How Costly Are Markups?

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Fourth ECB Annual Research Conference

Motivation

- Increase in product market concentration, markups
  - Kehrig-Vincent, Autor et al.
  - Barkai, De Loecker-Eeckhout, Gutierrez-Philippon, Hall
- Question:
  - What are the efficiency costs of markups?

Model

- Heterogeneous firms, endogenously variable markups
  - firms with larger market shares charge larger markups
  - markups returns to sunk investments

- Use data to evaluate magnitude of 3 distortions:
  - uniform output tax reduces aggregate investment, employment
  - size-dependent tax reallocates factors towards unproductive firms
  - too little entry

Model

Consumers

- Representative consumer owns all firms, maximizes

$$\sum_{t=0}^{\infty} \beta^t \left(\log C_t - \psi \frac{L_t^{1+\nu}}{1+\nu} \right), \qquad \text{subject to} \qquad C_t = W_t L_t + \Pi_t$$

- Firm profits net of investment in new products, Π_t

Final Goods Producers

- Final good used for consumption, investment, materials

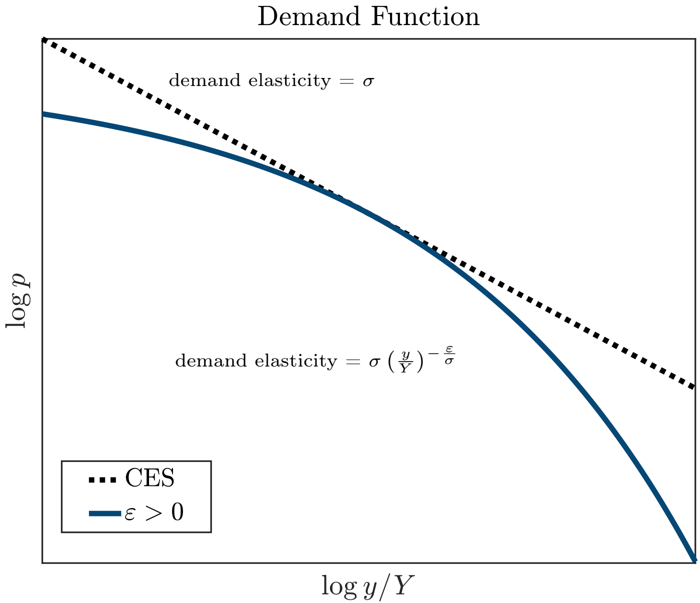
$$Y_t = C_t + X_t + B_t$$

- Assembled from intermediate varieties ω using Kimball aggregator

$$\int_0^{N_t} \Upsilon\left(\frac{y_t(\omega)}{Y_t}\right) d\omega = 1 \qquad \text{with} \qquad \Upsilon' > 0 \text{ , } \Upsilon'' < 0$$

- Demand for variety ω:

$$p_t(\omega) = \Upsilon'\left(\frac{y_t(\omega)}{Y_t}\right) D_t$$


Demand Function
demand elasticity $= \sigma$
demand elasticity $= \sigma \left(\frac{y}{Y}\right)^{-\frac{\varepsilon}{\sigma}}$
CES
$\varepsilon > 0$
$\log p$
$\log y/Y$

Intermediate Goods Producers

- Each producer monopoly supplier of good ω
  - mass of new entrants M_t, fixed cost κW_t to enter
  - exit with probability δ so $N_{t+1} = (1-\delta)N_t + M_t$

- At entry draw *efficiency* $e \sim G(e)$, make one-time investment $k_t(e)$

- Production function at age i

$$y_{i,t}(e) = ek_{t-i}(e)^{1-\eta} v_{i,t}(e)^{\eta}$$

  - $v_{i,t}$ CES composite of labor and materials

Intermediate Goods Producers

- Solve in 2 stages:
  - given productivity $z = ek^{1-\eta}$, solve optimal price
    - markup times marginal cost, markup $\sim$ demand elasticity
    - gives profits $\pi(z)$
  - given $\pi(z)$, solve optimal investment, entry choice

Optimal Markup

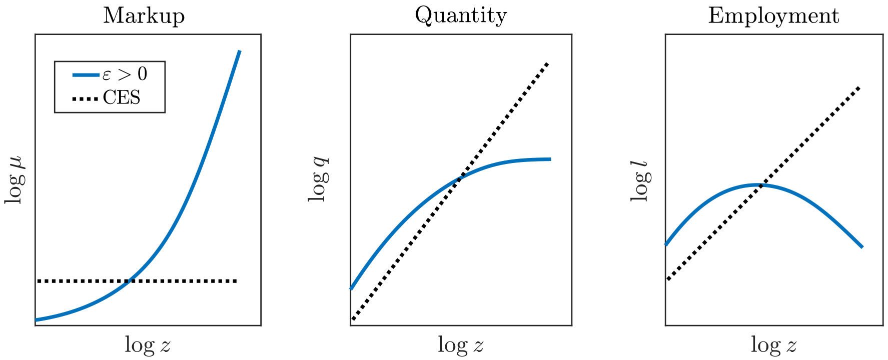
- Profits of firm with productivity z

$$\pi(z) = \max_{p} \; py - P_v v \qquad \text{subject to} \qquad p = \Upsilon' \left(\frac{y}{Y}\right) D$$

