Fixed costs, product heterogeneity and the force of competition

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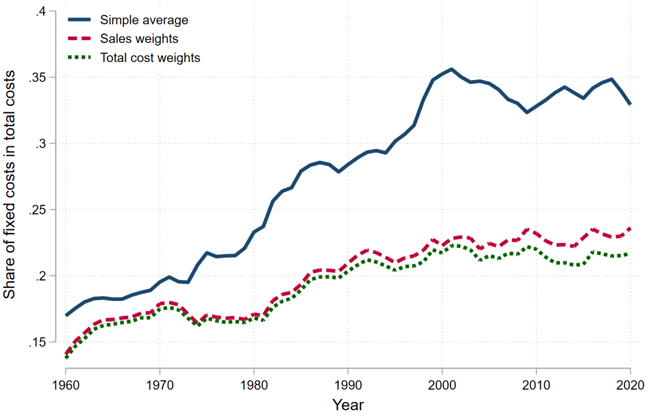
Share of fixed costs in total costs, US (Compustat)



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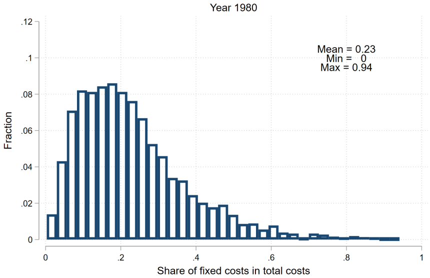

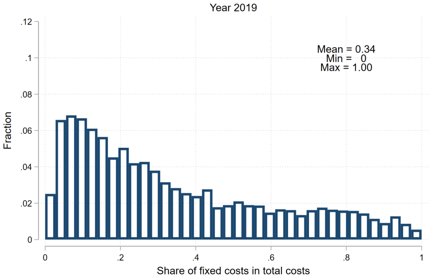

This paper

- Observations:
  - The share of fixed costs in total costs is large (and heterogeneous)
  - This share has has grown substantially over the last decades
    - Similar in other economies: EU, Japan, UK, the World
- Questions:
  - What are the macroeconomic effects of fixed costs?
  - What factors could explain the observed rise in fixed costs?
- Tractable general equilibrium model with:
  - Increasing returns due to fixed costs
  - Ex-ante heterogeneity in product characteristics
  - Competitive markets, i.e., no market power

Roadmap

1. **The fixed-cost economy**
2. Understanding the rise of fixed costs
3. Concluding remarks

Preferences and technology

- Setup:
  - Continuum of identical individuals with mass L
  - Continuum of goods, indexed by $z \in [0, \infty)$
  - Labor is the only factor of production
- Preferences:

$$U = \int_0^\infty \frac{\sigma}{\sigma - 1} C(z)^{\frac{\sigma-1}{\sigma}} dz \qquad (\sigma > 1)$$

- Technology:

$$Q(z) = \max\left\{\frac{L(z) - \phi(z)}{\upsilon(z)}, 0\right\}$$

  - $\phi(z) \in [0, \infty)$ and $\upsilon(z) \in (0, \infty)$
  - Order goods s.t. cost index $I(z) \equiv \phi(z)\upsilon(z)^{\sigma-1}$ is non-decreasing
  - Assume $I(z)$ is continuous, strictly increasing, and $\lim_{z\to\infty} I(z) = \infty$

Utility maximization

- Consumer's problem:

$$\max_{\{C(z)\}} U = \int_0^\infty \frac{\sigma}{\sigma-1} C(z)^{\frac{\sigma-1}{\sigma}} dz \quad \text{s.t.} \quad \int_0^\infty P(z)\, C(z)\, dz \leq W$$

- Solution implies:

$$\lambda P(z) = C(z)^{-\frac{1}{\sigma}}$$
$$U = \frac{\sigma}{\sigma-1} \lambda W$$

- Normalization: $\lambda = 1$

Producer competition

- Free entry:
  - No producer makes losses
  - No producer could offer a lower price and make profits
  - Note: $\phi(z)$ is a fixed cost, not a sunk cost

