The Micro–Agregated Profit Share

Tecnológico de Monterrey

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March 21, 2025

Motivation

Growing interest in evolution of market power, aggregate profits, and their connection

- Important for antitrust, taxation, and redistribution
- Important for understanding evolution of income shares

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2. Aggregation

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1. Measurement
2. Aggregation
3. No link between indicators of aggregate market power and profit share

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This Paper

1. Theory: Provide this connection, resolve aggregation issues, measurement progress
2. Empirics: New estimates for US

Questions & Main Findings

How much has market power increased in the US in the last 50 years?

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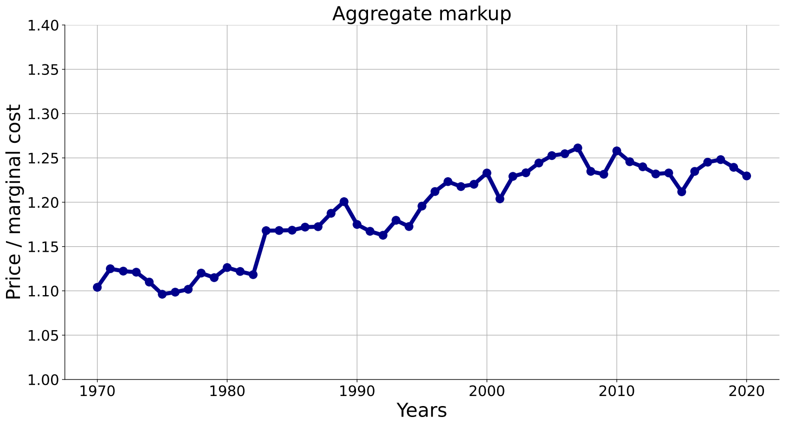
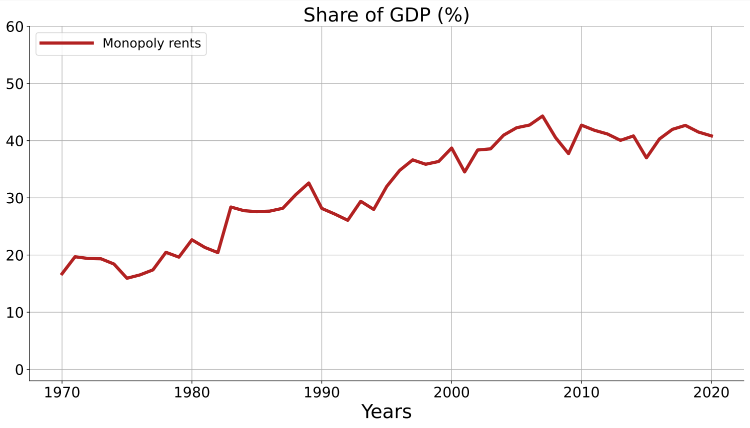
1. Agg. markup increased from 10% of price over marginal cost in 1970 to 23% in 2020



Questions & Main Findings

- Because of rising markups, monopoly rents increased from 18% in 1970 to 40% in 2020



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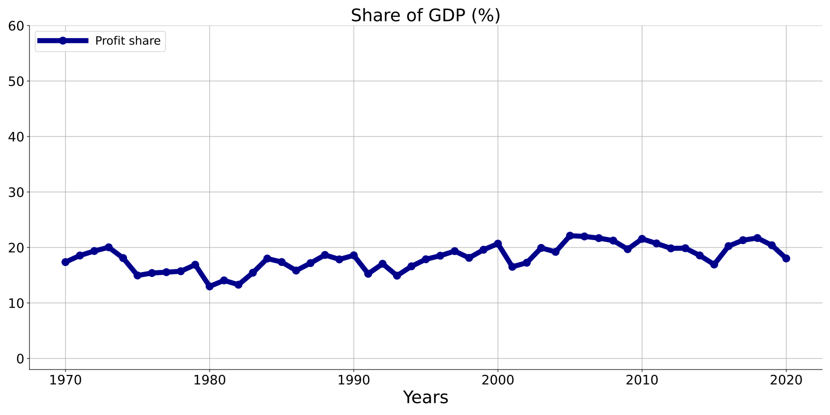

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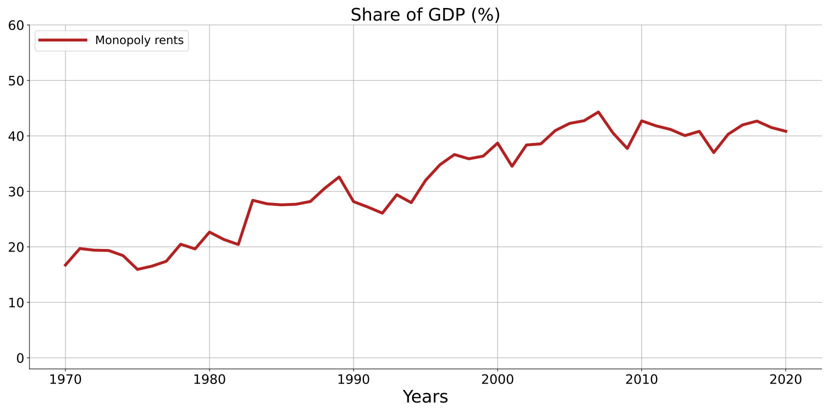
- How is this possible?: Monopoly rents increased because of rising markups



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What happened to aggregate profits?

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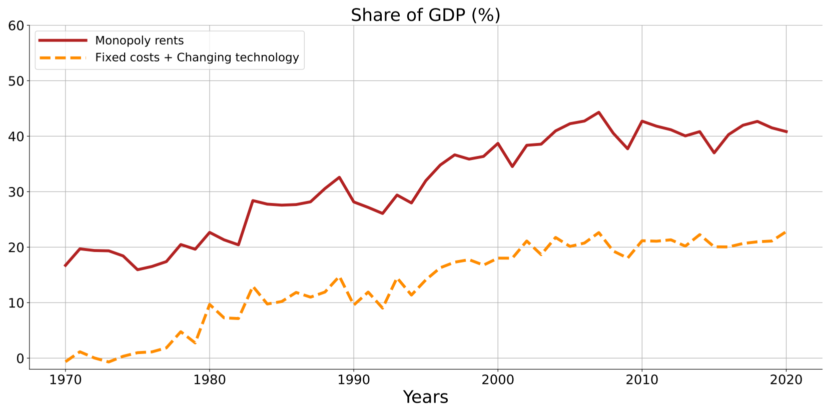
    - Simultaneously, fixed costs increased and technology changed



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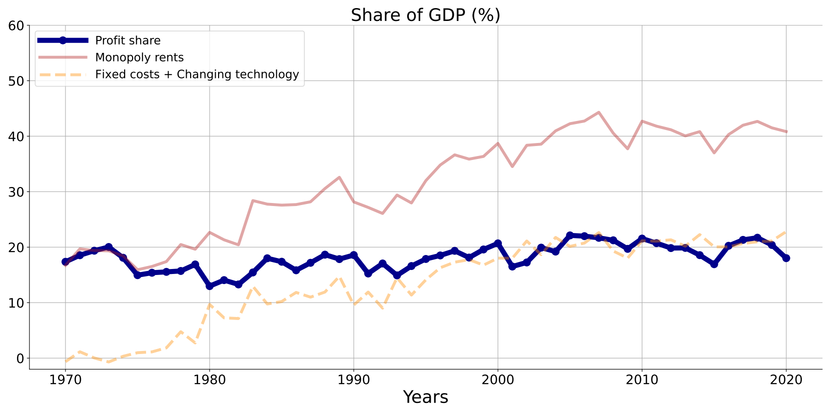

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   - Do sanity checks on micro estimates of markups, markdowns, returns to scale
   - Calibrate models with monopolistic and monopsonistic “wedges”

Related Literature

- **Functional Distribution of Income.** Elsby Hobijn Sahin 2013; Karabarbounis Neiman 2014, 2019; Barkai 2020; Kehrig Vincent 2021; Eggertson Robbins Wold 2021; ...

  + New method to construct profit share

- **Market Power & Macroeconomics.** Basu 2019; De Ridder 2019, 2024; De Loecker Eeckhout Unger 2020; Gutierrez Jones Philippon 2021; Edmond Midrigan Xu 2023; Hsieh Rossi-Hansberg 2023; ...

  + Provide link between aggregate indicators of market power and profit share
    (allowing for arbitrary IO networks, returns to scale, explicit fixed costs, monopsony)

- **Production Networks.** Quesnay 1758; Leontief 1951, 1966; Hulten 1978; Long Ploser 1983; Acemoglu Akcigit Kerr 2016; Grassi 2017; Baqaee Farhi 2019, 2020, 2022, 2024; ...

  + Clarify role of production networks in profit share

Rest of the Talk

1. Theory
    - Constructing the Profit Share (Macro vs. Micro Approach)
    - The Micro Approach
        - Obtaining profit rates
        - Aggregating profit rates
        - Linking the profit share to indicators of aggregate market power
2. Empirics
    - Data and Methodology
    - Results for the United States (1970–2020) [No Monopsony]
3. Conclusion

Theory

The Macro Approach

- Macro approach backs out profit share from National Accounts:

$$\underbrace{\text{GDP}}_{\text{Value added}} = \underbrace{WL}_{\text{Labor income}} + \underbrace{RK}_{\text{Capital income}} + \text{Wedge income}$$

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- **Profit share calculated by imputing/estimating user cost of capital,** R

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  - Need to use Domar weights (= producer sales / GDP)
    - Sufficient statistics for production networks that capture double marginalization

Network Example

- Economic profits not observable
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  - Economic profits = Revenues − Opportunity costs
- To make progress, assumptions on producer behavior & technology required

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- **Markets clear**: $y_i = c_i + \sum_{j \in \mathcal{N} \setminus \mathcal{F}} x_{ji}$

Obtaining Profit Rates

Proposition 1': Economic Profit Rate (No Monopsony) ▸ RS & FC

Assume cost minimization and a production function that satisfies standard regularity conditions.

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Assume cost minimization and a production function that satisfies standard regularity conditions. Then, the profit rate (defined as profits over sales) of a *monopolist* producer can be written as

$$s_\pi = 1 - \underbrace{\frac{\text{RS}}{\mu}}_{\text{monopoly term}},$$

where $\mu := p/\text{mc}$ is the markup, and $\text{RS} := \text{ac}/\text{mc}$ are returns to scale, which are given by

$$\text{RS} = \underbrace{SE}_{\text{scale elasticity}} \times \underbrace{\left(\frac{\text{Total Costs}}{\text{Total Costs} - \text{Fixed Costs}}\right)}_{\text{fixed-costs adjustment factor}} \equiv \text{SE}^{\text{adj}}.$$

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- Generalizes Basu–Fernald allowing for fixed costs

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▸ Proof ▸ Markdowns ▸ $\mathrm{RS} = \mathrm{SE}^{\mathrm{adj}} - \mathcal{M}$

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- Generalizes Basu–Fernald allowing for fixed costs + market power in factor markets

Aggregating Profit Rates

Lemma

If individual profit rates (defined as profits over sales) are aggregated using Domar weights (defined as sales over GDP), then Micro and Macro approaches both yield the profit share.

