A Theory of Falling Growth and Rising Rents

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

Motivation

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

1. Falling "long run" growth (after a burst of growth)

2. Falling labor share (due to composition)

3. Rising (national) concentration

Our story

Theory of endogenous growth with heterogeneous firms.

Source of the change since the 1990s: IT 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 (2019), Liu, Mian and Sufi (2019)

Rising concentration:
Chatterjee and Eyigungor (2019), Hsieh and Rossi-Hansberg (2019), Hopenhayn et al. (2019)

Declining labor share:
Koh et al. (2016), Kehrig & Vincent (2017), Autor et al. (2017), Barkai (2017), De Loecker & Eeckhout (2018), Eggertsson et al. (2018), Farhi & Gourio (2018), Karabarbounis & Neiman (2018), Martinez (2018)

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

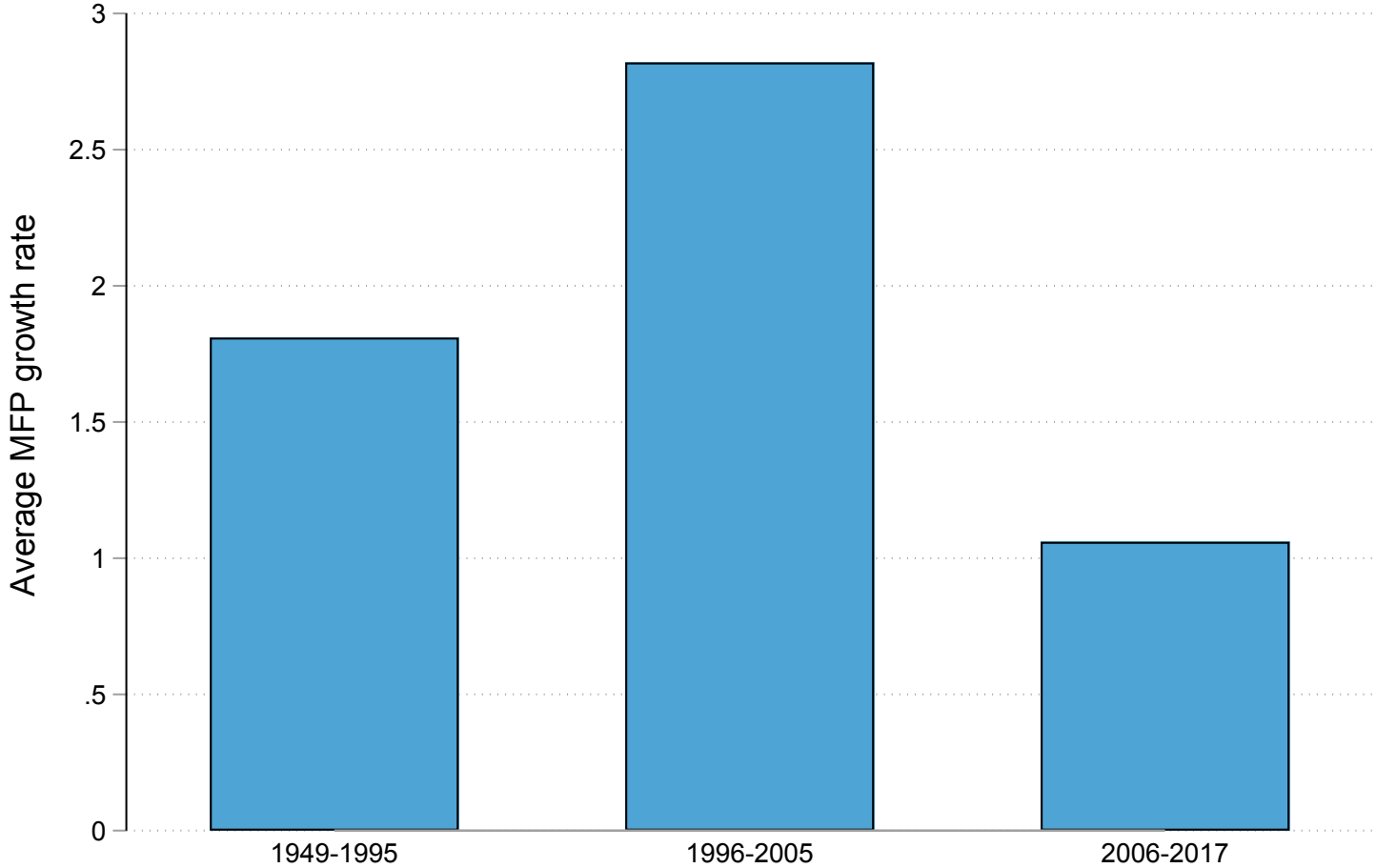
Roadmap for today