- Implications:
  - There is, at most, a single producer operating in each market
  - If there is no producer, $Q(z) = 0$ and $P(z) = \infty$
  - If there is a producer, $P(z)$ equals average cost:

$$P(z) = \underbrace{\left(1 + \frac{\phi(z)}{\upsilon(z) Q(z)}\right)}_{\text{markup}} \upsilon(z) W$$

evaluated at market demand:

$$P(z) = \left(\frac{Q(z)}{L}\right)^{-\frac{1}{\sigma}}$$

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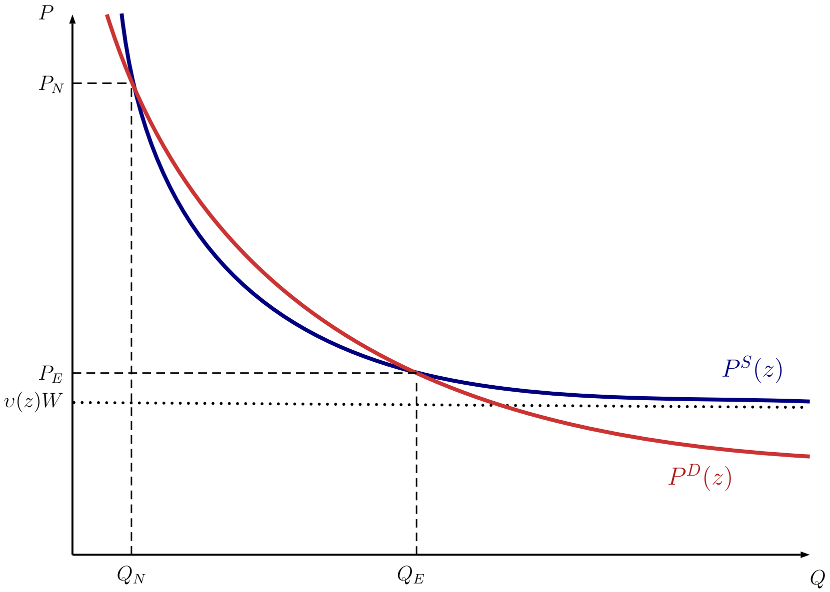
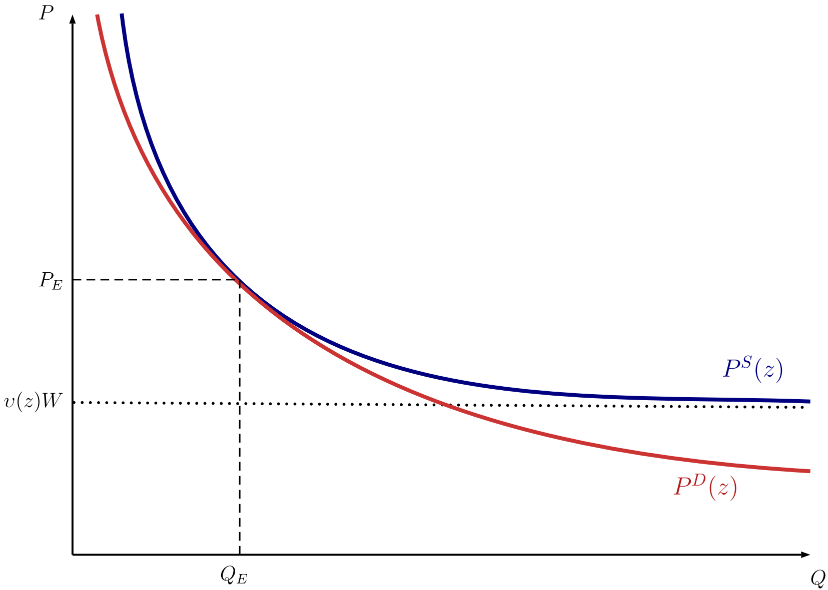
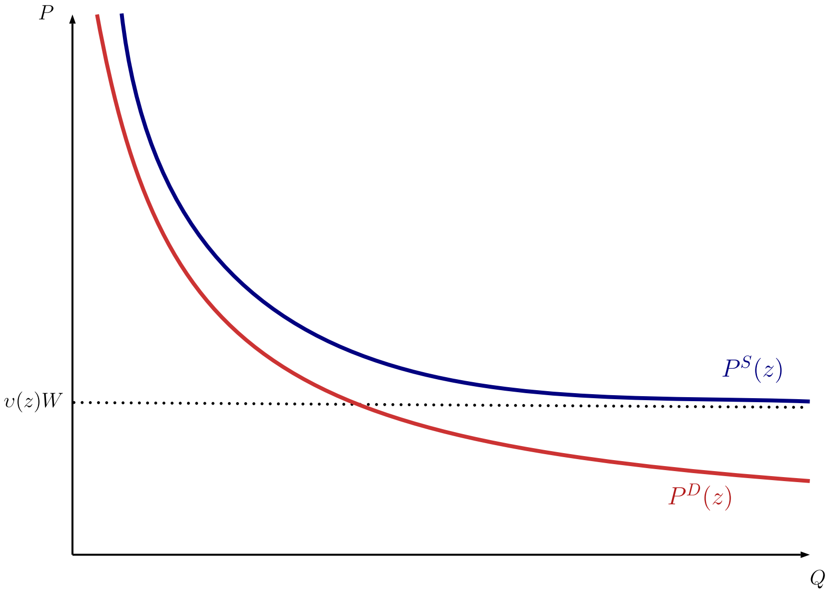
Inframarginal good: $z < \bar{z}$