- Optimal markup increases in relative size $q = y/Y$

$$\mu(q) = \frac{\theta(q)}{\theta(q) - 1} = \frac{\sigma}{\sigma - q^{\frac{\varepsilon}{\sigma}}}$$

Static Choice



Dynamic Choices

- Having paid κW_t and drawn e, entrant chooses investment $k_t(e)$ to

$$\max \, -k_t(e) + \beta \sum_{i=1}^{\infty} (\beta(1-\delta))^{i-1} \left(\frac{C_{t+i}}{C_t} \right)^{-1} \pi_{t+i} \left(e k_t(e)^{1-\eta} \right)$$

- Mass of entrants M_t pinned down by free entry condition

$$\kappa W_t = \int \left\{ -\, k_t(e) + \beta \sum_{i=1}^{\infty} (\beta(1-\delta))^{i-1} \left(\frac{C_{t+i}}{C_t} \right)^{-1} \pi_{t+i} \left(e \right) \right\} dG(e)$$

Aggregation

- Let $n_{i,t}$ measure of producers of age i

- Aggregate production function

$$Y_t = E_t K_t^{1-\eta} V_t^{\eta}$$

$$\text{where} \qquad K_t = \sum_i n_{i,t} \int k_{t-i}(e)\, dG(e), \qquad V_t = \sum_i n_{i,t} \int v_{i,t}(e)\, dG(e)$$

- Aggregate efficiency

$$E_t = \left[\sum_i n_{i,t} \int \frac{q_{i,t}\left(e\right)}{e} dG\left(e\right) \right]^{-1}$$

Distortions

Three Sources of Inefficiency from Markups

1. Uniform output tax
2. Size-dependent firm tax
3. Entry distortion

Illustrate by comparing equilibrium allocations to those chosen by planner

Planner's Problem

$$\max \sum_{t=0}^{\infty} \beta^t \left(\log C_t^* - \psi \frac{\left(L_{p,t}^* + M_t^* \kappa\right)^{1+\nu}}{1+\nu} \right)$$

subject to

$$\sum_i n_{i,t}^* \int \Upsilon \left(\frac{y_{i,t}^*(e)}{Y_t^*} \right) dG(e) = 1$$

same resource constraints

Uniform Output Tax

- Employment

$$\psi C_t L_t^{\nu} = W_t = \frac{1}{\mathcal{M}_t} \times \frac{\partial Y_t}{\partial L_{p,t}}$$

- Investment

$$\rho + \delta = \frac{1}{\mathcal{M}} \times \frac{\partial Y}{\partial K}$$

- Aggregate markup $\mathcal{M}_t \equiv$ uniform output tax

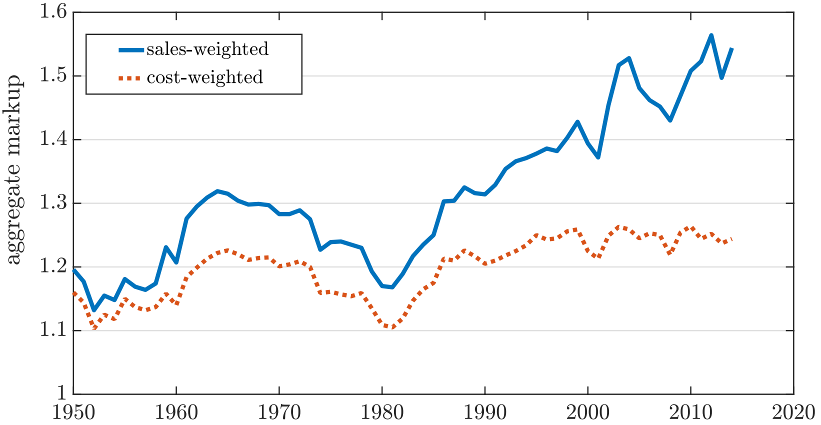
$$\mathcal{M}_t = \sum_i n_{i,t} \int \mu_{i,t}(e) \, \frac{v_{i,t}(e)}{V_t} dG(e)$$

Aggregate Markup

- Aggregate markup wedge = cost-weighted average of firm markups
  - not driven by specifics of demand system
  - ratio of aggregates = denominator-weighted average of individual ratios

- Compare to more popular sales-weighted average using Compustat
  - compute firm markups using De Loecker-Eeckhout 2018 approach