Motivating facts

Theoretical framework

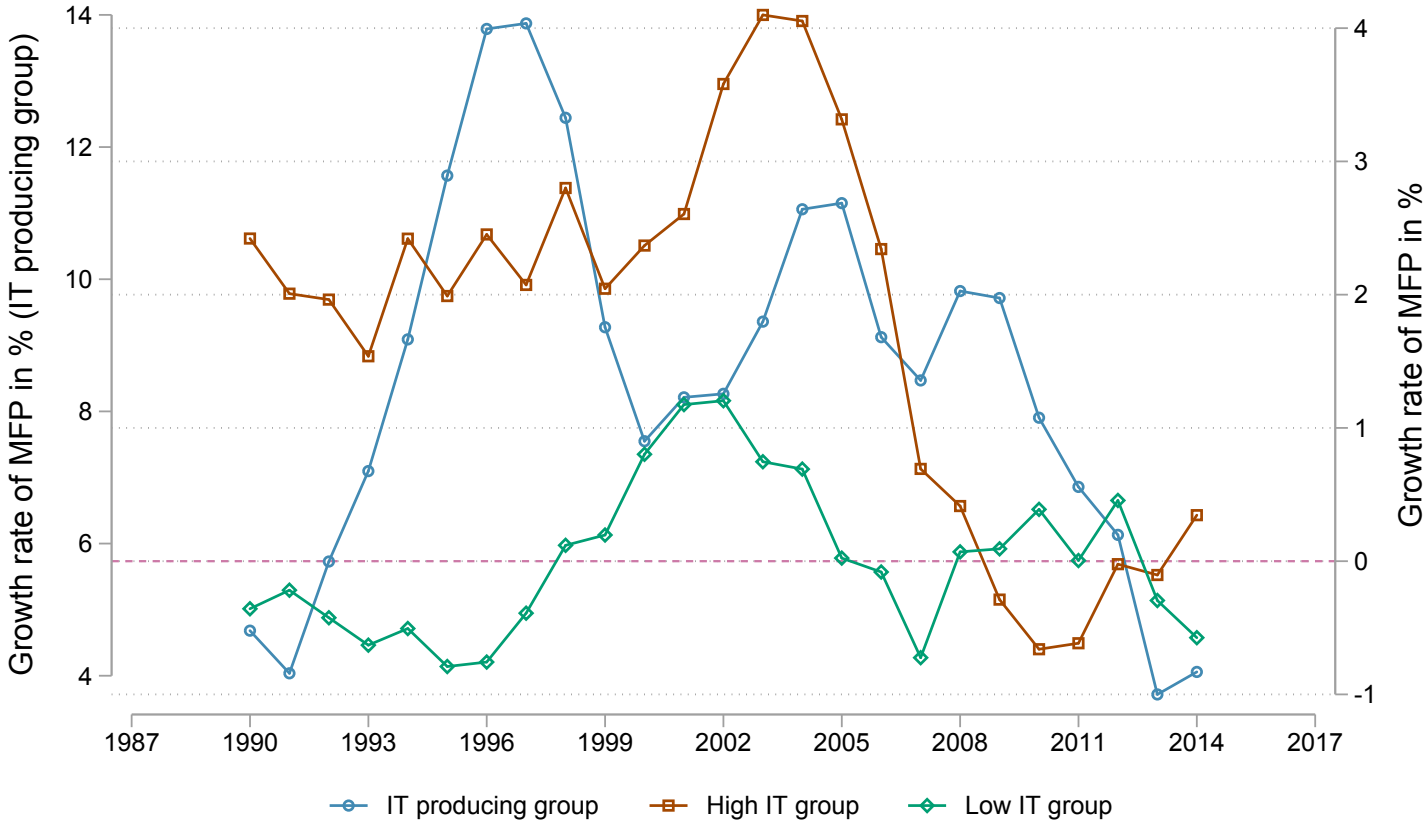
Quantification

Rise and Decline in TFP Growth



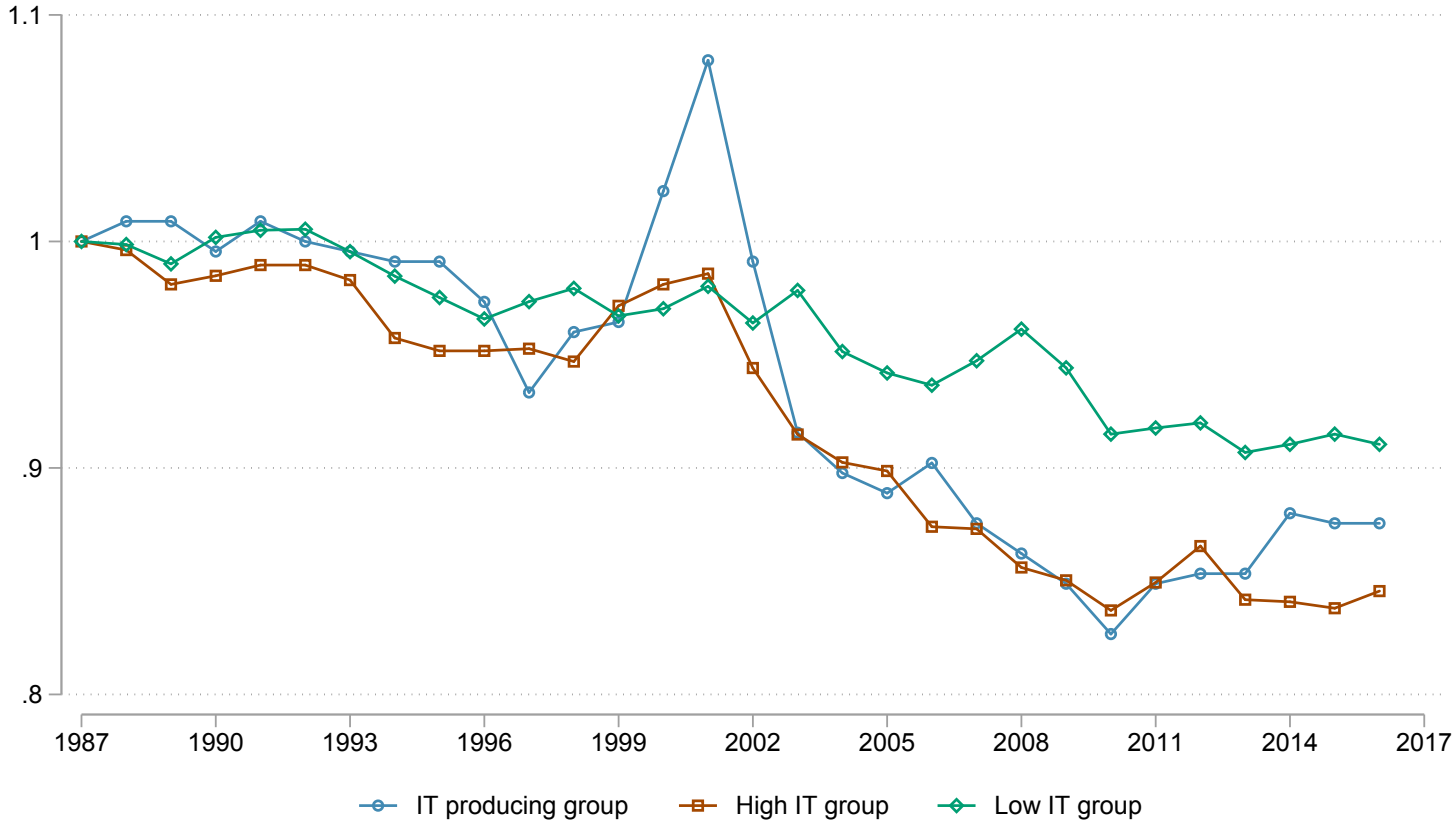
BLS MFP growth + R&D and IP contribution; labor augmenting.

TFP Growth by IT intensity



Update of Fernald (2015) figure 6A; 5-year moving average.

Labor share by IT intensity



1987 is normalized to 1 for each group

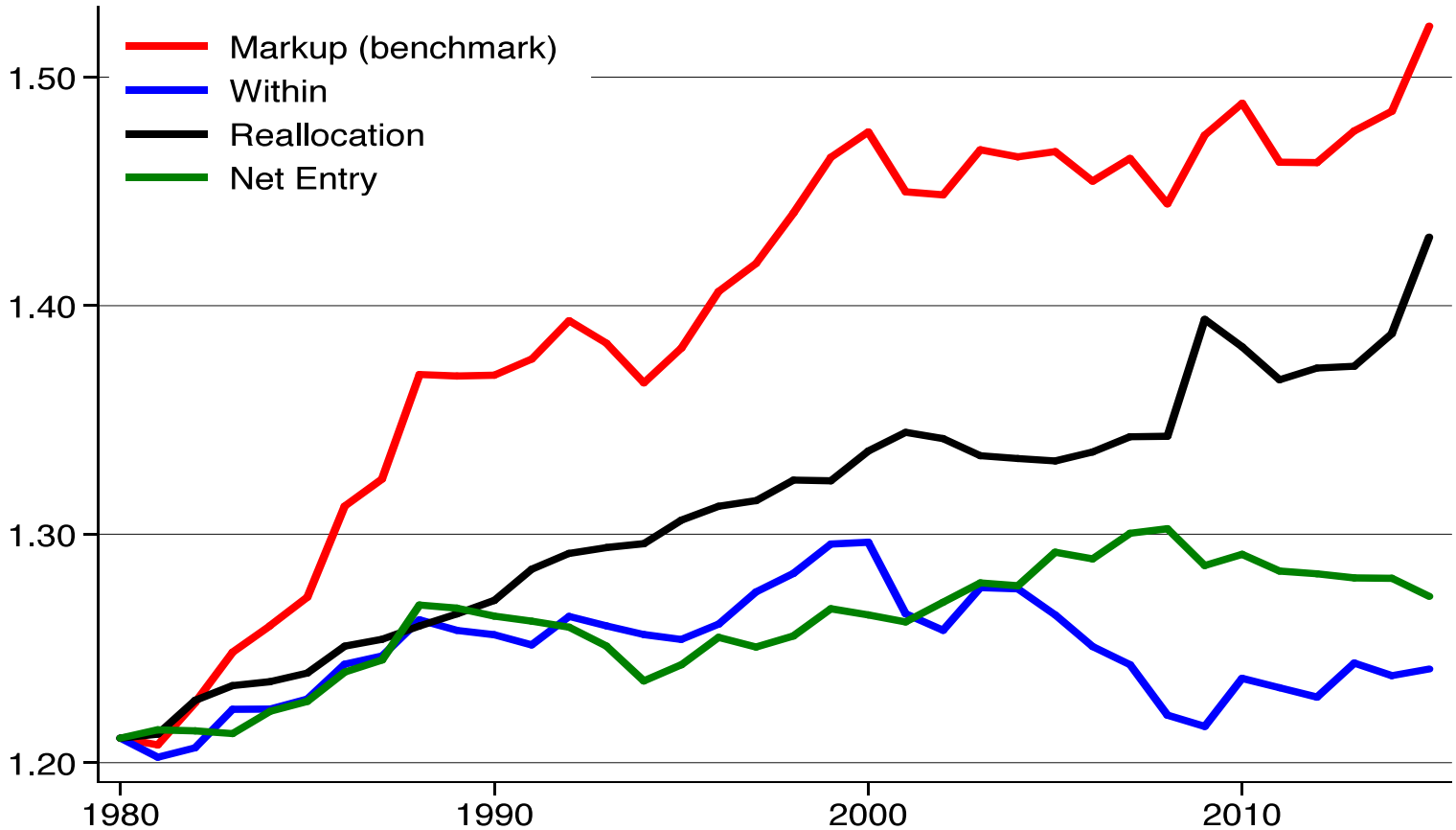
Declining Labor Share (mostly due to composition)

