Competition, Technological Investments, and Productivity

Ana Paula Cusolito (World Bank)
Alvaro Garcia (University of Chile)
William Maloney (World Bank)

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*Preliminary, Work in Progress*

Motivation

Main question:

What is the effect of competition on productivity (TFPQ) in Chile? What is the role of investments (physical and R&D related) to explain the observed effects?

Two main channels:

1) **Reallocation (between)** – more PMC encourages the exit of unproductive firms and the reallocation of resources towards the most productive firms. Aggregate efficiency increases. **Empirical support** (Pavnick 2002, Melitz 2003, Syverson 2004 and 2009 among others.

2) **Firm/plant Upgrading (within)**– more competition affect firms' incentives to invest in productivity enhancing activities to scape competition. **Theoretically ambiguous & empirically unresolved** (Aghion et al. 2005, Bloom et al 2016, Hashmi 2013, Dhyne et al 2017 among others.
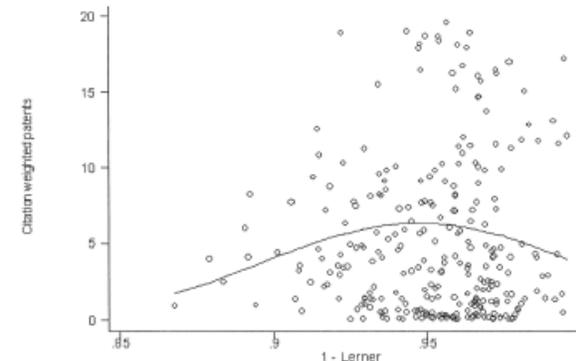
Motivation

Theoretically: ambiguous effects

1) *Competition reduces innovation efforts* – (Schumpeter 1942; Aghion & Howitt 1992)
- PCM shrink markups making more difficult to finance fixed innovation costs.
- Lower monopoly rents discourage firms to allocate efforts to innovate.

2) *Competition fosters innovative activities* – (Aghion et al., 1997, Akcigit et al., 2017)
- Incumbent firms innovate to escape competition.

3) *Heterogeneous effects* – (Aghion et al. 2005; Akcigit et al 2017)
- Key: leading versus lagging firms.

Empirically: Challenges for estimating TFPQ and identification of the innovation effects on efficiency

1) *Innovation literature: negative effect of innovation on productivity* – (Hall 2011)
- Prices are embedded in the productivity measure. Process innovation decreases prices.

2) *Productivity literature: endogeneity, selection, price biases* – (Olley and Pakes 1996, Levinson and Petrin 2003, Ackerberg, Caves and Frase 2015, De Loecker et al., 2017)

Results

❑ **Competition on Technological Innovations:**

- Downstream competition decreases overall investments (machinery, vehicles, building) and in-house R&D expenditures.
- Upstream competition increases in-house R&D expenditures.

❑ **Competition on TFPQ:**

- Output decreases but labor and materials don't adjust. Frictions.
- Downstream competition decreases productivity.

❑ **Competition on Prices, Markups, and Intermediate inputs**

- Heterogeneous effects of DPMC and UPCM on marginal costs, markups, and prices.
- DPMC reduces markups. Output decreases but firms adjust markups to minimize effects on sales. Marginal costs increases and prices, too. Input prices decreases, too (lower quality and/or effects of UPMC).
- UPMC reduces marginal costs but markups go up. Imperfect pass-through.

Literature

❑ **Competition and Productivity:**

- Pavcnik ('02), Melitz ('03), Syverson ('04), Foster et al. ('08).
- Lieeva & Trefler ('10), Bustos ('11), Impullitti & Licandro ('16).
- Bloom et al. ('12), Dhyne et al ('17), Iacovone ('12), Chen & Steinwender ('17).

❑ **Competition and Innovation:**

- Blundell et al. ('99), Aghion et al., ('05), Bloom et al. ('16), Aghion et al., ('17), Coelli et al., ('17)

❑ **Innovation on productivity**

- Hall ('11, literature review), Aghion, et al., ('09), Geroski, P. A. (1989), Griliches and Mairesse (1984), Griliches, (1998).

Data

1) TFPQ

- Annual National Industrial Survey (ENIA) covers the universe of manufacturing plants (10+).
- Panel of Chilean manufacturing plants (period 1996-2007).
- 4,800 plants p/year, 20% exporters, 2/3 of all plants are small (less than 50 employees)
- Standard plant-level information (sector, size, revenues, etc.) and (i) value and quantity of all products, (ii) variable cost for each product, and (iii) value and quantity of all inputs

2) Technological Innovation

- Annual National Industrial Survey that collects information on technological investments at the plant level.
- The combined ENIA-EIT dataset consists of 3,900 plant-year observations, which corresponds to about 20 percent of the ENIA sample for the years where EIT is available.