Cost vs Sales-Weighted Average



sales-weighted average = cost-weighted average + coefficient of variation

Size-Dependent Tax

- Aggregate productivity

$$E = \left(N \int \frac{q\,(e)}{e} dG(e) \right)^{-1}$$

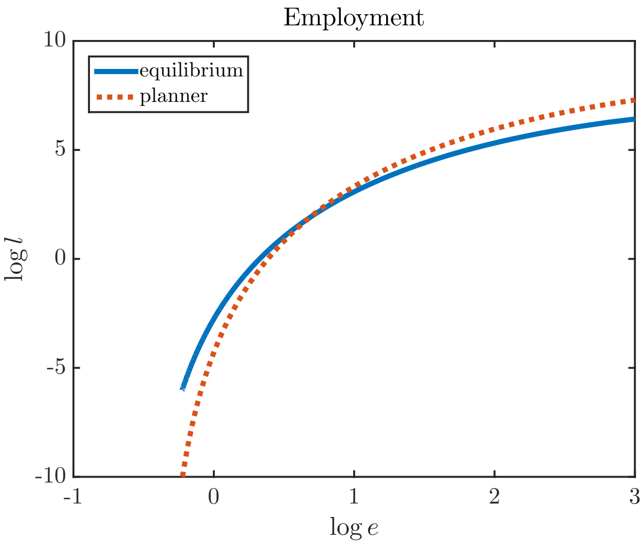
- Planner maximizes E by choosing

$$\Upsilon'(q^*(e)) \sim \frac{1}{e}$$

- Equilibrium: markup increases with e and firm size

$$\Upsilon'(q(e)) \sim \frac{\mu(q(e))}{e}$$

Planner Reallocates to High Productivity Firms



Entry Distortion

- Equilibrium entry determined by markup $\mu(q)$
- Planner values firms due to love-for-variety
  - decreasing returns so higher productivity with higher N
  - N/Y depends on $\frac{\Upsilon(q)}{\Upsilon'(q)q}$
- N/Y coincide with CES, ambiguous otherwise
- Y too low in equilibrium, so N too low

details

Parameterization

Calibration

- Assign conventional values to standard parameters

- Calibrate three key parameters jointly

  ξ Pareto tail productivity, to match sales concentration

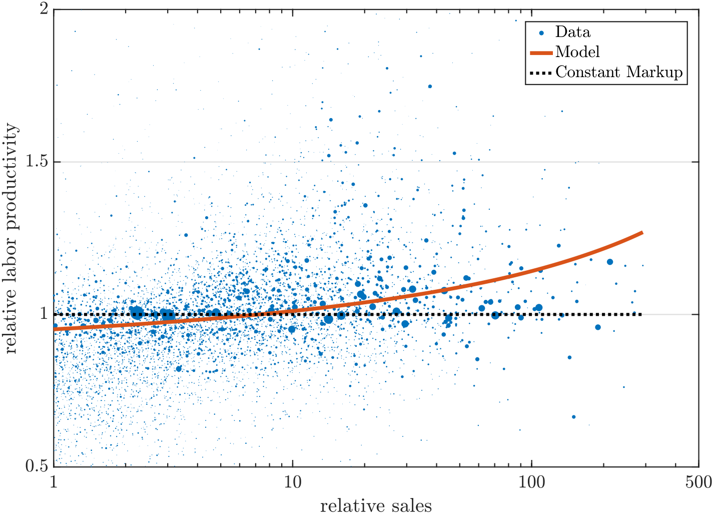
  σ average elasticity, to match $\mathcal{M} = 1.15$

  ε superelasticity, to match relationship labor productivity and sales

- SBA Statistics of US Businesses, 6-digit NAICS, 2012

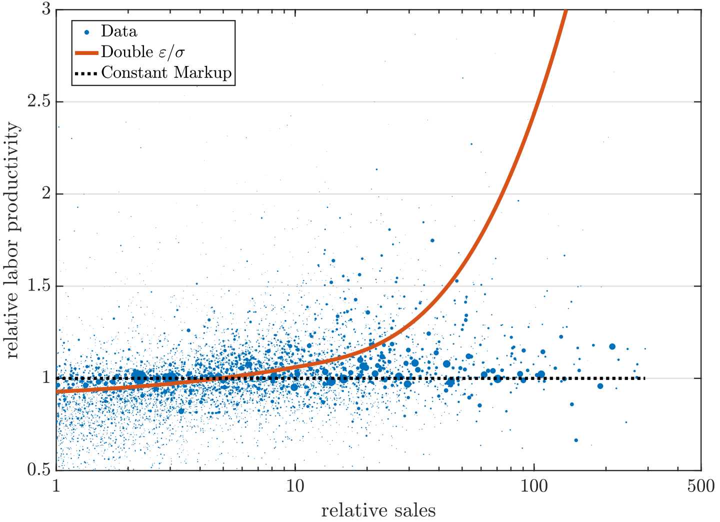
  – 'firm' = size class

Implies $\varepsilon/\sigma = 0.14$



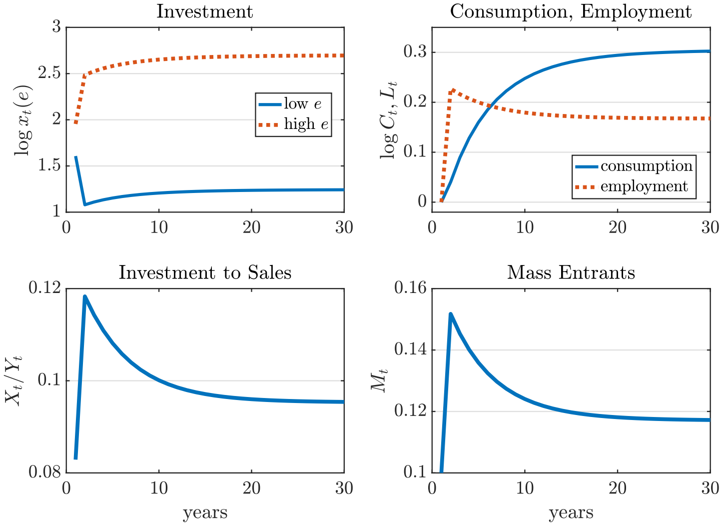
Markups $\sim$ labor productivity py/l.

