Quantifying Market Power

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Richmond Fed
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Motivation

Summary of facts: rise of markups

Understanding Causes and Consequences:

1. Causes:
    - Market Structure: M&A, antitrust enforcement (e.g. ABInbev)
    - Technology: fixed cost and productivity shocks (Amazon Paradox)
2. Consequences: secular trends
    - Wage Stagnation & Labor Force Participation decline
    - Labor Share decline
    - Decline in Business Dynamism
    - Superstar firms: reallocation of sales towards high markup, large firms

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$\Rightarrow$ General Equilibrium framework w/ Imperfect competition output mkt

Facts about Market Power

Estimating markups

- Cost based method
- Use accounting data 1955–2016
- Estimate production function (output elasticity):
- From firm's FOC for cost minimization:

$$\mu_{it} = \theta_{it}^{V} \frac{P_{it} Q_{it}}{P_{it}^{V} V_{it}}.$$

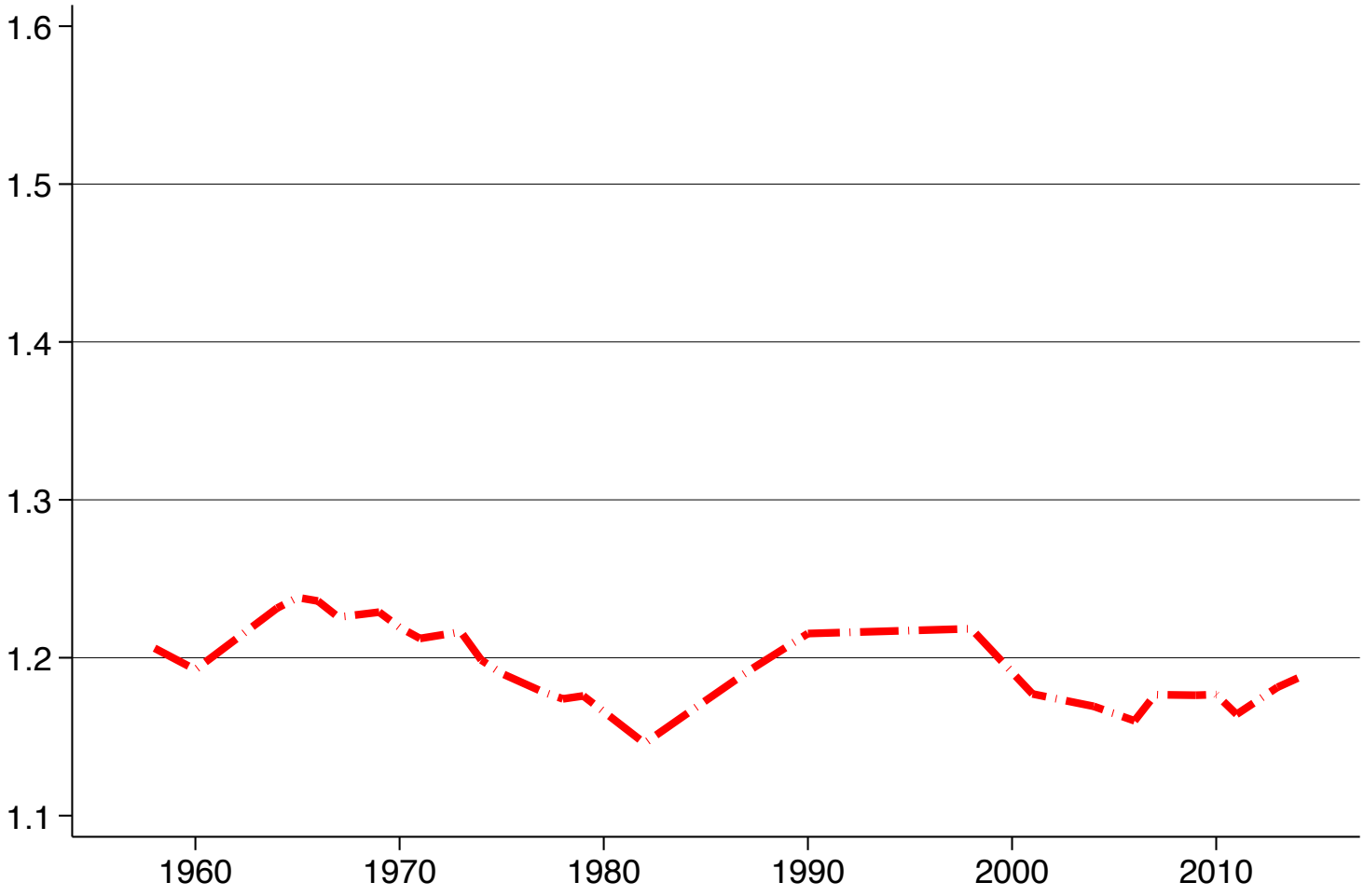
- Individual Markup $\Rightarrow$ distribution for markups
- Average markup, weighted by m_{it} (sales, costs, employment,...):

$$\mu_t = \sum_i m_{it} \mu_{it}$$

- With fixed costs: calculate profit rate (distribution)

