Proximity to the Frontier, Markups, and the Response of Innovation to Foreign Competition: Evidence from Matched Production-Innovation Surveys in Chile

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- Aghion et al., (2021) find a detrimental effect on French firms' sales and patenting for Chinese competition in *output* markets –with the negative impact being concentrated in low-productivity firms– but a weak and positive effect when competition is concentrated in *input* markets.

What do we do?

- Explore the reaction of innovation inputs and outputs to exogenous competition changes using the canonical China shock (Autor, Dorn, and Hanson, 2013; Bloom et al., 2016; Aghion et al., 2021) and a unique matched firm production/innovation panel data set from Chile.

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- Literature focuses on citation-weighted patents as the main innovation outcome, which is less relevant for developing countries. We differentiate across different types of innovation inputs and outputs (e.g., R&D expenditures, product and process innovation, quality upgrading).

Main findings

- We confirm the importance of distance to the frontier on the direction of the change. However, we show that rents also play an important role in determining the magnitude of the impact of competition on innovation.

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- Leaders/Laggards
    - TFPQ shows non-statistically significant decline except for the top 10 percent (7.6%), which we define as leaders.
    - Leaders show a near equal rise in quality (8.1%), their only significant increase in innovation, which may explain why they are producing fewer units and hence show falling TFPQ.
    - We find consistently negative impacts of competition across the spectrum of innovation inputs and outputs for the other 90%.

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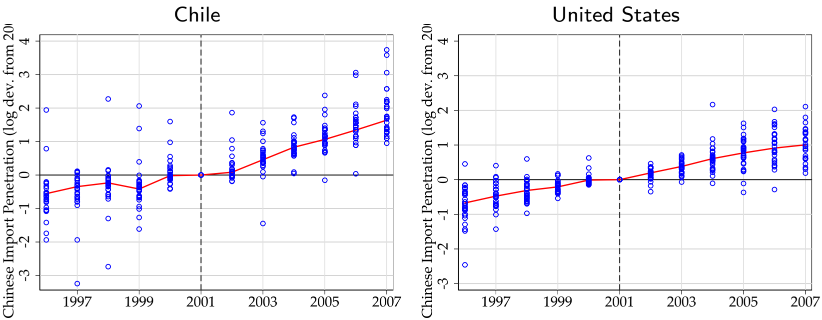
  - We find consistently negative impacts of competition across the spectrum of innovation inputs and outputs for the other 90%.
- Markups
  - Import competition has a negative effect on markups. Whether capturing rents per se or perhaps access to internal financing, rents appear to exacerbate the leader/laggard differences.
  - Process and product innovation among laggards with shrinking rents fell 11% and 13%, respectively.
  - However, for leaders with rising rents product innovation and product quality rose by 15% and 21%, respectively.

Figure: Imports from China in Chile and the United States, 1996-2007



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Empirical strategy

$$y_{ijt} = \alpha_i + \alpha_{jt} + \beta \ln(\text{Imp}_{ij,t-1}) + \gamma X_{ijt} + \varepsilon_{ijt} \quad (1)$$

$$\ln(\text{Imp}_{ij,t-1}) = \lambda_i + \lambda_{jt} + \delta \ln(\text{Imp}_{ij,t-1}^{LASSO}) + \theta X_{ijt} + \vartheta_{ijt} \quad (2)$$

$$y_{ijt} \quad = \quad \alpha_i + \alpha_{jt} + \beta \ln(\widehat{\text{Imp}_{ij,t-1}}) + \gamma X_{ist} + \varepsilon_{ijt} \quad (3)$$

- ADH (2013)
- G-PSS (2020), BHJ (2021)
- Lasso: BCCH (2012)

TFPQ, markups, and quality estimation

$$q_{ijt} = \beta_{lj} l_{it} + \beta_{kj} k_{it} + \beta_{mj} m_{it} + \omega_{ijt} + \varepsilon_{ijt} \tag{4}$$

$$\omega_{ijt} = g(\omega_{ijt-1}, d^{x}_{ijt-1}, d^{i}_{ijt-1}, d^{x}_{ijt-1} \times d^{i}_{ijt-1}) + \xi_{ijt} \tag{5}$$

$$\mu_{ijt} \equiv \frac{P_{ijt}}{MC_{ijt}} = \left(\frac{\partial Q_{ijt}(\cdot)}{\partial V_{ijt}} \frac{V_{ijt}}{Q_{ijt}} \right) \Bigg/ \left(\frac{P^{V}_{ijt} \cdot V_{ijt}}{P_{ijt} \cdot Q_{ijt}} \right) = \frac{\beta_{mj}}{Exshare_{m\,ijt}} \tag{6}$$

$$\ln q_{ijt} = \alpha_1 + \alpha_2 \ln \hat{p}_{ijt}(TFPQ_{ijt}) + \alpha_j + \alpha_t + \varepsilon_{ijt} \tag{7}$$