▸ Alternative aggregation scheme ▸ Intuition for Domar weights ▸ Math behind Domar weights

Proof.

$$\Lambda_{\Pi}^{\text{Macro}} = \frac{\Pi}{\text{GDP}}$$

Π: total profits

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Π: total profits π_i: producer i's profits s_π: profit rate (profits over sales) py: sales

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Proof.

$$\Lambda_{\Pi}^{\text{Macro}} = \frac{\Pi}{\text{GDP}} = \frac{\sum_{i\in\mathcal{I}} \pi_i}{\text{GDP}} = \frac{\sum_i s_{\pi_i} p_i y_i}{\text{GDP}} = \sum_{i\in\mathcal{I}} \underbrace{\frac{p_i y_i}{\text{GDP}}}_{\text{Domar weight}} \times s_{\pi_i}$$

Π: total profits $\quad$ π_i: producer i's profits $\quad$ s_π: profit rate (profits over sales) $\quad$ py: sales

Aggregating Profit Rates

Lemma

If individual profit rates (defined as profits over sales) are aggregated using Domar weights (defined as sales over GDP), then Micro and Macro approaches both yield the profit share. ▸ Alternative aggregation scheme ▸ Intuition for Domar weights ▸ Math behind Domar weights

Proof.

$$\Lambda_{\Pi}^{\text{Macro}} = \frac{\Pi}{\text{GDP}} = \frac{\sum_{i \in \mathcal{I}} \pi_i}{\text{GDP}} = \frac{\sum_i s_{\pi_i} p_i y_i}{\text{GDP}} = \sum_{i \in \mathcal{I}} \underbrace{\frac{p_i y_i}{\text{GDP}}}_{\text{Domar weight}} \times s_{\pi_i} \equiv \Lambda_{\Pi}^{\text{Micro, DW}}.$$

Π: total profits π_i: producer i's profits s_π: profit rate (profits over sales) py: sales

Main Theoretical Result

Theorem: The Profit Share & Market-Power Indicators

With cost-minimizer producers, each of which operates a production function that satisfies standard regularity conditions, the profit share (defined as profits over aggregate value added) can be expressed as

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where $\chi = \text{Sales}/\text{GDP}$ is the input-output multiplier, $\overline{\mathsf{SE}}^{\text{adj}}$ is the sales-weighted scale elasticity (adjusted for fixed costs), $\overline{\mu}_{\text{hsw}}$ is the harmonic sales-weighted markup (Baqaee Farhi 2020; Edmond Midrigan Xu 2023)

$$\overline{\mu}_{\text{hsw}} = \left(\sum_i \frac{p_i y_i}{\sum_j p_j y_j} \times \frac{1}{\mu_i}\right)^{-1}$$

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$$\overline{\mathcal{M}} = \sum_i \frac{p_i y_i}{\sum_j p_j y_j} \left\{ \left(\frac{\mathsf{TC}_i}{\mathsf{TC}_i - \mathsf{FC}_i} \right) \sum_j \theta_{ij} (1 - \nu_{ij}) \right\}$$

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With cost-minimizer producers, each of which operates a production function that satisfies standard regularity conditions, the profit share (defined as profits over aggregate value added) can be expressed as

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▶ Special cases: ▸ No Monopsony ($\overline{\mathrm{RS}} = \overline{\mathrm{SE}}^{\mathrm{adj}}$) ▸ No Monopsony, No fixed costs, CRS

Why Is This Theorem Useful?

1. Assess origins of market power (monopoly vs. monopsony)at desired level of aggregation

▸ Profit share decomposition

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5. Calibrate models with monopolistic and monopsonistic "wedges"

▸ Networks & Inference

Empirics

Data

Firm-level data from US Compustat:

- Publicly-traded firms
- Annual data from 1970–2020 with 20 (2-digit) NAICS industries
- Data on:
  - Sales (SALE)
  - Cost of goods sold (COGS): Labor compensation + Materials
  - Selling, general, and administrative expenses $(\mathrm{SG\&A})$
  - Physical capital (PPEGT)
  - Investment in physical capital (CAPX)
  - Intangible capital $(\mathrm{K\_INT})$ following Peters and Taylor (2017)
  - R&D following Peters and Taylor (2017)

Methodology: Producer Theory

Cost Minimization (No Monopsony)

$$\begin{aligned} \min \quad & \mathsf{TC}_{it} \equiv \underbrace{p^v_{it} v_{it} + r_{it} k_{it}}_{\text{production-related costs}} + \underbrace{\mathsf{FC}_{it}}_{\text{non-production costs}} \\ \text{s.t.} \quad & y_{it} = F_i\left(v_{it}, k_{it}; \omega_{it}\right) \geq \overline{y}_{it} \end{aligned}$$

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FOC for variable input yields markup:

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- Output price over marginal cost
- Output elasticity wrt variable input
- Inverse revenue share of variable cost

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Returns to scale: $\mathsf{RS}_{it} = \underbrace{\left(\theta^v_{it} + \theta^k_{it}\right)}_{\substack{\equiv \mathsf{SE}_{it} \\ \text{(scale elasticity)}}} \times \underbrace{\left(\frac{\mathsf{TC}_{it}}{\mathsf{TC}_{it} - \mathsf{FC}_{it}}\right)}_{\text{fixed-cost adjustment factor}}$

Methodology: Producer Function Estimation

- Use control function approach to get output elasticities

  (Olley and Pakes 1996, Levinsohn Petrin 2003, De Loecker Warzynski 2012, Ackerberg Caves Frazer 2015,...)

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- Estimation at (2-digit NAICS) industry level, allowing for time-varying technologies so that elasticities and returns to scale can vary over time
  1. Get *revenue* elasticities $\{\hat{\theta}^v_{jt}, \hat{\theta}^k_{jt}\}$ for each industry j
  2. Compute markups and returns to scale $\{\mu_{it}, \mathrm{RS}_{it}\}$ for each firm i

PFE Details | Biases: Revenue vs. Output Elasticities

Markups, RS, & Profit Shares: $\Lambda_\Pi = \chi\left(1 - \frac{\overline{\mathsf{RS}}}{\overline{\mu}_{\mathsf{hsw}}} - \mathsf{Cov}_\omega\left[\mathsf{RS}, \frac{1}{\mu}\right]\right)$

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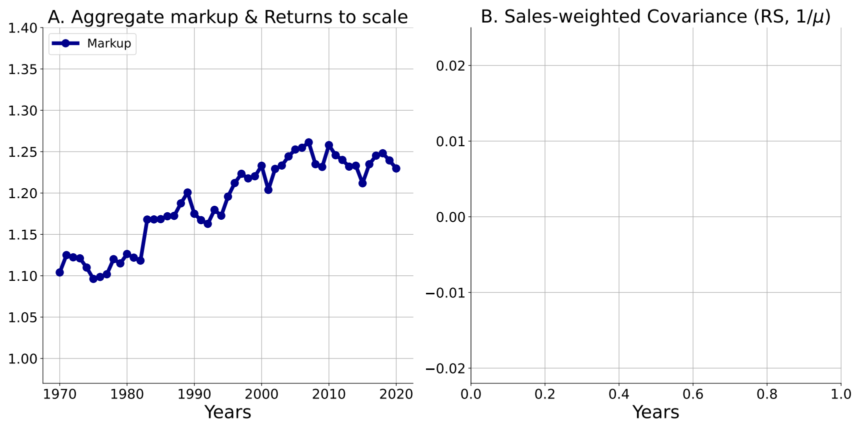
- Harmonic sales-weighted markup increasing since 1970 ▸ Decomposition ▸ Distribution ▸ DEU



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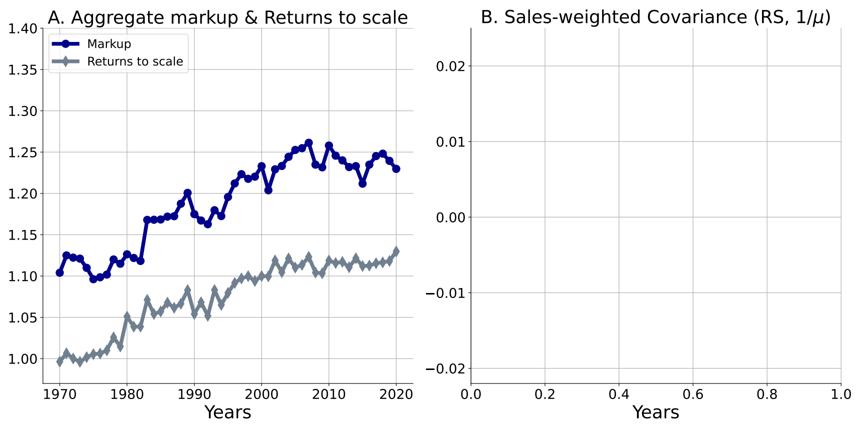

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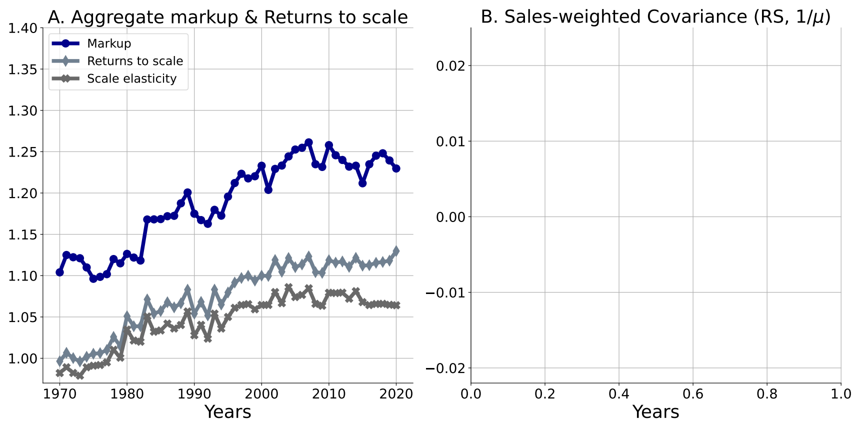
- Scale elasticity increased from around 0.98 to 1.06 (RS = SE × FC adj. factor) ▸ RS & FC



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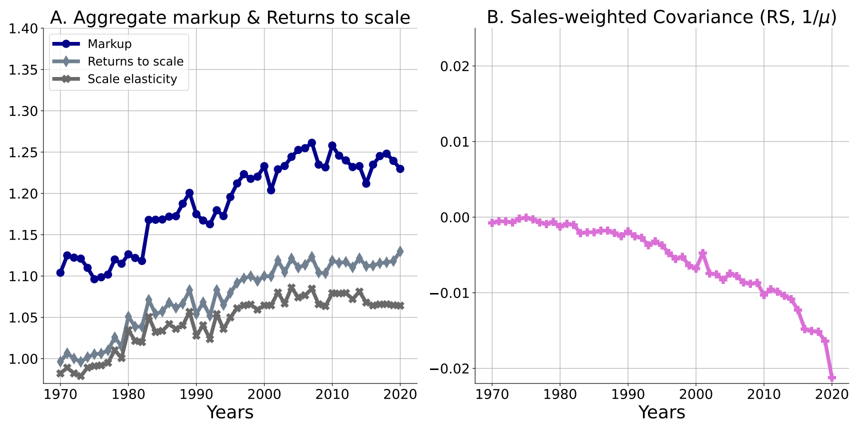
- Small negative correlation between returns to scale and inverse markups ▸ IO term



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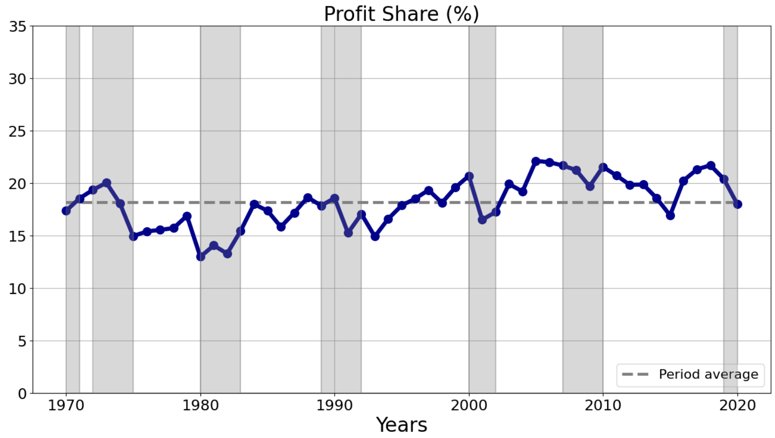
Profit share in the US has been roughly constant at around 18%

(consistent with average profit rate of 10% because of double marginalization)



Profit Share Decomposition: $\Lambda_\Pi = \chi\left(1 - \frac{\overline{\text{RS}}}{\overline{\mu}_{\text{hsw}}} - \text{Cov}_\omega\left[\text{RS}, \frac{1}{\mu}\right]\right)$

- We can decompose profit share into several sources of market power:

$$\Lambda_\Pi = \underbrace{\chi\left(1 - \frac{1}{\overline{\mu}_{\text{hsw}}}\right)}_{\text{Monopoly rents}} + \underbrace{\chi\left\{\left(\frac{1}{\overline{\mu}_{\text{hsw}}} - 1\right)(1 - \text{RS}) - \text{Cov}_\omega\left[\text{RS}, \frac{1}{\mu}\right]\right\}}_{\text{Non-linearities}} - \underbrace{\chi(\text{RS} - 1)}_{\substack{\text{Fixed costs \&} \\ \text{Changing technology}}}$$