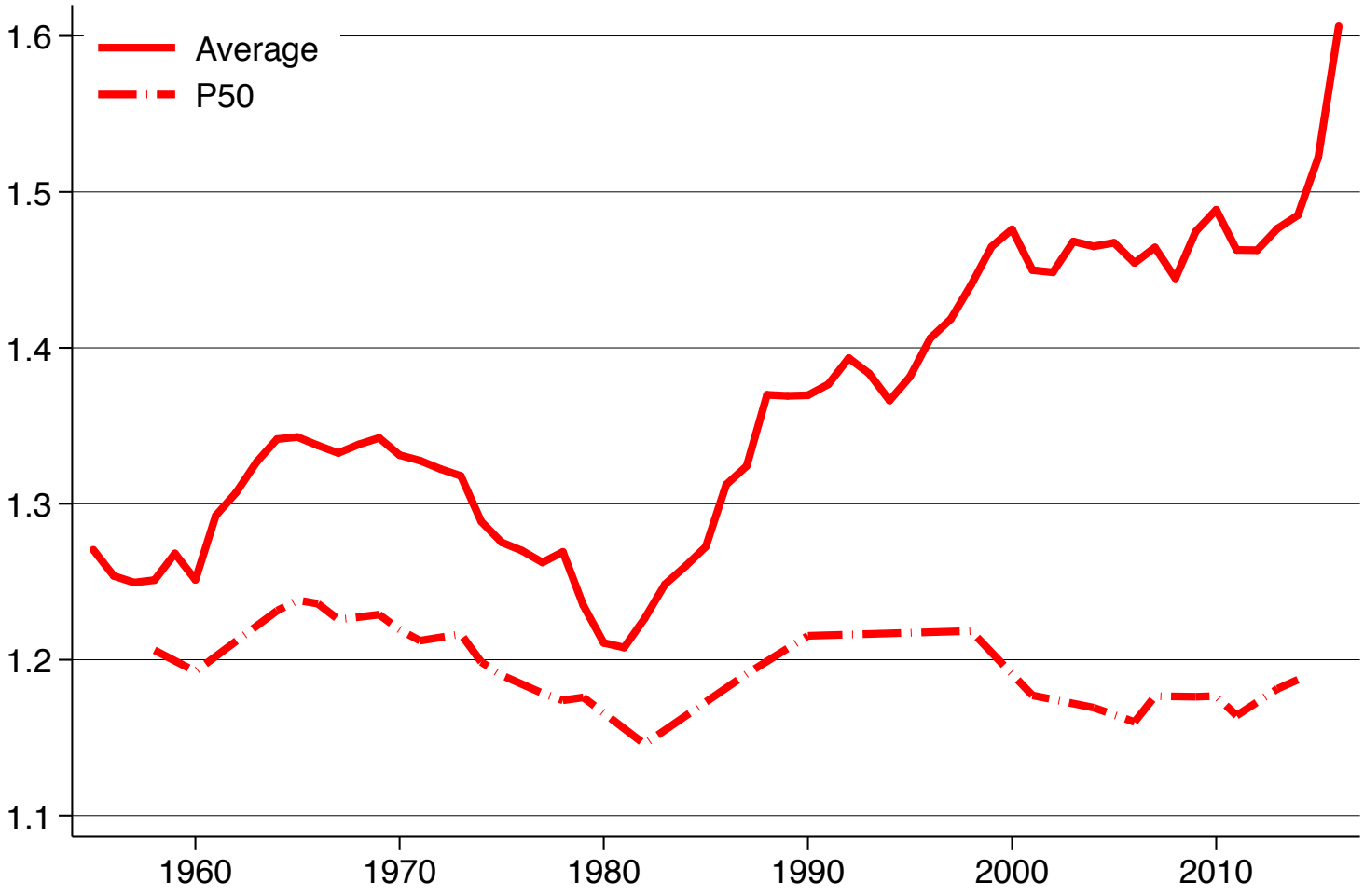
1. Heterogeneity

No Change... in median markup



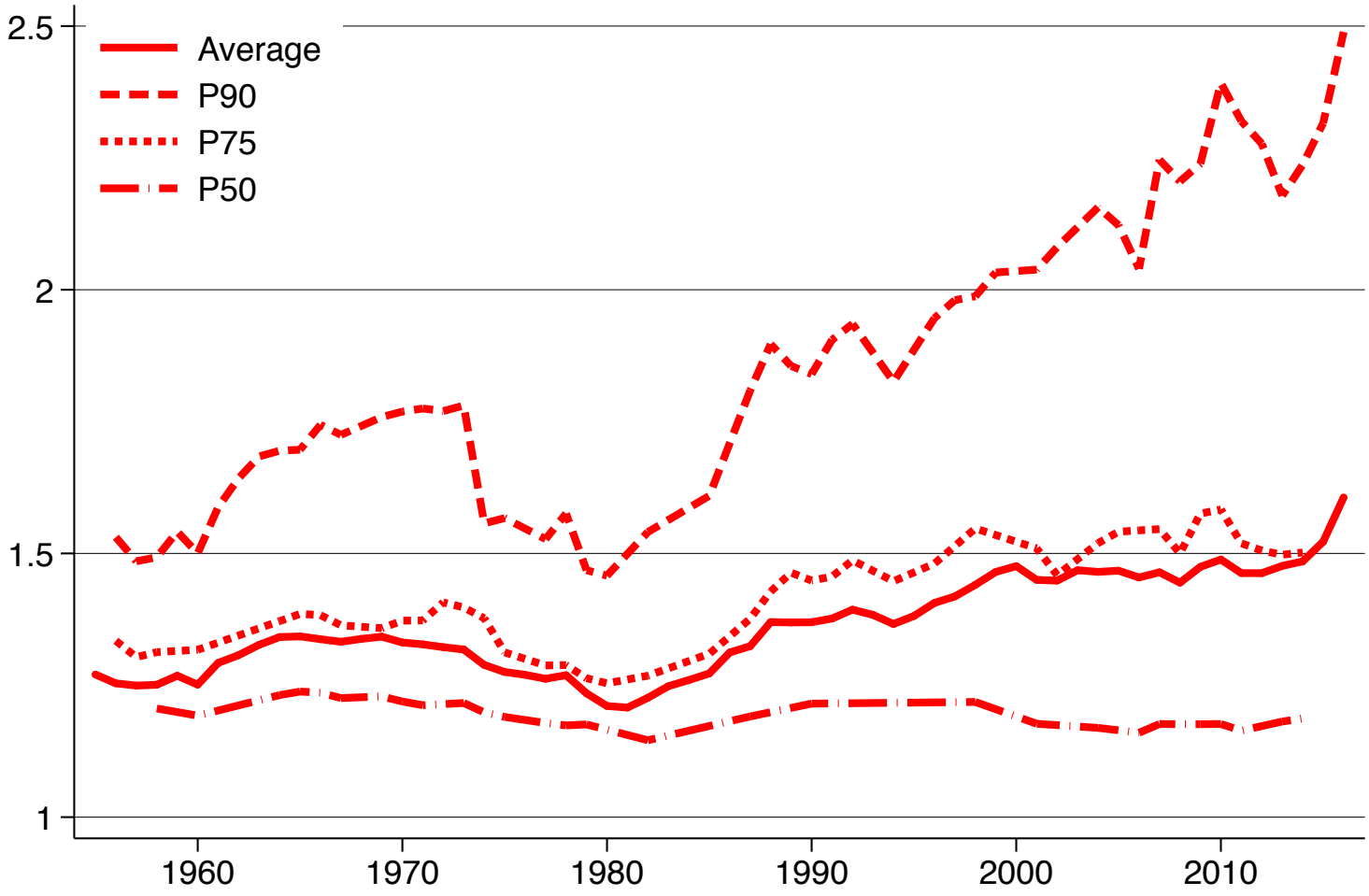
1. Heterogeneity

Increase in Average Markup since 1980



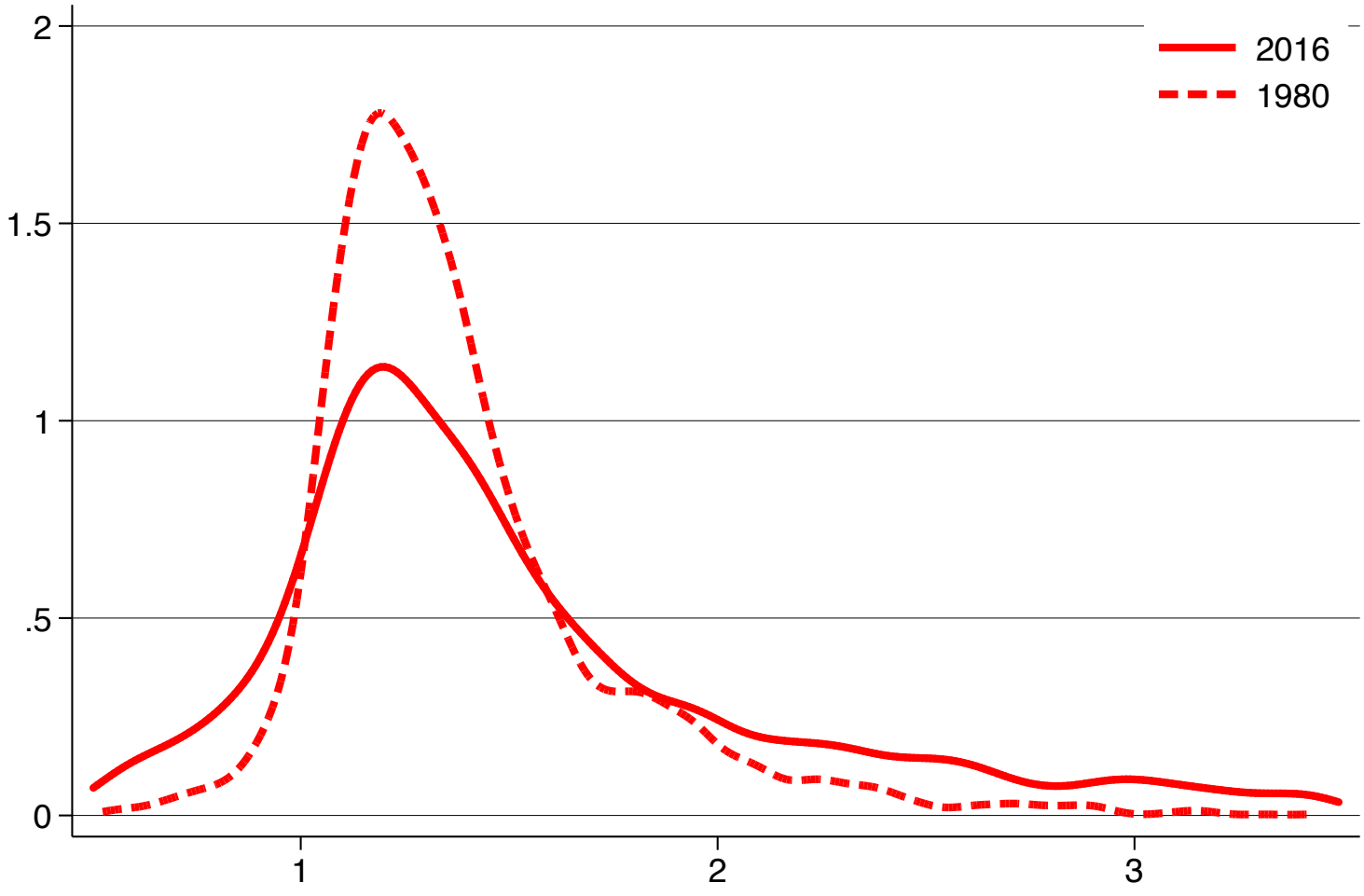
1. Heterogeneity

All Action in Upper Half Distribution



1. Heterogeneity

Kernel Density 1980, 2016

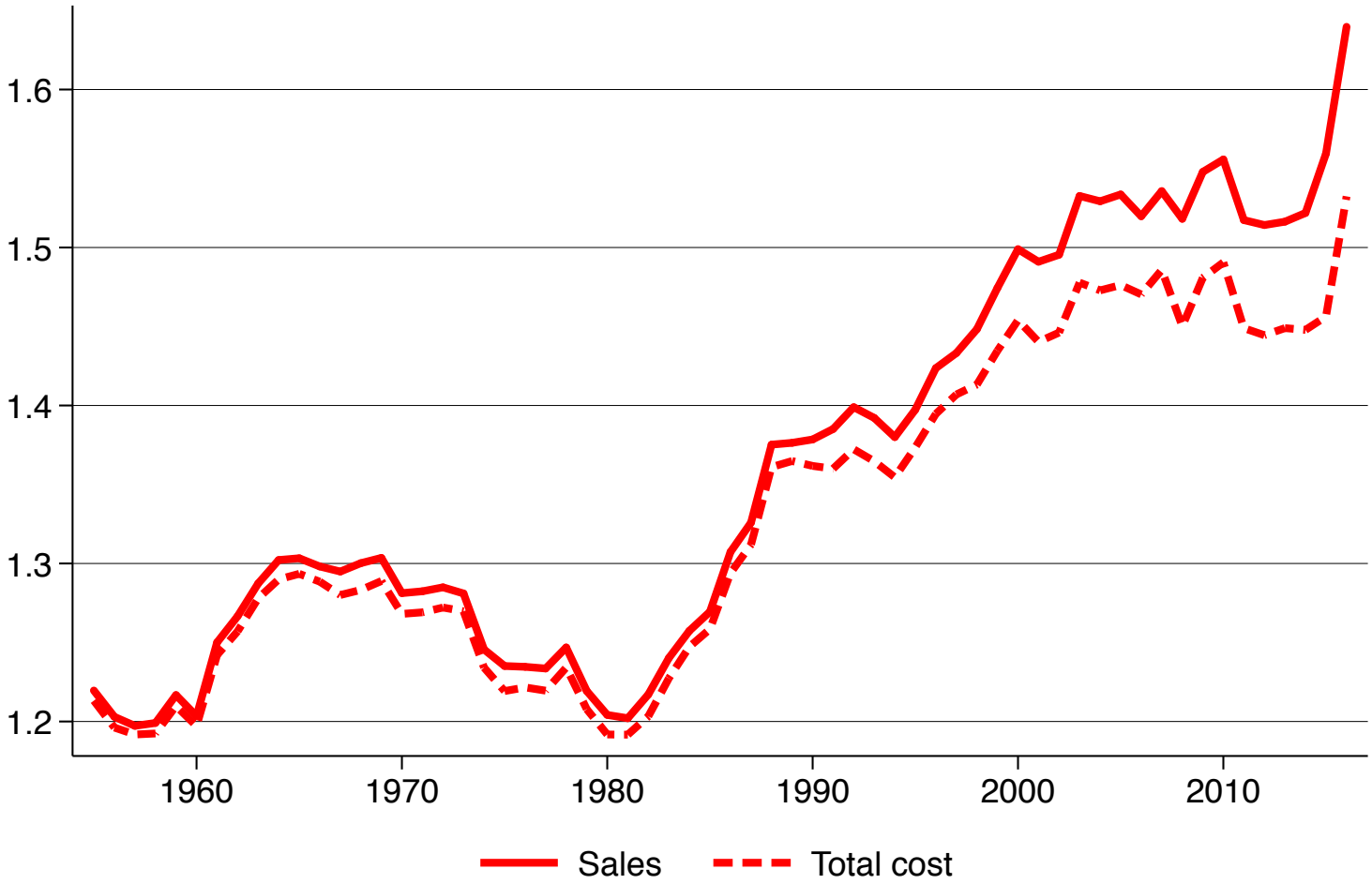


Facts

1. Heterogeneity: sharp rise for few firms; no rise for most

2. Reallocation

Weighting Matters: Input Weight



- See Edmond, Midrigan and Xu (2018)

2. Reallocation

$$\Delta\mu_t = \underbrace{\sum_i m_{i,t-1}\Delta\mu_{it}}_{\Delta \text{ within}} + \underbrace{\sum_i \mu_{i,t-1}\Delta m_{i,t}}_{\Delta \text{ market share}} + \underbrace{\sum_i \Delta\mu_{i,t}\Delta m_{i,t}}_{\Delta \text{ cross-term}}$$
$$+ \underbrace{\sum_{i\in\text{Entry}} \mu_{i,t}m_{i,t} - \sum_{i\in\text{Exit}} \mu_{i,t-1}m_{i,t-1}}_{\text{net entry}}$$

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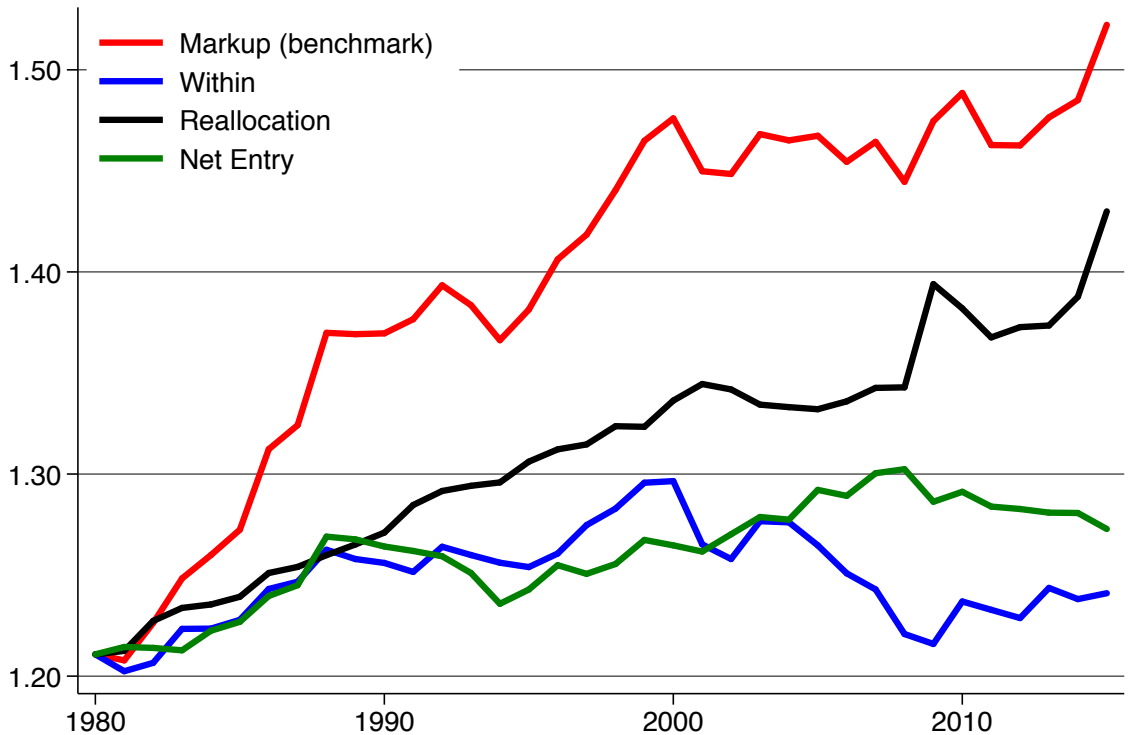


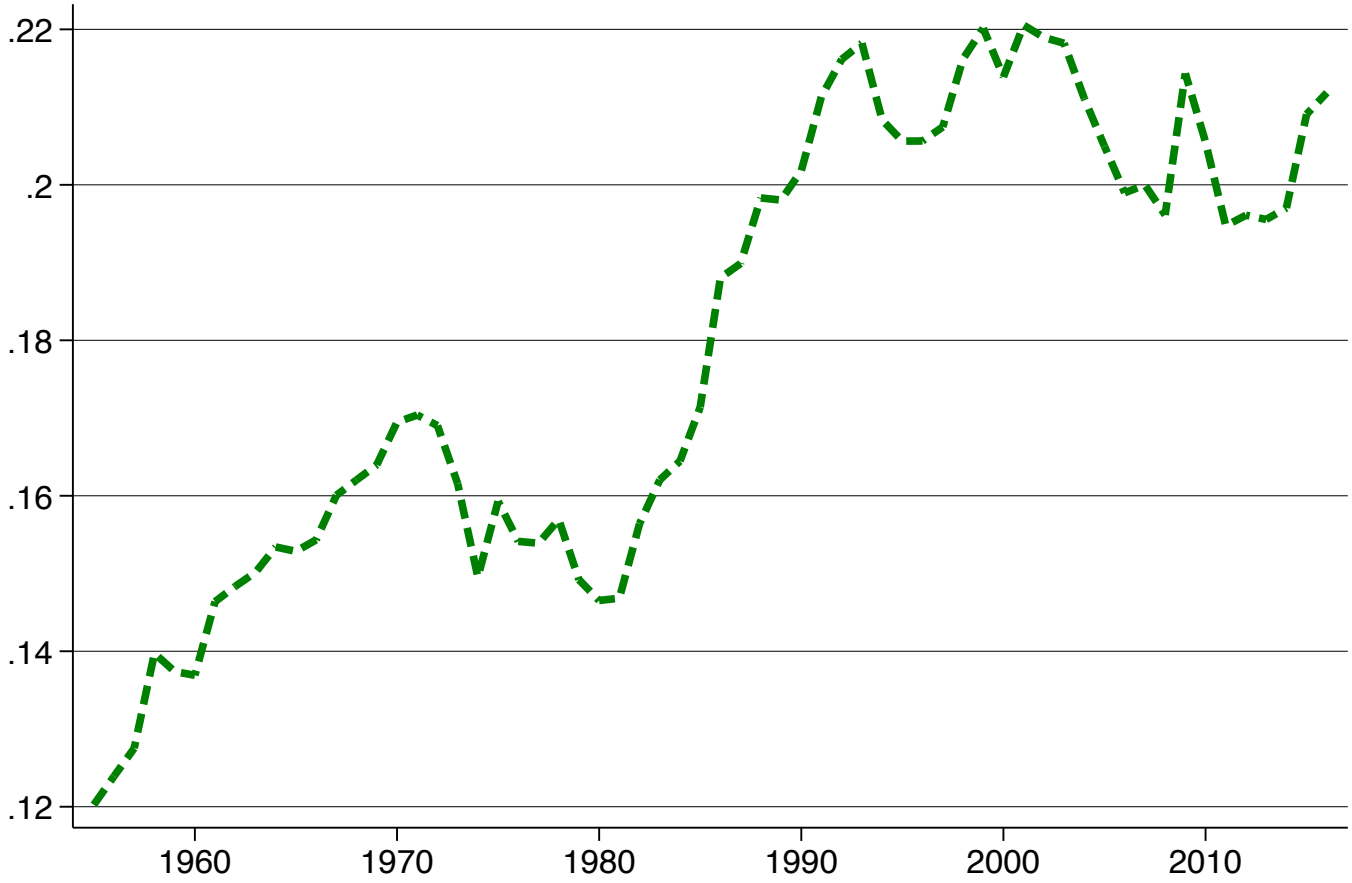
See also Superstar Firms (Autor, Dorn, Katz, Patterson, Van Reenen (2018))

Facts

1. Heterogeneity: sharp rise for few firms; no rise for most
2. Reallocation of sales from low to high markup firms (2/3)

3. Technology Matters

Rise in Overhead (SG&A)



