Market power and TFP growth in Chile

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Motivation (1)

Global debate on increasing inequality and market power in advanced economies

- But markups in the goods market in the emerging world have not increased, (e.g. South America).

Recent social unrest in Chile after decades of income growth and mild reduction in inequality

- A common source of discontent: Firms' market power.
- Firms market power $\Longrightarrow$ Redistribution from workers to owners $\Longrightarrow$ Income inequality

Yet, little evidence on the level, evolution, decomposition, and effects of market power in Chile.

Motivation (2)

Questions:

(a) What is the market power evolution at the products market (markups) in Chile for the last decade and a half.

(b) What are the aggregate TFP growth effects of markups.

What this paper does:

(a) Estimates firm-level markups for the 2005-2020 period.

(b) Uses rich administrative micro-data from tax records, including prices of output and inputs and I-O firm-level data.

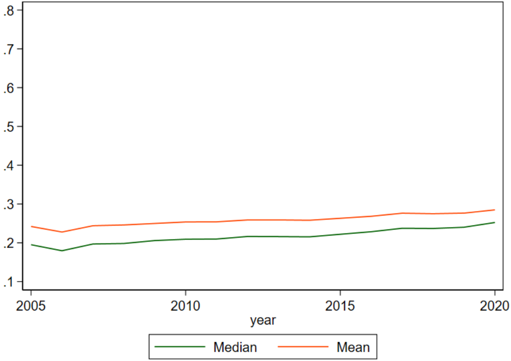
(c) Aggregates from micro markups to macro misallocation.

Key take away: Markups generated a decline in the Chilean economy's allocative efficiency, which could explain TFP growth stagnation for the last decade in Chile.

Motivation (3)

First, is there any market power in Chile?

Revenue-based profit share evolution



Revenue-based profit share$_{it} = 1 - \frac{r_{it} K_{it}}{P_{it} \cdot Q_{it}} - \frac{WB_{it}}{P_{it} \cdot Q_{it}} - \frac{ME_{it}}{P_{it} \cdot Q_{it}}$

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Markup: Production Approach (DLW, 2012) (1)

- Cost minimization of firm i given its technology (Q_{it}), capital stock (K_{it}) and variable inputs (V_{it})

- Lagrangian:

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

- FOC with respect to variable input V:

$$\frac{\partial \mathcal{L}}{\partial V_{it}} = P_{it}^{V} - \lambda_{it} \frac{\partial Q(.)}{\partial V_{it}} = 0$$

- Rearranging and multiplying by $\frac{V_{it}}{Q_{it}}$:

$$\frac{\partial Q(.)}{\partial V_{it}} \frac{V_{it}}{Q_{it}} = \frac{1}{\lambda_{it}} \frac{P_{it}^{V} V_{it}}{Q_{it}}$$

Markup: Production Approach (2)

Markup : price to marginal cost ratio ($\mu = \frac{P}{MC}$ with $MC = \lambda$)

$$\frac{P_{it}}{\lambda_{it}} = \underbrace{\frac{\partial Q(.)}{\partial V_{it}} \frac{V_{it}}{Q_{it}}}_{\theta_{it}^{V}} \underbrace{\frac{P_{it} Q_{it}}{P_{it}^{V} V_{it}}}_{1/s_{it}^{V}}$$

$$\mu_{it} = \frac{\theta_{it}^{V}}{s_{it}^{V}}$$

Markup relies on two objects:

- Variable input share (s_{it}^{V}): Usually observed in the data
- Output elasticity of variable input (θ_{it}^{V}): Need to estimate it, this is the key challenge!