Marginal good: $z = \bar{z}$



Inactive good: $z > \bar{z}$



General equilibrium

Result 1. *There is a unique equilibrium, which is characterized by the solution to:*

$$P(z) = \begin{cases} \min P \quad s.t. \;\; P^{1-\sigma} L = \left[\upsilon(z) P^{-\sigma} L + \phi(z) \right] W & \text{if } z \leq \bar{z} \\ \infty & \text{if } z > \bar{z} \end{cases}$$

$$I(\bar{z}) = \frac{1}{\sigma - 1} \left(\frac{\sigma}{\sigma - 1} W \right)^{-\sigma} L$$

$$W = \int_0^{\bar{z}} P(z)^{1-\sigma} dz$$

where $I(z) = \phi(z) \upsilon(z)^{\sigma - 1}$ *and* $Q(z) = P(z)^{-\sigma} L$.

- This system delivers prices $P(z)$, measure of active goods $\bar{z}$ and wage W
- Key exogenous elements: (i) market size L, and (ii) schedules $\phi(z)$ and $\upsilon(z)$

Comparative statics

Result 2. *An increase in market size L leads to*:

- *an increase in production $Q(z)$ of goods already produced,*
- *an increase in measure of goods produced $\bar{z}$, and*
- *an increase in wage W.*

Intuition: spread fixed costs over more units $\rightarrow$ lower average costs

Result 3. *A uniform fall in fixed costs by a factor of γ^{-1} with $\gamma > 1$ has the same equilibrium effects as an increase in market size by a factor of γ.*

Result 4. *A uniform fall in marginal costs by a factor of γ^{-1} with $\gamma > 1$ leads to:*

- *an increase in production $Q(z)$ of goods already produced by a factor of γ,*
- *no change in measure of goods produced $\bar{z}$, and*
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Normative properties

Result 5. *The social planner's allocation is characterized by the solutiont to:*

$$P^{SP}(z) = \begin{cases} \upsilon(z) W^{SP} & \text{if } z \leq \bar{z}^{SP} \\ \infty & \text{if } z > \bar{z}^{SP} \end{cases}$$

$$I\left(\bar{z}^{SP}\right) = \frac{1}{\sigma - 1}\left(W^{SP}\right)^{-\sigma} L$$

$$W^{SP}\left(1 - \frac{1}{L}\int_0^{\bar{z}^{SP}} \phi(z) dz\right) = \int_0^{\bar{z}^{SP}} P^{SP}(z)^{1-\sigma} dz$$

where $I(z) = \phi(z)\upsilon(z)^{\sigma-1}$ *and* $Q^{SP}(z) = P^{SP}(z)^{-\sigma} L$.

- Both production and entry margins are distorted:
  - Prices equal marginal cost instead of average cost
  - Planner values the entire consumer surplus instead of revenue

Result 6. *The market equilibrium is inefficient. It features an:*

- *insufficient product variety, i.e.,* $\bar{z} < \bar{z}^{SP}$, *and*
- *excessive production of goods with low cost-index, i.e.,* $Q(z) > Q^{SP}(z)$ *for low* z.

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- Both production and entry margins are distorted:
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Result 7. *The effects on the planner's allocation of an increase in market size L, of a uniform fall in fixed costs $\phi(z)$, or a uniform fall in marginal costs $\upsilon(z)$, are the same as in the market economy.*

Roadmap

1. The fixed-cost economy
2. **Understanding the rise of fixed costs**
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Fixed-cost shares

- Definitions ($t = year$):

$$F_t(z) \equiv \frac{\phi_t(z)}{\phi_t(z) + \upsilon_t(z) Q_t(z)} \quad \text{(fixed-cost share of good } z\text{)}$$

$$F_t \equiv \frac{1}{L_t} \int_0^{\bar{z}_t} \phi_t(z)\, dz \quad \text{(aggregate fixed-cost share)}$$

- How can we explain an increase from $F_{1980} \approx 0.17$ to $F_{2019} \approx 0.24$?