3. Technology Matters

Markups, Profits and SG&A

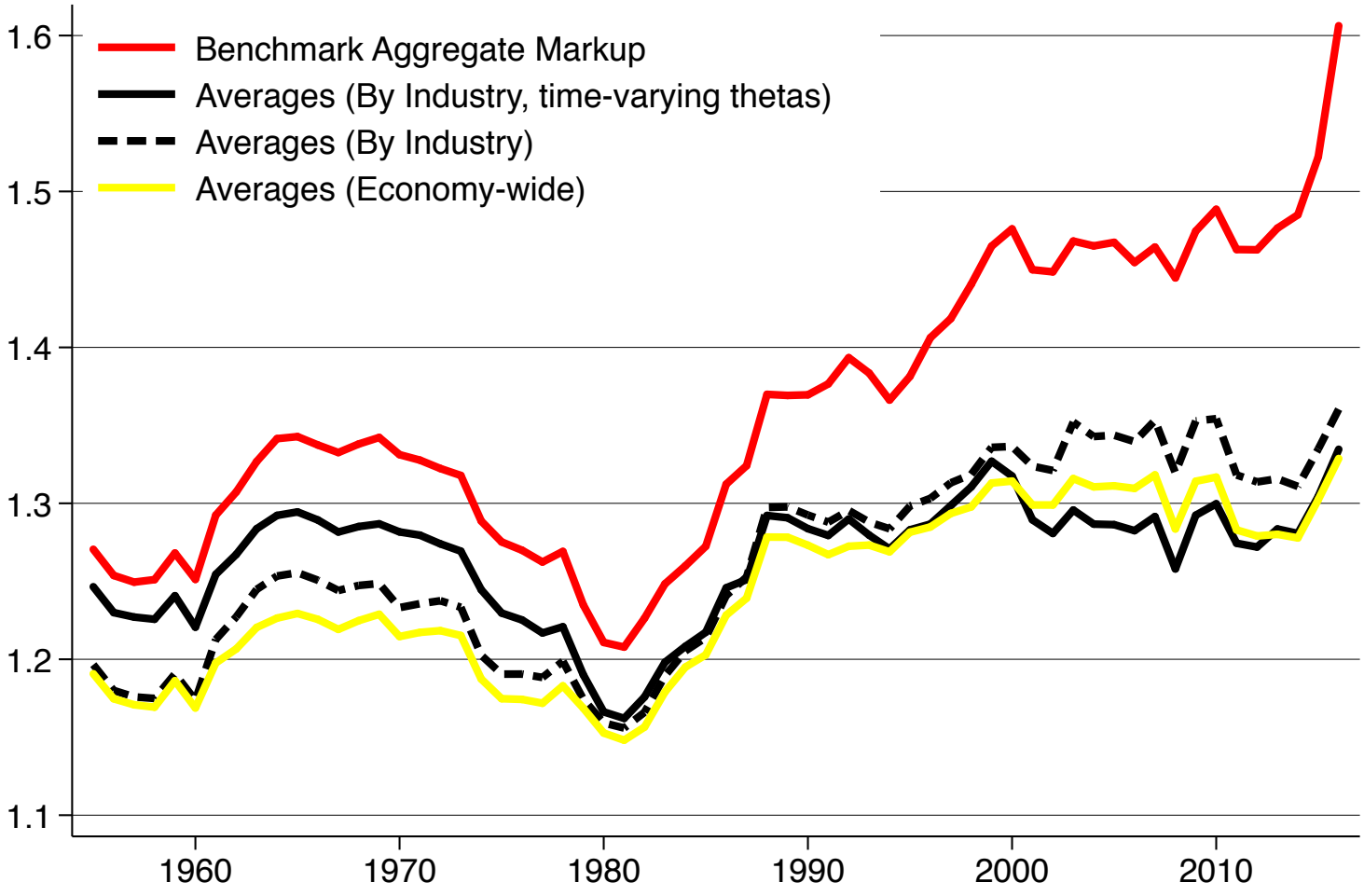
	Markup (log)			Profit Rate (log)	
	(1)	(2)	(3)	(4)	(5)
SG&A (log)	0.56			0.15	
	(0.01)			(0.03)	
R&D Exp. (log)		0.16			0.10
		(0.01)			(0.01)
Advertising Exp. (log)		0.05			0.03
		(0.00)			(0.01)
R&D dummy			0.06		
			(0.01)		
Advertising dummy			-0.00		
			(0.03)		
R^2	0.61	0.07	0.43	0.04	0.05
N	26,743		247,615	26,743	

Facts

1. Heterogeneity: sharp rise for few firms; no rise for most
2. Reallocation of sales from low to high markup firms (2/3)
3. Technology Matters: Overhead cost (SG&A) $\uparrow$

4. Magnitude of Increase

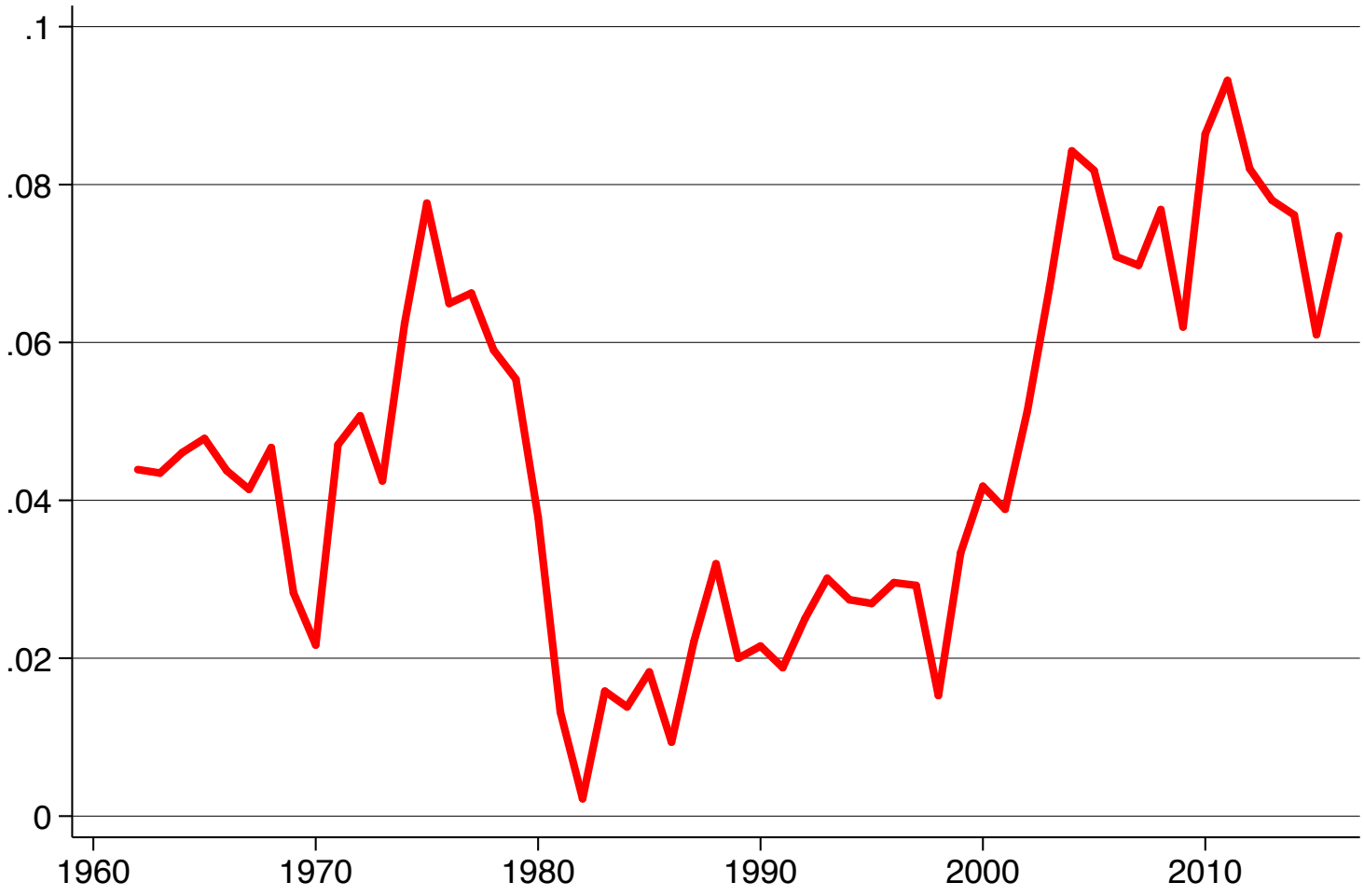
a. Aggregation: Industry Averages: +20 points



- See also Hall (2018)

4. Magnitude of Increase

b. Profit Rate: +7-8 ppt



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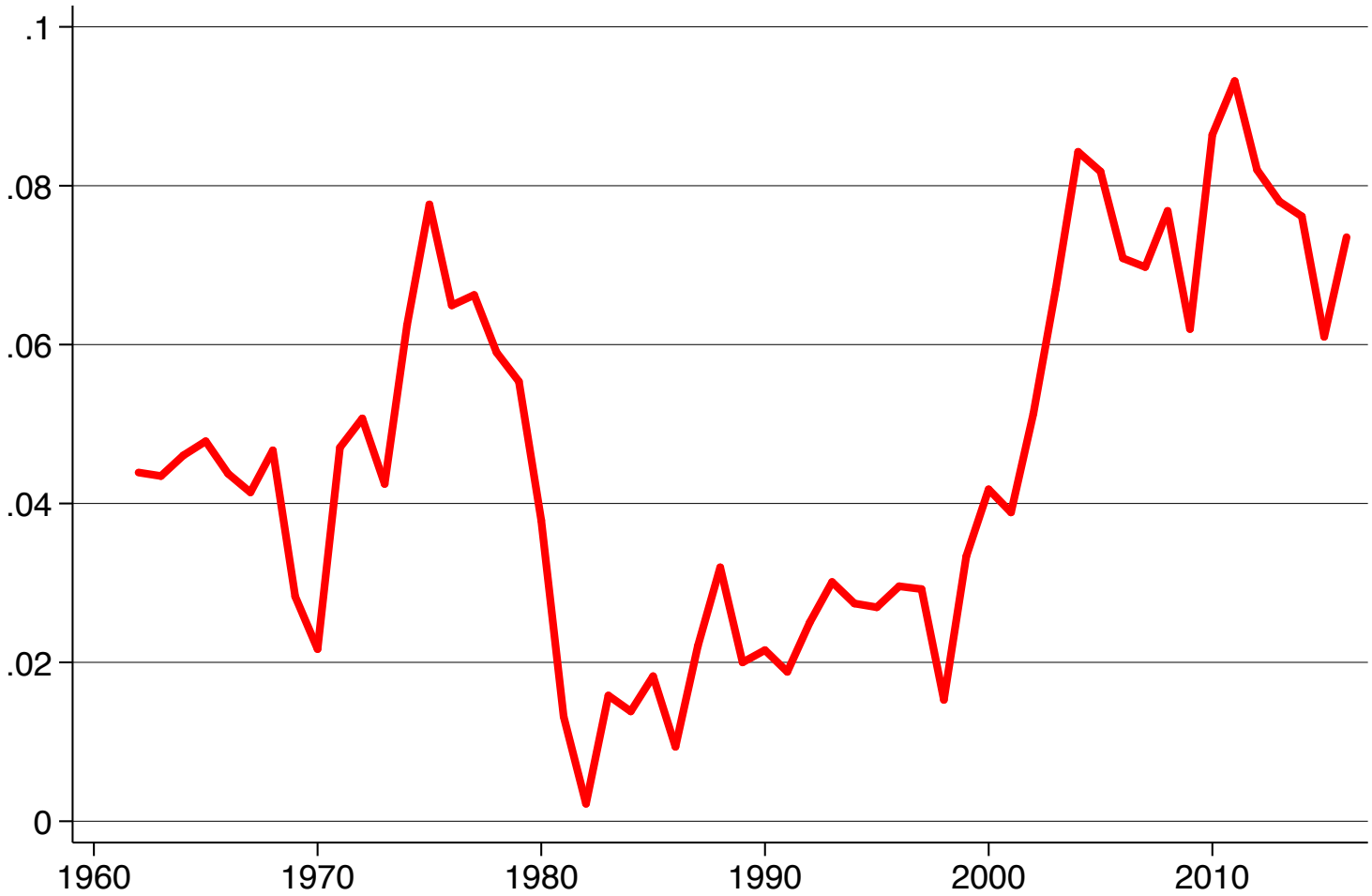

- Profits/Value Added: +15%
- Similar for operating profits (= measure by James Traina (2018))

4. Magnitude of Increase

Profit Rate vs Markup

- The profit rate:

$$\pi = \frac{PQ - C(Q)}{PQ} = 1 - \frac{1}{\mu}\frac{AC}{MC}$$

$\Rightarrow$ With $\mu = 1.6$ in 2016, implied profit rate is $\pi = 1 - \frac{1}{1.61} = 0.38$!!

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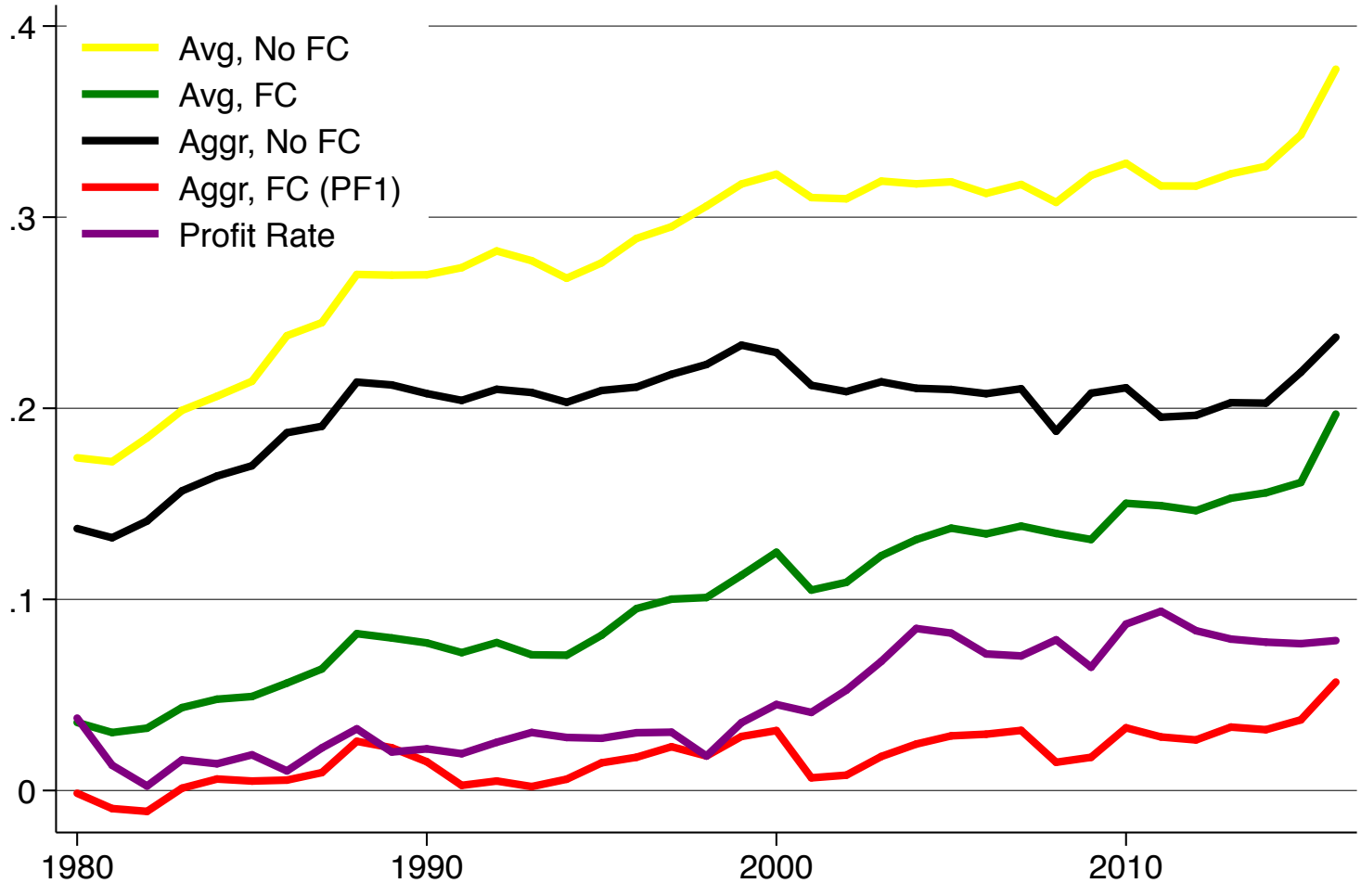
  $\Rightarrow$ With $\mu = 1.6$ in 2016, implied profit rate is $\pi = 1 - \frac{1}{1.61} = 0.38$!!