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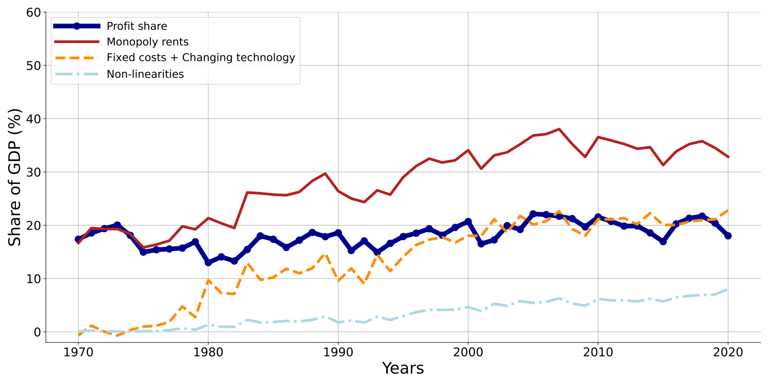

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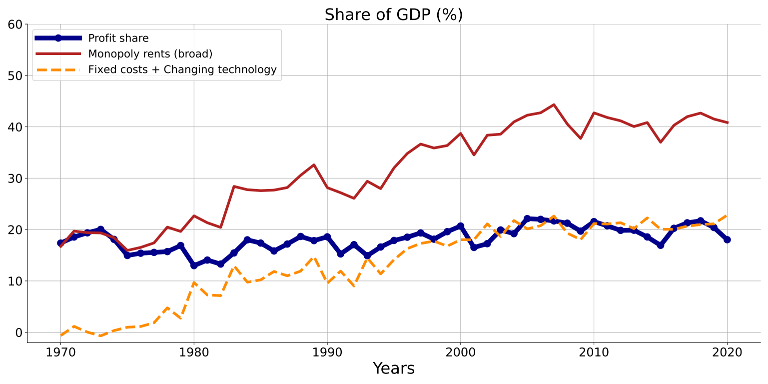

Additional Results

1. Industry-level Heterogeneity: ▸ 2019 Scatter plot ▸ Markups ▸ Returns to scale
2. Markup Heterogeneity: ▸ Distribution ▸ Percentiles ▸ Decomposition
3. Robustness: ▸ No intangibles ▸ OPEX vs. COGS ▸ DEU (2020) Replication
4. Benchmarking: ▸ Micro vs. Macro Approach ▸ DEU (2020) markup comparison
5. Implications for Income Shares: ▸ See
6. Basu–DEU Controversy: ▸ See
7. Profit Share and the User Cost of Capital: ▸ Details
8. Profit Share Decomposition for US Census of Manufactures: Work in Progress

Conclusion

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- We construct profit share from micro-level data using novel theoretical results:
    1. Profit share as Domar-weighted profit rates
    2. Genereal expression for profit rate in terms of monopoly and monopsony terms
    3. Aggregation theorem linking profit share to several indicators of aggregate market power—markup, markdowns, returns to scale—and a sufficient statistic for production networks

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  3. Aggregation theorem linking profit share to several indicators of aggregate market power—markup, markdowns, returns to scale—and a sufficient statistic for production networks

- **Main theoretical result clarifies existing controversies and allows us to:**
  - Assess origins of profits (monopoly vs. monopsony) at desired level of aggregation.
  - Understand determinants of profits (monopoly + monopsony + fixed costs + technology)
  - Use aggregate measures of markup, markdowns, and returns to scale
  - Assess external validity of micro estimates of markups, markdowns, and returns to scale
  - Calibrate models with monopolistic and monopsonistic wedges

Conclusion

- Using micro-data for the United States, we document that from 1970 to 2020:
  1. Several indicators of market power have increased
     - Aggregate markup has increased from 10% of price over marginal cost to 23%
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     - Increase in monopoly rents completely offset by rising fixed costs and changing technology
- To make these points, we need our theoretical results + micro data

Questions?

Thank You!

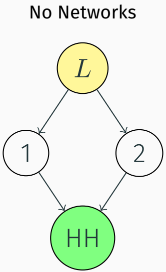
(Email: luisperez@smu.edu)

(Website: `https://luisperezecon.com`)

Appendix

Simple Example: Profit Share and Production Networks

- Two producers, $i \in \{1, 2\}$, each with profit rate $s_{\pi_i} = 0.10$



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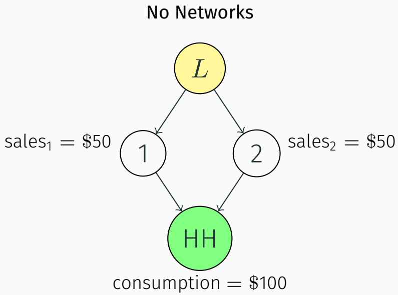

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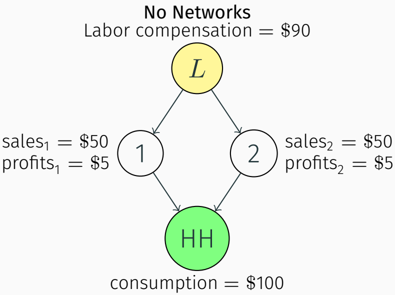

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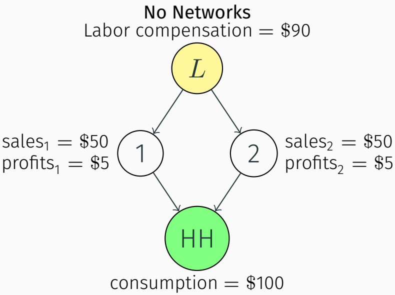

$$\Lambda_{\Pi}^{\text{Macro}} = \frac{\text{Profits}}{\text{Value added}} = 0.10$$

Simple Example: Profit Share and Production Networks

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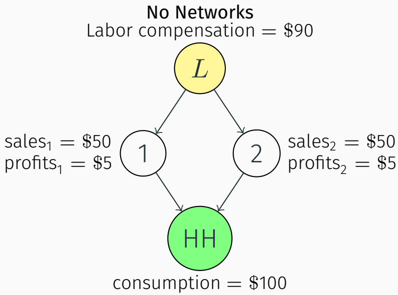

$$\Lambda_{\Pi}^{\text{Macro}} = \frac{\text{Profits}}{\text{Value added}} = 0.10$$

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Back to Micro Approach
Back to Lemma

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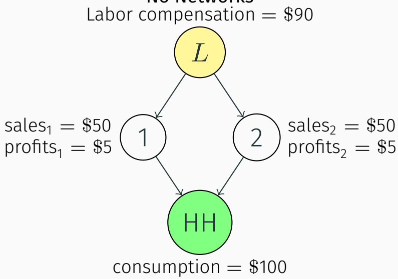

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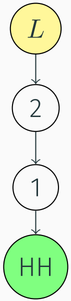

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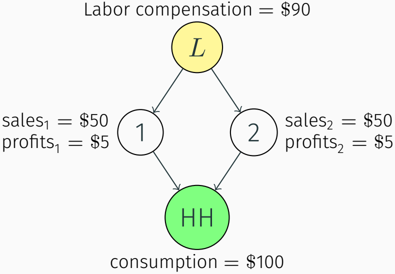

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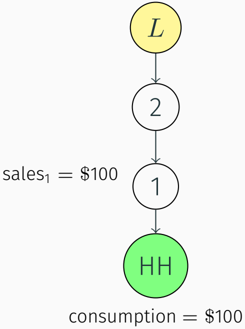

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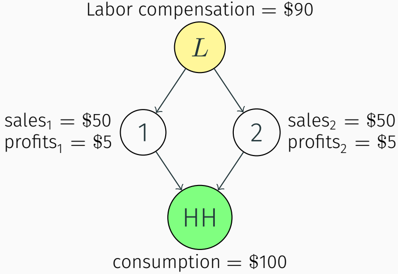

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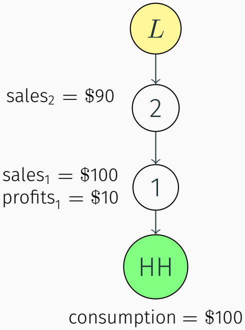

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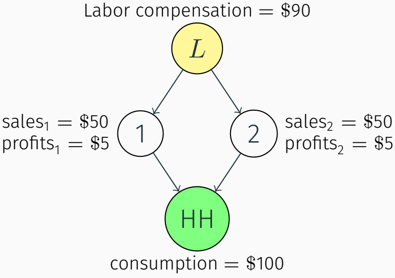

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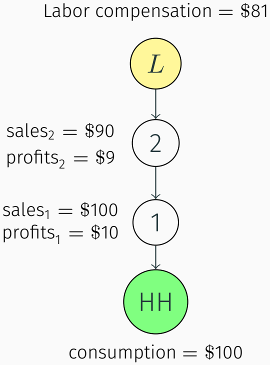

Simple Example: Profit Share and Production Networks

Back to Micro Approach Back to Lemma

- Two producers, $i \in \{1, 2\}$, each with profit rate $s_{\pi_i} = 0.10$

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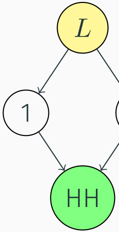
Labor compensation $= \$90$



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sales$_2 = \$50$
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consumption $= \$100$

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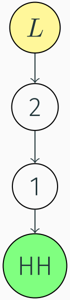

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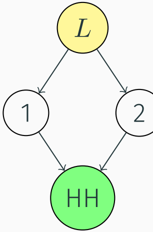

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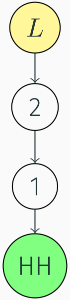

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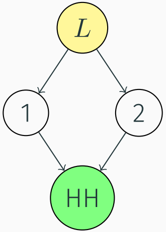

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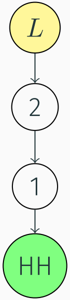

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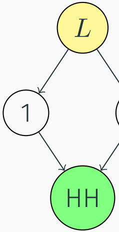

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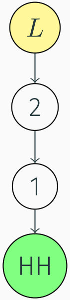

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Other weights do not generally work
(cost shares, VA shares, etc.)

Alternative Aggregation Scheme

- Use of Domar weights crucially relies on employed notion of profit rate
- If profit rate defined as profits divided by value added (instead of sales), then aggregation calls for value-added weights:

$$\begin{aligned}
\Lambda_{\Pi}^{\text{Macro}} &= \frac{\Pi}{\text{GDP}} \\
&= \frac{\sum_i \pi_i}{\text{GDP}} \\
&= \sum_i \underbrace{\frac{\text{VA}_i}{\text{GDP}}}_{\text{VA shares}} \times \underbrace{\frac{\pi_i}{\text{VA}_i}}_{\equiv s_{\pi_i}^{\text{VA}}} \equiv \Lambda_{\Pi}^{\text{Micro,VA}}
\end{aligned}$$

Π: total profits π_i: producer i's profits s_{π}^{VA}: profit rate (profits over value added)

Back

Math behind Domar Weights

Back

- Market clearing requires:

$$
\begin{aligned}
y_i &= \sum_j x_{ji} + c_i \\
\iff \qquad p_i y_i &= \sum_j p_i x_{ji} + p_i c_i \\
&= \sum_j \underbrace{\frac{p_i x_{ji}}{p_j y_j}}_{\equiv \Omega_{ji}} \times p_j y_j + p_i c_i
\end{aligned}
$$

i, j: producer indices $\quad$ y: gross output $\quad$ x_{ji}: producer j's demand of i $\quad$ c: final demand $\quad$ p: price

- Divide by GDP and write in matrix form:

$$
\lambda_i = \sum_j \Omega_{ji} \underbrace{\frac{p_j y_j}{\text{GDP}}}_{\equiv \lambda_j} + \underbrace{\frac{p_i c_i}{\text{GDP}}}_{\equiv b_i} \qquad \Longrightarrow \qquad \lambda' = b'(I - \Omega)^{-1} = b' + b'\Omega + b'\Omega^2 + \cdots
$$

Link Between Increasing Returns and Fixed Costs

- We think of firms as facing two types of fixed costs:
    1. Non-production related (eg, R&D, licensing and regulatory costs)

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- Example illustrates how production-related FC may be captured by scale elasticity:
  - For simplicity, assume there are *only* production-related fixed costs, so that $RS = SE$