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. (2017) Table 5.

Within firm markups



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

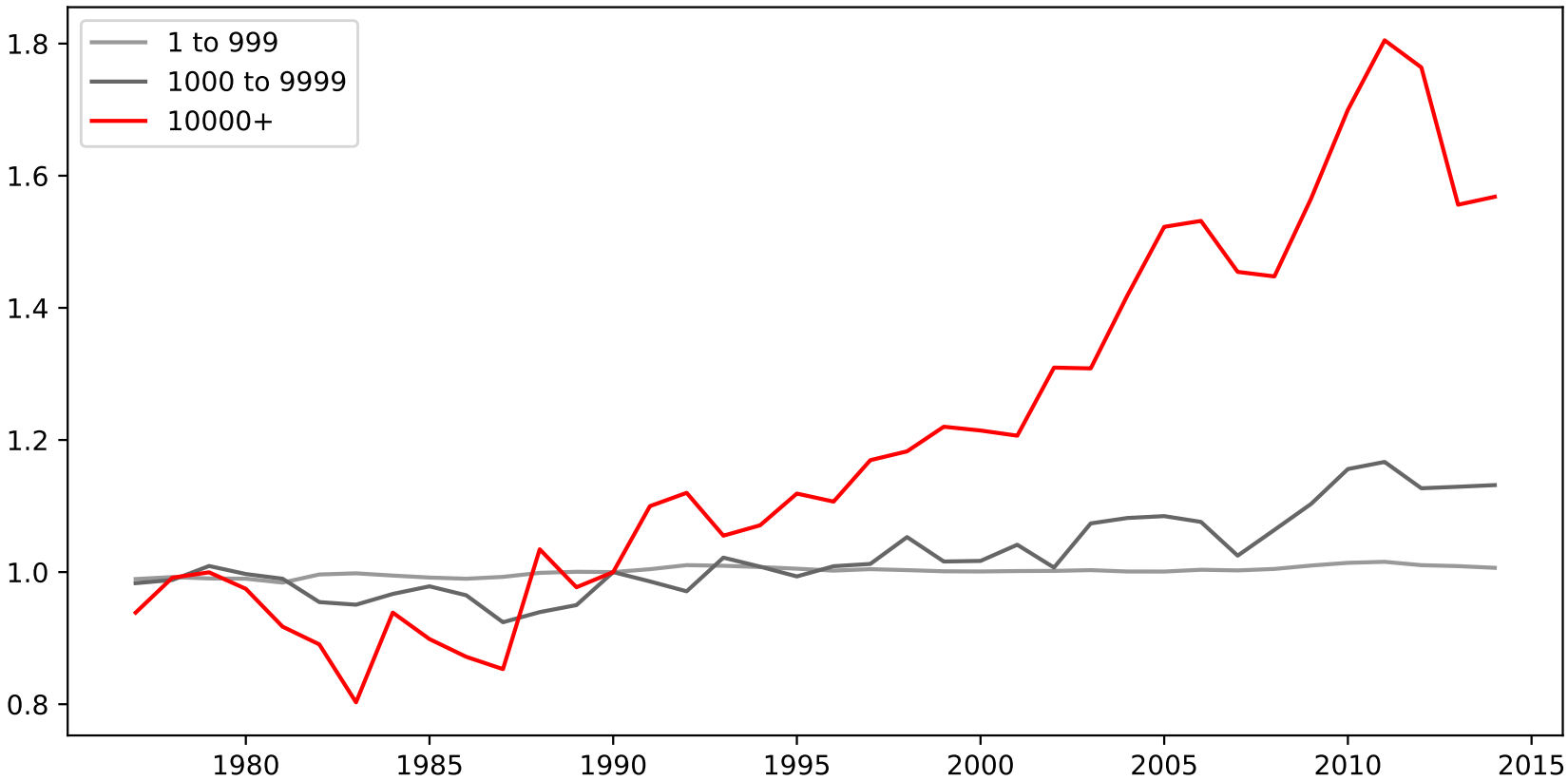
Rising National Concentration

Cumulative change over specified period (ppt)

	1982–2012				92–12	92–07
	MFG	RET	WHO	SRV	FIN	UTL
Δ Top 4 firms sales share	4.2	15.0	2.4	4.2	8.4	5.7
Δ Top 20 firms sales share	4.8	16.2	6.0	6.0	14.4	3.6

Autor et al. 2017 Table 1. Sales-weighted across 4-digit industries.