- This logic uses:
  1. Representative Firm Economy: but Aggregation (Jensen's Inequality)
  2. Unchanged economies of scale ($AC = MC$): but $\frac{AC}{MC} \uparrow$ (Overhead $\uparrow$)

4. Magnitude of Increase

Profit Rate vs Markup



Facts

1. Heterogeneity: sharp rise for few firms; no rise for most
2. Reallocation of sales from low to high markup firms (2/3)
3. Technology Matters: Overhead cost (SG&A) $\uparrow$
4. Magnitude of the Increase?
   - A Weighting and Aggregation is crucial
   - B Profit rate (+7-8 ppts) $\neq$ Markup (+30-40 points)

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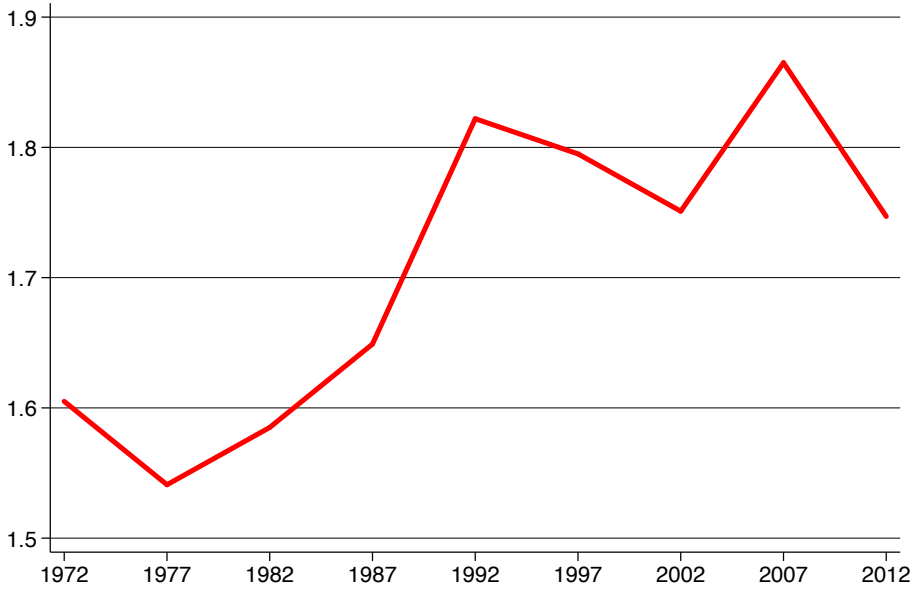
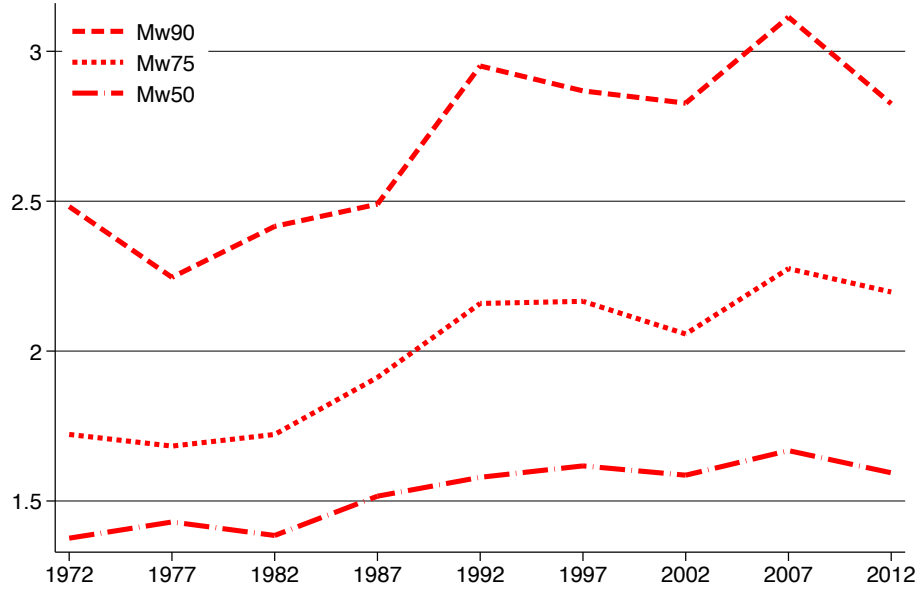
$\therefore$ Only publicly traded firms (40% of GDP)

Robustness: US Censuses

Manufacturing





Global Markup

134 countries; 70,000 firms; 1980-2016

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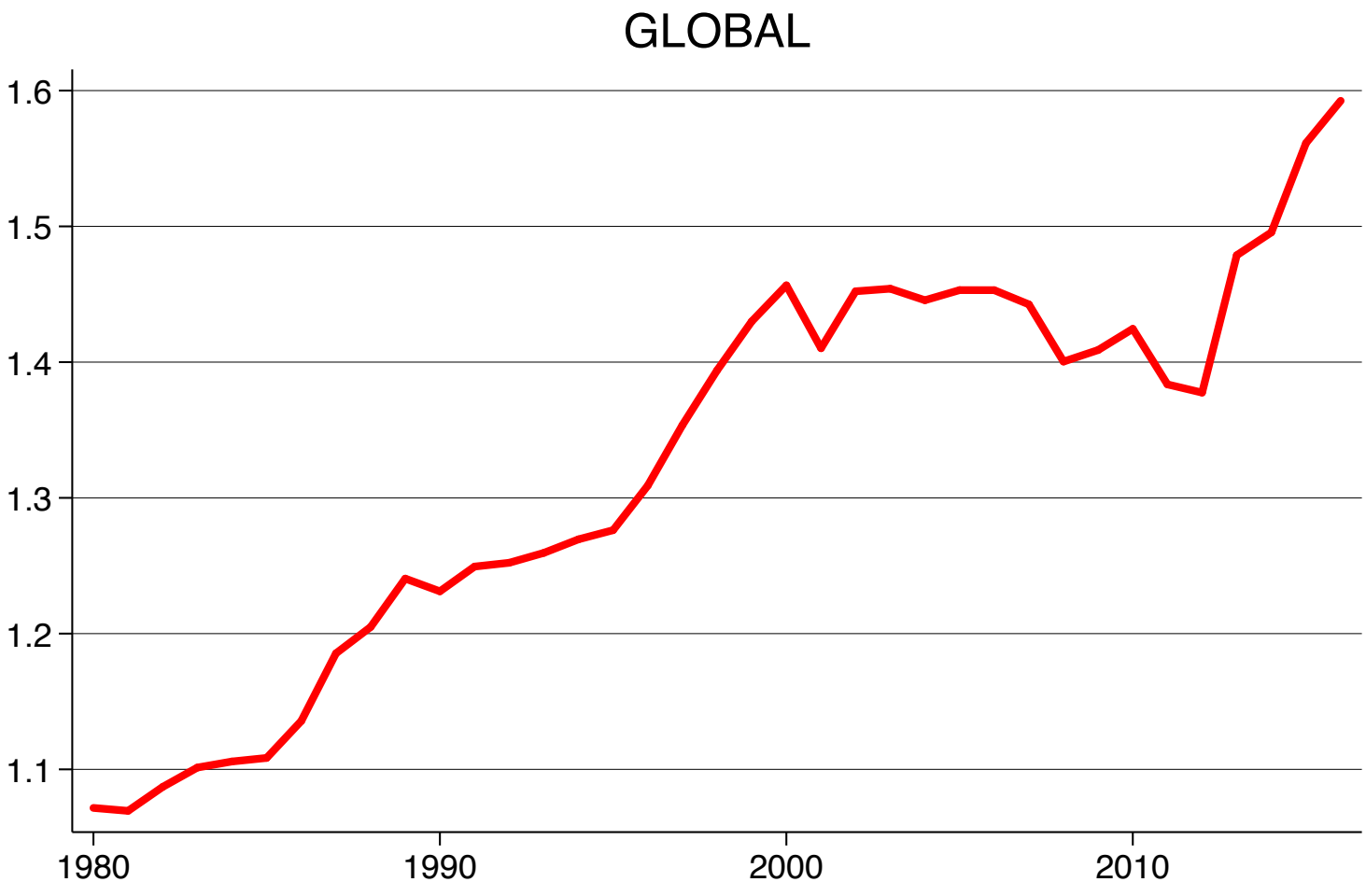

Market Power in GE:

Causes and Consequences

GE Model of Market Power

1. Model
   - Build on Atekson Burstein (2008)
   - New: Overhead, shocks, endogenous market structure and free entry
2. Causes
   - Technology: Fixed costs, Dispersion of shocks (Amazon paradox)
   - Market Structure: Potential entrants (M&A and antitrust)
3. Estimate SMM
   - Match Moments: Markups, Profit rates, Reallocation
   - Non-targeted Moments: Wages, LF participation, Labor Share, TFPR
4. Experiments
   - Match time series of non-targeted moments
   - Decompose changes: Technology vs. Market Structure

Model Setup

- J sectors; N_j firms in each sector; M potential entrants
- Household Pref.: nested CES, elasticity η within sector, θ between
- Market Structure:
  1. Cournot (or differentiated Bertrand) within sector
  2. Entry at fixed cost ϕ ("sequential"; Berry (1982))
- Firm's (static) optimization:
  1. Draw random productivity: fixed and variable component $a + z$
  2. Entry decision b_{ijt}
  3. Choose employment l_{ijt}

Model Limitations

Our model does not have:

- Dynamic pricing: Edmond, Midrigan, Xu (2018); Mongey (2018)
- Investment in productivity: Sutton (1993, 1998)
- Skill/Consumer heterogeneity
- Monopsony: Berger, Herkenhoff, Mongey (2019); Azar, Marinescu, Steinbaum (2018)
- Change in preferences/demand/globalization: Jaimovic, Rebelo, Wang (2018); Bornstein (2019)

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- Change in preferences/demand/globalization: Jaimovic, Rebelo, Wang (2018); Bornstein (2019) – globalization $\approx$ technological change

Model Setup

Households

$$\max_{\{c_{ijt},l_{ijt}\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U\left(\left(\frac{1}{J_t}\right)^{\frac{1}{\theta-1}}\left[\sum_{j=1}^{J} c_{jt}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}\right)$$

$$\text{where} \quad c_{jt} = \left(\frac{1}{N_{jt}}\right)^{\frac{1}{\eta-1}}\left[\sum_{i=1}^{M} b_{ijt}\, c_{ijt}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

$$\text{s.t.} \quad \sum_{j=1}^{J}\sum_{i=1}^{M} b_{ijt}\, p_{ijt}\, c_{ijt} = W_t L_t + \Pi_t$$

$$L_t = \sum_{j=1}^{J}\sum_{i=1}^{M} b_{ijt}\, l_{ijt} + \sum_{j=1}^{J} N_{jt}\phi$$

$$N_{jt} = \sum_{i=1}^{M} b_{ijt} \quad \text{and} \quad J_t = \sum_{j=1}^{J} N_{jt}$$

Model Setup

Firms

- Firm $i \in \{1, \ldots, M\}$ in sector $j \in \{1, \ldots, J\}$;
  $b \in \{0, 1\}$ entry decision $\Rightarrow N_j \leq M$

$$\pi_{ijt} = \max_{b_{ijt}, y_{ijt}} \quad b_{ijt} \Big[\underbrace{p(y_{ijt}, y_{-ijt}, Y_t) y_{ijt}}_{\text{Sales}} - \underbrace{W_t l_{ijt}}_{\text{Variable costs}} - \underbrace{W_t \phi}_{\text{Overhead}} \Big]$$

$$\log y_{ijt} = \log z_{ijt} + \alpha \log l_{ijt}$$

$$\log z_{ijt+1} = \rho_z \log z_{ijt} + \varepsilon_{ijt}, \quad \varepsilon_{ijt} \sim \mathcal{N}\left(-\frac{1}{2} \frac{\sigma_\varepsilon^2}{1 + \rho_z}, \sigma_\varepsilon^2 \right)$$

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- Demand

$$p_{ijt} = \left(\frac{1}{J_t} \right)^{\frac{1}{\eta}} \left(\frac{1}{N_{jt}} \right)^{\frac{1}{\theta}} \left(\frac{y_{ijt}}{y_{jt}} \right)^{-\frac{1}{\eta}} \left(\frac{y_{jt}}{Y_t} \right)^{-\frac{1}{\theta}}, \quad y_{jt} = \left(\frac{1}{N_{jt}} \right)^{\frac{1}{\eta - 1}} \left[\sum_{i=1}^{N} b_{ijt} y_{ijt}^{\frac{\eta - 1}{\eta}} \right]^{\frac{\eta}{\eta - 1}}$$

- Labor Supply

$$\log L_t = \log \bar{\varphi} + \varphi \log W_t$$

Firm optimality

- Equilibrium demand elasticity

$$
\begin{aligned}
-\frac{d \log p_{ijt}}{d \log y_{ijt}} &= \frac{1}{\eta} + \left(\frac{1}{\theta} - \frac{1}{\eta}\right) \frac{d \log y_{jt}}{d \log y_{ijt}} \\
\frac{1}{\epsilon_{ijt}} &= \frac{1}{\eta} + \left(\frac{1}{\theta} - \frac{1}{\eta}\right) s_{ijt}
\end{aligned}
$$