Link Between Increasing Returns and Fixed Costs

- Suppose there is a firm that produces according to

$$y = \begin{cases} A(k - \overline{k})^{\alpha}, & k > \overline{k} > 0 \\ 0, & \text{otherwise} \end{cases}$$

A: productivity $\quad$ k: capital $\quad$ $\overline{k}$: minimum capital requirement $\quad$ α: governs returns to scale

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- $\text{RS} = \text{SE}$ *if and only if* there are only production-related fixed costs
- Thus, if $\alpha = 1$ and $k > \bar{k} > 0$, there are IRS because of fixed costs

▸ Back to Profit Rates ▸ Back to Empirics

Proof of Proposition 1

- Cost minimization problem of producer i:

$$\min_{\mathbf{x}_i \geq 0} \quad \mathsf{TC}_i \equiv \sum_{j \in \mathcal{N}} w_j(x_{ij})x_{ij} + \mathsf{FC}_i$$

$$\text{s.t.} \quad y_i = F_i\left(\{x_{ij}\}_{j\in\mathcal{N}}; A_i\right) \geq \overline{y}_i$$

TC: total costs $w_j(x_{ij})$: rental rate of input j which depends on quantity demanded by i, x_{ij} FC: fixed costs
F: production function $\mathcal{N}$: Set of inputs A: productivity parameter $\overline{y}$: minimum output requirement

- Generic FOC (interior demand of input j) + Envelope Theorem + Duality:

$$w_j(x_{ij})x_{ij} = \mathsf{mc}_i y_i \theta_{ij} \nu_{ij}$$

mc: marginal cost $\theta_{ij} \equiv \frac{\partial F_i}{\partial x_{ij}} \frac{x_{ij}}{y_i}$: elasticity of output wrt input j $\nu_{ij} \equiv \frac{w_j}{\mathsf{MRP}_{ij}}$: markdown of producer i on j

Proof of Proposition 1

- Summing over all inputs j:

$$\sum_j w_j(x_{ij})x_{ij} = \mathsf{mc}_i y_i \left(\sum_j \theta_{ij}\nu_{ij} \right)$$

- Doing some algebraic manipulations:

$$\sum_j w_j(x_{ij})x_{ij} = \mathsf{mc}_i y_i \left(\mathsf{SE}_i - \sum_j \theta_{ij}\{1-\nu_{ij}\} \right),$$

where SE is the scale elasticity.

- Using definition of markup, we can write producer i's profit rate as:

$$s_{\pi_i} = 1 - \frac{\mathsf{SE}_i}{\mu_i}\left(\frac{\mathsf{TC}_i}{\mathsf{TC}_i - \mathsf{FC}_i}\right) + \frac{1}{\mu_i}\left(\frac{\mathsf{TC}_i}{\mathsf{TC}_i - \mathsf{FC}_i}\right)\sum_j \theta_{ij}(1-\nu_{ij})$$

Back

Production Function Approach

- Focus on input whose markdown we want to obtain—say, labor ℓ
- Write conditional cost-minimization problem for that input:

$$\begin{aligned} \min_{\ell_t \geq 0} \quad & w_t(\ell_t)\ell_t \\ \text{s.t.} \quad & y_t = F(\ell_t, \mathbf{X}^*_{-\ell,t}; \omega_t) \geq \overline{y}_t, \end{aligned} \tag{1}$$

  where $w_t(\ell_t)$ is the wage, which depends on quantity demanded, and $\mathbf{X}^*_{-\ell,t}$ is vector of optimized inputs other than ℓ_t
- Let λ_t be the Lagrange multiplier associated with the constraint and take FOC:

$$\left[1 + \frac{w_t'(\ell_t)\ell_t}{w_t(\ell_t)}\right] = \lambda_t \times \frac{\partial F(\ell_t, \mathbf{X}^*_{-\ell,t})/\partial \ell_t}{w_t(\ell_t)} \tag{2}$$

Production Function Approach: Markdowns

- Letting

$$\varepsilon_{St}^{-1} = \left.\frac{w_t'(\ell_t)\ell_t}{w_t(\ell_t)}\right|_{\ell=\ell^*} \tag{3}$$

denote the firm's perceived (inverse) elasticity of labor supply, we can write FOC (2) as

$$1 + \varepsilon_{St}^{-1} = \frac{\lambda_t}{p_t} \times \frac{\partial F(\ell_t, \mathbf{X}^*_{-\ell,t})}{\partial \ell_t}\frac{\ell_t}{y_t} \times \frac{p_t y_t}{w_t(\ell_t)\ell_t}$$

- Using duality arguments, we can write the labor markdown $\nu \equiv (1 + \varepsilon_S^{-1})^{-1}$. Hence,

$$\frac{1}{\nu_t} = \underbrace{\mu_t^{-1}}_{\substack{\text{inverse}\\\text{markup}}} \times \underbrace{\frac{\theta_t^\ell}{\alpha_t^\ell}}_{\substack{\text{labor's output elasticity}\\\text{divided by its revenue share}}}$$

Duality Back

Markdowns and Duality

- Conditional profit-maximization problem:

$$\max_{\ell_t \geq 0} \quad R_t(\ell_t) - w_t(\ell_t)\ell_t,$$

where $R_t(\ell_t) \equiv \text{rev}(\ell_t, \mathbf{X}^*_{-\ell,t}(\ell))$ is revenue function with all inputs other than labor at optimum

- FOC:

$$R'_t(\ell^*_t) = \left[1 + \underbrace{\frac{w'_t(\ell^*_t)\ell^*_t}{w_t(\ell^*_t)}}_{\equiv \varepsilon^{-1}_{St}}\right] w_t(\ell^*_t)$$

- Defining markdown ν as ratio of rental rate to MRPL, we have

$$\nu_t := \frac{w_t(\ell^*_t)}{R'_t(\ell^*_t)} = (1 + \varepsilon^{-1}_{St})^{-1}$$

Back

Returns to Scale

- Recall cost-minimization problem:

$$\min_{\mathbf{x}_i \geq 0} \quad \mathsf{TC}_i \equiv \sum_{j \in \mathcal{N}} w_j(x_{ij}) x_{ij} + \mathsf{FC}_i$$

$$\text{s.t.} \quad y_i = F_i\left(\{x_{ij}\}_{j \in \mathcal{N}}; A_i\right) \geq \overline{y}_i$$

- Optimality implies:

$$\underbrace{\sum_j w_j(x_{ij}) x_{ij}}_{\equiv \mathsf{TC}_i - \mathsf{FC}_i} = \mathsf{mc}_i y_i \left(\mathsf{SE}_i - \sum_j \theta_{ij} \{1 - \nu_{ij}\} \right)$$

- Doing simple algebraic manipulations:

$$\underbrace{\frac{\mathsf{AC}_i}{\mathsf{mc}_i}}_{\equiv \mathsf{RS}_i} \frac{\mathsf{TC}_i - \mathsf{FC}_i}{\underbrace{\mathsf{AC}_i y_i}_{\equiv \mathsf{TC}_i}} = \mathsf{SE}_i - \sum_j \theta_{ij} \{1 - \nu_{ij}\}$$

Returns to Scale

- Hence,

$$\mathrm{RS}_i = \underbrace{\mathrm{SE}_i \left(\frac{\mathrm{TC}_i}{\mathrm{TC}_i - \mathrm{FC}_i} \right)}_{\equiv \mathrm{SE}^{\mathrm{adj}}} - \underbrace{\left(\frac{\mathrm{TC}_i}{\mathrm{TC}_i - \mathrm{FC}_i} \right) \sum_j \theta_{ij} \{1 - \nu_{ij}\}}_{\equiv \mathcal{M}}$$

- **Limiting cases:**
  - No monopsony (ie, $\nu_{ij} := w_j / \mathrm{MRP}_j \to 1, \forall j$):

$$\mathrm{RS}_i = \mathrm{SE}_i \left(\frac{\mathrm{TC}_i}{\mathrm{TC}_i - \mathrm{FC}_i} \right) \equiv \mathrm{SE}_i^{\mathrm{adj}}$$

  - No monopsony (ie, $\nu_{ij} := w_j / \mathrm{MRP}_j \to 1, \forall j$) + No fixed costs (ie, $\mathrm{FC}_i \to 0$)

$$\mathrm{RS}_i = \mathrm{SE}_i$$

Back

Proof Aggregation Theorem

- By Lemma 1, the aggregate profit share can be computed as

$$\Lambda_{\Pi} = \sum_i \frac{p_i y_i}{\text{GDP}} \times s_{\pi_i}$$

- By Proposition 1,

$$s_{\pi_i} = 1 - \frac{\text{SE}_i^{\text{adj}}}{\mu_i} + \frac{\mathcal{M}_i}{\mu_i}$$

Proof of Aggregation Theorem (cont'd)

- Hence,

$$\begin{aligned}
\Lambda_{\Pi} &= \sum_i \frac{p_i y_i}{\text{GDP}} \left(1 - \frac{\text{SE}_i^{\text{adj}}}{\mu_i} + \frac{\mathcal{M}_i}{\mu_i}\right) \\
&= \underbrace{\left(\sum_k \frac{p_k y_k}{\text{GDP}}\right)}_{\equiv \chi} \sum_i \underbrace{\frac{p_i y_i}{\sum_k p_k y_k}}_{\equiv \omega_i} \left(1 - \frac{\text{SE}_i^{\text{adj}}}{\mu_i} + \frac{\mathcal{M}_i}{\mu_i}\right) \\
&= \chi \left(1 - \mathbb{E}_\omega \left[\frac{\text{SE}^{\text{adj}}}{\mu}\right] + \mathbb{E}_\omega \left[\frac{\mathcal{M}}{\mu}\right]\right) \\
&= \chi \left(1 - \frac{\overline{\text{SE}}^{\text{adj}}}{\overline{\mu}_{hsw}} + \frac{\overline{\mathcal{M}}}{\overline{\mu}_{hsw}} - \text{Cov}_\omega \left[\text{SE}^{\text{adj}}, \frac{1}{\mu}\right] + \text{Cov}_\omega \left[\mathcal{M}, \frac{1}{\mu}\right]\right)
\end{aligned}$$

Back

Special Case I: No Monopsony

Theorem 1'

With cost-minimizer producers, arbitrary returns to scale, fixed costs, and no market power in input markets, the profit share can be computed as

$$\begin{aligned}\Lambda_\Pi &= \chi\left(1 - \mathbb{E}_\omega\left[\frac{\mathsf{SE}^{\mathsf{adj}}}{\mu}\right]\right)\\ &= \chi\left(1 - \frac{\overline{\mathsf{SE}}^{\mathsf{adj}}}{\overline{\mu}_{hsw}} - \mathsf{Cov}_\omega\left[\mathsf{SE}^{\mathsf{adj}}, \frac{1}{\mu}\right]\right),\end{aligned}$$

where $\chi = \sum_{i\in\mathcal{I}} \frac{p_i y_i}{\mathsf{GDP}}$ is IO multiplier, $\mathbb{E}_\omega\left[\frac{\mathsf{SE}^{\mathsf{adj}}}{\mu}\right]$ is the sales-weighted expected value of individual scale elasticities (adjusted for fixed costs) over markups, $\overline{\mathsf{SE}}^{\mathsf{adj}}$ is the sales-weighted scale elasticity adjusted for fixed costs, and $\overline{\mu}_{hsw}$ is the harmonic sales-weighted markup.

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$$\Lambda_{\Pi} = \chi\left(1 - \mathbb{E}_{\omega}\left[\frac{\mathsf{SE}^{\mathsf{adj}}}{\mu}\right]\right)$$
$$= \chi\left(1 - \frac{\overline{\mathsf{SE}}^{\mathsf{adj}}}{\overline{\mu}_{hsw}} - \mathsf{Cov}_{\omega}\left[\mathsf{SE}^{\mathsf{adj}}, \frac{1}{\mu}\right]\right),$$

where $\chi = \sum_{i \in \mathcal{I}} \frac{p_i y_i}{\mathsf{GDP}}$ is IO multiplier, $\mathbb{E}_{\omega}\left[\frac{\mathsf{SE}^{\mathsf{adj}}}{\mu}\right]$ is the sales-weighted expected value of individual scale elasticities (adjusted for fixed costs) over markups, $\overline{\mathsf{SE}}^{\mathsf{adj}}$ is the sales-weighted scale elasticity adjusted for fixed costs, and $\overline{\mu}_{hsw}$ is the harmonic sales-weighted markup.