- From Results 2-4, fixed-cost shares are:
  - affected by changes in market size L or (uniform) changes in $\phi_t(z)$, but
  - unaffected by (uniform) changes in $\upsilon_t(z)$

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Intensive vs extensive margin growth

Result 7. *Suppose* $\frac{L_{2019}}{L_{1980}} = \gamma_L > 1$ *or* $\frac{\phi_{2019}(z)}{\phi_{1980}(z)} = \gamma_\phi < 1$*. Then* $\bar{z}_{2019} > \bar{z}_{1980}$*, and:*

$$F_{2019} - F_{1980} = \underbrace{(F^O_{2019} - F_{1980})}_{\text{intensive margin}} + \underbrace{\omega(F^N_{2019} - F^O_{2019})}_{\text{extensive margin}},$$

where:

- *O are goods such that* $z \leq \bar{z}_{1980}$; $1 - \omega$ *is their market share;*
- *N are goods such that* $\bar{z}_{1980} < z \leq \bar{z}_{2019}$; ω *is their market share.*

Moreover:

- *Intensive margin growth is negative,* $F^O_{2019} < F_{1980}$*;*
- *Extensive margin growth is positive,* $F^N_{2019} > F^O_{2019}$*.*

Takeaway: growth in "effective" market size $\gamma \equiv \frac{\gamma_L}{\gamma_\phi}$ has ambiguous effects on F

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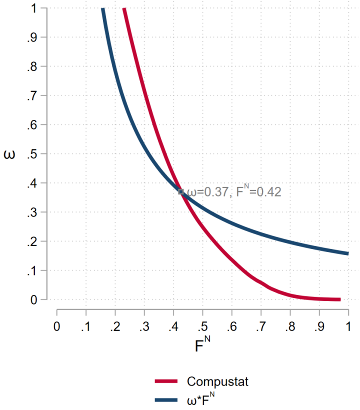
Intensive vs extensive margin growth

- We perform this procedure:
  1. Make an assumption about the growth in "effective" market size $\gamma \equiv \frac{\gamma_L}{\gamma_\phi}$
     - Increase in the US labor force: $\gamma_L = 1.6$
     - Three scenarios for technical change: $\gamma_\phi \in \{1, \frac{2}{3}, \frac{1}{2}\}$
     - **Therefore,** $\gamma \in \{1.6, 2.4, 3.2\}$
  2. Use two observations:
     - $F_{1980} = \gamma\,(1-\omega)\,F_{2019}^{O}$
     - $F_{2019} = (1-\omega)\,F_{2019}^{O} + \omega F_{2019}^{N}$
     - **Therefore:**

$$\omega F_{2019}^{N} = F_{2019} - \frac{F_{1980}}{\gamma} \in \{0.126, 0.157, 0.173\}$$

  3. Use Compustat data to decompose the product ωF_{2019}^{N} into its two components...

Intensive vs extensive margin growth



- Therefore, $\omega \in \{0.25, 0.37, 0.44\}$ and $F^N_{2019} \in \{0.5, 0.42, 0.39\}$

Intensive vs extensive margin growth

- Take the baseline scenario:
  - 63% of the goods produced in 2019 would have also been produced in 1980. As their markets grew, their average fixed-cost share declined from 17% to 11%.
  - 37% of the goods produced in 2019 would not have been produced in 1980. Their average fixed-cost share is 42%, about 4 times larger than that of old goods.

- Extensive and intensive margin growth:

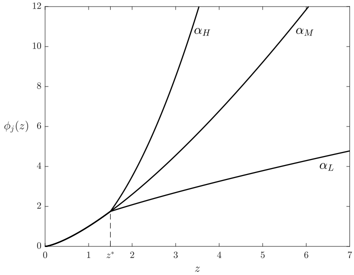
γ	Intensive margin growth	Extensive margin growth
1.6	−0.028	0.087
2.4	−0.058	0.117
3.2	−0.076	0.135

An illustrative example

- Consider three economies, low (L), medium (M) and high (H)
- Assume $v_j(z) = 1$ for all j, but:

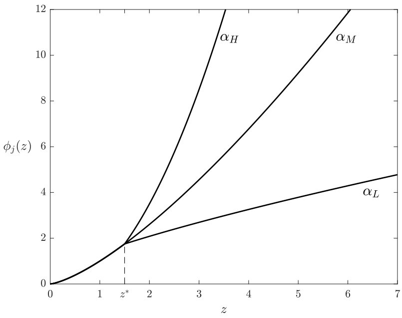
$$\phi_j(z) = \begin{cases} z^{\alpha_0} & \text{if } z \leq z^* \\ z^{\alpha_j} + \left(z^{*\alpha_0} - z^{*\alpha_j}\right) & \text{if } z > z^* \end{cases}$$

for $j \in \{L, M, H\}$, where $\alpha_H > \alpha_M = \alpha_0 > \alpha_L$

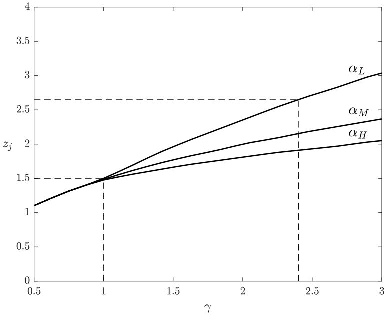


- Start at $z = z^*$, so that there is a common initial condition
- What are the effects of an increase in effective market size γ?