- TFPQ estimation: ACF (2015), DL (2013) and LP (2003)
- Price index: SW (2013) and EH (2017)
- Markup estimation: DL and W (2012)
- Quality estimation: KSW (2013), EHKK (2013)
- Leaders/laggards: Hansen (2000)

Data: ENIA and EIT

- **ENIA**
  - Plant-level balance-sheet data (10 employees+) for the period 1996-2007- including detailed information on all outputs produced and inputs used in production, and their respective prices by each plant
  - Products in ENIA are defined according to the CUP (equivalent 7-digit ISIC level)
  - Roughly 4,800 manufacturing plants per year, about 20 percent are exporters, and two-thirds are small plants (less than 50 workers)
  - Our final sample consists of 29,283 plant-product-year observations

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- **EIT**
  - Technological innovation survey, nationally representative innovation survey of manufacturing firms
  - All plants representing more than 2 percent of the sectoral value added enter compulsory in the innovation survey
  - On average, EIT firms are larger, more export oriented, and more profitable than ENIA plants. But there are not ss differences for TFPQ and markups (only at 10%). Systematic differences are uncorrelated with variation in exposure to the competition shock.
  - The combined ENIA-EIT dataset gathers information on 4,704 plant-year observations (1,377 unique plants) that cover roughly 20 % of the ENIA for the years where EIT is available.
  - Information on innovations inputs (e.g., overall spending, R&D) and innovation outcomes (e.g., patent stock, product and process innovation)

Table: Summary Statistics

	Mean	Std. Dev.	Percentiles			Sample Size	
			P25	P50	P75	Plant-years	Plants
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Plant-Level Variables							
Output Volume (in logs)	8.879	1.898	7.472	8.560	10.153	29,283	3,090
Markups	1.207	0.566	0.859	1.083	1.391	28,839	3,090
Revenue (in logs)	13.336	1.823	11.966	12.980	14.510	29,283	3,090
Output Price (in logs)	4.456	0.564	4.189	4.478	4.736	29,283	3,090
Physical TFP (in logs)	6.587	2.731	5.513	6.660	7.912	29,283	3,090
Revenue TFP (in logs)	6.544	2.691	5.687	6.636	7.987	29,283	3,090
Marginal Cost (in logs)	4.356	0.694	3.987	4.368	4.745	29,283	3,090
Product Quality (in logs)	0.088	1.811	-1.237	-0.237	1.196	24,439	3,088
Profit Rate	0.441	0.495	0.170	0.364	0.622	29,283	3,090
Input Price (in logs)	4.455	0.508	4.187	4.462	4.729	29,283	3,090
Innovation Variables							
Overall Innovative Spending (IHS)	4.569	5.543	0.000	0.000	10.597	4,704	1,377
R&D Spending (IHS)	2.996	4.890	0.000	0.000	8.425	4,704	1,377
Patents Stock (IHS)	0.154	0.566	0.000	0.000	0.000	4,704	1,377
% (Positive Process Innovation)	0.506	0.500	0.000	1.000	1.000	4,704	1,377
% (Positive Product Innovation)	0.432	0.495	0.000	0.000	1.000	4,704	1,377
Product Quality	1.441	2.087	-0.150	1.455	3.017	4,345	1,337
Chilean Imports of Chinese Products							
Observed Imports (million US$)	75.98	155.49	3.05	18.17	73.46	364	364
Predicted LASSO Imports (million US$)	74.68	154.72	3.10	17.45	71.19	364	364