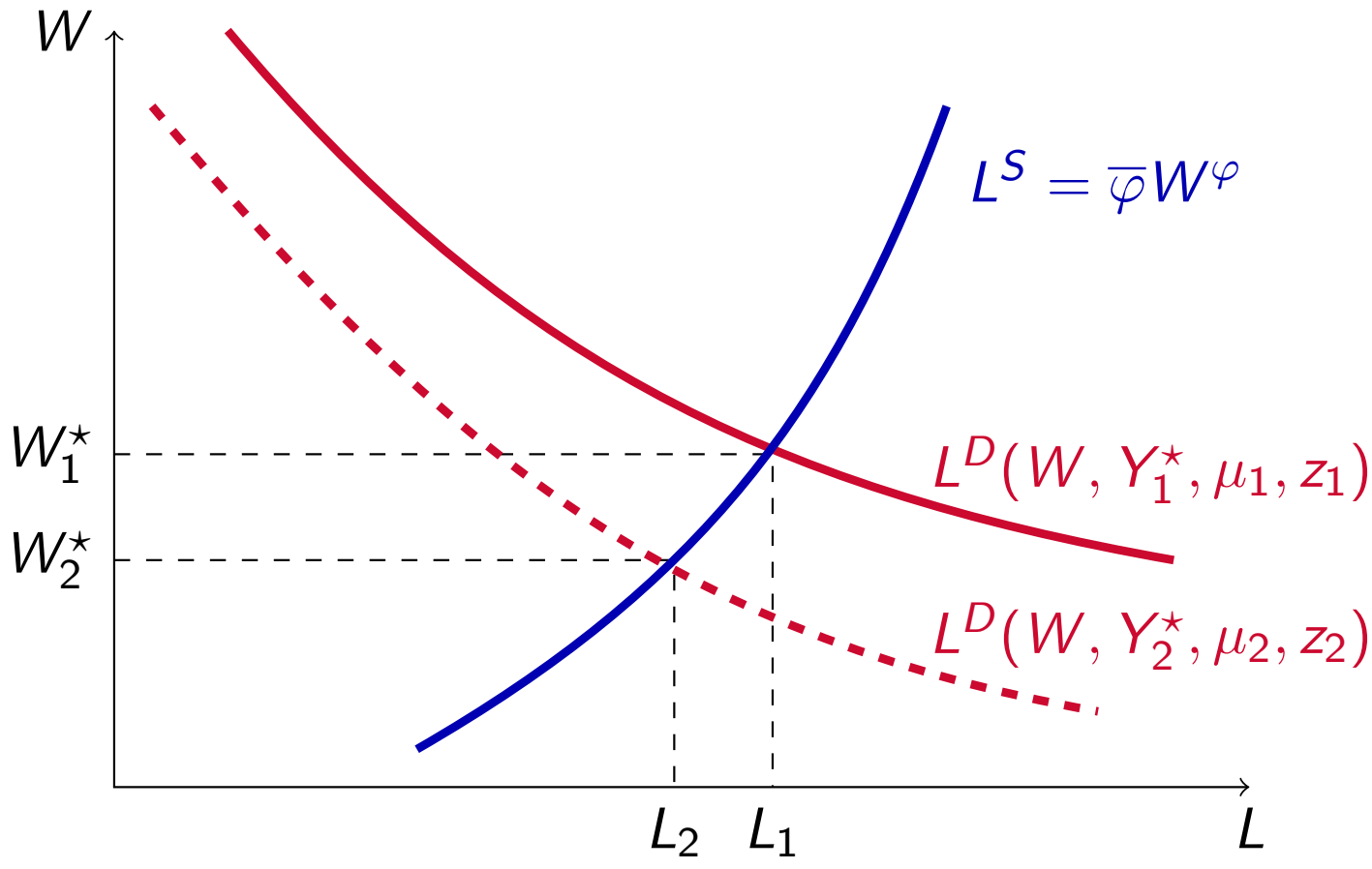
- Markups

$$
\mu(s_{ijt}) = \frac{\epsilon(s_{ijt})}{\epsilon(s_{ijt}) - 1}
$$

- Prices

$$
p_{ijt} = \left[\mu(s_{ijt}) \frac{W}{z_{ijt}} \; s_{ijt}^{\frac{\eta-\theta}{\eta-1}\frac{1-\alpha}{\alpha}} \; Y^{\frac{1-\alpha}{\alpha}} \right]^{\frac{1}{1+\theta\frac{1-\alpha}{\alpha}}}
$$

1. General Equilibrium: $W^\star, L^\star, Y^\star$



- Input markets are competitive, no monopsony power

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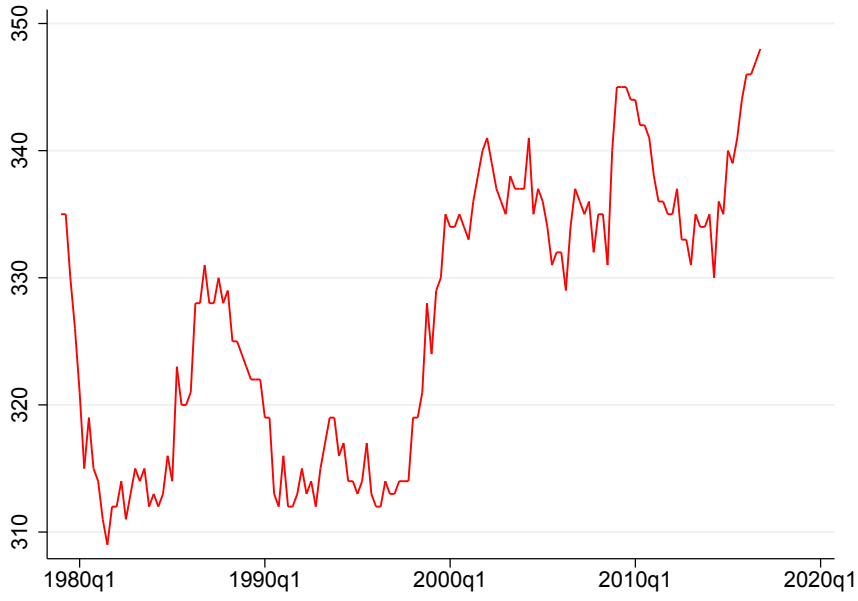

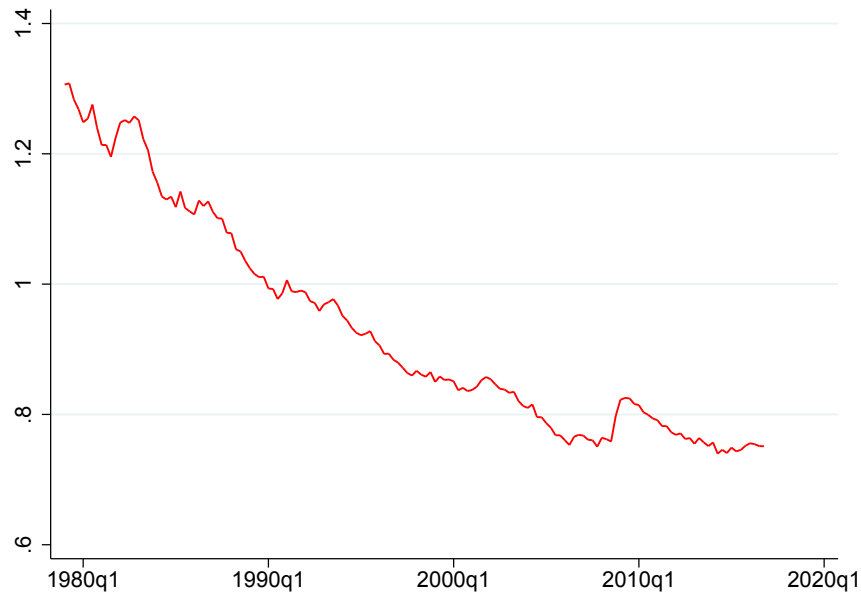

2. Decline in Labor Share

Stylized Fact no more?

- Decline in the aggregate: a.o. Karabarbounis & Neiman (2017)
- At the firm level: effect of markups

$$\mu_i = \theta_i^V \frac{P_i Q_i}{P_i^V V_i} \qquad \overset{V=L}{\Rightarrow} \qquad \frac{WL_i}{S_i} = \frac{\theta_i^L}{\mu_i}$$

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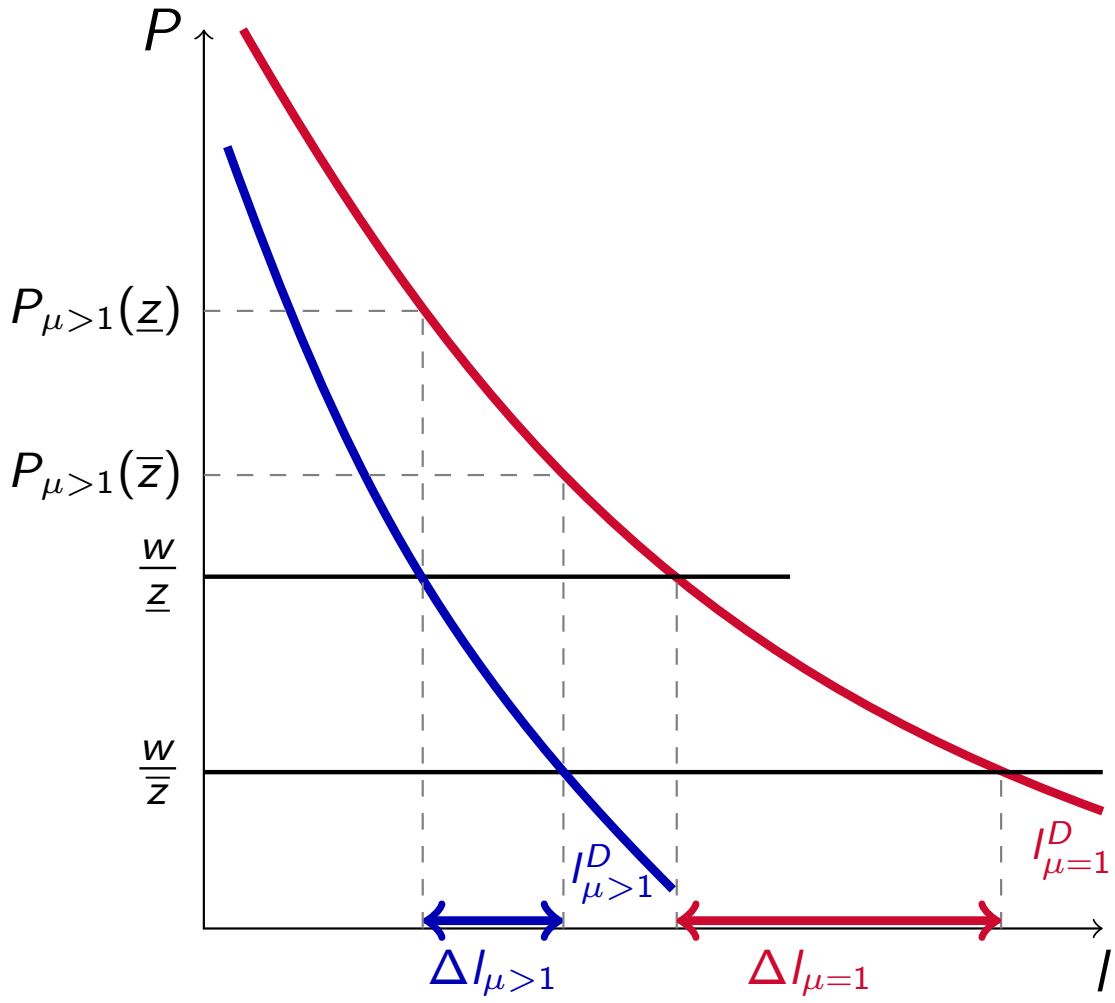
	Labor Share (log)			
	(1)	(2)	(3)	(4)
Markup (log)	-0.24	-0.23	-0.20	-0.24
	(0.03)	(0.03)	(0.03)	(0.03)
Year F.E.		X	X	X
Industry F. E.			X	
Firm F.E.				X
R^2	0.02	0.08	0.21	0.88

3. Decline in labor dynamism



3. Decline in labor dynamism

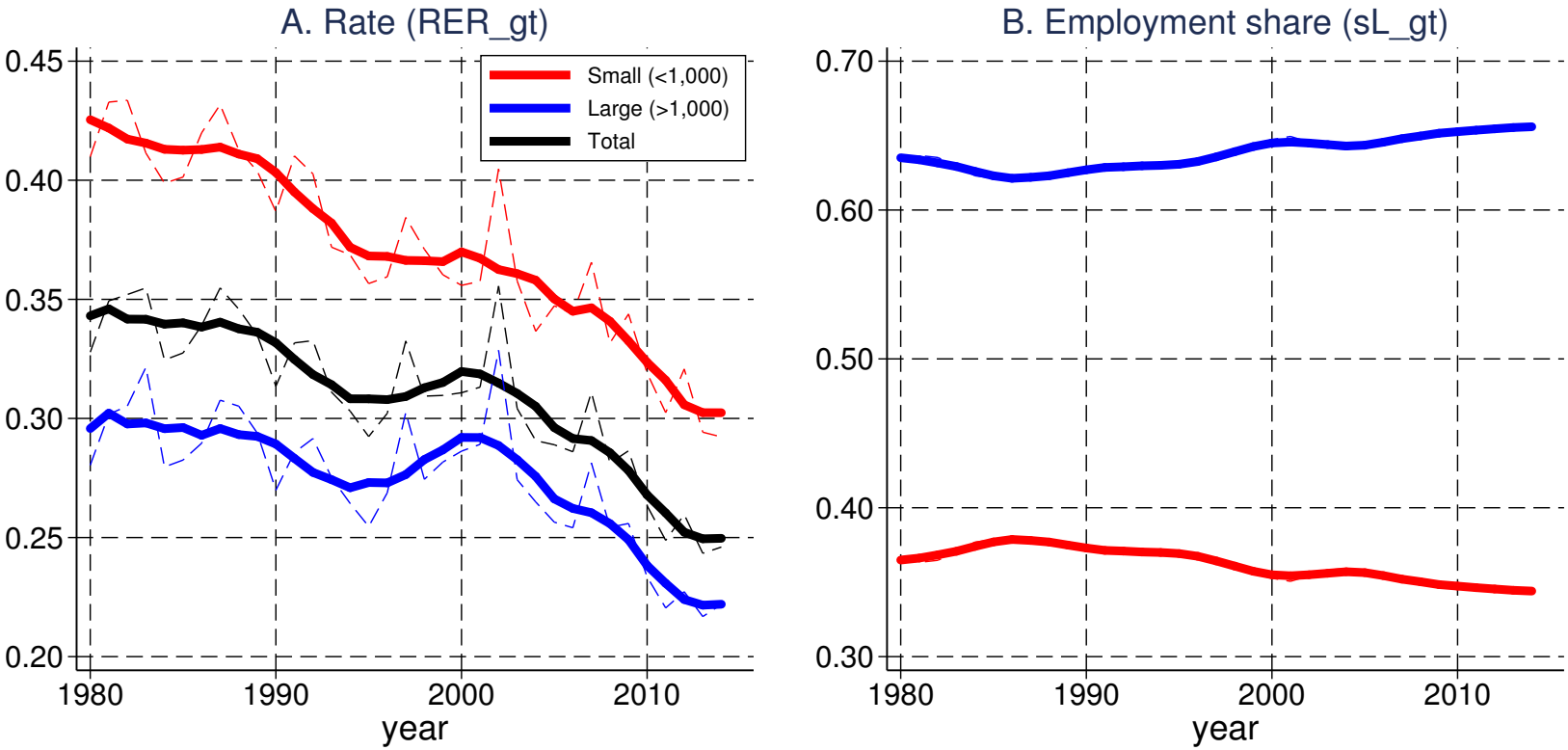
$$\log l_{ijt} = \log y_{ijt} - \log z_{ijt}$$

$$d \log l_{ijt} = \left(\underbrace{\varepsilon(s_{ijt})}_{\frac{\partial \log y_{ijt}}{\partial \log p_{ijt}}} \times \underbrace{\Omega(s_{ijt}; \eta, \theta)}_{\frac{\partial \log p_{ijt}}{\partial \log z_{ijt}}} - 1 \right) d \log z_{ijt}$$