- Elucidates discussion between Basu 2019, DEU 2020, and others Details Back to Theorem

Special Case II: No Monopsony, No Fixed Costs, CRS

Theorem 1"

With cost-minimizer producers, constant returns to scale, no fixed costs, and no market power in input markets, the profit share can be computed as

$$\Lambda_\Pi = \chi \left(1 - \frac{1}{\overline{\mu}_{hsw}}\right)$$

where $\chi = \sum_{i \in \mathcal{I}} \frac{p_i y_i}{\text{GDP}}$ is the input-output multiplier, and $\overline{\mu}_{hsw}$ is the harmonic sales-weighted markup.

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- Permits backing out profit share or aggregate markup under strong assumptions
  - Makes clear the role of production networks in computing profit share Networks & Inference

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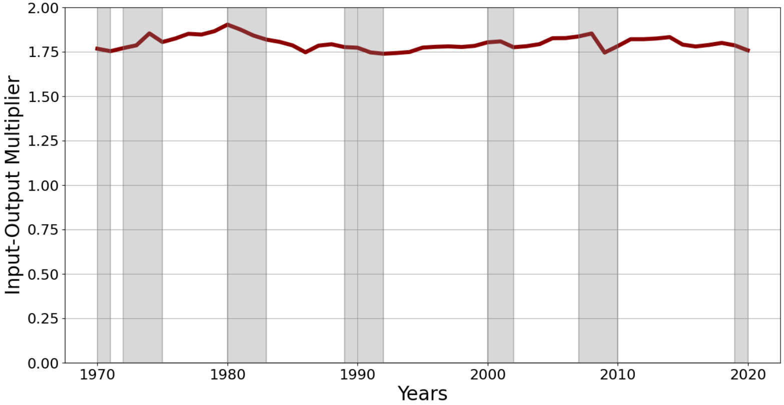
- Permits backing out profit share or aggregate markup under strong assumptions
  - Makes clear the role of production networks in computing profit share Networks & Inference
- This profit share would attain in Baqaee and Farhi (2020)’s IO framework Back to Theorem

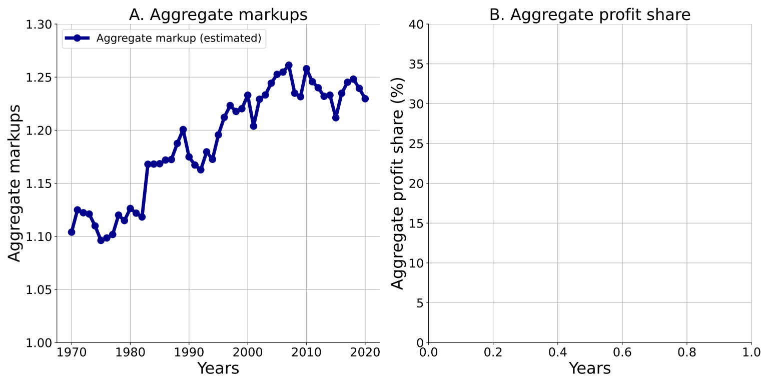
Networks and Inference: IO Multiplier

- Input-output multiplier: $\chi = \frac{\text{Sales}}{\text{Value added}}$
- In US data, IO multiplier stable (≈ 1.8) and mildly procyclical Back to Empirics



Networks and Inference: $\Lambda_\Pi = \chi\left(1 - \frac{1}{\bar{\mu}_{hsw}}\right)$

- Need to take IO networks into account to make inference from aggregate markup to aggregate profit share. (conversely, from aggregate profit share to aggregate markup)



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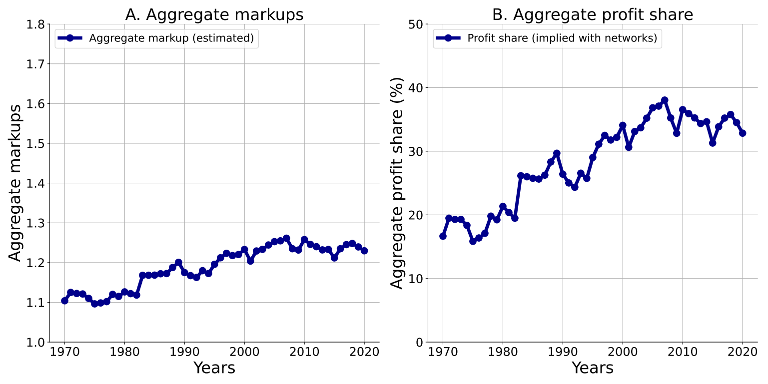

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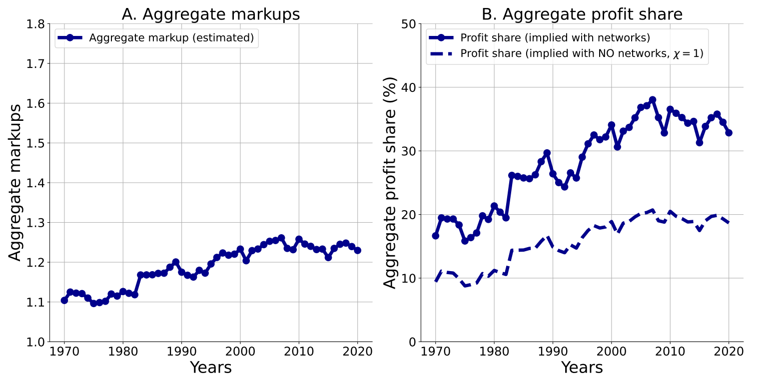

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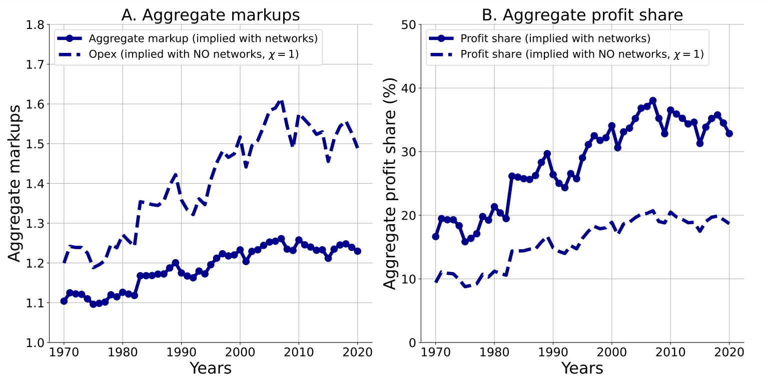

Back to Special Case Back to Main Slides

Methodology: Production Function Estimation

- One of the standard approaches in IO literature to get output elasticities
  (Olley Pakes 1996, Levinsohn Petrin 2003, De Loecker Warzynski 2012, Ackerberg Caves Frazer 2015,...)
- Informal discussion:
  - Specify production function and take log transformation:
    $$y_{it} = f_i\left(v_i, k_i; \beta\right) + \omega_{it} + \varepsilon_{it},$$
    where ω is productivity and ε is an unanticipated shock/measurement error
  - Impose assumptions on technology, timing, and productivity process
  - Estimate production function parameters in **two-step procedure**:
    1. First-stage (non-parametric) regression to obtain output free of measurement error
    2. Construct productivity estimates, obtain productivity shocks, and estimate PF parameters in a second stage through GMM using appropriate moment conditions
  - Calculate elasticities (θ^v, θ^k)

Methodology: Production Function Estimation

- PFE at the (2-digit NAICS) industry level, allowing for time-varying technologies so that input elasticities and returns to scale can vary over time

Table 1: Estimation Details in the Application of the Control Function Approach

Technology	Cobb–Douglas
Elasticities	Time-varying, 9-year rolling windows
Method	Olley and Pakes (1996)
Productivity process	AR(1)
Degree of polynomial	3rd
Ackerberg-Caves-Frazer correction	✓
Deflated variables	✓
Outcome, y	SALE
State, k	PPEGT + K_INT
Free, ℓ	OPEX ($=$ COGS $+$ SG&A)
Proxy, x	CAPX

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Biases Associated with Revenue Elasticities

- We estimate *revenue*- rather than *output* elasticities because of data limitations
- **Biases associated with revenue elasticities**:
  - Bond et al 2021: when revenue elasticity used in place of output elasticity, estimated markup of a firm that max static profits equals 1 and not informative of true markup
    - Key to this argument: static profit maximization
    - In more general environments in which firms maximize discounted sum of profits, static profit maximization need not apply, although firms may minimize costs statically (eg, Abreu 1986)
    - Imposing cost minimization only, the use of revenue elasticities results in downward-biased markups when firms face downward-sloping demand curves

Biases Associated with Revenue Elasticities

- **Biases associated with revenue elasticities** (cont'd):
  - Revenue-based markups understate true markups w/ monopolistic competition; $\mu^R \leq \mu$
    - Cost minimization implies true markup $\mu = \theta_\ell \alpha_\ell^{-1}$, where $\theta_\ell := \frac{\mathrm{d}y}{\mathrm{d}\ell}\frac{\ell}{y}$ is output elasticity
    - Revenue-based markup uses revenue elasticity, ie, $\mu^R = \theta_\ell^R \alpha_\ell^{-1}$, where $\theta_\ell^R := \frac{\mathrm{d}R}{\mathrm{d}\ell}\frac{\ell}{R}$
    - We show that $\mu^R = \theta^{Ry}\mu$, where $\theta^{Ry} := \frac{\mathrm{d}R}{\mathrm{d}y}\frac{y}{R}$ is revenue elasticity of output
    - When firms face-downward sloping demand curves and can influence prices, $\theta_y^R \leq 1$
    - Hence, $\mu^R \leq \mu$
    - Similar argument in: Klette Griliches 1996, Bond et al 2021, De Ridder et al 2022

Biases Associated with Revenue Elasticities

- **Biases associated with revenue elasticities** (cont'd):
  - Profit rates unbiased when using revenue elasticity in place of output elasticity; $s_\pi^R = s_\pi$
    - Output-based profit rate $s_\pi = 1 - \frac{\text{RS}}{\mu}$
    - Revenue-based profit rate $s_\pi^R = 1 - \frac{\text{RS}^R}{\mu^R}$
    - We show that RS^R and μ^R both biased by same factor θ^{Ry}, so biases cancel and $s_\pi^R = s_\pi$

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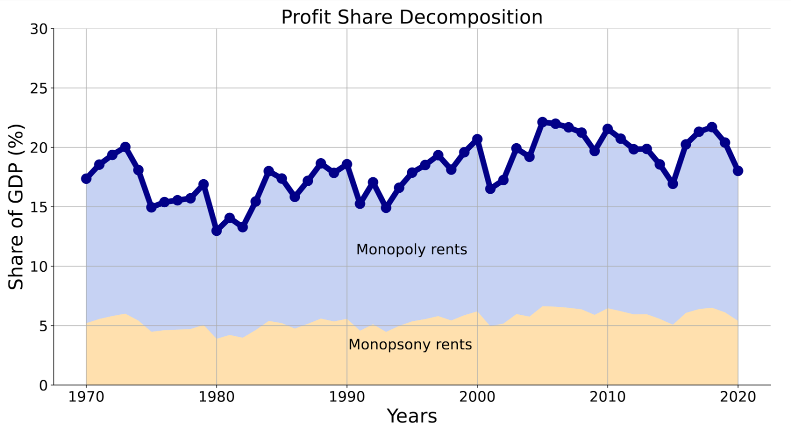
Aggregate Sources of Profits: Monopoly vs. Monopsony

- **Disclaimer**: Fictitious markups & markdowns. For illustration purposes only.