Results

Table: Effect of Chinese Import Competition on Plants' Outcomes

	(1) Output	(2) Markup	(3) Revenue	(4) Output Price	(5) TFPQ	(6) TFPR	(7) Marginal Cost	(8) Quality	(9) Profits	(10) Input Price
A. Baseline										
ln(CHN Imports(-1))	-0.0693**	-0.0346***	-0.0083	0.0611***	-0.0377	-0.0158	0.0956***	0.0100	-0.0542***	0.0315
	(0.0299)	(0.0107)	(0.0198)	(0.0226)	(0.0241)	(0.0134)	(0.0262)	(0.0218)	(0.0134)	(0.0240)
First-Stage F-Statistic	74.3	74.3	74.3	74.3	74.3	74.3	74.3	58.2	74.3	74.3
Industry-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	29,283	29,283	29,283	29,283	29,283	29,283	29,283	24,439	29,283	29,283
B. Interactions with Leaders / Laggards										
ln(CHN Imports(-1))										
× Leaders Indicator	-0.0517	-0.102***	0.0537**	0.105***	-0.0866**	-0.0445	0.207***	0.0851**	-0.0882**	0.0505
	(0.0377)	(0.0220)	(0.0253)	(0.0342)	(0.0403)	(0.0322)	(0.0396)	(0.0358)	(0.0379)	(0.0326)
× Laggards Indicator	-0.0812**	-0.0249**	-0.0248	0.0564**	-0.0397	-0.0165	0.0813***	-0.0060	-0.0505***	0.0286
	(0.0353)	(0.0114)	(0.0224)	(0.0232)	(0.0258)	(0.0140)	(0.0266)	(0.0237)	(0.0142)	(0.0249)
First-Stage F-Statistic	35.5	35.5	35.5	35.5	35.5	35.5	35.5	27.5	35.5	35.5
Industry-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	29,283	29,283	29,283	29,283	29,283	29,283	29,283	24,439	29283	29,283

Results

Table: Effect of Chinese Import Competition on Innovation Variables

	(1)	(2)	(3)	(4)	(5)	(6)
	Innovative Spending		Innovation Outputs			
	Overall Spending	R&D Spending	Patents Stock	Process Innovation	Product Innovation	Product Quality
A. Baseline						
ln(CHN Imports(-1))	-1.084**	-0.610	-0.0397	-0.0874***	-0.0741***	0.00356
	(0.462)	(0.524)	(0.0427)	(0.0288)	(0.0283)	(0.0417)
Avg. elasticity (IHS variables)	*-1.084*	*-0.610*	*-0.067*	—	—	—
First-Stage F-Statistic	42.9	42.9	42.9	42.9	42.9	45.75
Industry-year FE	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes
Observations	4,704	4,704	4,704	4,704	4,704	4,345
B. Interactions with Leaders / Laggards						
ln(CHN Imports(-1))						
× Leaders Indicator	-1.075	0.640	-0.152	-0.0503	0.0445	0.177***
	(0.823)	(0.889)	(0.146)	(0.0662)	(0.0694)	(0.0629)
Avg. elasticity (IHS variables)	*-1.075*	*0.640*	*-0.159*	—	—	—
× Laggards Indicator	-1.273*	-0.965	-0.040	-0.109***	-0.0907**	-0.0419
	(0.669)	(0.619)	(0.045)	(0.0367)	(0.0352)	(0.0498)
Avg. elasticity (IHS variables)	*-1.273*	*-0.965*	*-0.093*	—	—	—
First-Stage F-Statistic	14.5	14.5	14.5	14.5	14.5	16.0
Industry-year FE	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes
Observations	4,704	4,704	4,704	4,704	4,704	4,345

Table: Heterogeneity: Split by Change in Markups

	(1)	(2)	(3)	(4)	(5)	(6)
	Innovative Spending		Innovation Outputs			
	Overall Spending	R&D Spending	Patents Stock	Process Innovation	Product Innovation	Product Quality
ln(CHN Imports(-1))						
× Increasing Markups	-0.480	-0.114	0.0041	-0.106**	-0.0432	0.0141
	(0.682)	(0.649)	(0.0466)	(0.0463)	(0.0349)	(0.0504)
Avg. elasticity (IHS variables)	*-0.480*	*-0.114*	*0.0061*	—	—	—
× Declining Markups	-1.356**	-0.804	-0.0595	-0.0865**	-0.0970**	-0.00591
	(0.567)	(0.680)	(0.0717)	(0.0387)	(0.0435)	(0.0675)
Avg. elasticity (IHS variables)	*-1.356*	*-0.804*	*-0.1133*	—	—	—
First-Stage F-Statistic	23.5	23.5	23.5	23.5	23.5	12.5
Industry-year FE	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes
Observations	4,692	4,692	4,692	4,692	4,692	4,335