Double ε/σ



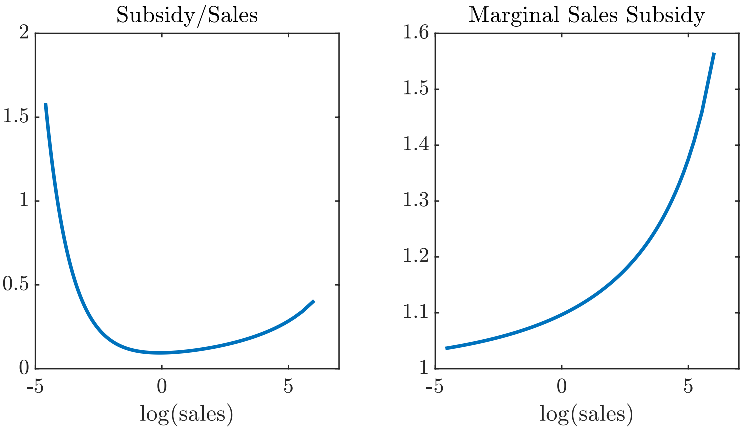
How Costly Are Markups?

From Distorted to Efficient Steady State



Consumption-equivalent welfare gains 6.6%

Requires Large Subsidies to Large Firms



Marginal subsidy equal to firm markup

Largest gains from uniform output subsidy

	efficient	uniform	size-dependent
log deviation from benchmark, $\times 100$			
consumption, C	29	29	1.2
employment, L	17	16	-0.3
mass of firms, N	13	6.3	-2.9
aggregate efficiency, E	2.9	1.0	0.3
welfare gains, CEV, %	6.6	4.9	1.3

Negligible gains from entry subsidy: 0.1%.

Economy with 8% Aggregate Markup

	efficient	uniform	size-dependent
log deviation from benchmark, $\times 100$			
consumption, C	15	11	1.7
employment, L	9.0	8.2	0.0
mass of firms, N	15	3.5	-0.1
aggregate efficiency, E	2.0	0.3	0.6
welfare gains, CEV, %	2.7	1.2	1.3

Economy with 25% Aggregate Markup

	efficient	uniform	size-dependent
log deviation from benchmark, $\times 100$			
consumption, C	57	57	2.3
employment, L	26	25	-0.5
mass of firms, N	16	10	-2.8
aggregate efficiency, E	5.6	2.6	0.5
welfare gains, CEV, %	18.9	15.4	2.5

Why Small Gains from Size-Dependent Subsidies?

- Compare equilibrium E to efficient E^*

aggregate productivity loss	
benchmark $\varepsilon/\sigma = 0.14$	0.8%
double ε/σ	1.8%

- Losses small since markups high precisely when low demand elasticities
  - losses 6× larger if use CES to compute misallocation
- Also narrow measure of misallocation: var(MP) due to firm size

Why Negligible Gains from Entry?

- Recall aggregate markup is weighted average

$$\mathcal{M}_t = \sum_i n_{it} \int \mu_{it}(e) \, \frac{v_{it}(e)}{V_t} \, dG(e)$$

- Individual $\mu_{it}(e)$ fall, but weights $v_{it}(e)/V_t$ on large firms increase

- Aggregate $\mathcal{M}$ hardly changes, from 1.150 to 1.149

- Implies rising entry barriers cannot explain rising markups

- Related to ACDR 2018 neutrality result in international trade

Oligopolistic Competition

- Nested CES, θ across sectors $\gamma > \theta$ within, as in Atkeson-Burstein

- Finite number of firms $n(s)$ in sector s, oligopolistic competition

- With Cournot competition, firm with sales share $\omega_i(s)$ has markup

$$\frac{1}{\mu_i(s)} = 1 - \left(\omega_i(s)\frac{1}{\theta} + (1 - \omega_i(s))\frac{1}{\gamma}\right)$$