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Controversy with DEU 2020's Markup Estimates

- Basu 2019 notes:

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- **We clarify Basu–DEU discussion by providing an exact (and more general) mapping from micro to macro data, which nests Basu's BoE calculation as a special case**

Basu's Back-of-Envelope Calculation

- Assume representative firm, no fixed costs, and no market power in input markets

Basu's Back-of-Envelope Calculation

- Assume representative firm, no fixed costs, and no market power in input markets
- Basu's back-of-envelope calculation

$$\Lambda_{\Pi}^{\text{Basu}} = \chi \left(1 - \frac{\overline{\text{SE}}}{\overline{\mu}}\right)$$

$\overline{SE}$: sales-weighted scale elasticity $\overline{\mu}$: sales-weighted markup

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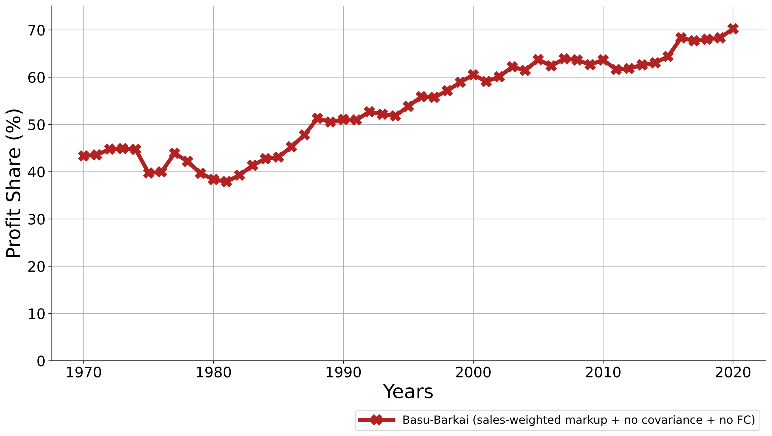
... And boils down to Basu's BOE calculation *if* no fixed costs and no heterogeneity

Mapping Micro-Level Estimates to the Profit Share: $\Lambda_\Pi = \chi \left(1 - \frac{\overline{\mathsf{SE}^{\mathsf{adj}}}}{\overline{\mu}_{\mathsf{hsw}}} - \mathsf{Cov}_\omega \left[\mathsf{SE}^{\mathsf{adj}}, \frac{1}{\mu}\right]\right)$

- Map DEU 2020's estimates to profit share using different formulas



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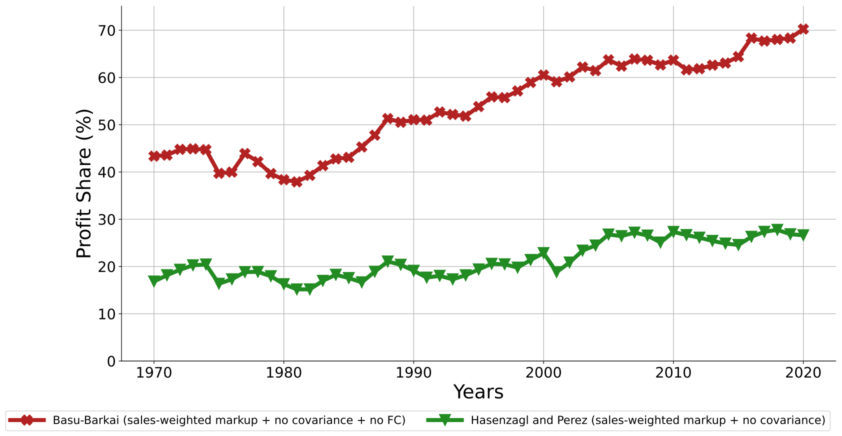

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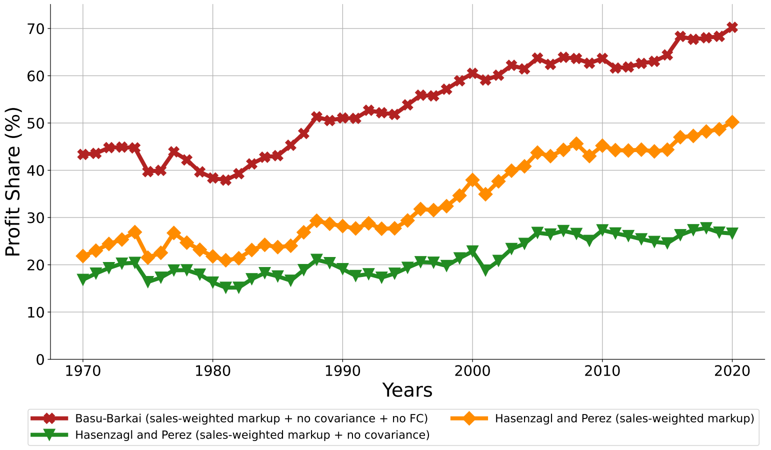

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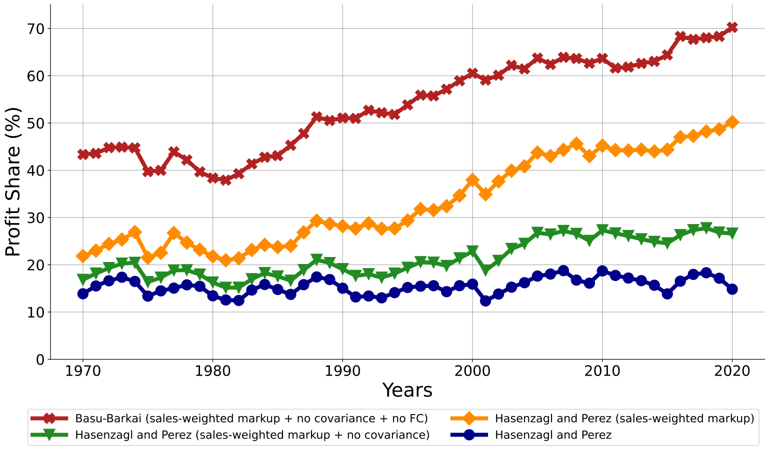


Back to Theorem
Back to Additional Results

Shift-Share Analysis of Aggregate Markup

- We provide a statistical decomposition for the harmonic sales-weighted markup

Proposition: Markup Decomposition

$$\Delta\overline{\mu}_{\text{hsw}} = -\frac{1}{\overline{\mu}_t^{\text{hsw}}\overline{\mu}_{t-1}^{\text{hsw}}}\left\{\underbrace{\sum_{i\in\mathcal{C}}\overline{\omega}_i\Delta\mu_i^{-1}}_{\text{within component}} + \underbrace{\sum_{i\in\mathcal{C}}\Delta\omega_i\left(\overline{\mu_i^{-1}} - \overline{\mu^{-1}}\right)}_{\text{between component}}\right\}$$

$$\underbrace{-\frac{1}{\overline{\mu}_t^{\text{hsw}}\overline{\mu}_{t-1}^{\text{hsw}}}\left\{\sum_{i\in\mathcal{E}}\omega_{it}\left(\mu_{it}^{-1} - \overline{\mu^{-1}}\right) - \sum_{i\in\mathcal{X}}\omega_{i,t-\tau}\left(\mu_{i,t-\tau}^{-1} - \overline{\mu^{-1}}\right),\right\}}_{\text{net effect of entry and exit}}$$

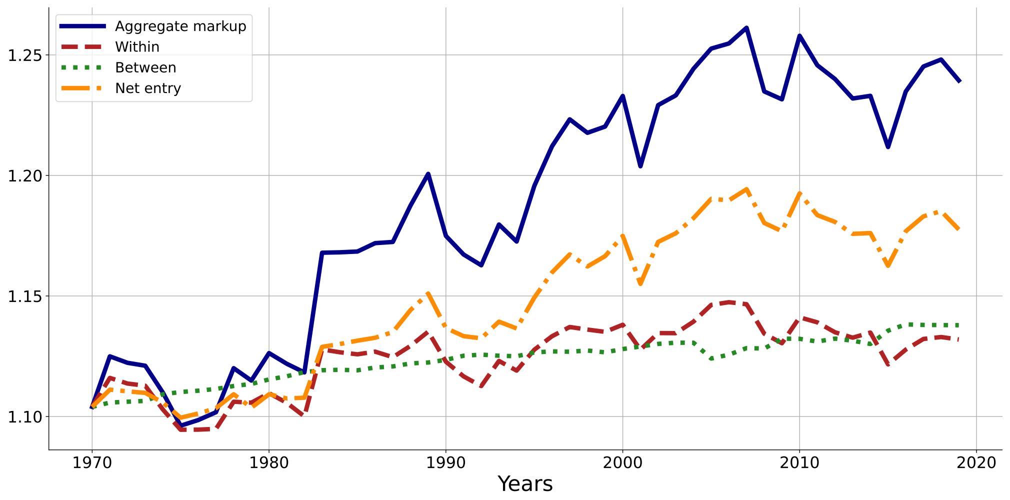
where t, τ index time, i index producers, μ are markups, ω are sales weights, $\overline{X}$ is the (arithmetic) mean of X, and $\Delta X = X_t - X_{t-1}$.

Shift-Share Analysis of Aggregate Markup

Back to Empirics

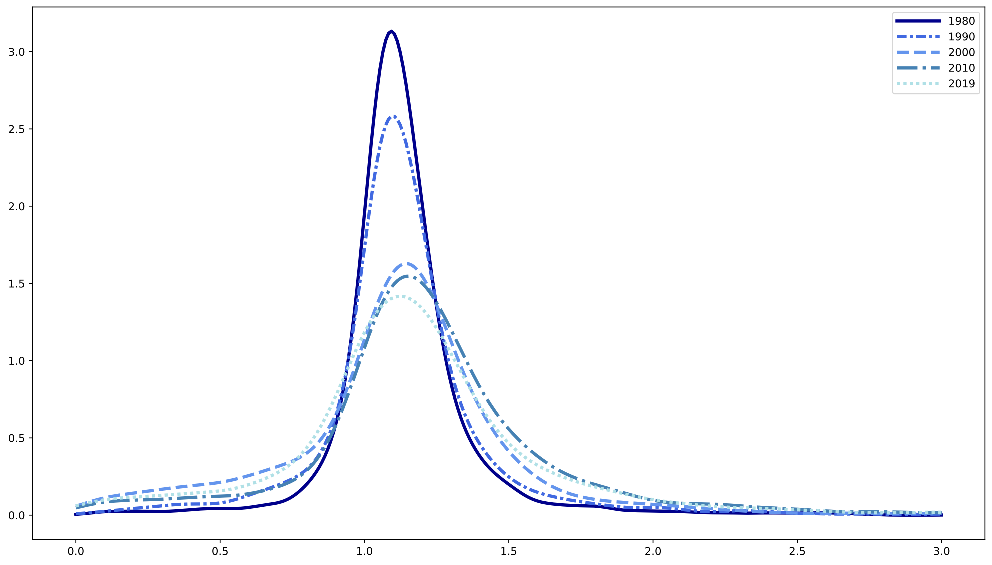
Back to Additional Results

Aggregate markup increased mostly because entrants charge higher markups

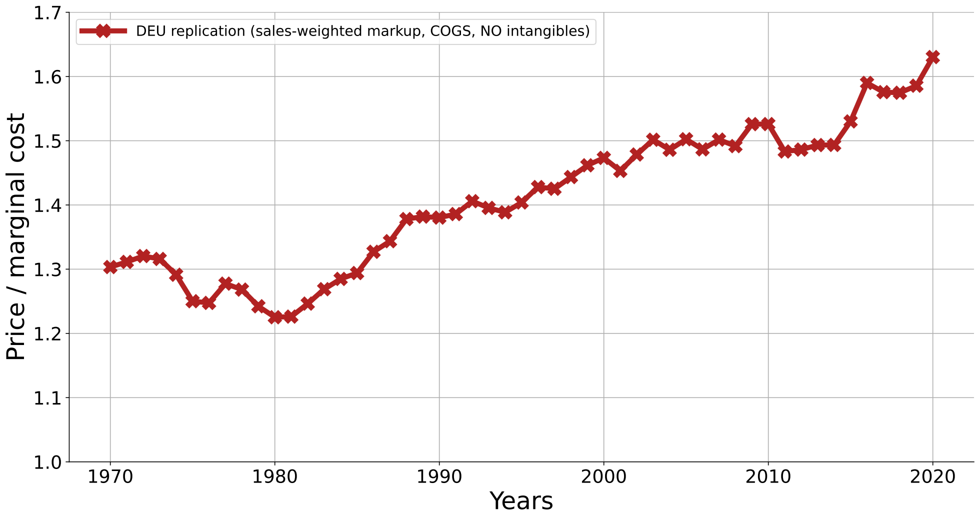


Snapshots of Markup Distribution

Back to Empirics Back to Additional Results



The Aggregate Markup: Comparison with DEU 2020



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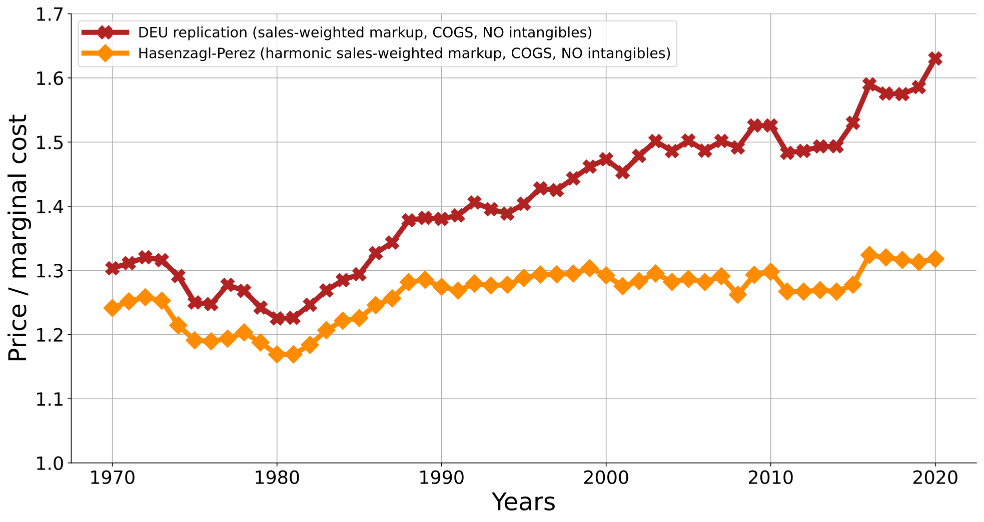

