drops permanently to a lower level.

How does the new steady state compare to the old one?

Particularly interested in effects on

- Concentration $S^\star$
- Labor income share $1 - \alpha^\star$ (within firm and overall)
- Growth rate $g^\star$ and rate of creative destruction $z^\star$

Steady state effect of lower ψ_o on concentration

Proposition

$S^\star$ rises monotonically as ψ_o falls.

Intuition:

A larger size gap $n_H^\star - n_L^\star$ is needed to yield a given difference in their marginal overhead costs.

Steady state effect of lower ψ_o on the labor income share

The labor income share within high and low productivity firms is monotonically *increasing* in $S^\star$.

Intuition: with a higher $S^\star$ a producer is more likely to face a high productivity competitor $\rightarrow$ lower markup.

However, the between effect goes in the opposite direction (increasing $S^\star$ tends to decrease the labor income share).

Overall effect: the aggregate labor share is decreasing in $S^\star$ (and therefore falls when ψ_o falls) as long as $S^\star > 1/2$.

Steady state effect of lower ψ_o on the growth rate

Proposition

For some parameter values, growth slows as ψ_o falls.

Marginal value of innovating on an additional line determines the rate of creative destruction and growth.

Direct effect: lower $\psi_o \rightarrow$ higher incentive to innovate.

GE effect: as $S^\star$ increases $\rightarrow$ expected markup in a product line decreases.

For a range of parameter values the GE effect dominates.

Theory extensions

Case with $\Delta > \gamma$

Allowing for M&A activity

Endogenous entry and exit of *firms*

Endogenous number of products

Transition dynamics after a decrease in ψ_o

Initially, as S has not increased yet, incentive to do R&D increases.

And static process efficiency gains are realized during the transition as S increases.

Both effects will contribute to a burst of growth during the transition.

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Quantification

Assess the quantitative importance of the mechanism next.

Overall strategy:

- Calibrate baseline parameter values plus the change in ψ_o to try to fit data on concentration, the aggregate labor share, and the initial growth rate.
- How big is the resulting productivity slowdown?

Baseline Calibration

	Target	Model
1. % decline in labor share	4.4	4.2
2. within change/baseline labor share	7.5	7.7
3. top 10% concentration 1987–1992	67.5	67.5
4. top 10% concentration 2007–2012	72.8	72.8
5. productivity growth 1948–1995	1.8	1.8
6. baseline real interest rate	5.0	4.9
7. baseline R&D/PY	10.0	9.8

Untargeted	Data	Model
8. productivity growth 2006–2017	1.1	1.4
Share of growth decline explained		**60%**
9. aggregate labor share	54.1	34.8

Sources: 1 & 9: BLS compensation share of value added, 2–4: Autor et al. (2017), 5 & 8: BLS MFP.

Baseline Parameter Values

1. share of H-type firms	ϕ	0.137
2. productivity gap	Δ	2.202
3. quality step	γ	2.935
4. discount factor	β	0.971
5. initial overhead cost	ψ_o	1
6. new, lower overhead cost	ψ_o'	0.954
7. R&D cost	ψ_c	5.816

Initial vs. new steady state

	Initial	New
1. creative destruction rate ($z^\star$)	1.7	1.3
2. share of H-type products ($S^\star$)	92.8	99.9
3. products per H-type firm ($n_H^\star$)	1	1.078
4. products per L-type firm ($n_L^\star$)	0.012	0.000
5. labor share of H-type firms	32.7	34.1
6. labor share of L-type firms	72.1	75.0
7. aggregate labor share	35.6	34.1
8. R&D/PY	9.8	7.3
9. Overhead/PY	18.5	20.5
10. Rents/PY	36.2	38.1

Conclusion

We provide an endogenous growth theory built around firms with heterogeneous quality, productivity and markups.