Results

Table: Change in Markups combined with Leader/Laggard Indicator

	(1)	(2)	(3)	(4)	(5)	(6)
	Innovative Spending		Innovation Outputs			
	Overall Spending	R&D Spending	Patents Stock	Process Innovation	Product Innovation	Product Quality
log(CHN Imports(-1)) × Laggards						
× (Declining Markup)	-1.497‡	-1.333†	-0.060	-0.127***	-0.1508***	-0.0754
	(0.911)	(0.844)	(0.086)	(0.0475)	(0.0574)	(0.0943)
Avg. elasticity (IHS variables)	*-1.497*	*-1.333*	*-0.095*	—	—	—
× (Increasing Markup)	-0.778	-0.376	0.021	-0.1079**	-0.0424	-0.018
	(0.744)	(0.694)	(0.050)	(0.0511)	(0.0398)	(0.0489)
Avg. elasticity (IHS variables)	*-0.778*	*-0.376*	*0.046*	—	—	—
log(CHN Imports(-1)) × Leaders						
× (Declining Markup)	-0.938	0.916	-0.153	-0.0794	0.0402	0.1486**
	(0.810)	(0.836)	(0.150)	(0.0713)	(0.0717)	(0.0679)
Avg. elasticity (IHS variables)	*-0.938*	*0.916*	*-0.208*	—	—	—
× (Increasing Markup)	-0.219	1.873‡	-0.071	-0.0604	0.1487*	0.2061*
	(1.276)	(1.143)	(0.179)	(0.0867)	(0.0883)	(0.1129)
Avg. elasticity (IHS variables)	*-0.219*	*1.873*	*-0.072*	—	—	—
First Stage F-Stat	7.8	7.8	7.8	7.8	7.8	10.6
Industry-year FE	yes	yes	yes	yes	yes	yes
Plant FE	yes	yes	yes	yes	yes	yes
Observations	4,692	4,692	4,692	4,692	4,692	4,335

Conclusions

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- However, we show that rents also play an important role in determining the magnitude of the impact of competition on innovation (Schumpeter's theory).
- The paper shows alternatively channels through which competition reforms can have important distributional effects by widening the profitability gap between leaders and laggards.

Appendix: Plant-prices

- We follow Eslava et al., 2013; Smeets and Warzynski, 2013; Eslava and Haltiwanger, 2017 to derive price indexes:
    1. We compute for each output and input at the plant-product-year level, the log difference of its price relative to the average industrial price for the same year.
    2. We construct a weighted average price deviation index, using plant-product revenues and expenditure shares, respectively, as weights.
    3. We add the plant-level log-deviation derived in the previous step to the average price index defined for each 4-digit ISIC sector.

Back

TFPQ Methodology

$$y_{ijct} = a_j + b_j l_{ijct} + c_j k_{ijct} + d_j m_{ijct} + tfpr_{ijct} + D_c + D_t + e_{ijt}$$

$$m_{ijct} = h\left(l_{ijct}, k_{ijct}, tfpr_{ijct}, DTA_{ijct}, ETA_{ijct}, SOEp_{ijct}, SOEc_{ijct}, D_c, D_t\right),$$

$$tfpr_{ijct} = h^{-1}\left(l_{ijct}, k_{ijct}, m_{ijct}, DTA_{ijct}, ETA_{ijct}, SOEp_{ijct}, SOEc_{ijct}, D_c, D_t\right).$$

$$\begin{aligned} y_{ijct} \quad = \quad & a_j + h^{-1}\left(l_{ijct}, k_{ijct}, m_{ijct}, DTA_{ijct}, ETA_{ijct}, SOEp_{ijct}, SOEc_{ijct}, D_c, D_t\right) \\ & + b_j l_{ijct} + c_j k_{ijct} + d_j m_{ijct} + D_c + D_t + e_{ijt}. \end{aligned}$$

$$tfpr_{ijct} = g\left(tfpr_{ijct-1}\right) + \varepsilon_{ijct}$$

$$\begin{aligned} tfpr_{ijct} \quad = \quad & \alpha_j + \rho_{j1} tfpr_{ijct-1} + \rho_{j2} tfpr^2_{ijct-1} + \rho_{j3} tfpr^3_{ijct-1} + D_c + D_t + \varepsilon_{ijct} \\ & + \Psi\left(DTA_{ijct-1}, ETA_{ijct-1}, SOEp_{ijct-1}, SOEc_{ijct-1}, tfpr_{ijct-1}\right), \end{aligned}$$

$$E\left[\varepsilon_{ijct}\left(b_{jc},\ c_{jc},\ d_{jc}\right)\begin{pmatrix} l_{ijct-1} \\ k_{ijct} \\ m_{ijct-1} \end{pmatrix}\right] = 0$$

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