Extensive margin growth

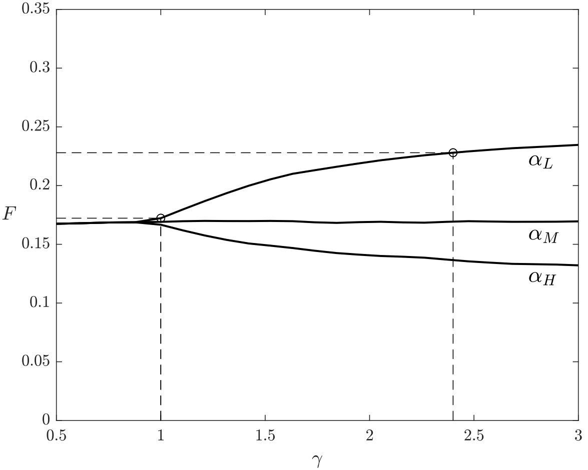


Fixed-cost schedule



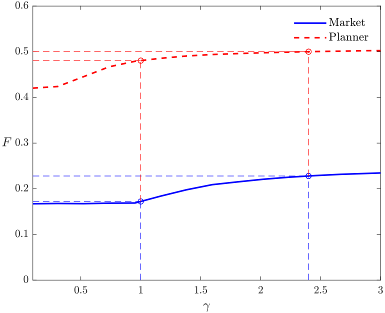
Marginal good

Aggregate fixed-cost share

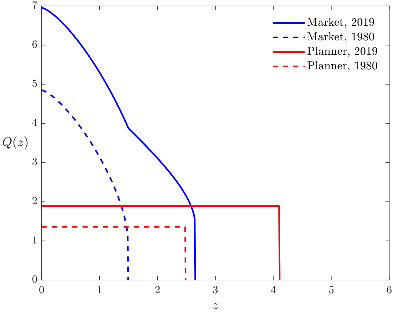


- Paradoxically, economy where ϕ rises slowest has the highest fixed-cost share!
- This example also gets F^O_{2019}, F^N_{2019} and ω roughly right for the $j = I$ economy

Inefficiencies



Panel a: Aggregate fixed-cost share



Panel b: Quantities produced

- Welfare loss sizeable: 14.3% in 1980, but declined to 12.7% in 2019

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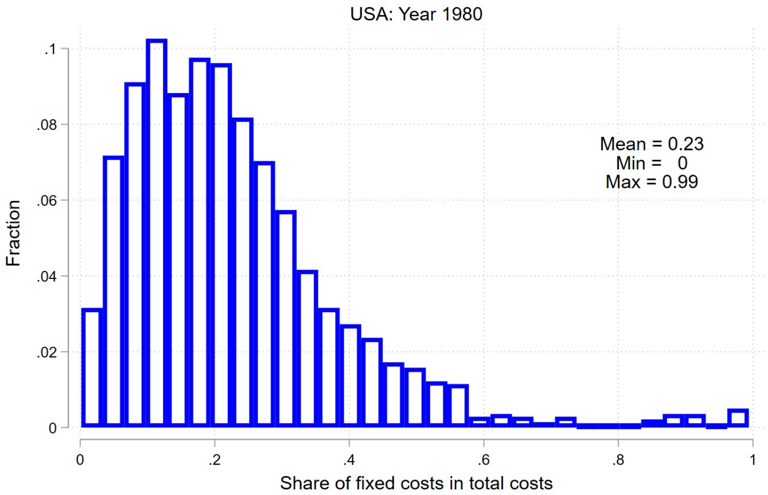
What have we learned?

- Questions:
  - What are the macroeconomic effects of fixed costs?
  - What factors could explain the observed rise in fixed costs?
- A tractable general-equilibrium model of the fixed-cost economy:
  - Increases in market size raise quantities produced, raise the measure of goods produced and wages (welfare).
  - Market equilibrium is inefficient since goods are priced at average cost and entry decisions do not value the entire consumer surplus. Inefficiencies appear sizable.
- The evolution of the aggregate fixed cost-share is the balance of intensive and extensive margins of growth. In a baseline scenario:
  - 63% of the goods produced in 2019 were also produced in 1980. As their markets grew, their average fixed-cost share declined from 17% to 11%.
  - 37% of the goods produced in 2019 were not produced in 1980. Their average fixed-cost share is 42%, about 4 times larger than old goods.
- On the agenda:
  - Role of multi-product firms, of geography, and of market power.