As firm span of control increases, the theory predicts:

- Rising concentration
- A decline in the labor income share (driven by composition as opposed to a decline within firms)
- A fall in TFP growth after an initial burst

How our story is distinct

Closest stories in the literature:

- Akcigit and Ates (2018)
- Liu, Mian and Sufi (2018)

We differ in

- our driving force
- generating opposite trends for labor's share (and markups) within versus across firms
- generating/emphasizing a burst of growth before the growth slowdown

Next steps

Solving numerically for the transition

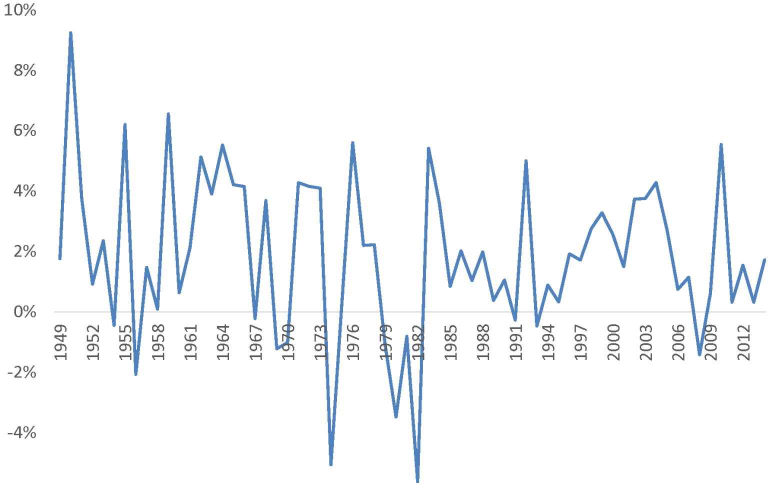
Welfare analysis

Modeling entry and exit

Antitrust policy: how to deal with FAMANG?

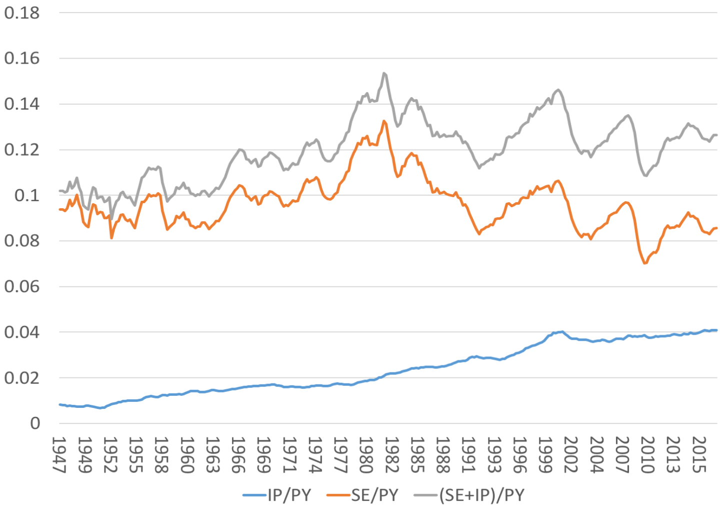
Appendix

Rise and decline in TFP growth



Source: BLS multifactor productivity series + R&D and IP contribution in labor augmenting form.

Non-rising investment rate



Source: BEA. Nominal investment over nominal GDP

Public debate

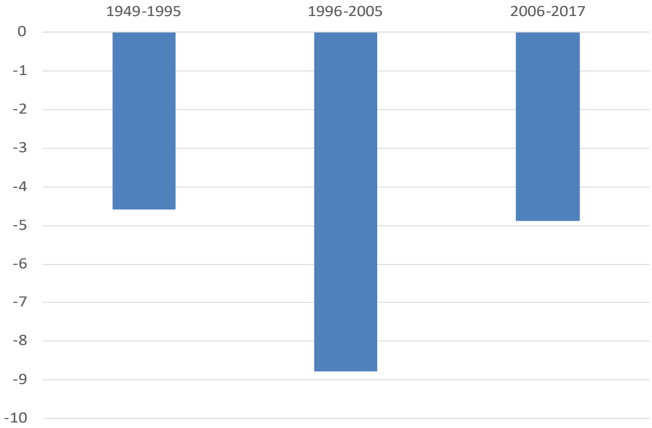
"Big Business Is Too Big" David Leonhardt, New York Times, April 2 2018

The United States has an oligopoly problem–a concentration of corporate power that has been building for years but is only now starting to receive serious attention from policymakers, think tanks and journalists…This consolidation has helped hold down wages, raise prices and reduce job growth–while lifting corporate profits…The Democrats have put antitrust policy at the center of their economic agenda.