3) Competition

- China import penetration in the U.S. Upstream and downstream competition using input-output matrix.

Methodology

❑ **Empirical challenges (and solutions)**

▪ **Find an efficiency measure not affected by price bias**

  ▪ <u>Problem</u>: often, productivity estimations are revenue based, which means that the residual has confounded factors from the supply and the demand.

  ▪ <u>Solution</u>: construct plant-level price deflators and compute physical productivity measures (real output as dependent variable-TFPQ)

▪ **Deal with reverse causality from efficiency to PMC**

  ▪ <u>Problem</u>: import competition can be higher in sectors with TPFQ disadvantages.

  ▪ <u>Solution</u>: lagged downstream and upstream product market competition.

❑**Empirical Approach for Estimating TFP, Markups, and Marginal Costs**

▪ PF elasticities are estimated following Ackerberg et al. (2015):

  ▪ correct for endogeneity in input choice and selection

  ▪ allow productivity to be affected by previous export status (we include export dummy and dummy for investment physical capital, following De Loecker 2013)

  ▪ deals with potential misidentification of the labor coefficient in Olley Pakes (1996) and Levinsohn and Petrin (2003).

▪ Markups are estimated following De Loecker and Warzynski (2012) methodology.

Downstream and Upstream Chinese Import Penetration

BASELINE IN REGRESSIONS: U.S. IMPORTS FROM CHINA
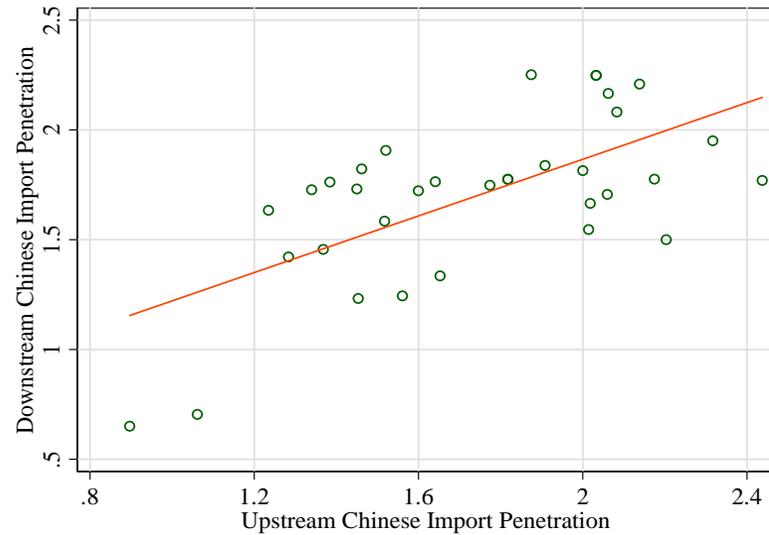
USING CHILEAN IMPORTS FROM CHINA
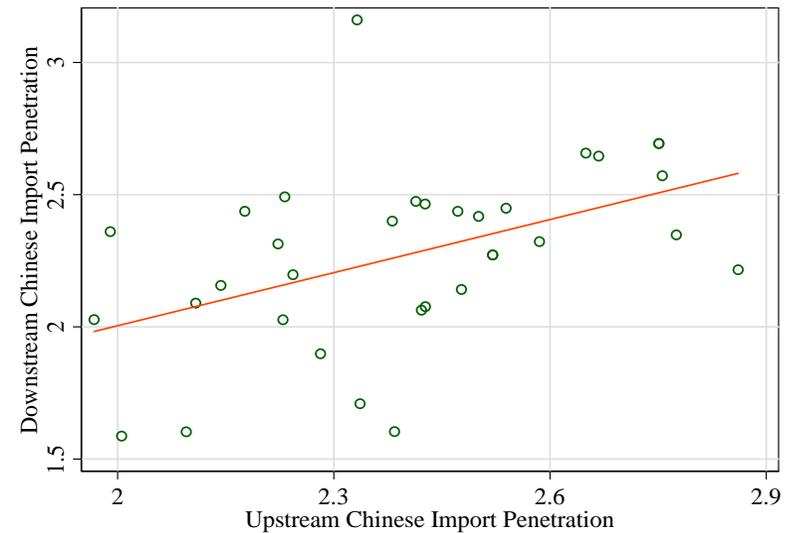
Note: Upstream and Downstream import penetration from China are computed using 1996 Chilean Input-Output matrices.