Estimation of Output Elasticity of Variable Input: Assumptions

Assumptions following Ackerberg, Caves & Frazier (ACF, 2015):

- A general production function with x_{it} being all production function inputs and interactions and ω_{it} the hicks-neutral firm productivity:

$$q_{it} = f(x_{it}; \beta) + \omega_{it} + \epsilon_{it} \tag{1}$$

- First order Markov process for productivity with innovation to productivity:

$$\omega_{it} = \omega_{it-1} + \varphi_{it} \tag{2}$$

- Moment conditions relying on instruments Z_{it}:

$$\mathbb{E}[Z_{it}\ \varphi_{it}(\beta)] = 0 \tag{3}$$

Estimation of Output Elasticity of Variable Input: Two-Step Approach

(a) Estimate the production function to get rid of measurement error: $q_{it} = q^*_{it} + \epsilon_{it}$

(b)
- First recover productivity as: $\omega_{it}(\beta) = q^*_{it} - x'_{it}\beta$
- Then recover innovations to productivity (φ_{it}) by solving: $\varphi_{it}(\beta) = \omega_{it}(\beta) - \mathbb{E}[\omega_{it}(\beta)|\omega_{it-1}(\beta)]$
- Use the productivity innovations to form moments and by GMM estimate the production function parameters (β)
- Use β to form the desired output elasticity of variable input

Aggregation: Setup (BF, 2020) (1)

Revenue-based input-output matrix. ij^{th} element is the expenditure of firm i on inputs from firm j as a share of firm i total revenue:

$$\Omega_{ij} \equiv \frac{p_j x_{ij}}{p_i y_i} \tag{4}$$

Cost-based input-output matrix. ij^{th} element the elasticity of firm i marginal costs relative to the price of firm j, Using Shppard's Lemma:

$$\tilde{\Omega}_{ij} \equiv \frac{\partial \log \mathbf{C}_i}{\partial \log p_j} = \frac{p_j x_{ij}}{\sum_{k=1}^{M} p_k x_{ik}} \tag{5}$$

Both related by **markup harmonic mean matrix**.

$$\tilde{\Omega} = \mathrm{diag}(\mu)\Omega \tag{6}$$

$\mathrm{diag}(\mu)$ is a Diagonal matrix with ii^{th} element: $\frac{\#\text{firms}}{\sum_t (\mu_{it})^{-1}}$

Aggregation: Setup (BF, 2020) (2)

Leontief inverse matrix capture both the direct and indirect firm exposures through the production networks:

$$\tilde{\Psi} \equiv (I - \tilde{\Omega})^{-1} = I + \tilde{\Omega} + \tilde{\Omega}^2 + \dots \tag{7}$$

Defining **sales shares**

$$b_{it} = \frac{p_{it} c_{it}}{\sum_{j=1}^{N} p_{jt} c_{jt}} \tag{8}$$

To form the **cost-based Domar Weight**; the relevance, both directly and through production networks, of suppliers in final goods demand.

$$\tilde{\Lambda}' \equiv b' \tilde{\Psi} \tag{9}$$

Aggregation: Setup (BF, 2020) (3)

TFP decomposition:

$$\underbrace{\Delta \log Y_t - \tilde{\Lambda}'_{t-1}(\Delta \log L_t + \Delta \log K_t)}_{\Delta \text{ Distorted Solow Residual}}$$
$$\approx \underbrace{\tilde{\Lambda}'_{t-1}\Delta \log A_t}_{\Delta \text{ Technology}} - \underbrace{\tilde{\Lambda}'_{t-1}\Delta \log \mu_t - \tilde{\Lambda}'_{t-1}(\Delta \log Sh_t^K + \Delta \log Sh_t^L)}_{\Delta \text{ Allocative Efficiency}}$$

- L_t and K_t: Production factors
- μ: Markup
- Sh_t^K and Sh_t^L: Factor shares

Key object: $\tilde{\Lambda}$

Cost-based Domar weight (As opposed to traditional revenue-based Domar weight used in national accounts)

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Data Sources

1. Sales, materials, investment: F29 (2005-2019)

2. Wage bill, employment: DJ1887 (2005-2019)

3. Initial capital stock: F22 (2005-2019)
   - Capital stock using perpetual inventory methods combining capital stock with investment.

4. I-O matices: Buying and selling books (forms 3327-3328) (2005-2014)
   - Firm-year level output and input flows.

5. Output and input prices: F2F electronic receipts (2015-2019)
   - Firm-year level output and input prices weighted by F2F transaction flows.

Data Cleaning

- Final sample does not include firms with missing variable of sales, capital, wage bill, or materials.
- Winzorized labor, capital and materials shares over sales at 1% of both tails of the distribution.
- Firms with negative value added (sales-materials), less than 2 workers or capital less than 10.000 CLP (USD 15) are exluded.