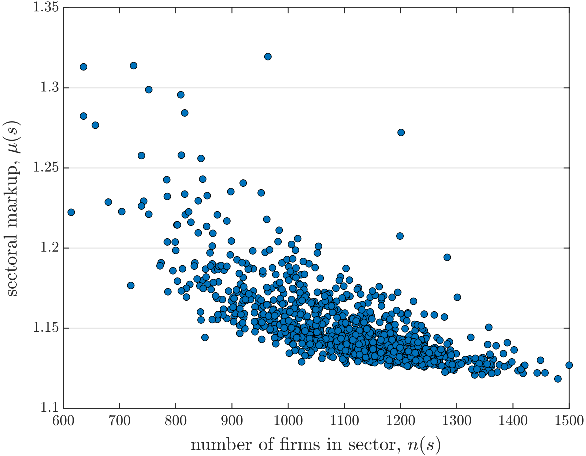
- Solve static sequential entry game, $n(s)$ pinned down by free entry

$$\int \pi(e\,;\,(\boldsymbol{e}_{n-1}(s), e))\,dG(e) \geq \kappa \geq \int \pi(e\,;\,(\boldsymbol{e}_n(s), e))\,dG(e)$$

- Calibrate this model to same concentration facts

Sectors with fewer firms have higher markups

Strong correlation sector $n(s)$ and markups $\mu(s)$



But this reduced-form correlation is not a good guide to policy.

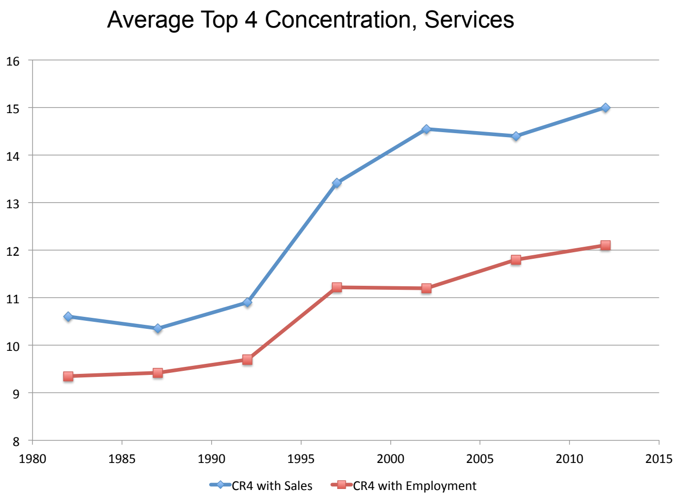
Entry still has small effect on aggregate markup

- Subsidize entry cost so number firms doubles
- Markup falls from 1.150 to 1.148
- Aggregate markup unchanged due to reallocation to large firms
- Sectoral correlations due to unusually large e draws in some sectors
  - leaders in such sectors charge high markups
  - other firms do not expect to profitably compete, do not enter

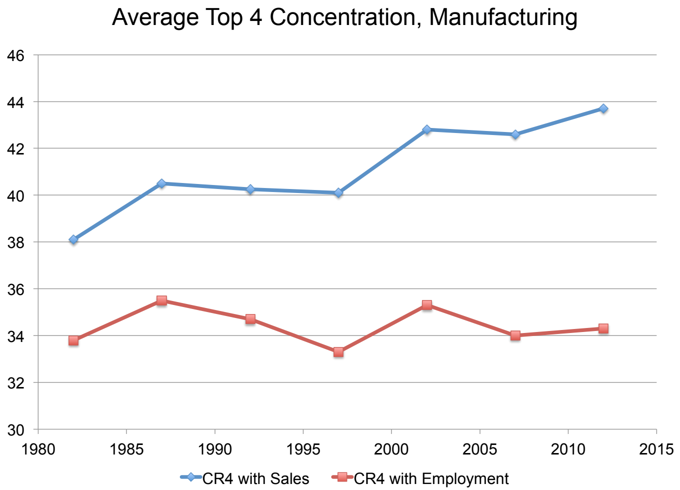
Conclusions

- Model with monopolistic competition and variable markups
  - potentially large costs of markups
  - mostly due to aggregate markup distortion
  - entry subsidy too blunt a tool, negligible gains
- Robust to assuming oligopolistic competition within industries