1. Incomplete pass-through reduces volatility $\Omega(s_{ijt}) < 1$
2. Small firms have higher reallocation rates
   (i) Higher $\varepsilon(s_{ijt})$, (ii) Higher pass-through $\Omega(s_{ijt})$
3. If shares increase, reallocation falls by more for small firms
   (i) Greater fall in $\varepsilon(s_{ijt})$, (ii) Greater decline in $\Omega(s_{ijt})$

$\rightarrow$ As in Amiti, Itshkoki, Konings (2018)

3. Decline in labor dynamism

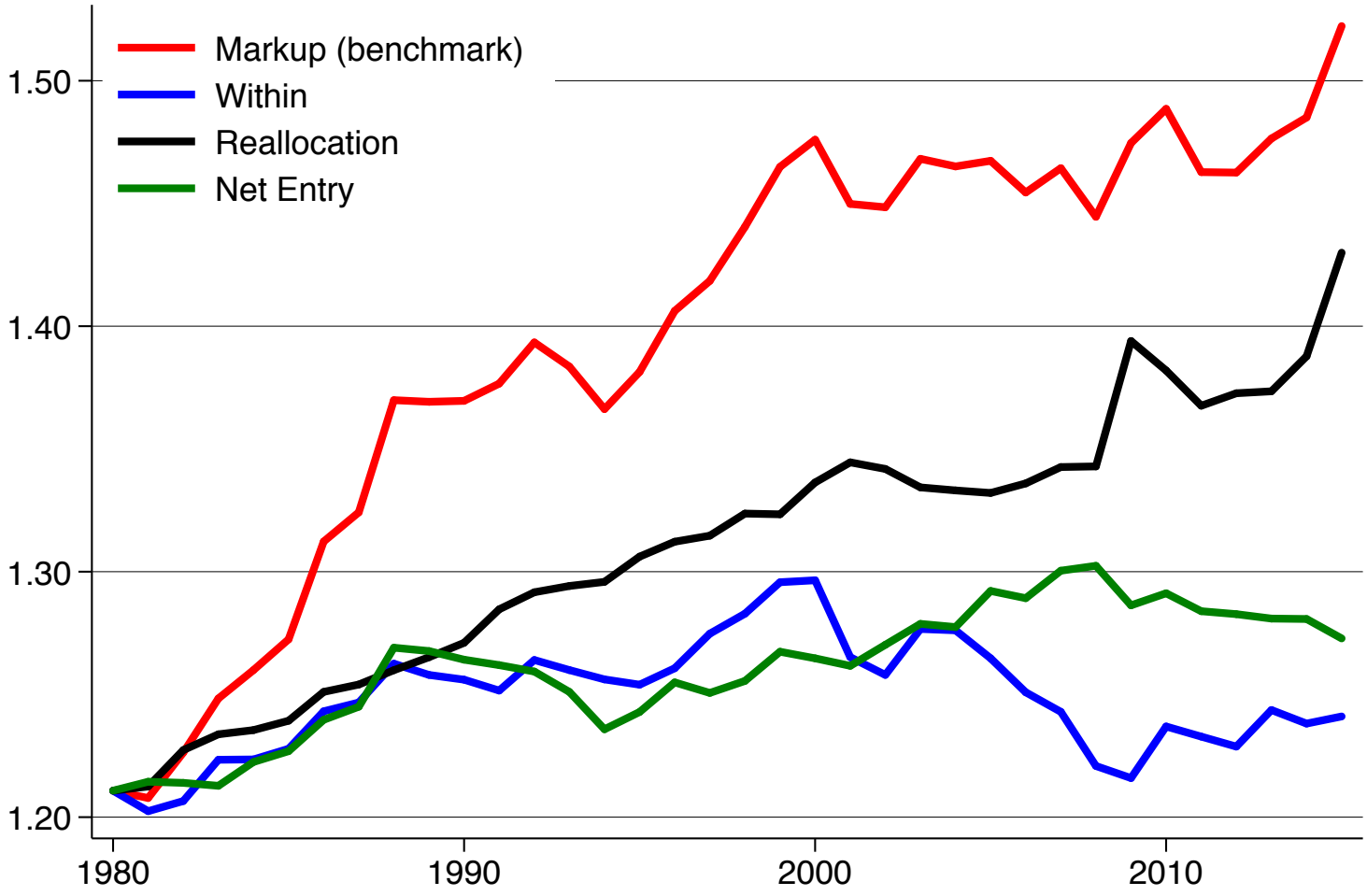


$$RR_t = \sum_{g \in \{Sm, Lg\}} s^L_{gt} RR_{gt} \quad , \quad RR_{gt} = \frac{JC_{gt} + JD_{gt}}{L_{gt}}$$

- 98 percent of ΔRR_t due to $\{\Delta RR_{gt}\}$, 3 percent due to $\{\Delta s^L_{gt}\}$
- 65 percent of ΔRR_t due to smaller firms

4. Reallocation and Superstar Firms

2/3 of rise in average markup



Calibration - Annual

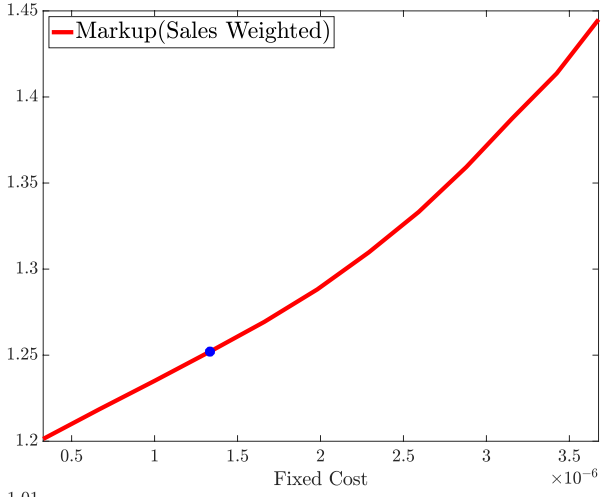
Parameter		
Across sector elasticity	θ	1.5
Within sector elasticity	η	10
Productivity persistence	ρ	0.85
Returns to scale	α	1
Elasticity labor supply	φ	0.25

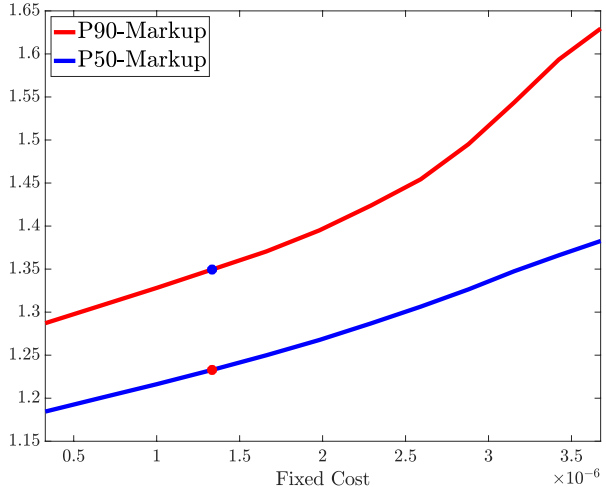
		1980		2016	
Moment		**Model**	**Data**	**Model**	**Data**
Markups	μ	1.25	1.20		
Markup - P90	P90(μ)	1.35	1.45		
Gross Profit Rate	π	0.12	0.12		
Overhead Labor Share	$\frac{L^{OH}}{L}$	0.08	0.08		
Reallocation Rate	RR	0.35	0.31		

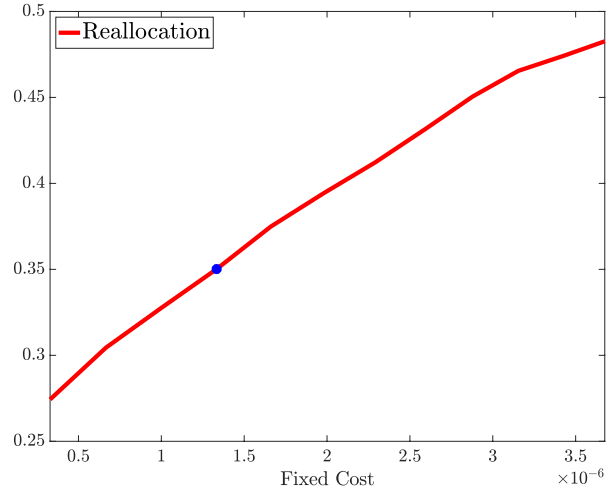
Estimated Parameter		**1980**	**2016**
Potential entrants	M	24	
Fixed Cost	$W\phi$	1.3*	
Productivity shock: temp	σ_ε	0.05	
Productivity shock: perm	σ_a	0.15	
Number of Entrants	N	7	
Welfare	C	1	