Around 120,000 firms a year in the final sample.

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Estimation Details: decisions

- Benchmark estimation:
  (a) Second order translog production function using 3 factors (K, L, M).
  (b) Estimation performed separately by 6 industries.
  (c) Time invariant output elasticities.
  (d) Materials is the variable input.
  (e) Control for output and input prices using F2F electronic receipts.

- Other approaches I did:
  (a) Cobb-Douglas production function.
  (b) Economy wide and 85 sectors estimates of output elasticities.
  (c) Labor variable input.
  (d) Value-Added production function estimation.
  (e) Time varriant output elasticities.
  (f) Excluding prices, both output and input.
  (g) Aggregation a la BF 2020 using sectoral data.

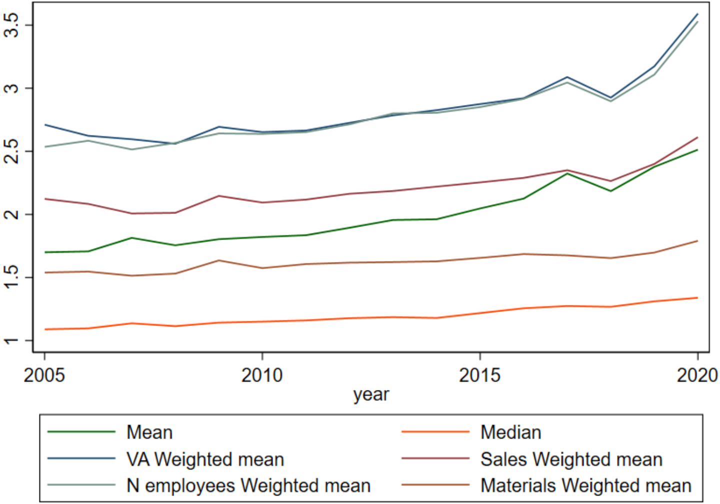
Estimation Details: Production function

$$q_{it} = \omega_{it} + \beta_l \ l_{it} + \beta_k \ k_{it} + \beta_m \ m_{it} + \beta_{lk} \ l_{it} \ k_{it} + \beta_{lm} \ l_{it} \ m_{it} \\ + \beta_{mk} \ m_{it} \ k_{it} + \beta_{ll} \ l_{it}^2 + \beta_{kk} \ k_{it}^2 + \beta_{mm} \ m_{it}^2 + \beta_{lkm} \ l_{it} \ k_{it} \ m_{it} + \epsilon_{it} \tag{10}$$

Intermediate inputs are assumed to be the variable input in production, and thus the markup estimation is performed using materials output elasticity and its share.

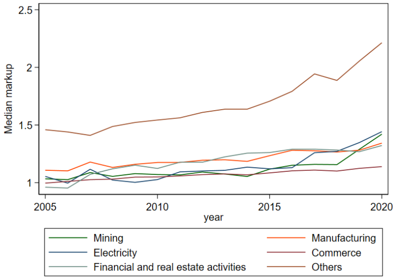
$$\theta_{it}^M = \frac{\partial q_{it}}{\partial m_{it}} = \beta_m + \beta_{lm} \ l_{it} + \beta_{mk} \ k_{it} + 2\beta_{mm} \ m_{it} + \beta_{lkm} \ l_{it} \ k_{it} \tag{11}$$

Markup: Time evolution

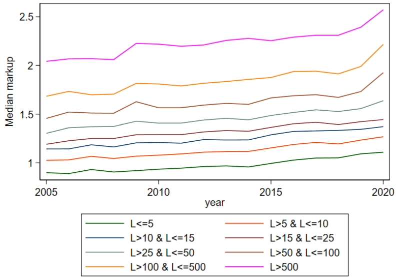


Markup: Heteronegeity in industry/firm size

Industry



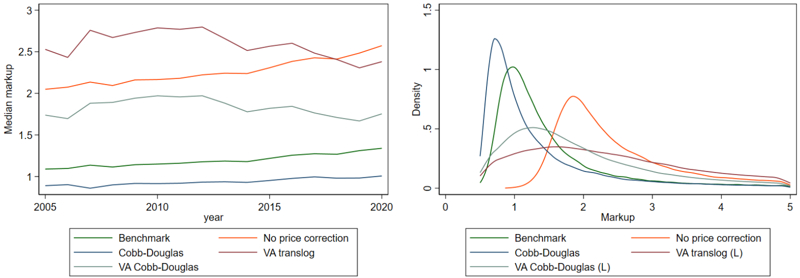
Size



- Similar trends across industries.
- Bigger firms charge higher markups.