Rising Establishments per Firm



Source: U.S. Census Bureau's *Business Dynamics Statistics*

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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 competitively produced with

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

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-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 $\Delta = \dfrac{\varphi^H}{\varphi^L} > 1$

Product quality

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

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

Firms choose R&D investment to maximize profits.

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

Markup

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

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

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

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:

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

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.

Firm problem in steady state

Focus on steady state where the fraction of lines served by high productivity firms $S^\star \in (0,1)$ and the rate of creative destruction $z^\star$ and hence $g^\star$ are both constant over time.

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

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

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

subject to

$$n' \geq n(1 - z^\star)$$

Steady state characterization

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

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

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

$$\phi J n_H^\star = S^\star$$

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

Steady state comparison: ψ_o drops

Recall overhead cost is $\psi_o \frac{n^2}{2} Y$. Suppose ψ_o 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.

Labor income share

R&D and overhead cost both denominated in final output.

No physical capital.

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

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

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

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

Two opposing effects 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 within a product line decreases.

For a range of parameter values the GE effect dominates and growth slows as ψ_o falls.

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Quantification

Overall strategy:

- Calibrate baseline parameter values to initial period
- Change ψ_o to match the between change in labor share
- How big is the resulting change in the growth rate, concentration, and aggregate labor share?

Generalizations: CRRA preferences with IES of $1/\theta$;
CES aggregation across products with elasticity σ

Baseline Calibration

Assigned: $\sigma = 4$, $\theta = 2$

Calibrated: $\psi_o^0 = 0.020$, $\phi = 0.032$, $\gamma = 1.47$, $\psi_c = 1.67$, $\beta = 0.978$, $\Delta = 1.34$.

	Target	Model
1. top 10% concentration 1987–1992	67.5	57.2
2. productivity growth 1949–1995	1.81	1.81
3. aggregate markup	1.27	1.27
4. real interest rate	6.1	5.9
5. intangible share	10.4	9.3
6. labor share and size relation	-1.10	-1.09

1, 6 Autor et al (2019), 2 BLS, 3 Hall (2018), 4 Farhi-Gourio (2018), 5 Corrado et al (2012)

Effect of decline in ψ_o

ψ_o falls 65.0% to match the between change in labor share

Targeted	Data	Model
Between change in labor share (%)	-11.6	-11.6

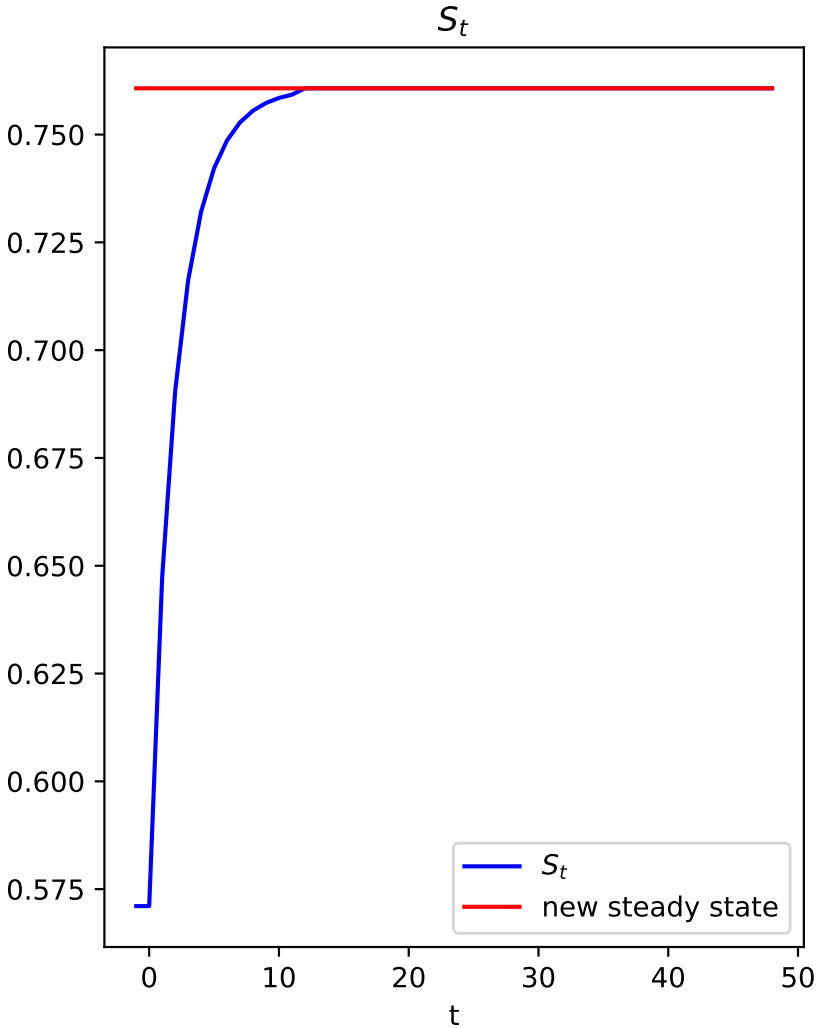
Untargeted	Data	Model
1. 2006–2017 productivity growth rate (ppt)	1.06	0.86
2. change in aggregate labor share (%)	-5.7	-3.6
3. within change in labor share (%)	5.9	8.0
4. change in concentration (ppt)	5.3	35.1
5. change in intangible share (ppt)	1.5	1.1