Appendix: additional evidence on fixed costs

Share of fixed costs in total costs (Worldscope)



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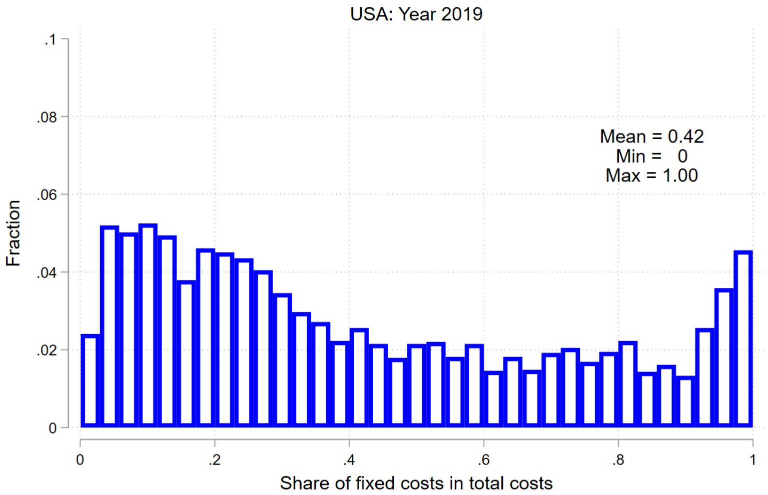

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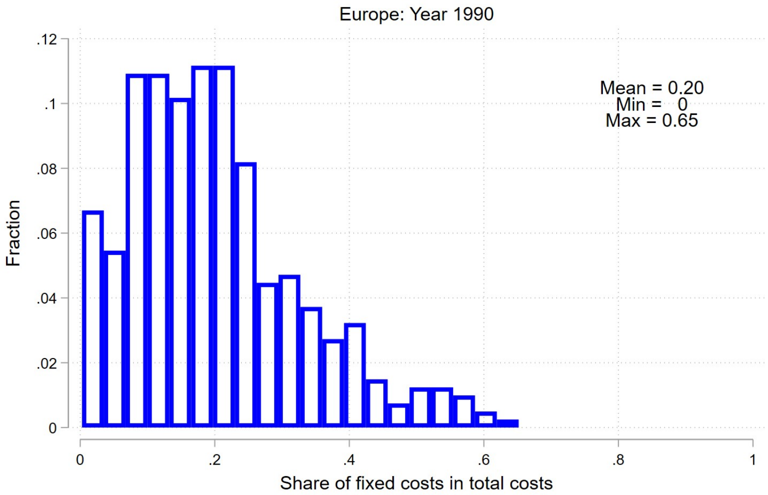

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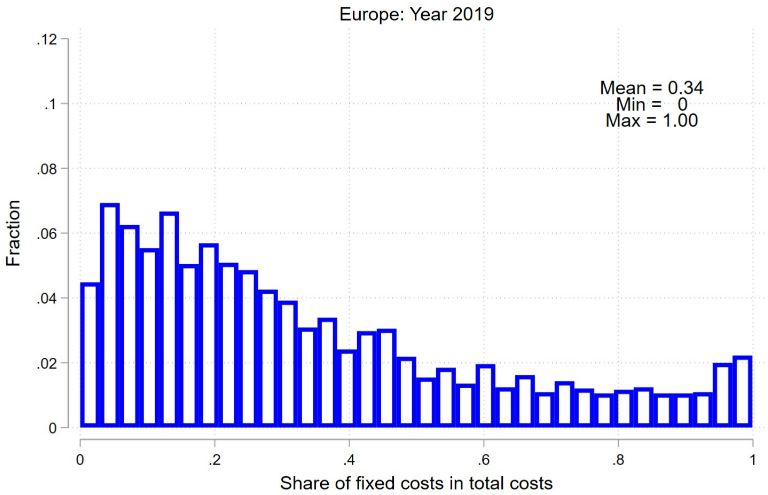