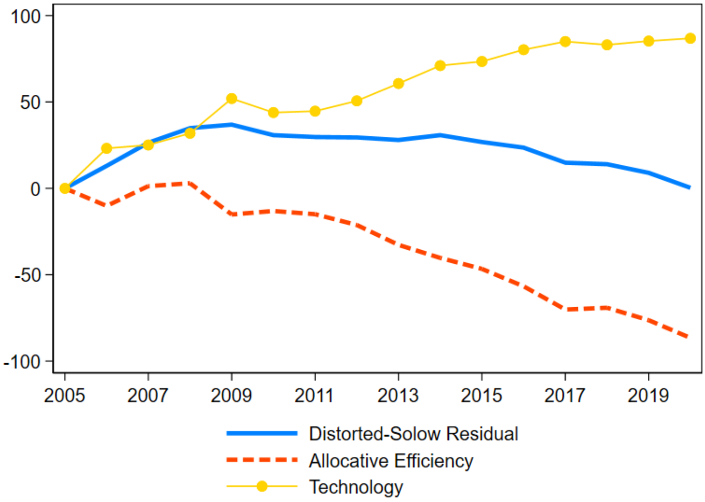
Markup: different estimation strategies

Time series | Distribution



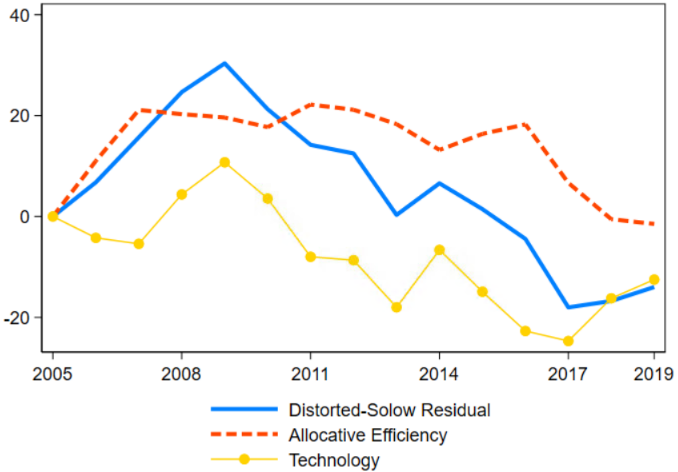
- Markups very sensitive in levels with different strategies. Different in trend conditional on production function assumption.
- Very different distributions.

Aggregation: BF, 2020



$$\underbrace{\Delta \log Y_t - \tilde{\Lambda}'_{t-1}(\Delta \log L_t + \Delta \log K_t)}_{\Delta \text{ Distorted Solow Residual}} \approx \underbrace{\tilde{\Lambda}'_{t-1}\Delta \log A_t}_{\Delta \text{ Technology}} - \underbrace{\tilde{\Lambda}'_{t-1}\Delta \log \mu_t - \tilde{\Lambda}'_{t-1}(\Delta \log Sh^K_t + \Delta \log Sh^L_t)}_{\Delta \text{ Allocative Efficiency}}$$

Aggregation: BF, 2020 (VA, L markup)



$\Longrightarrow$ Results are sensitive to the markup used. A technology decrease is difficult to rationalize.

Discussion

- Chile has had a stagnant TFP since the great recession and the end of the commodity price boom.
- Although markups are roughly constant, they contribute to a decline in TFP growth through a decline in allocative efficiency.
- Key to the conclusion was the suitable data usage.

$\Longrightarrow$ Need to open up the mapping between micro markups and aggregate misallocation. What are the channels that lead to output and productivity losses?