$\downarrow$ cost of ICT, $\uparrow$ intangibles

- Falling cost of ICT
  - BEA ICT deflator / GDP deflator
- Rising intangibles investment of large vs. small firms
  - Lashkari and Bauer (2018)
  - Crouzet and Eberly (2018)

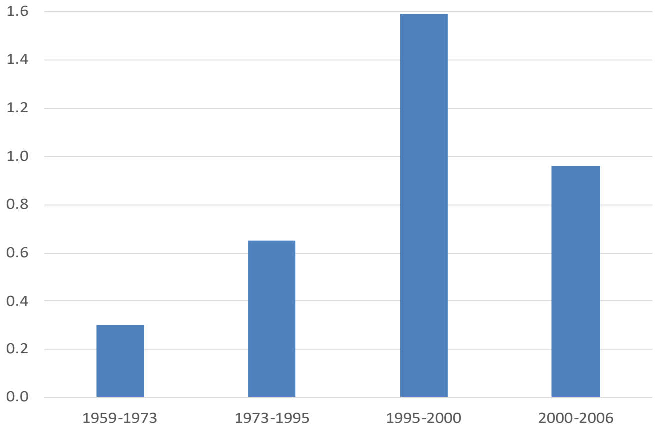
Relative price of ICT



Source: BEA (% change per year)

Return

Growth contribution of ICT



Source: Jorgenson, Ho and Stiroh (2008)
(% points per year contribution to labor productivity growth)

Concentration and growth

- Small (young) firms appear more innovative
  - Akcigit and Kerr (2018)
- Small (young) firms grow faster
  - Haltiwanger, Jarmin and Miranda (2013)

Return

Firm markup persistence

- Revenue/Inputs
  - Hsieh and Klenow (2009)
  - David and Venkateswaran (2018)
- Labor shares
  - De Loecker and Eeckhout (2018)
  - Gouin-Bonenfant (2018)

Return

Why not trade?

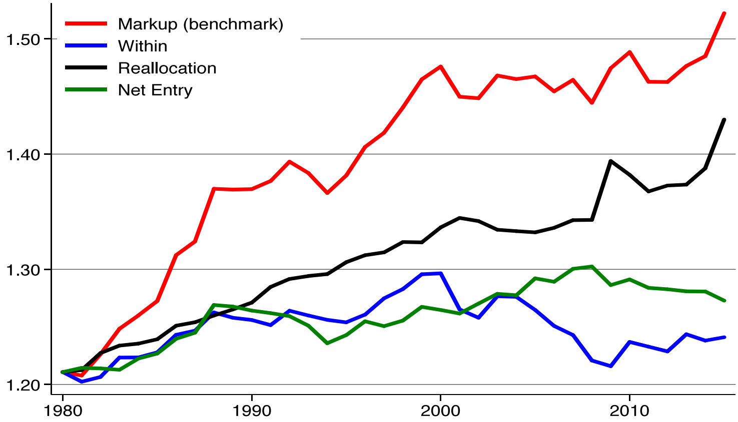
- labor's share has fallen in U.S. non-manufacturing
  - Autor et al. (2018)
- labor's share has fallen in many developing countries
  - Karabarbounis and Neiman (2013)

Why not competition policy?