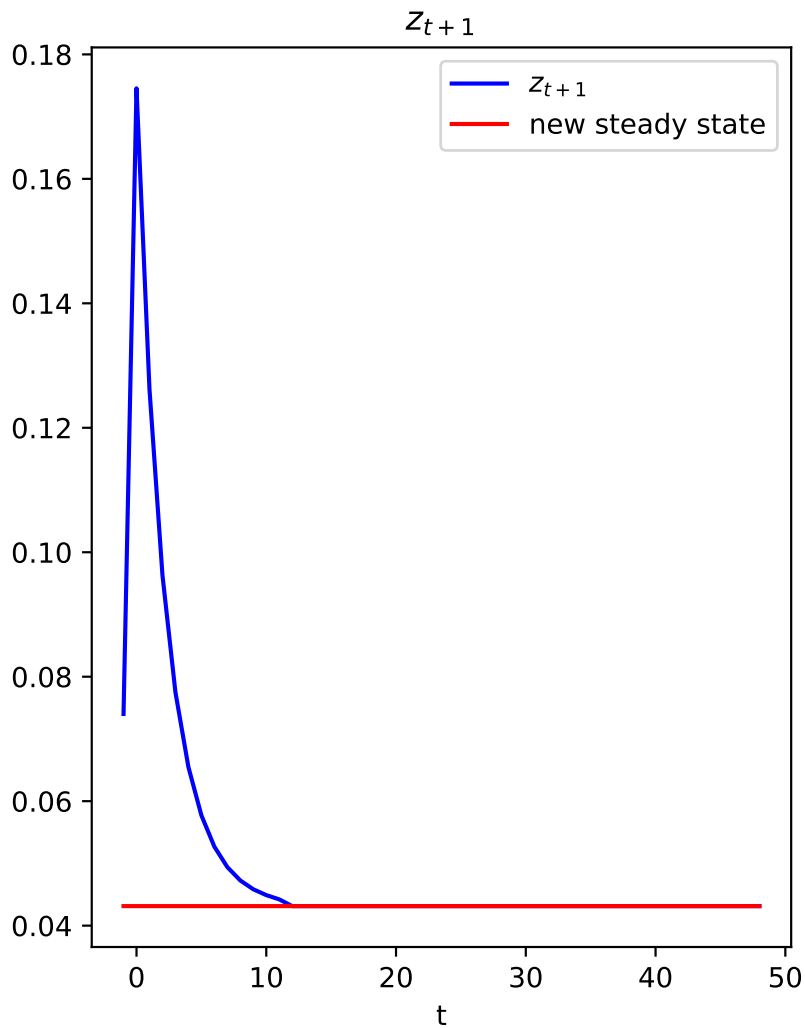
Sources: Elsby et al (2013), Autor et al. (2017), BLS MFP.