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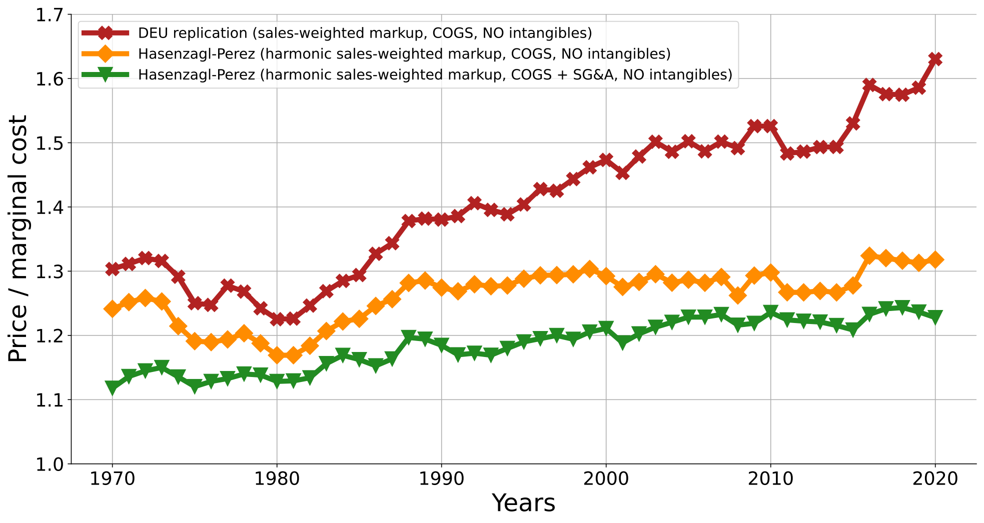
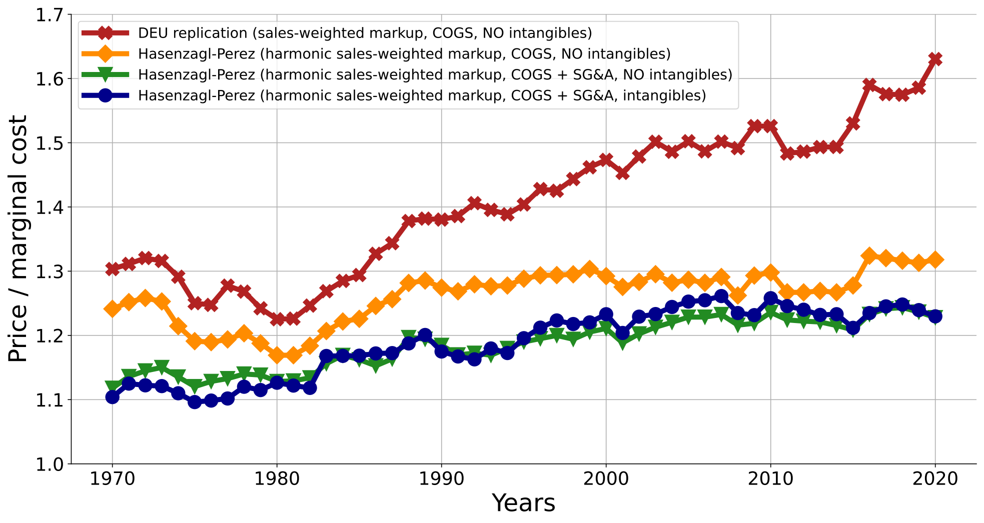


The Aggregate Markup: Comparison with DEU 2020

▸ Back to Intro ▸ Back to Empirics ▸ Back to Results



Industry-level Heterogeneity 2019: $\Lambda_{\Pi_i} = \hat{\chi}_i \left(1 - \frac{\overline{RS}_i}{\overline{\mu}_{i,hsw}} - \text{Cov}_\omega \left[RS_i, \frac{1}{\mu_i}\right]\right)$

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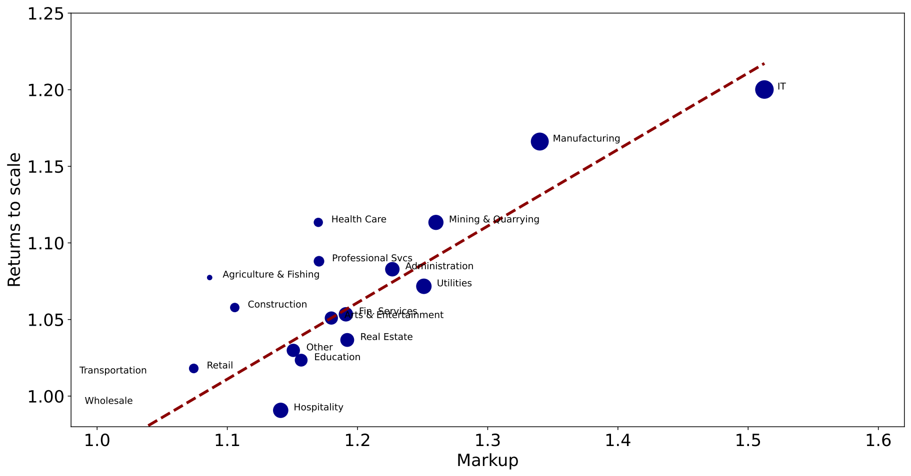
- More upstream sectors have higher markups, higher RS, higher profit shares (bigger●)



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Markups Across Industries and Over Time

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Returns to Scale Across Industries and Over Time

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Percentiles of Markup Distribution

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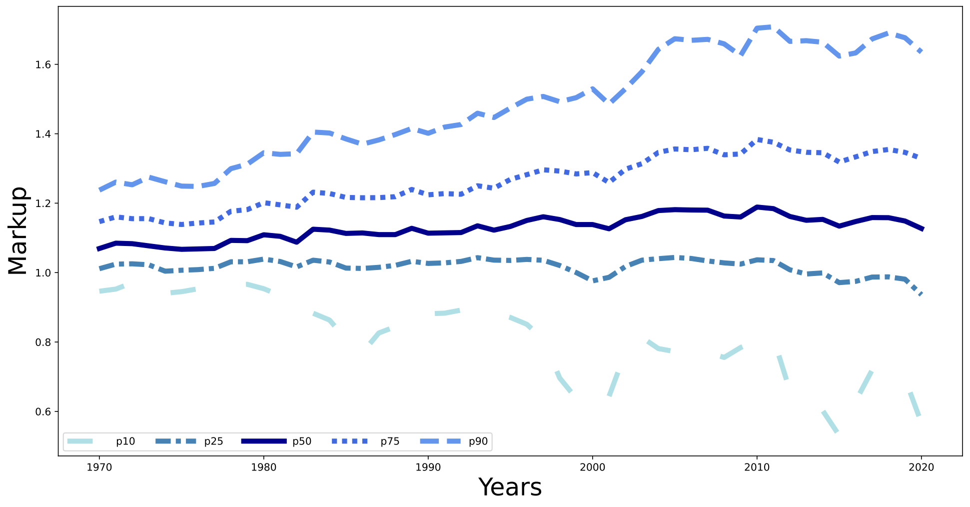

The Profit Share & The User Cost of Capital

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- **Our approach (Hasenzagl–Perez) implicitly assumes that we can compute the user cost of capital for each producer i using its capital FOC**. That is,

$$r_{it} = \frac{\theta_{jt}^{k}}{\mu_{it}} \times \frac{p_{it} y_{it}}{k_{it}}$$

  where θ_j^k is the output elasticity of capital for the industry j in which producer i operates, μ is the markup, py are sales, and k is the capital stock

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  - With financial frictions, risk premia and other wedges, rental rates differ across producers

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- DEU 2020's user cost of capital assumed to be homogeneous across producers:

$$r_t = i_t - \pi_t + \delta$$

i: nominal interest rate $\quad$ π: inflation rate $\quad$ δ: depreciation rate

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- They compute the user cost of capital using:
  - Fed funds rate (FF) as a proxy for nominal interest rate i
  - GDP implicit price deflator (GDPDEF) as a proxy for inflation rate π
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- **Points of contention**: return on capital driven by Federal Funds Rate, no role for financial frictions, homogeneous returns across producers, time-invariant deprec.

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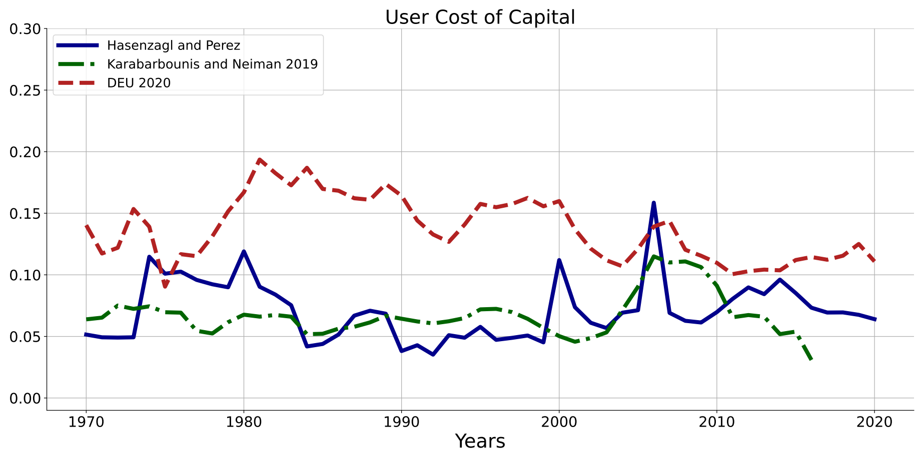
- We take this version of their R from their replication package

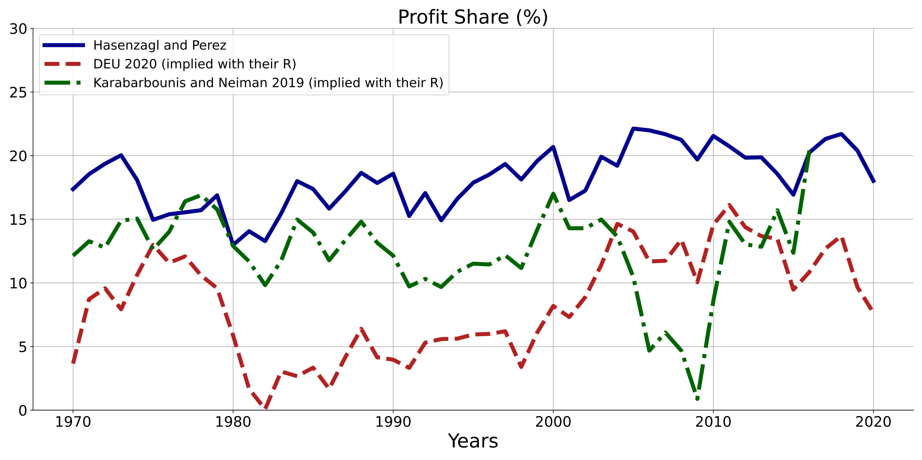
User Costs of Capital

- **Our series registers abrupt jumps during financial crises** (1973, 1980, 2000, 2007, 2012)
  - \+ Gilchrist and Zakrajšek 2012, Duarte Rosa 2015, Caballero et al 2017,...
  - – Brinca et al 2016, Chari et al 2007