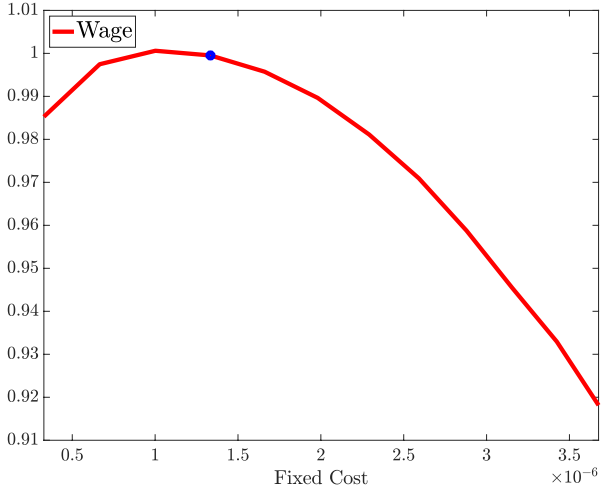
Comparative Statics

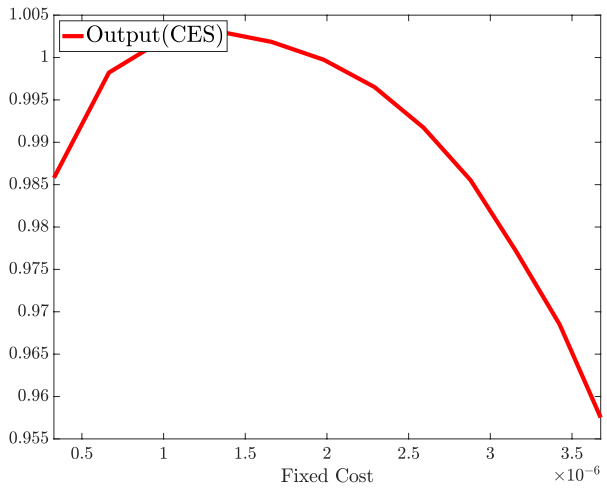
Technology: $W\phi \uparrow$

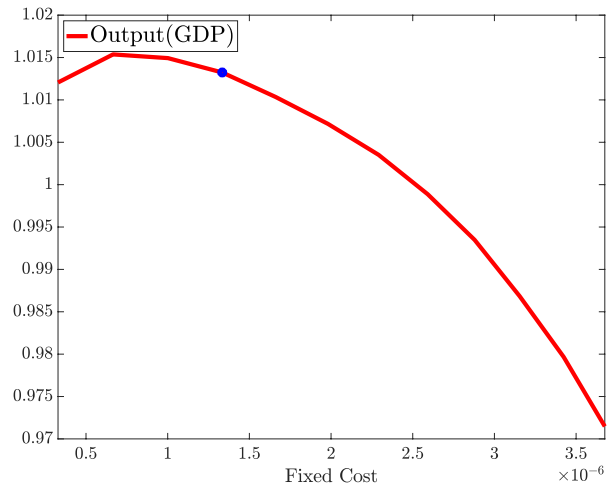






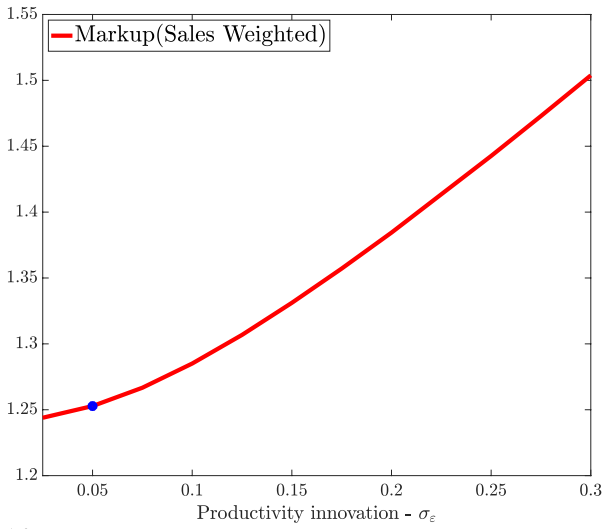


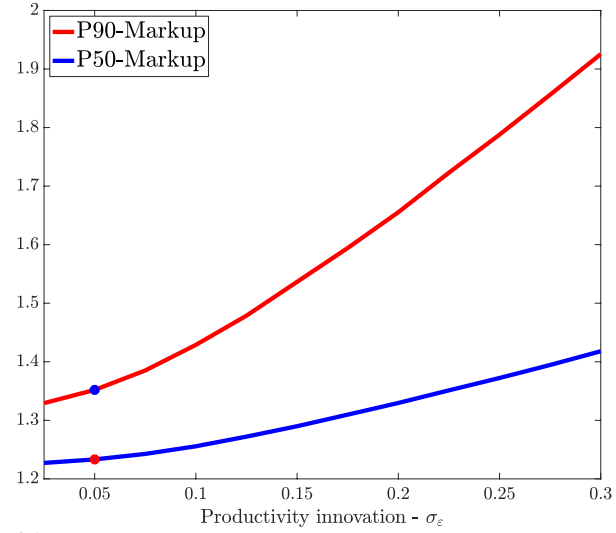


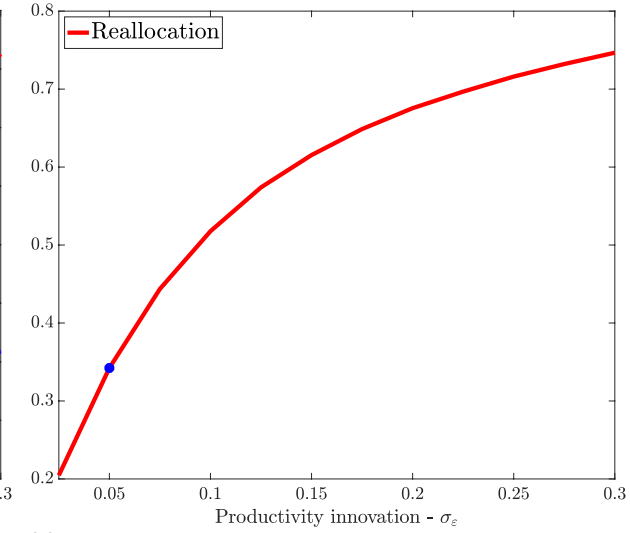


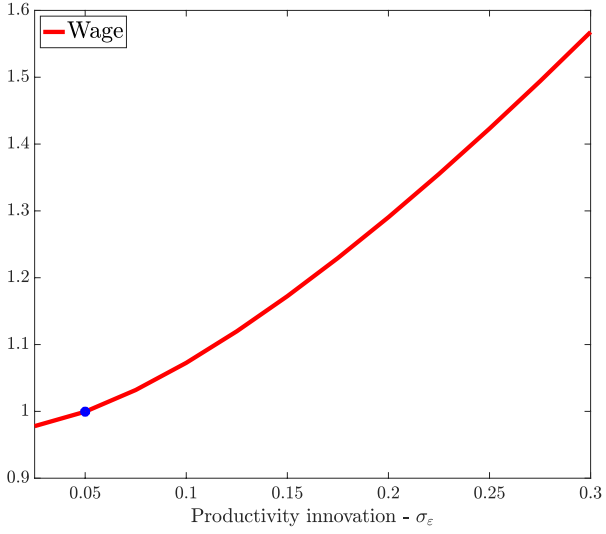
Comparative Statics

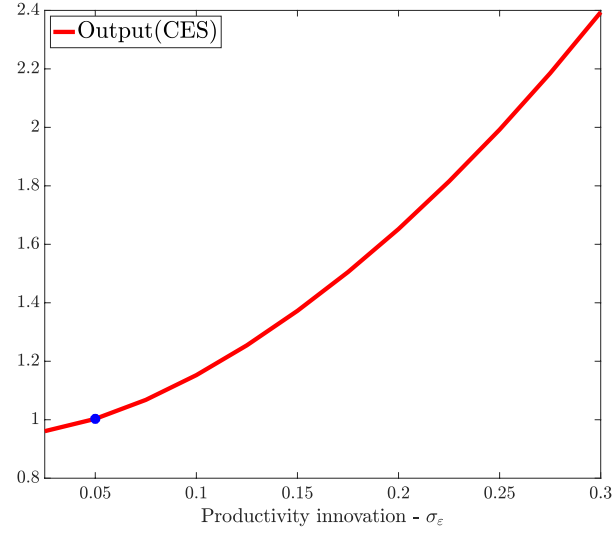
Technology: $\sigma_\varepsilon \uparrow$