Initial vs. new steady state

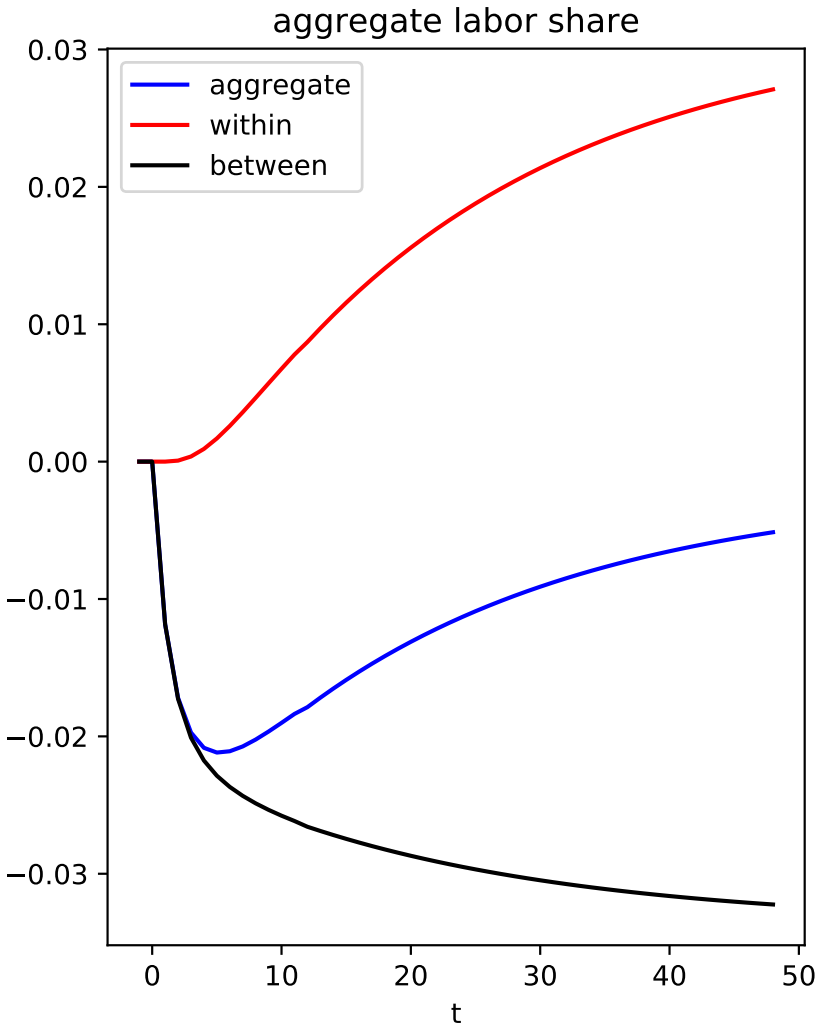
	Initial	New
1. creative destruction rate ($z^\star$)	2.58	1.20
2. % of H-type products ($S^\star$)	39.0	88.8
3. % of H-type sales ($\tilde{S}^\star$)	54.0	91.8
4. markup of H-type firms	1.33	1.33
5. markup of L-type firms	1.19	1.11
6. aggregate markup	1.27	1.31
7. R&D/PY	4.3	2.0
8. overhead/PY	5.0	8.3
9. rent/PY	11.7	13.4
10. real interest rate	5.9	3.9