- labor's share has fallen in many countries
  - Karabarbounis and Neiman (2013)
- local concentration has not risen
  - Rossi-Hansberg, Sarte, and Trachter (2018)

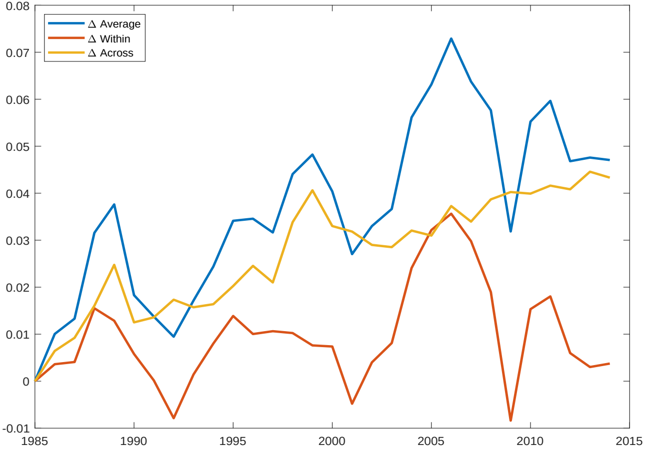
Return

Within firm markups



Source: De Loecker, Eeckhout and Unger (2018).

Within firm markups



Source: Baqaee and Farhi (2018).

Alternative Calibration: target labor share

	Target	Model
1. % decline in labor share	4.4	0.8
2. within change/baseline labor share	0.075	0.050
3. top 10% concentration 1987–1992	0.675	0.673
4. top 10% concentration 2007–2012	0.728	0.734
5. change in top 10% concentration	0.079	0.092
6. productivity growth 1948–1995	0.018	0.018
7. real interest rate	0.050	0.049
8. baseline R&D/PY	0.100	0.109
9. aggregate labor share	0.541	0.544

Untargeted	Data	Model
10. productivity growth 2006–2017	0.011	0.013
Share of growth decline explained		**59%**

Parameter Values when we target labor share

1. share of H-type firms	ϕ	0.0001
2. productivity gap	Δ	1.796
3. quality step	γ	1.980
4. discount rate	β	0.970
5. initial overhead cost	ψ_o	1
6. new, lower overhead cost	ψ_o'	0.936
7. R&D cost	ψ_c	4.219

Alternative Calibration: target lower R&D share

	Target	Model
1. % decline in labor share	4.4	4.2
2. within change/baseline labor share	0.075	0.077
3. top 10% concentration 1987–1992	0.675	0.675
4. top 10% concentration 2007–2012	0.728	0.727
5. change in top 10% concentration	0.079	0.078
6. productivity growth 1948–1995	0.018	0.018
7. baseline real interest rate	0.050	0.049
8. baseline R&D/PY	0.050	0.050

Untargeted	Data	Model
9. productivity growth 2006–2017	0.011	0.007
Share of growth decline explained		**142%**
10. aggregate labor share	0.541	0.418

Parameter Values when we target lower R&D share

1. share of H-type firms	ϕ	0.137
2. productivity gap	Δ	2.211
3. quality step	γ	2.446
4. discount rate	β	0.970
5. initial overhead cost	ψ_o	1
6. new, lower overhead cost	ψ_o'	0.954
7. R&D cost	ψ_c	2.471

Dynamic firm problem

A firm with $n_t(j)$ highest quality patents and facing a share $s_t(j)$ of high-productivity competitors solves

$$\begin{aligned} V_t(n_t(j), s_t(j), S_t, \alpha_t, j) \quad = \quad & \max_{x_t(j), n_{t+1}(j), s_{t+1}(j)} \{\Pi_t(n_t(j), s_t(j), \alpha_t, j) \\ & -x_t(j)\psi_c Y_t P_t \\ & + \frac{1}{1+r_t} V_{t+1}(n_{t+1}(j), s_{t+1}(j), S_{t+1}, \alpha_{t+1}, j)\} \end{aligned}$$

s.t.

$$x_t(j) = n_{t+1}(j) - n_t(j)(1 - z_{t+1})$$

$$n_{t+1}(j)s_{t+1}(j) = s_t(j)n_t(j)(1 - z_{t+1}) + x_t(j)S_t$$

and

$$x_t(j) \geq 0$$