Extras

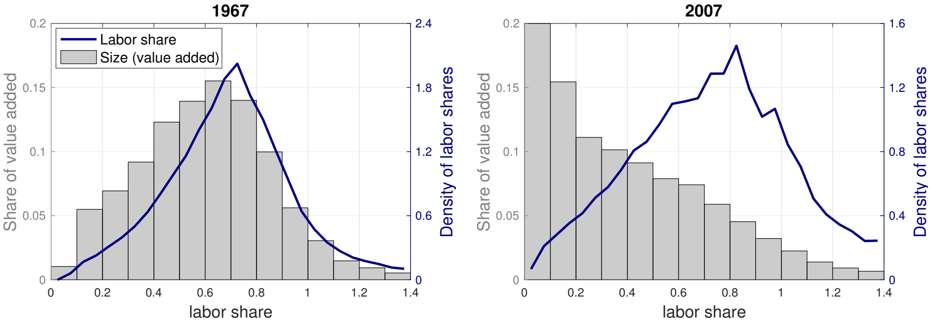


Source: Autor et al. 2017, average across 4-digit industries Back

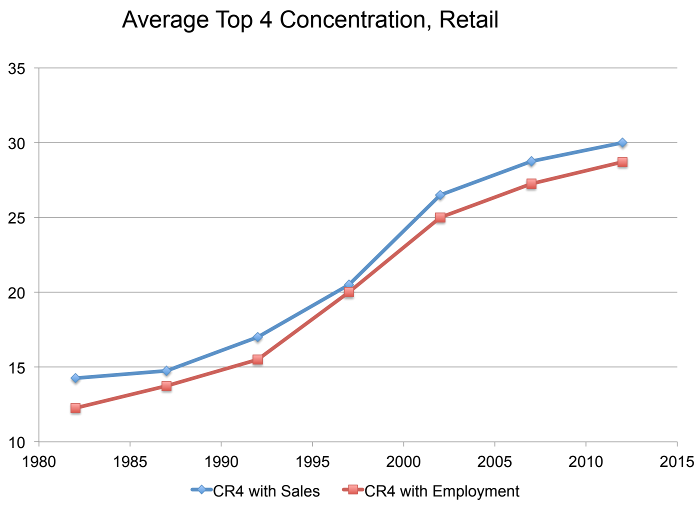


Source: Autor et al. 2017, average across 4-digit industries Back

Figure 1: The changing distributions of labor shares and value added



Source: Kehrig - Vincent 2017, U.S. Manufacturing Back



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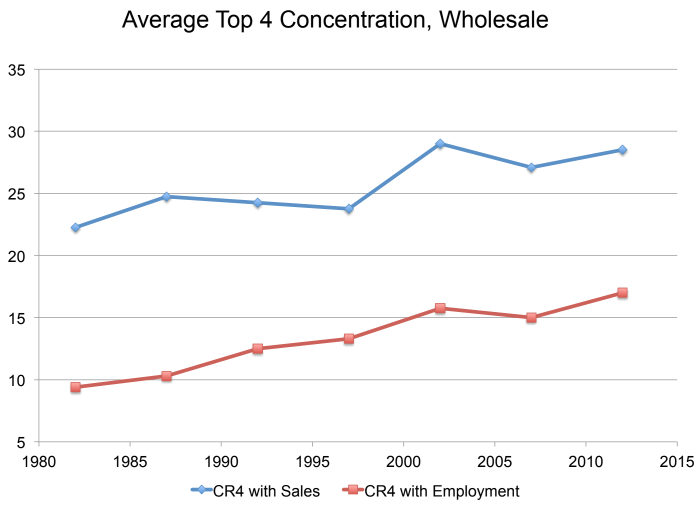


Source: Autor et al. 2017, average across 4-digit industries back

Bounds on Quantities and Prices

- Second order condition for profit maximization requires

$$1 < \theta(q) = \sigma q^{-\frac{\varepsilon}{\sigma}} \qquad \Leftrightarrow \qquad q < \sigma^{\frac{\sigma}{\varepsilon}} \equiv \overline{q}$$

  Gives upper bound on quantities

- Firms with high marginal costs shut down

$$p < \Upsilon'(0) \qquad \Leftrightarrow \qquad p < \frac{\sigma - 1}{\sigma} \exp\left(\frac{1}{\varepsilon}\right) \equiv \overline{p}$$

  Gives upper bound on prices

back

Estimates from Taiwan Manufacturing

- Suppose we have data on sales $s_i = p_i y_i$ and markups μ_i
- Model implies sales given by

$$s_i = p_i y_i = \Upsilon'(q_i) q_i \frac{DY}{N}$$

  and markups given by

$$\mu_i = \frac{\sigma}{\sigma - q_i^{\varepsilon/\sigma}}$$

- Eliminating q_i between these gives

$$\left(\frac{1}{\mu_i} + \log\left(1 - \frac{1}{\mu_i}\right)\right) = \text{const.} + \frac{\varepsilon}{\sigma} \log s_i$$

- Estimates of slope coefficient give ε/σ

Taiwan Manufacturing Data

- Product classification (more detailed than NAICS 6-digit)
  - examples: desktop computer, laptop, tablet, ...
- Measure producer markups using De Loecker and Warzynski (2012)
  - estimate a industry-specific production function
  - infer markup from variable input share + output elasticity
  - focus on single product producers
- All regressions control for product and year effects

Estimates of ε/σ

	I	II
estimate	0.145	0.161
(s.e.)	(0.002)	(0.007)
year fixed effects	Y	Y
product fixed effect	Y	N
producer fixed effect	N	Y

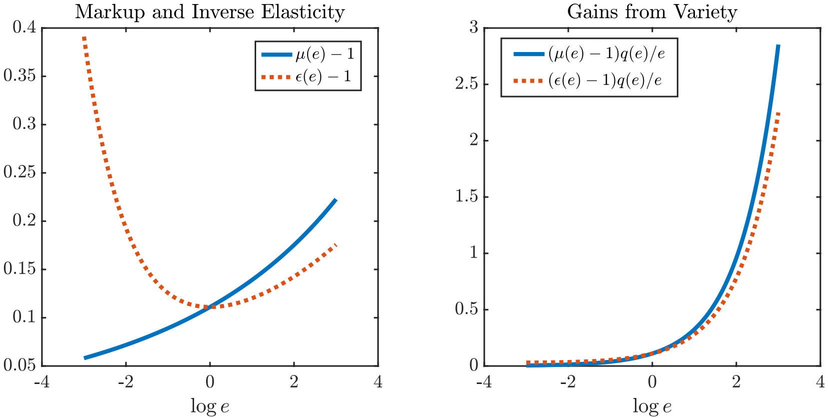
Back

Estimates 2-Digit Industries

NAICS industries	ξ	σ	ε	misallocation, %
benchmark	6.9	11.6	2.2	1.2
(1) exclude finance, real estate, education, religion	6.8	11.5	2.2	1.2
(2) exclude (1), health, accommodation, food	6.7	11.8	2.4	1.3
(3) only manufacturing	6.7	13.1	4.5	1.9