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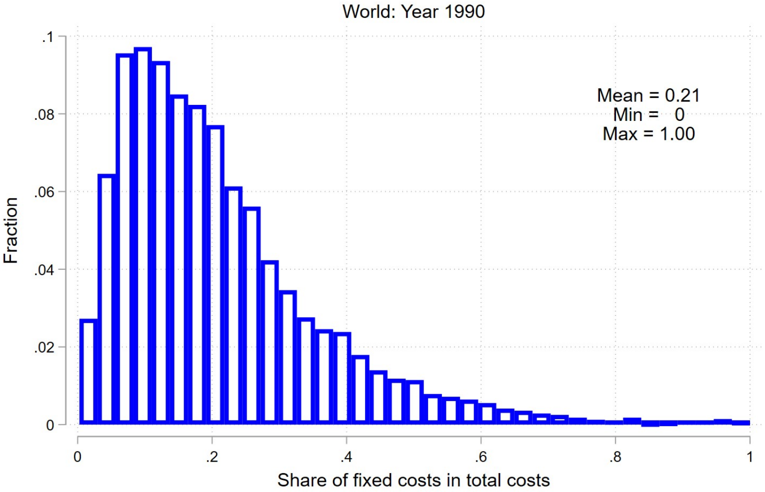

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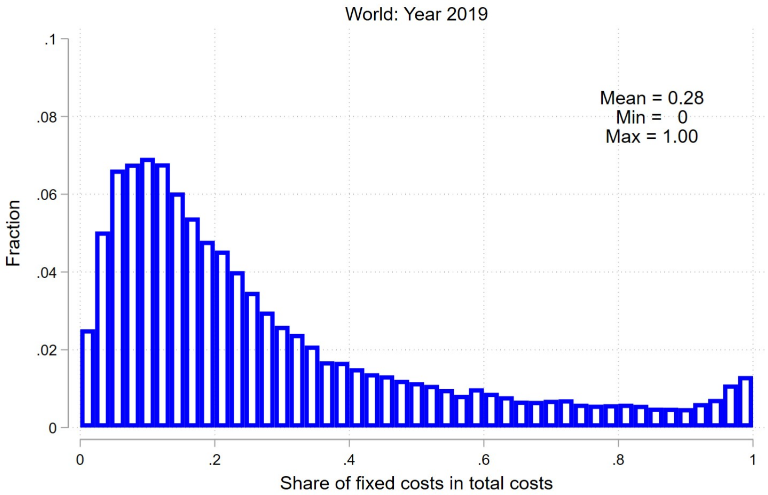

Sales and fixed costs, US (Compustat)

Table 1: Dependent variable: (Log) Sales

	(1)	(2)	(3)	(4)
Share of fixed costs in total costs	-4.859***	-5.113***	-5.602***	-5.948***
	(0.081)	(0.080)	(0.086)	(0.086)
Constant	13.382***	13.456***	13.599***	13.700***
	(0.031)	(0.031)	(0.032)	(0.031)
Observations	265413	265413	265413	265405
R-squared	0.167	0.210	0.251	0.307
Time FE	No	Yes	No	No
Industry FE	No	No	Yes	No
Industry-Time FE	No	No	No	Yes

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Markups, fixed costs and profits

- The markup (price over marginal cost) can be computed as:

$$\text{Markup} \equiv \frac{\text{sales}}{\text{variable costs}} = \frac{\text{total costs}}{\text{variable costs}} + \frac{\text{profits}}{\text{variable costs}}$$

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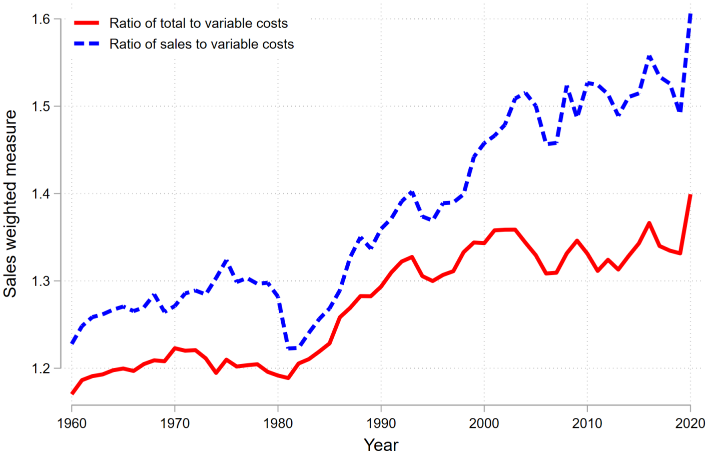