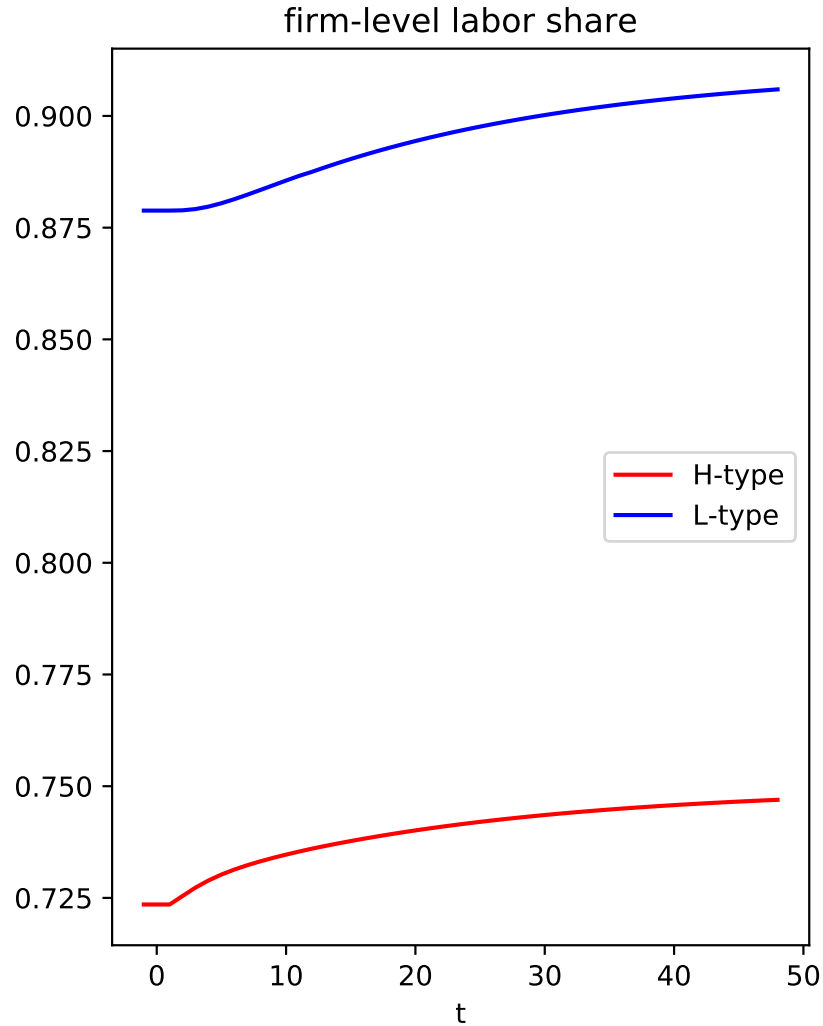
Transition after $\psi_o \downarrow$



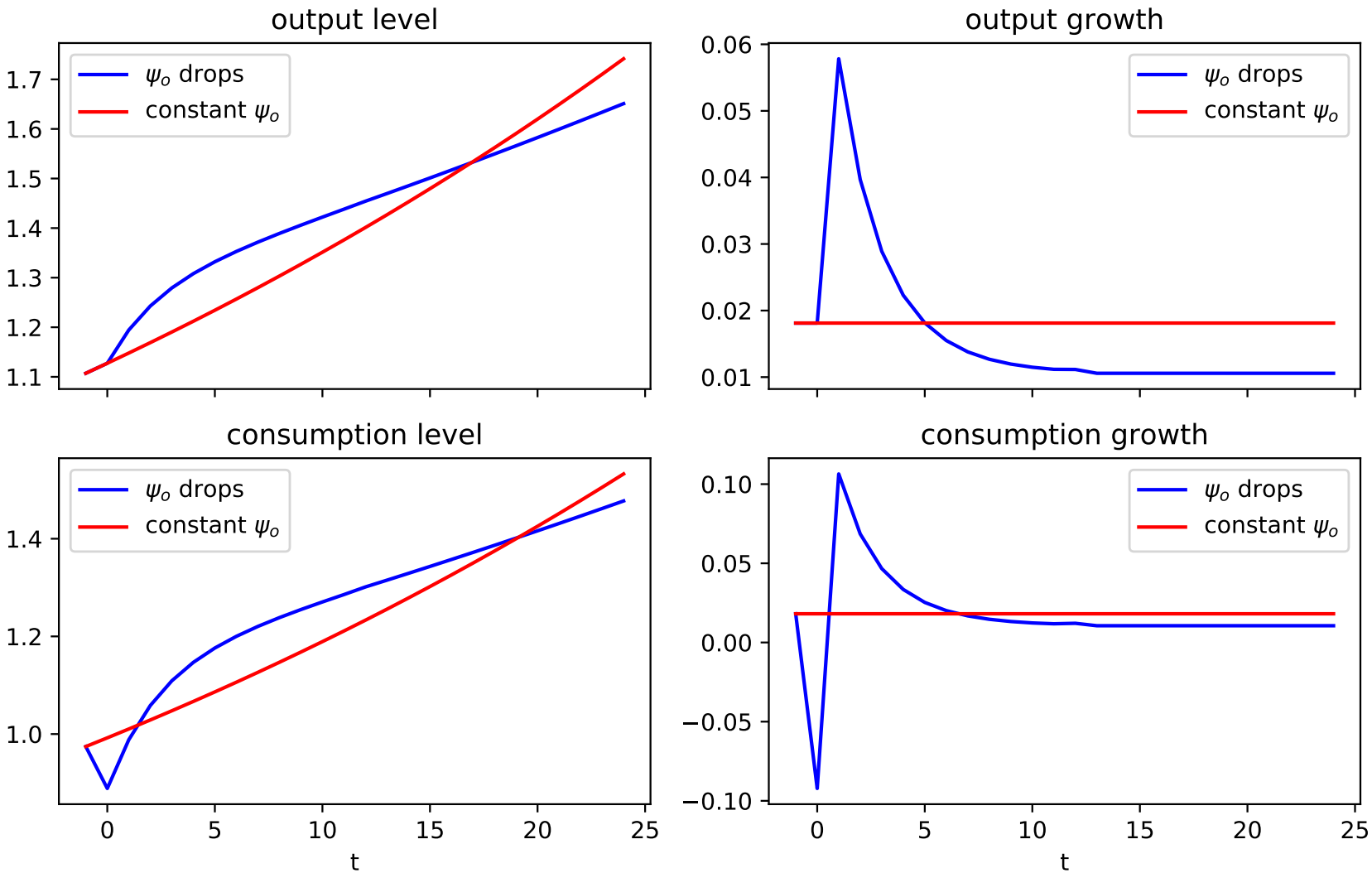


Labor share & markup after $\psi_o \downarrow$





Output and consumption: $\psi_o \downarrow$ vs. no decline



Welfare

Utility from a consumption path:

$$U(\{C_t\}_{t=0}^{\infty}) = \sum_{t=0}^{\infty} \beta^t \ln C_t$$

Consumption equivalence λ

$$U(\{(1+\lambda)C_t^{old}\}_t) = \frac{\ln(1+\lambda)}{1-\beta} + U(\{C_t^{old}\}_t) = U(\{C_t^{new}\}_t)$$

$\lambda = -5.1\%$ i.e. ψ_o decline *reduced* welfare

Changing other parameters

Moment	Data	$\psi_o \downarrow$	$\Delta \uparrow$	$\gamma \downarrow$	$\psi_c \uparrow$
labor share	$\downarrow$	$\downarrow$	$\uparrow$	$\uparrow$	$\leftrightarrow$
within	$\uparrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\leftrightarrow$
between	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\leftrightarrow$
concentration	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$	$\leftrightarrow$
growth	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\downarrow$
rent	?	$\uparrow$	$\downarrow$	$\downarrow$	$\downarrow$

How our story is distinct

Closest papers in the literature:

- Akcigit and Ates (2019)
- Liu, Mian and Sufi (2019)

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

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

Theory allows us to analyze the consequences of alternative comparative statics through firm composition.