back

Returns to Entry



$\mu(e) > \varepsilon(e)$ for large producers Back

Intuition for Magnification

- Suppose gross output production function:

$$Y = EL^{1-\phi}B^{\phi} \qquad \text{with} \qquad B = \frac{\phi}{\mathcal{M}}Y$$

- So GDP, $Y - B$ is equal to

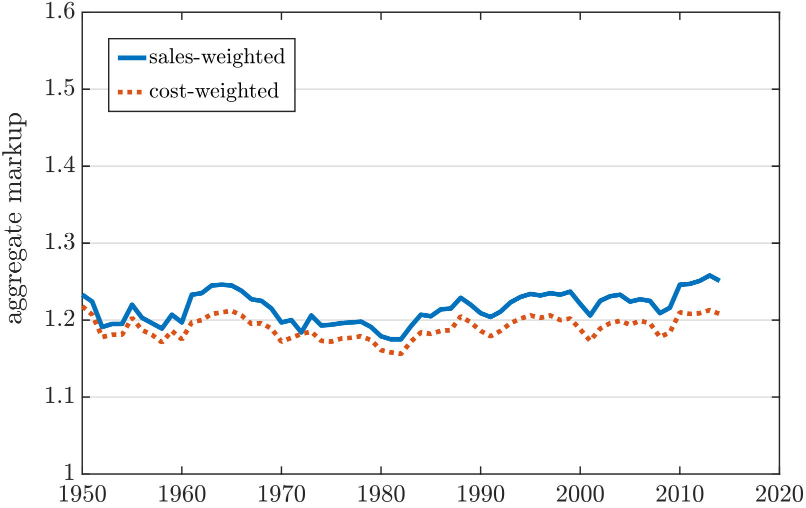
$$\text{GDP} = \text{TFP} \times L$$

- TFP lower both due to misallocation (lower A) and aggregate tax ($\mathcal{M}$)

$$\text{TFP} = \left(1 - \frac{\phi}{\mathcal{M}}\right)\left(\frac{\phi}{\mathcal{M}}\right)^{\frac{\phi}{1-\phi}} E^{\frac{1}{1-\phi}}$$

Back

Include SGA Expenses



Production Function

$$\Upsilon(q;\sigma,\varepsilon) = 1 + (\sigma - 1)\exp\left(\frac{1}{\varepsilon}\right)\varepsilon^{\frac{\sigma}{\varepsilon}-1}\left[\Gamma\left(\frac{\sigma}{\varepsilon},\frac{1}{\varepsilon}\right) - \Gamma\left(\frac{\sigma}{\varepsilon},\frac{q^{\varepsilon/\sigma}}{\varepsilon}\right)\right]$$

$\Gamma(s,t) = \int_x^\infty t^{s-1}e^{-t}dt$

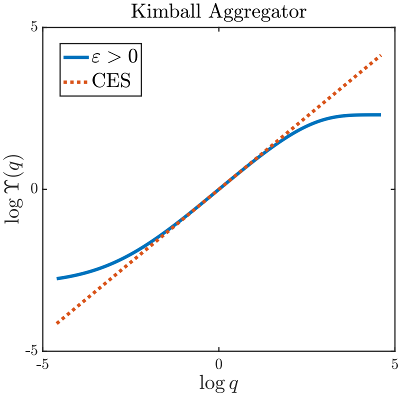
$\varepsilon = 0$: $\Upsilon(q) = q^{1-\frac{1}{\sigma}}$

Production Function

$$\Upsilon(q;\sigma,\varepsilon) = 1 + (\sigma-1)\exp\left(\frac{1}{\varepsilon}\right)\varepsilon^{\frac{\sigma}{\varepsilon}-1}\left[\Gamma\left(\frac{\sigma}{\varepsilon},\frac{1}{\varepsilon}\right) - \Gamma\left(\frac{\sigma}{\varepsilon},\frac{q^{\varepsilon/\sigma}}{\varepsilon}\right)\right]$$