Overview: Productivity Distributions
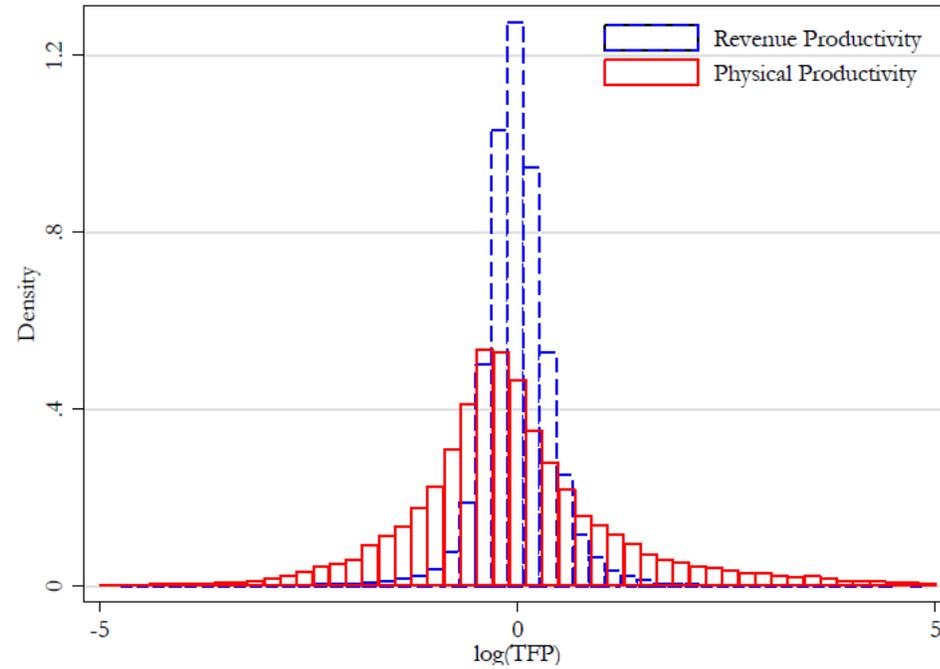
Notes: This figure shows the distribution of physical productivity and revenue productivity ("TFPR", blue-dashed bars) over a sample of 46,058 plant-year observations over 1996-2007. All variables are measured in logarithms, and are demeaned with respect to the respective (2-digit) sector-year averages.

Overview: Productivity Distributions

Correlations	Price	TFPQ	TFPR	Markup
Price	1.0000			
Physical TFPQ	−0.8737	1.0000		
Revenue TFP	0.0201	0.4432	1.0000	
Markups	0.0043	0.3895	0.8426	1.000
Standard Deviation	0.9155	1.0329	0.4927	0.5468

Notes: This table shows correlations and standard deviations for plant-level variables over 1996-2007. All variables are measured in logarithms, and are demeaned with respect to the respective sector-year averages.

❑ **Three observations**

- Strong negative correlation between TFPQ and prices
- Markup variation translates almost 1-to-1 into TFPR
- High-productivity firms charge higher markups

Results

Competition and Plants Output, Sales, Markups

	(1)	(2)	(3)	(4)	(5)	(6)
	Output	**Output**	**Sales**	**Sales**	**Markups**	**Markups**
Lagged Downstream Import Penetration	**-.513***	**-.230**	**-.196***	**-.145**	**-0.243***	**-0.108**
	(.115)	(.104)	(.0715)	(.0623)	(0.0508)	(0.0505)
Lagged Upstream Import Penetration	-.0149	-.231	-.104	-.115	**0.319***	**0.150***
	(.170)	(.179)	(.106)	(.0940)	(0.0578)	(0.0790)
log(Employment)	.496***	.491***	.515***	.514***	-0.0203***	-0.0214***
	(.0216)	(.0219)	(.0190)	(.0190)	(0.00696)	(0.00700)
Sector-year FE (1 digit)	Yes	---	Yes	---	Yes	---
Sector-year FE (2 digits)	---	Yes	---	Yes	---	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32370	32370	32370	32370	32370	32370
R-squared	.930	.929	.970	.970	0.655	0.653

Note: Standard errors in parentheses; (*): 10%, (**) 5%, and (***) 1%.

❑KEY TAKEAWAY

❑Plant's output shrinks in response to increase downstream competition.
❑Plants react by cutting markups to smooth the negative impact on sales.

❑Increased competition from China in upstream sectors shows no significant effect on output.
❑Plants do not appear to fully pass-through the lower input costs to final prices as markups go up.