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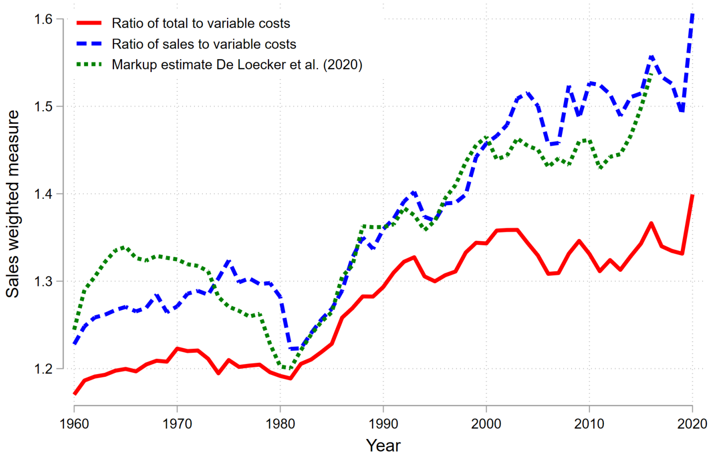


Markups, fixed costs and profits, US (Compustat)

Table 2: Growth decomposition 1960-2020

Period	Markup at the beginning of the period	Markup at the end of the period	% change in markup	Fixed costs contribution	Profits contribution
1960-2020	1.23	1.61	30.81	18.65	12.16
1980-2020	1.28	1.61	25.29	16.19	9.1

Sales and markups, US (Compustat)

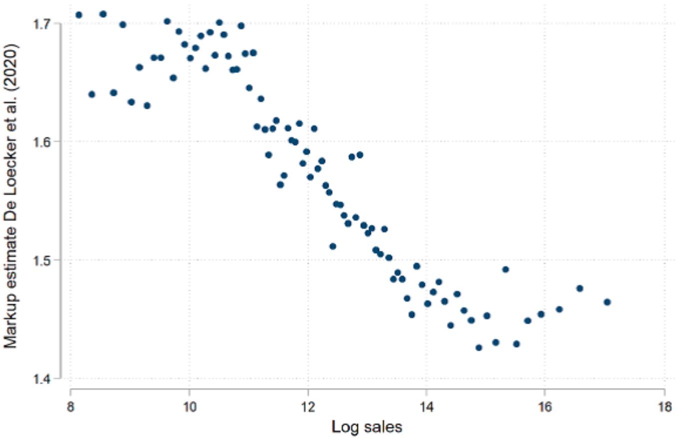
Table 3: Dependent variable: (log) sales

	(1)	(2)	(3)	(4)
Markup estimate De Loecker et al. (2020)	-0.147***	-0.165***	-0.092***	-0.102***
	(0.015)	(0.015)	(0.015)	(0.015)
Constant	12.184***	12.212***	12.098***	12.114***
	(0.034)	(0.033)	(0.033)	(0.033)
Observations	244419	244419	244419	244412
R-squared	0.004	0.036	0.062	0.103
Time FE	No	Yes	No	No
Industry FE	No	No	Yes	No
Industry-Time FE	No	No	No	Yes

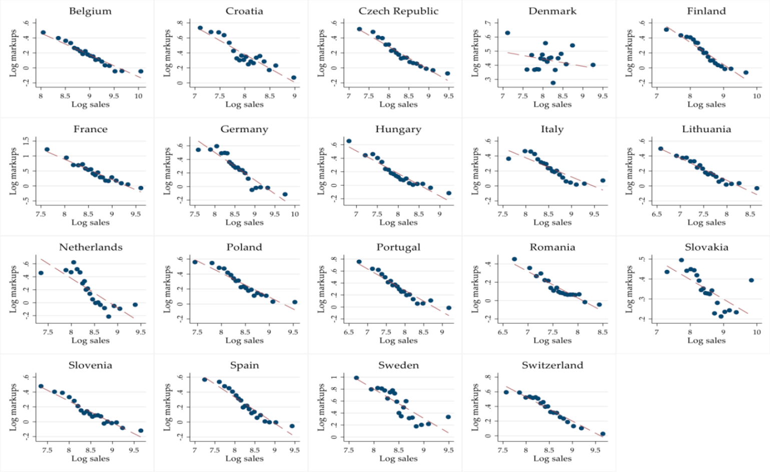
Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Sales and markups, US (Compustat)



Sales and markups in Europe, di Mauro et al. (2023)



Literature review (incomplete!)

- Documenting the rise of fixed costs:
  - De Loecker, Eeckhout, and Unger (2020), Abraham, Bormans, Konings, and Roeger (2020), Sandström (2020), Saibene (2017), De Ridder (2022), Hsieh and Rossi-Hansberg (2023)
- Modeling fixed costs with free entry:
  - Dixit and Stiglitz (1977), Krugman (1980), Baumol (1982), Baumol, Panzer, and Willig (1982), Gilbert (1989)
- Modeling product heterogeneity with free entry:
  - Hopenhayn (1992), Melitz (2003)

Fixed-cost shares across goods