Implied Profit Shares

- Profit share is very sensitive to the user cost of capital
- Our series is more stable and aligns better with the Kaldor facts See Back



Implications for Income Shares

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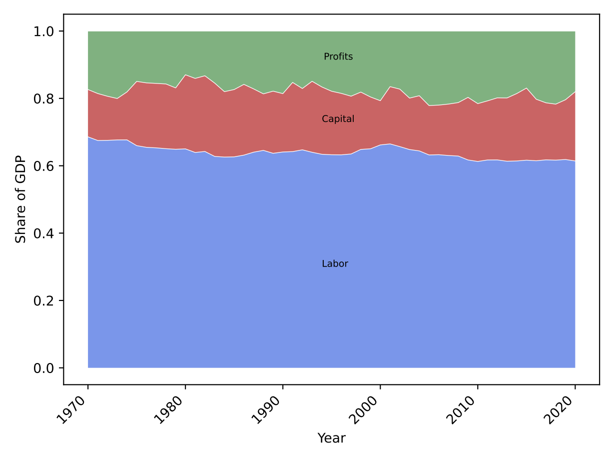
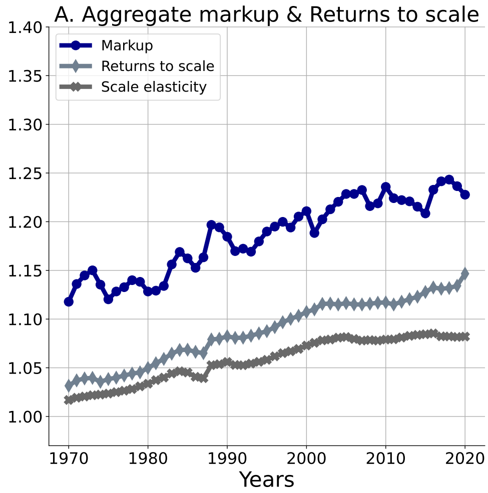
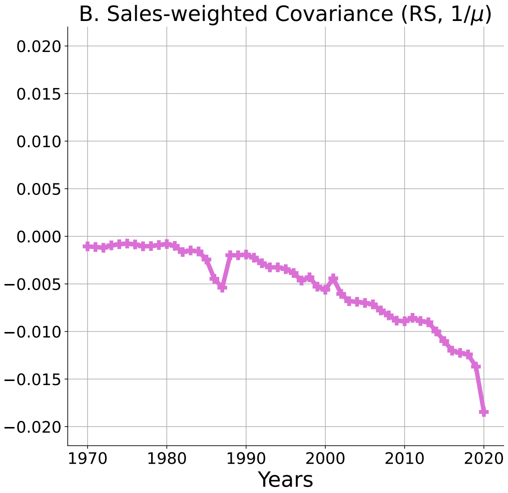
- We compute labor share from NIPA (assuming labor share for proprietors same as for rest) and use our estimates of the micro-aggregated profit share to back out the capital share

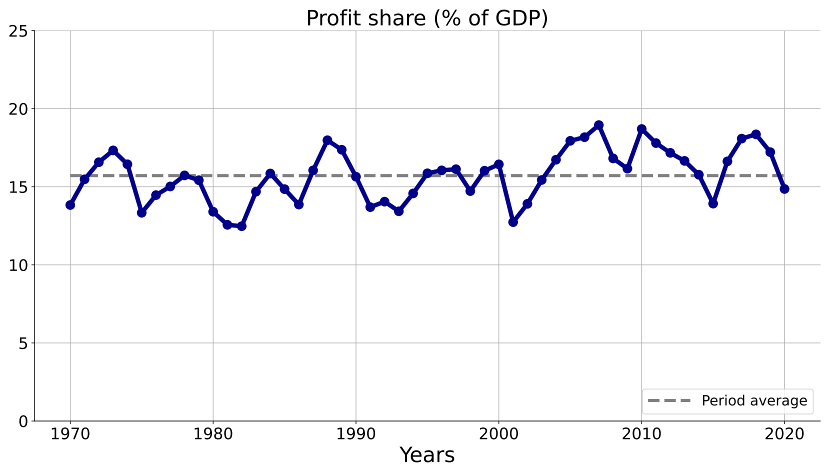


Robustness: No Intangibles





Robustness: No Intangibles



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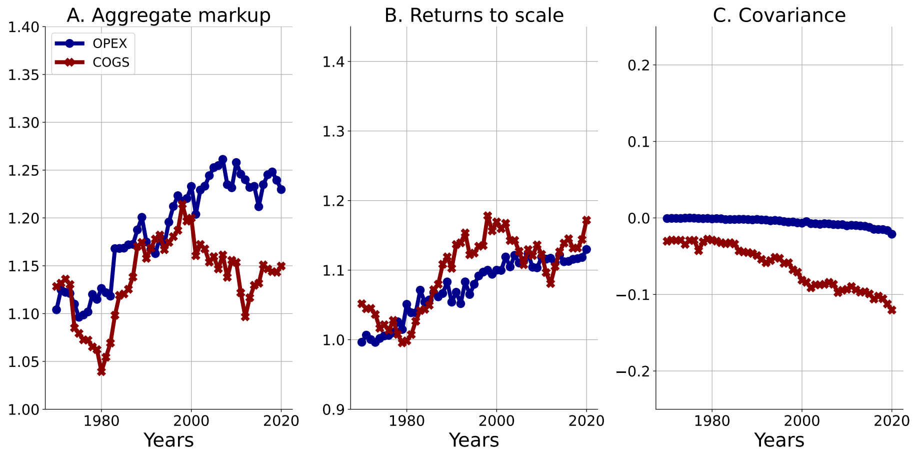
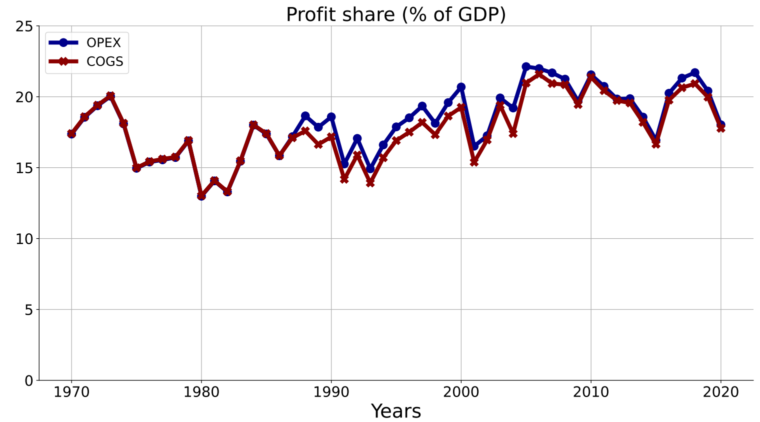
Variable Inputs, Markups, and Profitability

- The measure of variable input matters for elasticity estimates, and thus markups
- Several options for variable inputs. Two popular ones:
  - Cost of goods sold (COGS)
  - Operating expenses (OPEX) = COGS + Selling & General Administrative Expenses (SG&A)
    (SG&A includes advertising- and marketing expenses, commissions, utilities, etc.)
- Early studies relied on COGS as variable costs (eg, DEU 2020)
- Broad agreement today that OPEX is a better measure of variable costs

Variable Inputs, Markups, and Profitability



Variable Inputs, Markups, and Profitability



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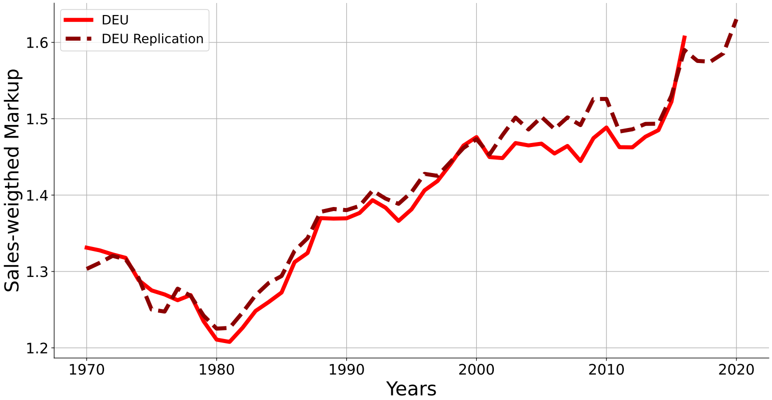
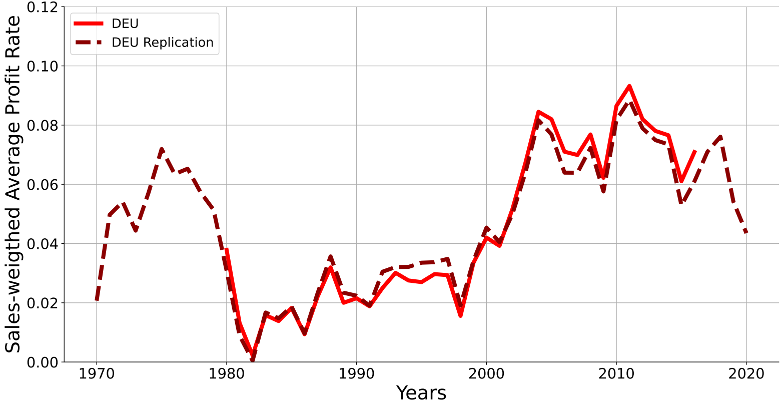
DEU 2020 Replication

- We replicate DEU 2020's sales-weighted markup estimates with COGS as variable input and PPEGT as (physical) capital



DEU 2020 Replication

- We replicate DEU's sales-weighted profit rate with their user cost of capital R



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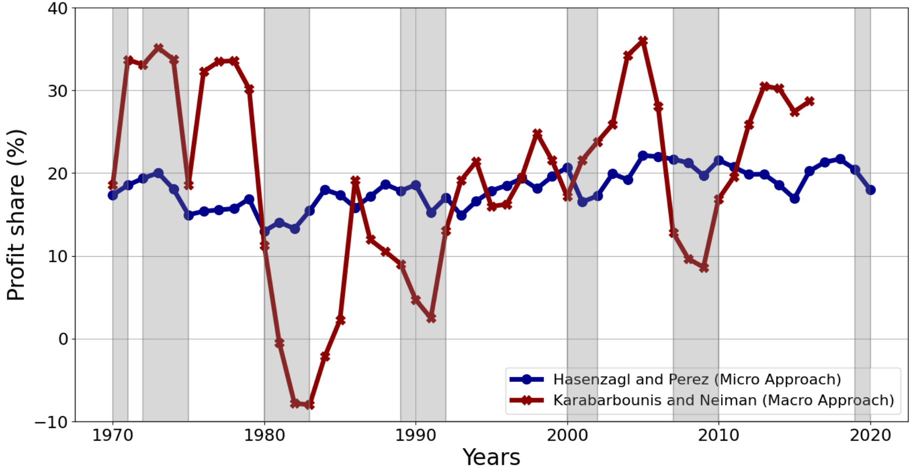
The Profit Share: Micro vs. Macro Approach



The Profit Share: Micro vs. Macro Approach

- **Levels** of micro and macro profit share both **very high**. Why?
  - **Micro profit share computed with Compustat data** (ie, publicly traded firms)
    - If large firms have higher profit rates than other firms, profit share is an upper bound
  - If **intangibles** mismeasured, both approaches **misattribute capital income to profits**
  - If **fixed costs** underestimated, **profit share overestimated**
  - Reasons to believe we both misattribute some capital income to profits
    - Correlation between macro profit share and R is -0.83
    - Correlation between micro profit share and R is -0.33
  - Our levels are more reasonable
    - Not extremely volatile
    - Imply capital shares of about 20–25% Details
- **Both** micro and macro profit shares are **procyclical** Back to Additional Results