$$\Gamma(s,t) = \int_x^\infty t^{s-1}e^{-t}dt$$

$$\varepsilon = 0\text{:}\;\; \Upsilon\left(q\right) = q^{1-\frac{1}{\sigma}}$$



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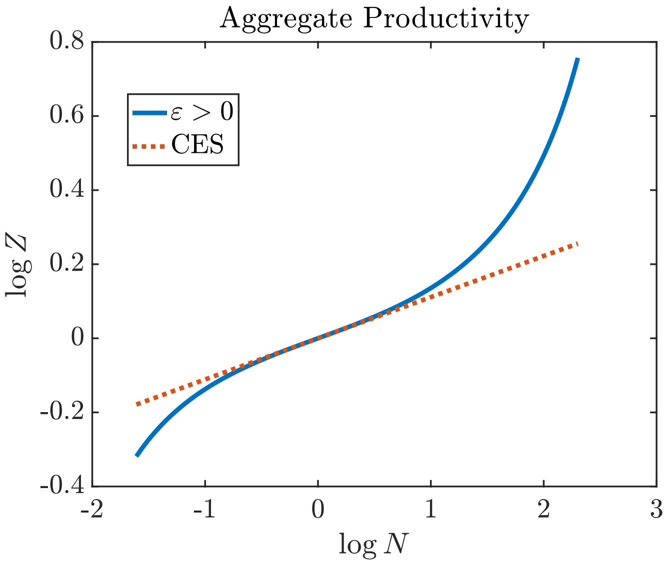
Gains from Variety

- TFP increases with number of producers due to decreasing returns
- Suppose N_t identical producers with $y_t = l_t = L_t/N_t$
- Aggregate productivity $Z_t = Y_t/L_t$ satisfies

$$N_t \Upsilon\left(\frac{y_t}{Y_t}\right) = N_t \Upsilon\left(\frac{1}{N_t}\frac{1}{Z_t}\right) = 1$$

  – with CES, $Z_t = N_t^{\frac{1}{\sigma-1}}$


Aggregate Productivity
$\varepsilon > 0$
CES
0.8
0.6
0.4
0.2
0
-0.2
-0.4
$\log Z$
-2
-1
0
1
2
3
$\log N$

back

Entry Distortion

- Equilibrium amount of entry determined by markups

$$\kappa W_t = \int \left\{ \beta \sum_{i=1}^{\infty} (\beta(1-\delta))^{i-1} \left(\frac{C_{t+i}}{C_t} \right)^{-1} \left(1 - \frac{1}{\mu_{t+i}(e)} \right) p_{t+i}(e) y_{t+i}(e) \right\} dG(e)$$

- Planner instead sets

$$\kappa \psi C_t^* L_t^{*\nu} = \int \left\{ \beta \sum_{i=1}^{\infty} (\beta(1-\delta))^{i-1} \left(\frac{C_{t+i}^*}{C_t^*} \right)^{-1} \left(\epsilon_{t+i}^*(e) - 1 \right) p_{t+i}^*(e) y_{t+i}^*(e) \right\} dG(e)$$

where

$$\epsilon_{t+i}^*(e) = \frac{\Upsilon\left(q_{t+i}^*(e)\right)}{\Upsilon'\left(q_{t+i}^*(e)\right) q_{t+i}^*(e)} \qquad \text{and} \qquad p_t^*(e) = \frac{\Upsilon'\left(q_t^*(e)\right)}{\int \Upsilon'(q_t^*(z)) q_t^*(z) dH_t^*(z)}$$

Steady State

- Equilibrium allocation

$$\frac{N}{Y} = \frac{1}{\rho + \delta} \frac{E}{\kappa \psi C L^{\nu}} \int (\mu(e) - 1) \frac{q(e)}{e} dG(e)$$

- Planner allocation

$$\frac{N^*}{Y^*} = \frac{1}{\rho + \delta} \frac{E^*}{\kappa \psi C^* L^{*\nu}} \int (\epsilon^*(e) - 1) \frac{q^*(e)}{e} dG(e)$$

- $\mu(e) = \epsilon(e)$ for CES, $\mu(e) > \epsilon(e)$ for high e with Kimball figure

- N/Y ambiguous, N too low

back

Neutrality Result in ACDR 2017

- Individual producers' q satisfies

$$\Upsilon'(q) = \mu(q)\frac{1}{B}\frac{1}{e}$$

  - B depends on aggregate variables: N, Y, W, D with $B'(N) < 0$

- Aggregate markup satisfies

$$\mathcal{M} = \frac{\int_1 \mu(q(e,B))\frac{q(e,B)}{e}dG(e)}{\int_1 \frac{q(e,B)}{e}dG(e)}$$

- Let $x = Be$ and use $G(e)$ Pareto

$$\mathcal{M} = \frac{\int_B \mu(q(x))\frac{q(x)}{x}dG(x)}{\int_B \frac{q(x)}{x}dG(x)}$$

Neutrality Result in ACDR 2017

- Aggregate markup is

$$\mathcal{M} = \frac{\int_B \mu(q(x)) \frac{q(x)}{x} dG(x)}{\int_B \frac{q(x)}{x} dG(x)} = \frac{U(B)}{V(B)}$$

- So $\mathcal{M}'(B)$ depends on the smallest firm's markup

$$\mathcal{M}'(B) = -\left(\mu(q(B)) - \mathcal{M}(B)\right) \frac{q(B)g(B)}{BV(B)} \geq 0$$

- Since $B'(N) < 0$, $\mathcal{M}'(N) \leq 0$
  - but effect small since $q(B) \approx 0$ ($= 0$ in ACDR)

back