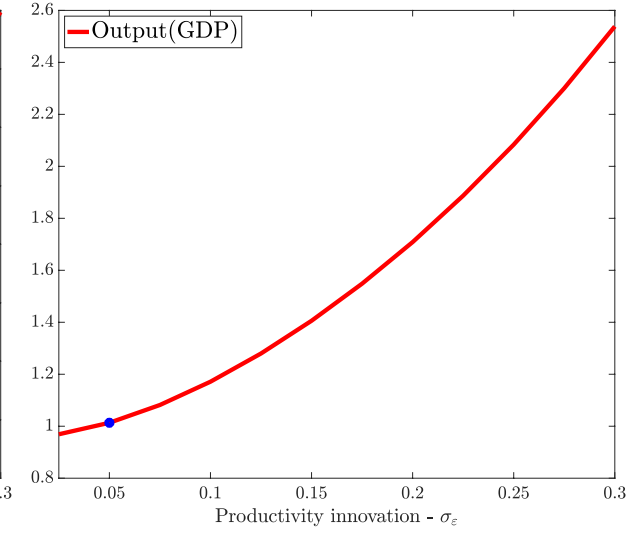






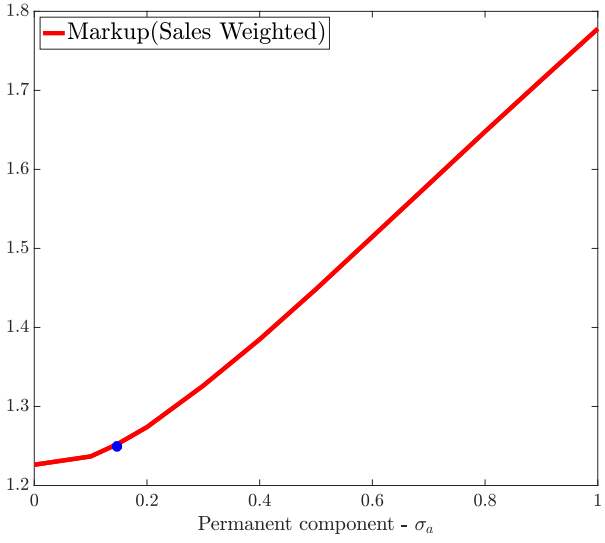


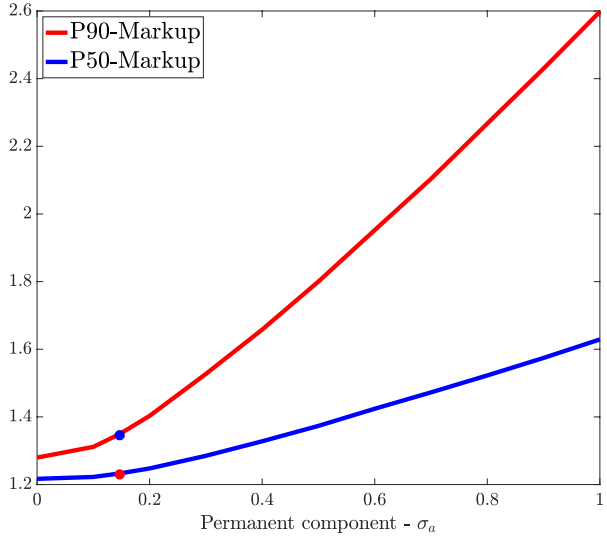


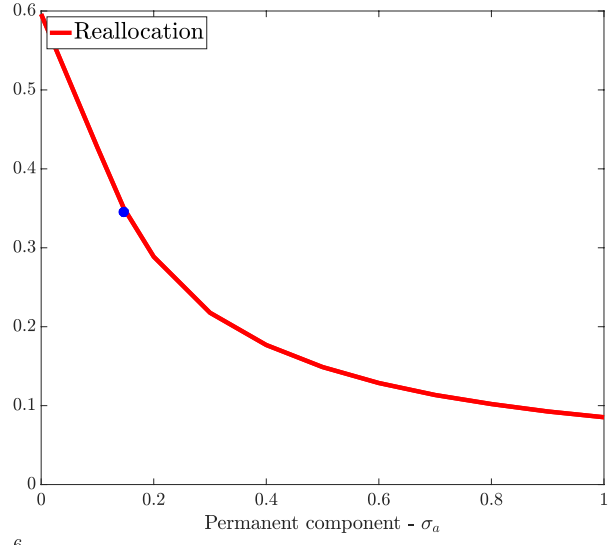


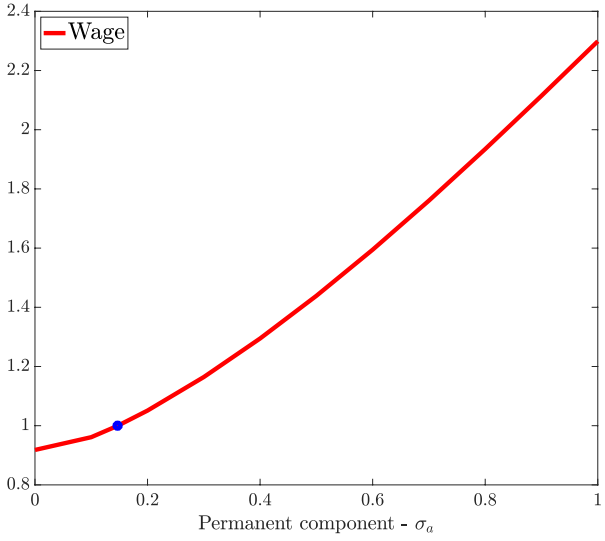
Comparative Statics

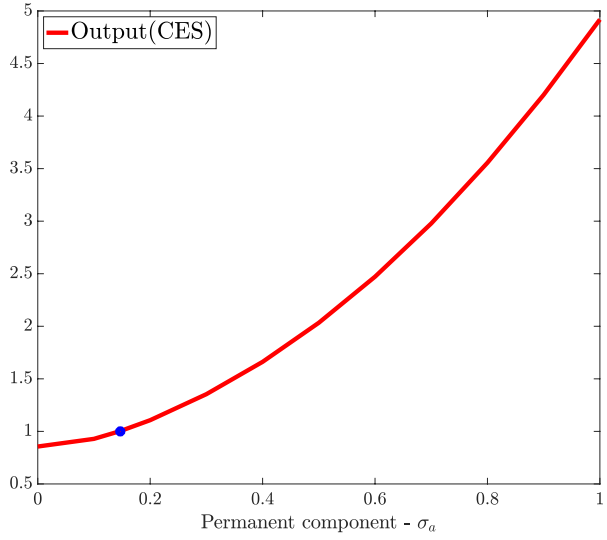
Market Structure: $\sigma_a \uparrow$

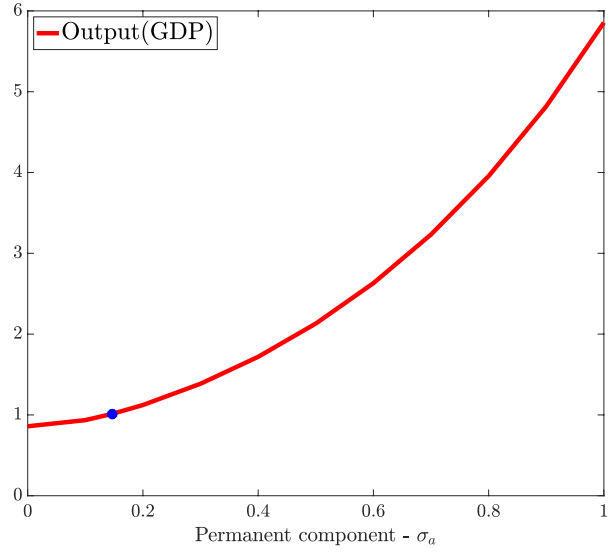






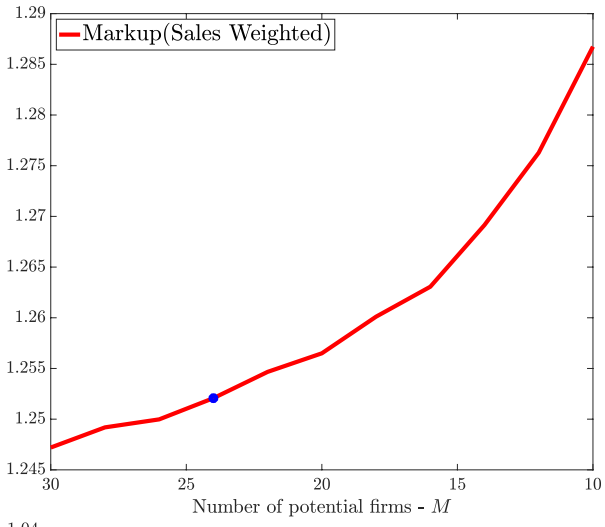


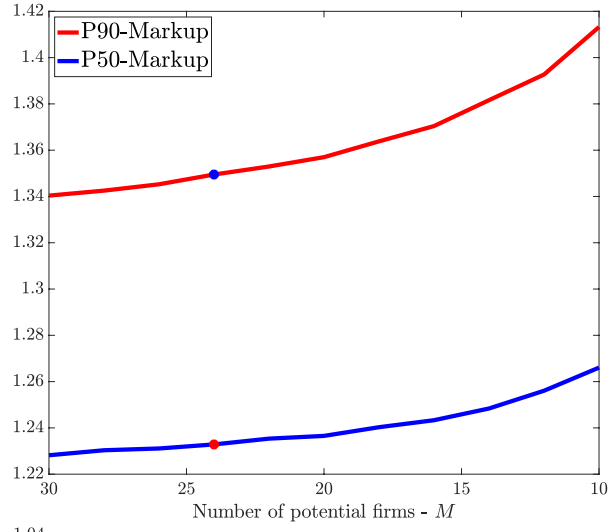


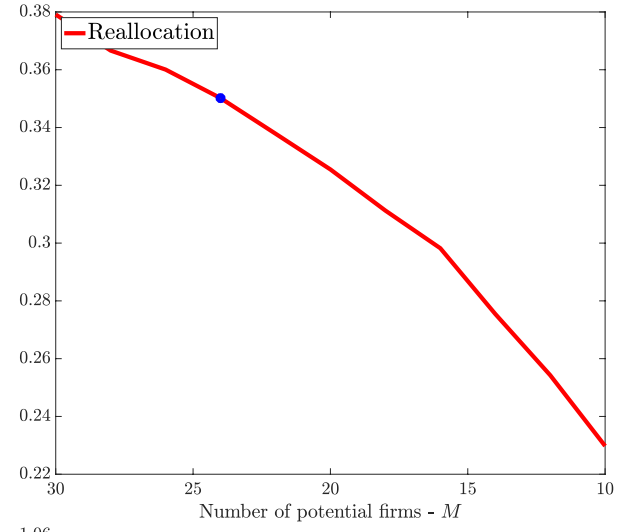


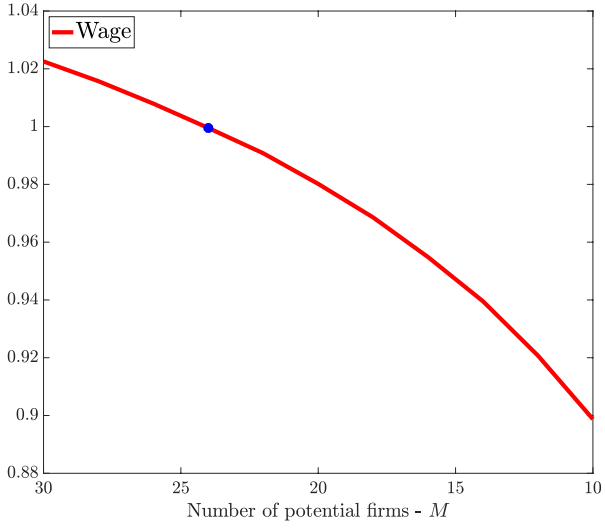
Comparative Statics

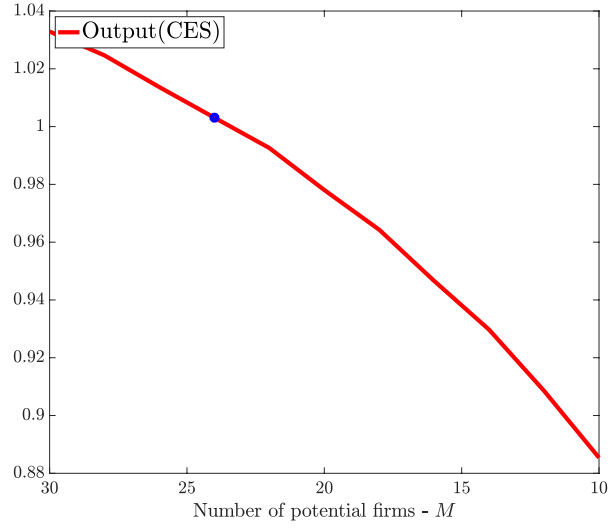
Market Structure: $M \downarrow$

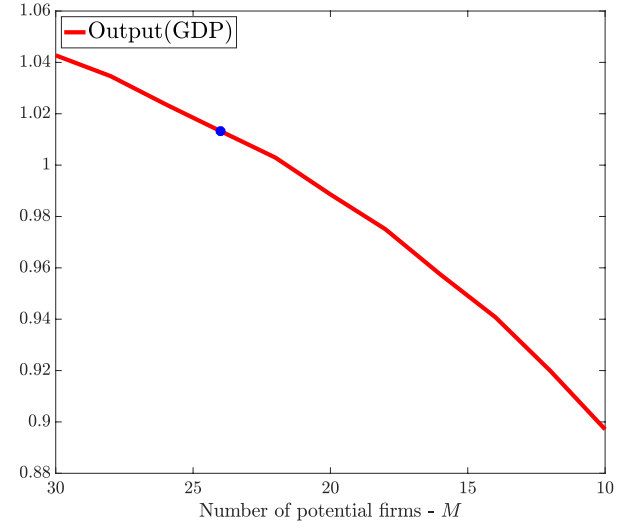












1980 – 2016

		1980		2016	
Moment		**Model**	**Data**	**Model**	**Data**
Markups	μ	1.25	1.20	1.50	1.60
Markup - P90	P90	1.35	1.45	1.70	2.45
Gross Rrofit Rate	π	0.12	0.12	0.21	0.18
Overhead Labor Share	$\frac{L^{OH}}{L}$	0.08	0.08	0.14	0.12
Reallocation Rate	RR	0.35	0.31	0.22	0.24

Estimated Parameter		**1980**	**2016**
Potential entrants	M	24	6
Fixed Cost	$W\phi$	1.3*	3.7*
Productivity shock: temp	σ_ε	0.051	0.054
Productivity shock: perm	σ_a	0.15	0.19
Number of Entrants	N	7	3
Welfare	C	1	0.81

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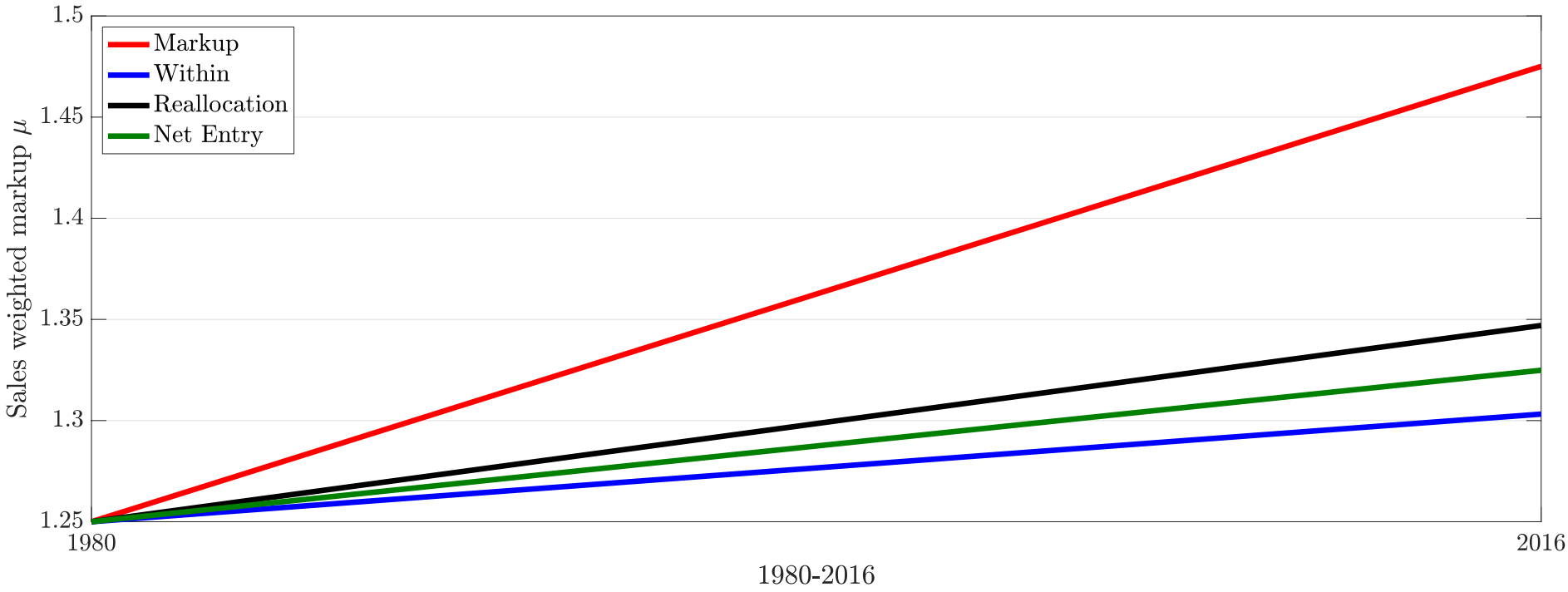
- Alternative Model: Dynamic adjustment costs (magnitude; profits?)

Non-targeted Moments

	1980		2016		% Change	
Moment	**Model**	**Data**	**Model**	**Data**	**Model**	**Data**
W	1.00	1.00	0.81	0.78	–19	–22
L	0.876	0.68	0.789	0.62	–10	–9
Labor Share	0.80	0.62	0.69	0.56	–14	–10
Startup rate	0.148	0.12	0.091	0.08	–39	– 33

Reallocation

1980 – 2016



Experiments

1980 Economy with 2016 Variables

	% Change 1980–2016					
	μ	$P90$	π	RR	W	L
Data	+33	+67	+50	–23	–34	–9
Model	+20	+26	+75	–37	–19	–10
M	+6	+10	+58	–54	–17	–9
ϕ	+17	+22	+58	–29	–21	–11
σ_ε	+17	+23	+58	–26	–20	–11
σ_a	+ 20	+26	+75	–37	–19	–10

Conclusions

1. Facts: Rise of Market Power since 1980
   - Heterogeneity: sharp rise for some, constant for most firms
   - Markups (20-40 points) $\neq$ Profit Rate (7-8 ppt's)
2. Quantifying Market Power in GE
   1. Causes: need both
      - Market Structure: to get labor reallocation down
      - Technology (mainly fixed cost): to get enough markup increase
   2. Consequences: macroeconomic implications
      - Wage Stagnation & LF Participation decline: equilibrium effect
      - Labor Share decline: at firm level
      - Decline in Business Dynamism: incomplete passthrough
      - Superstar firms: reallocation of sales towards high markup, large firms

Conclusions

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Cannot use Representative Agent framework to study Market Power: HA!!

Quantifying Market Power

Jan De Loecker[1] Jan Eeckhout[2] Simon Mongey[3]

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[2]UPF Barcelona and UCL
[3]Chicago

Richmond Fed
May 16, 2019

Future Work

1. Higher permanent heterogeneity in firm productivity
2. Correlation Entry Cost – Productivity

Data

- Accounting data on publicly listed firms:
  - Long time series: 1955–2016
  - Broad Cross Section: average 5,000 firms per year
- Selection?
  - Large firms; miss many small firms
  - Small subset of all firms
  - Publicly traded $\neq$ privately held firms
- But:
  - Covers all sectors and industries (contrast: Cens. of Manuf.)
  - 30% of US employment (Cens. of Manuf. 8.8%)

$\Rightarrow$ Allow for markup variation across producers and time; heterogeneity has substantial economic implications

Estimating Markups

- Two steps:
  1. Estimate Production Function: different models
  2. Derive Markup
- Important Caveats about the method:
  1. Frictionless adjustment (variable inputs) – ideally, e.g. electricity
  2. Use 'Cost of Goods Sold' as a variable input *bundle*
  3. Construct 'User Cost of Capital'
  4. Markup = Market Power?

▸ Intangibles?

- Cost vs. Demand approach: De Loecker-Scott (2016)
  Beer industry $\rightarrow$ similar estimates $\mu \approx 1.5$

Producer Behavior

- Production technology

$$Q_{it}(\boldsymbol{V}_{it}, K_{it}, \Omega_{it}) = F_{it}(\boldsymbol{V}_{it}, K_{it})\Omega_{it},$$

  - $\boldsymbol{V}_{it}$: variable inputs (labor, intermediate inputs)
  - K_{it}: capital stock
  - Ω_{it}: Hicks-neutral productivity term (TFP)

- Associated Lagrangian function (with *one* composite input):

$$\mathcal{L}(V_{it}, K_{it}, \lambda_{it}) = P_{it}^{V} V_{it} + r_{it} K_{it} - \lambda_{it}(Q_{it}(\cdot) - Q_{it})$$

- Consider FOC wrt the variable input V:

$$\frac{\partial \mathcal{L}_{it}}{\partial V_{it}} = P_{it}^{V} - \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial V_{it}} = 0$$

- Rearranging $\Rightarrow$ expression of output elasticity of input V_{it}:

$$\theta_{it}^{V} \equiv \frac{\partial Q_{it}(\cdot)}{\partial V_{it}} \frac{V_{it}}{Q_{it}} = \frac{1}{\lambda_{it}} \frac{P_{it}^{V} V_{it}}{Q_{it}}$$

Producer Behavior

- Lagrangian multiplier λ is a direct measure of marginal cost
- Define markup $\mu = \frac{P}{\lambda}$ or

$$\mu_{it} = \theta_{it}^{V} \frac{P_{it} Q_{it}}{P_{it}^{V} V_{it}}.$$

  depending on Sales $S_{it} = P_{it} Q_{it}$ and expenditure share θ_{it}^{V}, which is specific to technology
- Method:
  - Hall (1988): aggregate data
  - De Loecker-Warzynski (2012): micro data

Estimating markups

$$\mu_{it} = \theta_{it}^{V} \frac{P_{it} Q_{it}}{P_{it}^{V} V_{it}}.$$

- The method relies heavily on the data: sales/input expenditure
- Ratio is scaled by elasticity, $\theta(\beta)$:
  1. Estimate production function (parametric):
     - 1.1 Benchmark: time, sector-varying Cobb-Douglas ($q_{it} = x\beta_{st} + \omega_{it}$)
     - 1.2 Constant by sector/year, ($q_{it} = x\beta + \omega_{it}$)
     - 1.3 Firm/time specific: Translog ($q_{it} = x\beta_{1,s} + x^2\beta_{2,s} + \omega_{it}$)

     With correction for unanticipated shocks to output (ξ) ▸ Estimation
  2. Estimate cost-shares ("non-parametric", but... CRTS CD)
- Average markup (weighted by sales share m_{it}):

$$\mu_t = \sum_i m_{it} \mu_{it}$$

Intangibles

1. Income Statement:
   - SG&A – Selling, General Administrative Expenses: measure of organizational capital, Eisfeldt and Papanikolaou (2014)
   - R&D
2. Balance Sheet
   - Patents
   - Copyright, trademark
   - Goodwill

   But: Intangibles also measure profits (e.g. Goodwill)
3. Measurement: Barkai (2017)
   - 1996: \$31 billion out of \$410 billion in profits
   - 2011: \$57 billion out of \$983 billion in profits

Return

Estimation Elasticities: Detail

- Translog production function for each industry:

$$q_{it} = \beta_{v1} v_{it} + \beta_{k1} k_{it} + \beta_{v2} v_{it}^2 + \beta_{k2} k_{it}^2 + \omega_{it} + \epsilon_{it}$$

- Variation output elasticity over time and firms
- Output elasticity of the composite variable input:

$$\theta_{it}^{v} = \beta_{v} 1 + 2\beta_{v2} v_{it}$$

- Preserves identification results, with two key ingredients:
  1. $v = h(k, \omega)$
  2. $\omega = g(\omega) + \xi$
- Moment conditions from static optimization of variable inputs:

$$\mathbb{E}\left(\xi_{it}(\beta) \begin{bmatrix} v_{it-1} \\ v_{it-1}^2 \end{bmatrix} \right) = 0$$

Return

Estimation Production Technology

- Cobb Douglas:

$$q_{it} = \beta_v v_{it} + \beta_k k_{it} + \omega_{it} + \epsilon_{it}$$

- Olley-Pakes (1996): productivity is function of inputs: $\omega_{it} = h(v_{it}, k_{it})$
- Let:

$$q_{it} = \phi_t(v_{it}, k_{it}) + \epsilon_{it} \quad \text{where} \quad \phi = \beta_v v_{it} + \beta_k k_{it} + h(v_{it}, k_{it})$$

- Assume AR(1) productivity process: $\omega_{it} = \rho\omega_{it-1} + \xi_{it}$
  1. Regress deflated sales on variable inputs, capital and year dummies
  2. $\xi_{it}(\beta_v)$: from $\omega_{it}(\beta_v)$ on $\omega_{it-1}(\beta_v)$, where $\omega_{it} = \phi_{it} - \beta_v v_{it} + \beta_k k_{it}$
- Identify output elasticities $\mathbb{E}(\xi_{it}(\beta_v)v_{it-1}) = 0$ under assumption:
  1. v_{it} responds to productivity shock
  2. v_{it-1} does not

▸ Return

Translog Production Technology

- Industry-specific, time-varying output elasticities
- Preserves identification results (De Loecker-Warzynski (2012))
- Moment conditions from static optimization of variable inputs:

$$\mathbb{E}\left(\xi_{it}(\beta)\begin{bmatrix} v_{it-1} \\ v_{it-1}^2 \end{bmatrix}\right) = 0,$$

- With translog production function for each industry:

$$q_{it} = \beta_{v1} v_{it} + \beta_{k1} k_{it} + \beta_{v2} v_{it}^2 + \beta_{k2} k_{it}^2 + \omega_{it} + \epsilon_{it}$$

- Variation output elasticity over i, t, no longer attributed to markup
- Output elasticity of the composite variable input:

$$\theta_{it}^{v} = \beta_{v} 1 + 2\beta_{v2} v_{it}$$

- Markup defined as before; level difference, but normalization

▸ Return

Markup = Market Power?

Profit Rate: No Capital