Margins of plants' responses to Chinese competition: physical investments and R&D expenditures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	---------------- Physical Investment ----------------				---------------- R&D Expenditure ----------------				Input Price
	Overall	Machinery	Vehicles	Structures	Overall	in-House	Machinery	Training	
Lagged Downstream Import Penetration	**-.501***	**-.570****	-.448	-.195	-.759	**-1.560****	-1.343	-.731	**-.105***
	(.301)	(.277)	(.282)	(.299)	(1.095)	(.772)	(.976)	(.696)	(.0547)
Lagged Upstream Import Penetration	.681	.683	.627	.106	2.033	**2.874***	1.547	-1.399	.0921
	(.501)	(.459)	(.459)	(.548)	(1.926)	(1.466)	(1.868)	(1.229)	(.0991)
log(Employment)	1.319***	1.173***	.621***	.810***	.270	-.130	.453*	.0199	-.00160
	(.0923)	(.0882)	(.0724)	(.0966)	(.271)	(.210)	(.264)	(.173)	(.0109)
Sector-year FE (2 digits)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	32622	33482	32488	33922	5116	5116	5116	5116	32762
R-squared	.674	.689	.445	.572	.656	.649	.551	.573	.569

Note: Standard errors in parentheses; (*): 10%, (**) 5%, and (***) 1%.

❑ **KEY TAKEAWAY: Plants seem to cut their investment in physical capital and reduce their expenditures in R&D activities (at least in-house). In addition, there is evidence that plants purchase cheaper inputs.**

Another mechanism for adjustment?...Frictions

	1-digit sector				2-digit			
	Output	**Capital Stock**	**Materials Expenditure**	**Labor**	**Output**	**Capital Stock**	**Materials Expenditure**	**Labor**
Lagged Downstream Import Penetration	-.513***	-.129*	0.0481	0.0542	-.230**	-.127***	-0.0223	0.0277
	-0.115	-0.066	-0.0957	-0.0347	-0.104	-0.045	-0.0754	-0.0333
Lagged Upstream Import Penetration	-0.0149	-0.0444	-.346**	.126***	-0.231	0.0033	-.227*	.104**
	-0.17	-0.0996	-0.162	-0.0403	-0.179	-0.0739	-0.128	-0.0416
log(Employment)	.496***	.272***	.550***	---	.491***	.273***	.550***	---
	-0.0216	-0.0181	-0.0215		-0.0219	-0.018	-0.0215	
log(sales)	---	---	---	.306***	---	---	---	.304***
				-0.0114				-0.0115
Sector-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

❑ **KEY TAKEAWAY: No adjustment in variable inputs. Output decreases but labor and materials don't change. Frictions! …However, some effects on the capital stock.**

Plants' performance margins and Chinese competition

	1-digit					2-digit				
	TFPQ	**TFPR**	**Output Price**	**Marginal Cost**	**Markup**	**TFPQ**	**TFPR**	**Output Price**	**Marginal Cost**	**Markup**
Lagged Downstream Import Penetration	**-.348***	**-.194***	**.317***	**.560***	**-.247***	**-.196***	**-.108**	**.0847**	**.192**	**-.112**
	(.0676)	(.0430)	(.0731)	(.0989)	(.0499)	(.0609)	(.0452)	(.0579)	(.0893)	(.0520)
Lagged Upstream Import Penetration	.331***	.132***	-.0896	**-.408***	**.301***	.130	.0749	.116	-.0340	**.159***
	(.123)	(.0460)	(.124)	(.146)	(.0560)	(.111)	(.0692)	(.119)	(.171)	(.0855)
log(Employment)	-.171***	-.128***	.0189*	.0392***	-.0242***	-.173***	-.130***	.0231**	.0445***	-.0257***
	(.0141)	(.00798)	(.0102)	(.0125)	(.00702)	(.0140)	(.00816)	(.0105)	(.0129)	(.00712)
Sector-year FE	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Plant FE	Yes	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes
Observations	30161	34435	32370	32370	34809	30161	34435	32370	32370	34809
R-squared	.806	.901	.630	.626	.649	.806	.900	.630	.625	.647

Note: Standard errors in parentheses; (*): 10%, (**) 5%, and (***) 1%.

❏ **KEY TAKEAWAY: Downstream competition affects negatively plants efficiency .**
❏**TFPQ goes down, Marginal Costs goes up.**
❏**Output prices increase but to a lower extent than marginal costs.**
❏**TFPR decreases due mainly due to TFPQ, as prices move in the opposite direction.**

Conclusions

❑ This paper explores the effect of DPMC and UPMC on physical productivity through the investment channel.

❑ Reductions in TFPQ are mainly explained by the reduction in physical investments and in-house R&D expenditures, as well as frictions that impede the adjustment of labor and materials.

❑ Upstream competition is less intense, though has a positive effect on in-house R&D expenditures.

❑ Reductions in marginal costs due to cheaper intermediate inputs are imperfectly pass-through to prices.

❑ **Next steps**: explore heterogeneity of results depending on:

❑ Position in the value chain.

❑ Firm performance: laggard versus leaders

❑ Financially dependency